DEVELOPING AND IMPLEMENTING STEAM PEDAGOGY AT THE BASIC LEVEL: A STUDY THROUGH PARTICIPATORY ACTION RESEARCH IN NEPAL

Binod Prasad Pant

A Thesis

Submitted to
School of Education

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

Kathmandu University
Dhulikhel, Nepal

December 2024

AN ABSTRACT

of the thesis of *Binod Prasad Pant* for the degree *Doctor of Philosophy in Education* presented on 29 December 2024 entitled *Developing and Implementing STEAM Pedagogy at the Basic Level: A Study through Participatory Action Research in Nepal*

APPROVED BY

……..

Prof. Bal Chandra Luitel, PhD

Thesis Supervisor

……..

Prof. Sigrid Gjøtterud, PhD

Thesis Supervisor

……..

Assoc. Prof. Birgitte Bjønness, PhD

Thesis Supervisor

The issue of quality in school education in Nepal is discussed from the perspective of disengaged pedagogical approaches and an expert-driven teacher professional development modality. The arguments have been made from different angles, such as insufficient budgets, school governance, content-driven curricula, and teachers' inadequate skills and attitudes to develop and implement innovative pedagogical practices. One of the major challenges in school education is the overemphasis on knowledge reproduction rather than promoting knowledge production, which limits teachers' professional development and hinders students' holistic development. Focusing on rote memorization, this cognitive-centered approach fails to recognize children as holistic beings. Moreover, unsatisfactory student performance at the national level, particularly in mathematics and science subjects, has been indicated the inadequate performance of schools in Nepal. In this context, I planned to act as a

change agent in the school, working closely with the school teachers and community members. After several rounds of field visits, I developed a research proposal to make sense of the problems, negotiate, and establish a common goal for the actions.

This study aimed to explore innovative pedagogies, specifically STEAM-based approaches, to enhance teacher and student learning at the basic levels (grades 1-8). It also aimed to reflect on the lead researcher's professional development within the participatory action research (PAR) context. The study addresses two main research questions: 1. How do co-researchers develop and implement STEAM-based pedagogical approaches to promote students' learning at the basic school education level? 2. How do I, as the lead researcher, reflect on my professional development as a practitioner-researcher during and after the implementation of STEAM pedagogy in schools? I also developed four subsidiary research questions from the first primary research question, focusing on inquiry-based activities, promoting multi- and interdisciplinary learning, and fostering innovative STEAM projects.

The nature of the research issues demanded a multi-paradigmatic transformative research perspective, incorporating paradigms such as *Praśna* (i. e., questioning), *Karma* and *Dharma* (i.e., action and ethical responsibility), *Arthā* (i. e., meaning-making), *Kalā* (i. e., aesthetic and creative expression), and *Moksha* (i. e., liberation through awareness of everyday actions). The study was conducted in collaboration with teachers in schools in Kavre district, Nepal. The study followed three cycles of action and reflection. During the research journey, STEAM education was viewed from the lens of both Eastern and Western wisdom traditions. In the Eastern wisdom tradition, I used some concepts of Vedic tradition, such as *Śāstrārtha*, a debate that continues with arguments and counter-arguments with intellectual rigor and influential ability. I have used this concept during my field engagements with my co-researchers to discuss how the inquiry was implemented in the Eastern wisdom tradition. During the fieldwork and after the completion of each cycle, we had reflection sessions to critically reflect on the ongoing actions and generate the needs for the next cycle.

The key realizations from this research journey were as follows: a) Teachers' involvement in the entire journey of designing and implementing different pedagogical approaches challenged their limiting beliefs (e.g., experts should develop materials, and we, as teachers, are the consumers of the knowledge), leading them to take the initiative to create and apply innovative pedagogical approaches. b) The

students' active participation during the project implementation expanded their reflective, critical, and ethical understanding of the subject matter. c) As the lead researcher, I critically analyzed my roles and contributions in my professional communities. This included sharing my insights from this research journey through conference presentations, collaborating with various government bodies, and taking the initiative to update courses and introduce new programs at the university where I was associated. I do not claim that all of these contributions were possible due to this research study. But, I am mindful that my field experience influenced all the contributions I presented in this study as a PAR researcher.

In this research, we also made a theoretical and methodological contribution, such as a) PAR is like *Chautari* (a communal space for reflection and action); b) STEAM is rooted in the Gurukul Education System and is similar to *Pancha Tattva*.

…… 29 December 2024

Binod Prasad Pant

Degree Candidate

शोध सार

स्टिम शिक्षाको विद्यावारिधिको लागि विनोद प्रसाद पन्तको शोध प्रबन्धको शिर्षक *"आधारभूत तहमा स्टिम शैक्षणिक विधिको विकास र कार्यान्वयन : नेपालमा सहभागितामूलक कार्य अनुसन्धानमा आधारित अध्ययन" १४ पौष २०८१* मा प्रस्तुत गरिएको थियो ।

.....

प्रा. बालचन्द्र लुइटेल, पिएचडी
शोध निर्देशक

.....

प्रा. सिग्रिड जोटेरड, पिएचडी
शोध निर्देशक

.....

सह-प्राध्यापक बिरगिट जोनेस, पिएचडी
शोध निर्देशक

नेपालको विद्यालय शिक्षाको गुणस्तरका विषयमा छलफल हुँदा सिकारुलाई सिकाइमा संलग्न नगराउने ढाँचाको शैक्षणिक विधि र विज्ञद्वारा निर्देशित हुने खालको शिक्षकको पेशागत विकासको प्रारूपका दृष्टिकोणबाट छलफल हुने गर्छ । बजेटको कमी, विद्यालय प्रशासन, विषयवस्तु निर्देशित पाठ्यक्रम र नवीनम् शैक्षणिक अभ्यासको विकास तथा कार्यान्वयनका लागि शिक्षकमा सीप एवम् अभिवृत्तिको अपर्याप्तता लगायतका कोणबाट तर्क-वितर्क गरिन्छ । विद्यालय शिक्षाको एउटा मुख्य चुनौती भनेको ज्ञान निर्माणमा भन्दा ज्ञान पुनःर्निमाणमा अत्याधिक जोड दिनु हो र यो प्रवृत्तिले एकातिर शिक्षकको पेशागत विकासलाई कुण्ठित बनाएको छ भने अर्कोतिर विद्यार्थीको समग्र विकासमा बाधा पुऱ्याएको छ । घोकेर स्मरण गर्ने खालको सिकाइमा जोड दिने यस प्रकारको संज्ञानात्मकमुखी विधिले विद्यार्थीलाई समग्र मानवका रूपमा आत्मसात् गर्न सक्दैन । विशेषगरी राष्ट्रिय स्तरमा गणित र विज्ञान विषयमा विद्यार्थीको शैक्षिक उपलब्धि कमजोर देखिनुले नेपालको विद्यालय शिक्षामा प्राप्त प्रगति सन्तोषजनक नभएको प्रष्ट हुन्छ । यसै सन्दर्भमा, मैले विद्यालयका शिक्षक र समुदायका सदस्यसँग घनिष्ट सहकार्य गरी विद्यालय शिक्षामा परिवर्तनको बाहक बन्ने योजना बनाएँ । मैले विभिन्न चरणमा स्थलगत भ्रमण गरी समस्या

पहिचान गरेँ र छलफलका माध्यमबाट साझा कार्यमुलक उद्देश्य निर्धारण गरी एउटा अनुसन्धान प्रस्ताव तयार पारेँ ।

यो अध्ययनको उद्देश्य आधारभूत तह (कक्षा १ देखि कक्षा ८ सम्म) मा शिक्षक र विद्यार्थी दुवैको शिक्षण-सिकाइ वृद्धिका लागि विशेषत: स्टिममा आधारित नवीनतम् शैक्षणिक विधिको खोजी गर्ने हो । यसले सहभागितामूलक कार्य अनुसन्धानको परिधिभित्र रही अनुसन्धाताको पेशागत विकासमाथि समेत पुनरावलोकन गर्ने लक्ष्य राखेको थियो । यो अध्ययनले दुईवटा मुख्य प्रश्नलाई सम्बोधन गरेको : १. सह-अनुसन्धाताले आधारभूत विद्यालय शिक्षामा विद्यार्थीको सिकाइ प्रवर्द्धनका लागि कसरी स्टिममा आधारित शैक्षणिक विधिको विकास र कार्यान्वयन गर्छन् ? २. मुख्य अनुसन्धाता भई विद्यालयमा स्टिममा आधारित शैक्षणिक विधिको कार्यान्वयन गर्ने क्रममा र कार्यान्वयनपश्चात् एउटा अनुसन्धानकर्मीका हिसाबले मैले आफ्नो पेशागत विकासलाई कसरी चिन्तन तथा पुनरावलोकन गर्छु ? मैले खोजमूलक कार्यमा जोड दिने, बहु तथा अन्तर्विषयक सिकाइलाई प्रवर्द्धन गर्ने र नयाँ स्टिम परियोजनालाई सबल बनाउने गरी मुख्य अनुसन्धान प्रश्नअन्तर्गत चारवटा सहायक प्रश्नहरू समेत तयार पारेको थिएँ ।

अनुसन्धान मुद्दाहरूको प्रकृतिले यो अनुसन्धानले प्रश्न, कर्म तथा धर्म, अर्थ, कला (सौन्दर्यता र सिर्जनात्मक अभिव्यक्ति) र मोक्ष (दैनिक क्रियाकलापमाथिको सचेतनामार्फत् मुक्ति) जस्ता आयामहरूलाई समेटी बहु-प्रायोगिक रूपान्तरणमुखी अनुसन्धानको दृष्टिकोण (Multi-Paradigmatic Transformative Research Perspective) को माग गरेको थियो । नेपालको काभ्रे जिल्लाका विद्यालयका शिक्षकसँगको सहकार्यमा यो अध्ययन गरिएको हो । यस अध्ययनका क्रममा कार्य र पुनरावलोकनका ३ वटा चक्र अनुशरण गरिएको थियो । अध्ययन भ्रमणका क्रममा पूर्वीय र पाश्चात्य दुवै ज्ञान परम्पराको दृष्टिकोणबाट स्टिम शिक्षालाई हेरिएको थियो । मैले पूर्वीय ज्ञान परम्पराअन्तर्गत वैदिक परम्पराका शास्त्रार्थ अर्थात् बौद्धिक ऊर्जा, प्रभाव क्षमता र तर्क-वितर्कजस्ता केही अवधारणाहरू प्रयोग गरेको थिएँ । मैले पूर्वीय ज्ञान परम्परामा कसरी खोजमूलक अनुसन्धान हुने गर्छ भनेर छलफल गर्नका लागि आफ्ना सह-अनुसन्धातासँगको स्थलगत कार्यका क्रममा यो अवधारणा प्रयोग गरेको थिएँ । हामीले स्थलगत कार्यका क्रममा र हरेक चक्रको अन्त्यमा पुनरावलोकन सत्र सञ्चालन गरेर आफ्ना कामको आलोचनात्मक समीक्षा र त्यसपछाडिका आवश्यकता निर्धारण गरेका थियौँ ।

उक्त स्थलगत भ्रमणबाट प्राप्त प्रमुख सिकाइहरू यस प्रकार छन् : क) विभिन्न शैक्षणिक विधिको विकास र कार्यान्वयनको समग्र प्रक्रियामा शिक्षक संलग्न हुँदा उनीहरूले आफ्ना संकुचित धारणामाथि प्रश्न गरे (जस्तै, शिक्षण सामग्रीको निर्माण विज्ञले गर्ने र हामी शिक्षकले ज्ञानको प्रयोग मात्रै गर्नुपर्ने धारणा), र फलस्वरूप शिक्षकले नवीनम् शैक्षणिक विधिको विकास तथा प्रयोगका लागि अग्रसरता देखाए, ख) परियोजना कार्यान्वयनका क्रममा विद्यार्थीको सक्रिय सहभागिताले गर्दा उनीहरूमा विषयवस्तुमाथि चिन्तन गर्दै आलोचनात्मक सोच र नैतिक जिम्मेवारीसहित विषयवस्तु बुझ्न खोजे, ग) मुख्य अनुसन्धाताका रूपमा मैले मेरो पेशागत क्षेत्रमा आफ्नो भूमिका र योगदानलाई आलोचनात्मक रूपले विश्लेषण गरेँ । यसअन्तर्गत मैले यस अनुसन्धानको यात्राबाट प्राप्त सिकाइहरूलाई विभिन्न

सरकारी निकायसँग सहकार्य गरी सम्मेलनहरूमा प्रस्तुत गरेँ भने म आबद्ध विश्वविद्यालयको कोर्स अद्यावधिक गर्ने तथा नयाँ कार्यक्रमक थालनीको पहल गरेँ । यी सबै काम उक्त अनुसन्धान कार्यका कारण सम्भव भएको भन्ने मेरो दाबी त होइन, तर सहभागितामूलक कार्यमूलक अनुसन्धाताका रूपमा यस अध्ययनमा मैले प्राप्त गरेका स्थलगत अनुभवले मेरा यी काममा प्रभाव पारेका छन् भन्ने कुरामा म ढुक्क छु ।

यो अनुसन्धानमार्फत् हामीले अनुसन्धानका सिद्धान्त र विधिमा समेत केही नयाँ कुरा थप गरेका छौँ जस्तै (क) सहभागितामूलक कार्य अनुसन्धान एउटा चौतारीजस्तै हो, जहाँ गाउँलेहरू बसेर चिन्तन, छलफल गरी काम गर्छन्, र ख) स्टिम विधिको जरा गुरुकूल शिक्षा प्रणालीसँग जोडिएको छ र यो पञ्च तत्वजस्तै हो ।

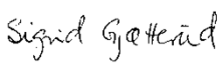
..... १४ पौष २०८१

विनोद प्रसाद पन्त

विद्यावारिधि शोधकर्ता

This thesis entitled *Developing and Implementing STEAM Pedagogy at the Basic Level: A Study through Participatory Action Research in Nepal presented by* Binod Prasad Pant on 29 December 2024.

APPROVED BY



……. 29 December, 2024
Prof. Sigrid Gjøtterud, PhD
Thesis Supervisor

……. 29 December, 2024
Assoc. Prof. Birgitte Bjønness, PhD
Thesis Supervisor

……. 29 December, 2024
Prof. Nick Hopwood, PhD
External Examiner

……. 29 December, 2024
Prof. Bhim Prasad Subedi, PhD
External Examiner

……. 29 December, 2024
Prof. Bal Chandra Luitel, PhD
Thesis Supervisor/Dean/Chair, Research Committee

I understand and agree 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.

……. 29 December, 2024
Binod Prasad Pant
Degree Candidate

© Copyright by Binod Prasad Pant
2024
All rights reserved.

DECLARATION

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

……. 29 December, 2024

Binod Prasad Pant

Degree Candidate

DEDICATION

To all co-researchers who made this journey possible.

ACKNOWLEDGEMENTS

I am grateful to Janahit School and the entire school community, as this study would not have been possible without their support and participation. I am thankful to the NORHED Rupantaran initiative and the people involved in it. I wholeheartedly thank my supervisors, Prof. Dr. Bal Chandra Luitel, Prof. Dr. Sigrid Gjøtterud, and Assoc. Prof. Dr. Birgitte Bjønness, for their continuous support and encouragement. I would like to express my gratitude to all research committee members, Prof. Dr. Mana Prasad Wagley, Prof. Dr. Jai Rai Awasthi, Prof. Dr. Mahesh Nath Parajuli, Prof. Dr. Laxman Gnawali, Prof. Dr. Hem Raj Kafle, Prof. Dr. Prakash C, Bhattarai, Prof. Dr. Dhanapati Subedi, Dr. Lava Deo Awasthi, Dr. Tikaram Poudel, Dr. Shesha Kanta Pangeni and Dr. Suresh Gautam for their constructive feedback to shape my doctoral thesis.

I am thankful to both external examiners, Prof. Dr. Nick Hopwood and Prof. Dr. Bhim Prasad Subedi, for their extensive review of the thesis. Similarly, I would like to take this opportunity to thank Prof. Dr. Lekhnath Sharma for the feedback on the document. I also thank Dr. Shree Krishna Wagle and Dr. Parbati Dhungana for their valuable input on the draft of the thesis. I thank all the STEAM Education department faculty members, Asst. Prof. Indra Mani Shrestha, Asst. Prof. Roshani Rajbanshi, PhD. Lecturer Niroj Dahal and Lecturer Netra Kumar Manandhar.

I take this opportunity to remember the faculties and staff of Kathmandu University School of Education who encouraged me in this journey. I thank Mr. Purushottam Ghimire, who helped me understand the different ideas of Eastern wisdom traditions.

I extend my heartfelt gratitude to my family members: father Gunanidhi Pant, mother Ishowri Pant, wife Usha Pandey, and two children, Bibek and Bibisha, for their unconditional love and care.

Binod Prasad Pant
Degree Candidate

TABLE OF CONTENTS

ACKNOWLEDGEMENTS i
TABLE OF CONTENTS ii
GLOSSARY vi
ABBREVIATIONS vii
LIST OF FIGURES ix
CHAPTER I 1
SETTING THE CONTEXT 1
How Did I Come to Join the Research Team? 1
Disciplinary Egocentrism in School-Level Curriculum 2
Disengaged Science and Mathematics Teaching 4
My Preliminary Visits to the Research Site 5
Myself and STEAM Education 6
Rationale for the Study 8
Statement of the Problem 9
Purpose of the Study 11
Research Questions 12
Significance of the Study 12
Structure of the Thesis 13
CHAPTER II 14
SITUATING MYSELF IN THE FIELD 14
Inquiry-Based Learning 14
Different Facets of STEAM Education 16
STEM: A Workforce Development Paradigm 16
Technology in STEAM Education 18
STEAM Education from Critical Theory Lens 20
STEAM Education as Transformative Perspective 21
Design Thinking in STEAM Pedagogy 23
STEAM Education from the Eastern Perspectives 25
STEAM Education in Nepal 26
Theoretical Lenses: Experiential and Transformative Learning 28
Review of Previous Studies 30
Chapter Summary 36
CHAPTER III 38

MAPPING MY RESEARCH JOURNEY 38
Axiology: Valuing Participation 38
Epistemology: Co-constructed Knowledge 39
Ontology: Transformative Being 39
Philosophical Mapping: Multi-paradigmatic PAR 40
Praśna Paradigm 42
Karma and Dharma Paradigm 43
Arthā Paradigm 44
Kalā Paradigm 44
Moksha Paradigm 45
PAR as Chautari 46
Methodological Mapping 47
Research Site and Co-researchers 47
Needs Identification 48
Collaborative Actions 49
Nature of "Data" and Generation Process 52
Meaning Making of the Actions and Reflections 53
Ensuring Quality in Research 54
Critical Reflexivity 54
Praxis 55
Pedagogical Thoughtfulness 56
Maintaining Ethics in PAR 56
Chapter Summary 57
CHAPTER IV 58
EXPLORING NEEDS OF CO-RESEARCHERS 58
What an Excitement! No… No… It's Fear, too! 58
It's time to Explore Our Needs! 62
Students are Demotivated! Let's Become Artistic Teachers! 67
We Heard about Integrated Curriculum: It's Better to Begin from There 71
Consolidating the Needs! Now, it's our Needs! We are in the same boat! 73
Chapter Summary 76
CHAPTER V 77
JOURNEY TOWARD DEVELOPING AND IMPLEMENTING INQUIRY-BASED LEARNING RESOURCES 77
Do Students Inquire about Knowledge and Skills? 77

Let's Begin with Inquiry-based Activities in the Early Grades! 84
Socratic Model of Questioning and *Śāstrārtha*: Inquiry-Based Approach 87
Is Inquiry-based Learning Useful in the Higher Grades? 92
IBL is Useful in Higher Grades, Too! 97
Mathematics and Scientific Knowledge are like facts! But also, we used IBL! 98
IBL Seems more Appropriate in Social Science! 100
IBL in my Language Class: A Great Experience! 101
Chapter Summary 105
CHAPTER VI 106
JOURNEY TOWARD MULTI/INTERDISCIPLINARY ACTIVITIES/PROJECTS 106
What Went Well and Where Are We Now? 106
What do Inter and Multidisciplinary Activities and Projects Mean to Us? 107
Multidisciplinary and Interdisciplinary Curriculum and Pedagogy 111
It's COVID Time! Let's Develop IT Skills and Develop Resource Materials 113
Teachers' Competencies in IT Skills 114
Teachers' Engagement in Project Development 116
Designing and Implementing Multidisciplinary Activities and Projects 119
Plants and Their Characteristics 123
Let's Gather to Develop Games 125
Multidisciplinary and Interdisciplinary Discourses in Education 127
Chapter Summary 131
CHAPTER VII 132
JOURNEY TOWARD TRANSFORMATIVE STEAM PROJECTS 132
Time and Gender Issues: Why Don't You Cook Food, Dear Father? 132
Profit And Loss: Is It Ethical to Make This Profit? 137
Journey of Vegetables from Farmer's Land to the Kitchen of Kathmandu Valley 149
No Soil, No Problems: Do Plants Grow Without Soil? 150
Save the Species: I Keep Water Plates on the Roof for the Birds 155
Transformation is Thinking 161
Transformation is a Conscious Attempt 164
Transformation is a Process 165
Transformation is a Product 166
Transformation is a Basis for Sustainability 168

Chapter Summary....170
CHAPTER VIII....171
CONTRIBUTIONS TO THE PROFESSIONAL COMMUNITY: A LEAD RESEARCHER'S SPACES....171
"Expert I" Transformed into "Co-Learner I"....171
Self into "Conscious Self" and Us....173
Different Layers of Participation: Ignoring to Autonomous....174
Ignoring....174
Agreed But No Action....175
Other-directed Participation....175
Autonomous Participation....176
"Communification" of Research through Transformative Approaches....178
Contributions to the Government Bodies....182
STEAM Education in Educational Training Centre (ETC)....183
STEM/STEAM Education in CEHRD....184
Action Research Curriculum in CEHRD....187
STEM/STEAM Education in the Provincial Government....189
STEAM Education in the Local Level Government....192
My Contributions to the National and International Conferences....193
Influence of My Research Journey to the University....199
Chapter Summary....200
CHAPTER IX....202
REFLECTING THE CONTRIBUTIONS AFTER THE COLLABORATIVE FIELD ENGAGEMENT....202
PAR Journey Ignited Fire in Our Minds....202
PAR Journey's Contributions to Developing, Implementing, and Sharing Resource Materials....203
Community Connection in PAR Journey....205
PAR as *Chautari* and Collaboration is Rooted in Vedic Tradition....206
Pancha Tattva and Gurukul as an Epistemology in STEAM Education....209
Implications of the Study....212
Limitations of the Study....214
Coda....215
REFERENCES....217

GLOSSARY

Alaya	place where something is available
Ardhanarishwor	Symbolizes the cosmic order's unity and complementarity of the divine masculine and feminine
Arthā	meaning-making process of the hidden truths
Ashtavakra	A sage in Hindu tradition for his teaching on self-realization
Bar	A sacred tree in Hindu culture representing strength and shelter
Chautari	A place under the tree built to rest during a walk or for gathering to discuss some social issues.
Dharma	provides guidance for properly performing karma
Guru	A teacher who imparts wisdom, knowledge, and enlightenment in Eastern wisdom
Gyan	wisdom often refers to spiritual or philosophical understanding
Kalā	aesthetic ways of expressions
Karma	action done by the doer in anticipation of movement or achievement
Moksha	liberation being aware of the everyday actions
Pancha Tattva	Five fundamental elements (i.e., earth, water, fire, air, sky) that formed the universe.
Pipal	A sacred tree in Hindu culture symbolizing wisdom and long life
*Pragya*higher	wisdom that transcends intellectual knowledge
Praśna	Asking questions to self, others, and context
Śāstrārtha	Discussion for intellectual engagement, allowing participants to explore and interpret sacred texts, philosophical concepts, historical events, and other scholarly studies
Satya	truth
Shishya	A learner who learns under the guidelines of Guru
Vidhya	knowledge with wisdom
Vidyalaya	place of wisdom
Vidyalaya	A place for developing and practicing knowledge (like schools)

ABBREVIATIONS

CARN	Collaborative Action Research Network
CDC	Curriculum Development Centre
CHERD	Center for Education and Human Resource Development
COVID -19	COronaVIrus Disease of 2019
DT	Design Thinking
ECD	Early Childhood Development
ERO	Education Review Office
ESD	Education for Sustainable Development
ETC	Educational Training Centre
HT	Head Teacher
IBL	Inquiry-Based Learning
ICT	Information and Communication Technology
KMC	Kathmandu Metropolitan City
KUSOED	Kathmandu University School of Education
MEd	Master of Education
MKO	More Knowledgeable Others
MoE	Ministry of Education
MoEST	Ministry of Education, Science and Technology
MPhil	Master of Philosophy
NGSS	The Next Generation Science Education Standards
NORHED	Norwegian Programme for Capacity Building in Higher Education and Research for Development
PTA	Parent Teacher Association
PAR	Participatory Action Research
PBL	Problem-Based Learning
PGDE	Post Graduate Diploma in Education
PhD	Doctor of Philosophy
SBP	Sustainable Backpack Program
SDG	Sustainable Development Goals
SMC	School Management Committee
SSRP	School Sector Reform Plan

STEAM	Science, Technology, Engineering, Arts, Mathematics
STEM	Science, Technology, Engineering, Mathematics
TERSD	Transformative Education Research and Sustainable Development
TPACK	Technological Pedagogical Content Knowledge
TPD	Teacher Professional Development
TVET	Technical and Vocational Education and Training
UNESCO	United Nations Educational, Scientific and Cultural Organization
WMW	Western Modern Worldview

LIST OF FIGURES

Figure 1 School Setting……....2
Figure 2 A drawing to Demonstrate Praśna as a Paradigm……42
Figure 3 Chautari Drawing…….46
Figure 4 The Timeline of Field Engagement in the Schools……..52
Figure 5 Socratic Model of Questioning Drawing…….87
Figure 6 Śāstrārtha Demonstration Drawing …….88
Figure 7 A teacher-made Resource for Mathematics Teaching……..…98
Figure 8 A Student's Engagement in the Classroom…….……99
Figure 9 A Virtual Meeting with Teachers during COVID…….……113
Figure 10 Teachers' Reflection in the Virtual Workshop…….…...114
Figure 11 An Email Communication with the Teachers …….…….....117
Figure 12 Teachers' Engagement in a Workshop……..…..125
Figure 13 Teacher-made Jigsaw ……..…..….126
Figure 14 STEAM Education at Janahit (Made by teachers) ……..142
Figure 15 Members of Janahit STEAM Club ……..……151
Figure 16 A Prototype of a Tree Using Design Thinking ……...152
Figure 17 Students' Engagement in *No Soil No Problems* Project ……...153
Figure 18 Students' Engagement in Designing Bird Habitats …….……..156
Figure 19 Refined Birds' Habitats in the *Save the Species* Project …….157
Figure 20 Students' Exploration in the Birds' Habitats ……..158

CHAPTER I
SETTING THE CONTEXT

This chapter presents how my research agenda emerged. For this, I discuss the context of my study, my personal and professional standpoints, my dilemmas and prospects, my strengths, and my positionality as a researcher. The chapter unfolds my research space and educates readers on my research area and researcher position.

How Did I Come to Join the Research Team?

My dream was to be a PhD student at a reputed university. I also wanted to contribute to the educational area by doing action-driven fieldwork. Working as a school teacher for over a decade and a teacher educator at the university for another decade, I have developed the confidence and courage to contribute to the school system. I was interested in working in the pedagogical aspect and teacher professional development. This became possible when I got an opportunity to be connected as one of the members of the Rupantaran initiative of Kathmandu University School of Education. The NORHED Rupantaran initiative supported this study at Kathmandu University. This initiative seeks to improve the quality of basic education teaching and learning in Nepal through contextualized pedagogical approaches. In addition, the initiative enhances the capacity of Kathmandu University and Tribhuvan University to develop contextualized educational programs. The project's primary objective is to pilot groundbreaking approaches in diverse school settings to enhance education, health, and livelihood opportunities.

In addition, it continues to support teacher educators to develop their professional competencies. This initiative includes marginalized groups in all project-related activities, enhancing Tribhuvan University's and Kathmandu University's capacity to carry out thorough research that guides the creation of policies and maintaining ongoing interactions with important stakeholders in order to expand promising models for enhancing teaching and learning outcomes in Nepal. This is designed to serve as an example and involve teachers and students in significant, long-term projects to enhance classroom teaching techniques. This approach serves as a paradigm for successful social entrepreneurship, enhances health and education outcomes, and has a definite multiplier effect. Reference and action schools are the two categories identified by the research team. The four reference schools would

receive a delayed intervention based on the action school's outcomes. The action school was at the core of the implementation site where project activities were concentrated. The name of the action school is Janahit Secondary School, located in Namobouddha Municipality – 07, Dharmashala. This school is around 48 kilometers east-north of Kathmandu, the capital city of Nepal. The four reference schools are in the same municipality. The names of the schools are Shree Dapcha Secondary School, Shree Saraswati Primary School, Shree Nabin Primary School, and Shree Kali Ganga Primary School.

Figure 1

School Setting

(Source: field work)

The most notable part of this initiative was to bring changes to the school system with the close participation of the teachers, students, and community members (see Chapter III for the details of the methodology part). The collaborative knowledge generation was the most appealing aspect for me. So, I wholeheartedly joined the team as a doctoral student.

Disciplinary Egocentrism in School-Level Curriculum

It is widely discussed that schoolteachers in Nepal usually teach different content under several subjects. The school assigns different teachers to teach different subjects. The curriculum appears largely aligned with the notion of *curriculum as subject matter* (Schubert, 1986) in the Nepali context. The purpose of such a notion of curriculum is to help students achieve subject-specific learning objectives and have very limited skills in dealing with real-world problems. The different subjects (e.g., English, Mathematics, and Science) are drawn from different disciplines. In doing so, the subject teacher is bound to teach the subject matter of his/her discipline. On a single day, the students have to make different journeys with teachers of different disciplinary mindsets. Such a seemingly different journey could hinder rich learning experiences among school students. Normally, the students are encouraged to memorize the information and demonstrate the limited skills to solve routine kinds of problems, thereby producing a procedural understanding of the subject matter (Baker

et al., 2004). Such practices created disciplinary egocentrism in the long run. Disciplinary egocentrism is a state of thinking and performing certain tasks where a person is hegemonized with the particular disciplinary knowledge system and ways of developing such knowledge (Connor et al., 2015) among students and teachers that generally does not allow them to think outside their disciplines. Multidisciplinary and unconventional approaches to knowledge and performance are not welcome in such a setting.

As mentioned in the National Education Framework (Ministry of Education [MoE], 2007) and National Curriculum Framework 2018, as indicated in the integrated curriculum (Curriculum Development Center [CDC], 2019), school education has envisaged producing creative and critical citizens who can solve real-world problems. Real-world problems require knowledge and skills from multiple disciplines. For example, if a student is asked to develop a model of a house, she/he has to use various knowledge and skills from different subject areas – designing ideas from engineering perspectives, taking the measurement of different parts, and calculating them by using mathematical knowledge and skills, using different available materials from the perspectives of contemporary society, being aware of strength and security from scientific perspectives and more than that, bringing uniqueness and creativity from the artistic perspectives. Our school education culture, which is referred to as the grammar of schooling (Tyack & Tobin, 1994), has been neglecting to develop such a holistic perspective, which is essential in the personal, social, and professional worlds.

Another issue in Nepali mathematics and science curricula is the decontextualization of teaching and learning approaches. It is widely discussed that school-level mathematics and science have to be embedded with cultural knowledge and practices (Luitel, 2013; Rosa & Orey, 2010). The cultural setting can be used as a *bridge* for bringing differing mathematical worlds together and showing relationships among those different worlds to develop the ideas of mathematics, which is a cultural construction where the students have been practicing different knowledge and skills since their birth (Luitel & Taylor, 2007) Such bridges can be rich connectors to make a strong relation between students' world and the world of formal schooling. Isozaki (2014, as cited in Isozaki, 2024) stated that Japan redefined the concept of science education by integrating Japan's social and cultural context during the late 19th century. In the Japanese language, *rika* represents science education, which is

different from the Western construct of science education. It emphasizes theoretical science education ideas and fosters scientific curiosity from a young age by cultivating inquiry-based learning. *Sansu*, mathematics education in Japan, aims to develop mathematical skills through practical applications and visualizations.

Disengaged Science and Mathematics Teaching

In this section, I discuss why mathematics and science teaching approaches are more disengaged and disempowering, focusing on transferring official knowledge as the ultimate truth. In my context, the overemphasis on rote learning and ready-made problem-solving strategies have been considered the core pedagogical approach.

Elsewhere, Nepali educators Luitel (2009, 2013, 2019) and Pant (2015, 2017, 2019) have illuminated the issues of mathematics teaching, which are more disengaged in nature. Going back to the needs of subjects like mathematics and science education in school, the Ministry of Education (MoE) has repeatedly documented (such as the School Sector Reform Plan [SSRP] 2009-2015, School Sector Development Plan [SSDP] 2016-2023) that mathematics and science are the foundations for other subjects that should make students able to solve life-related problems. There are several reasons for considering those disciplines as a basis for other disciplines. Mathematics is taken as a universal language (Hoffert, 2009). It has been discussed as so for two reasons: one is due to the ideas used in these disciplines, which are common in many areas, and the other is as a tool for communicating ideas.

Mathematics is usually regarded as a queen of other subjects, as argued by McGinn (2015). My image of mathematics and science was that they were difficult subjects that differed from other subjects. The major reason behind such belief was the culture of teaching in school education, which was more aligned with solving routine problems. I was taught ‘procedural knowing’ in mathematics rather than ‘conceptual knowing’ (Rittle-Johnson & Schneider, 2015). This approach to teaching could not cultivate creative and critical reasoning. In the procedural ways of knowing, emphasis is given to the pre-determined steps and algorithm, and the students are encouraged to follow the steps while solving routine problems. Such approaches kill the students' creativity and thus turn the classroom into a disengaged learning environment. However, conceptual knowing promotes relational understanding (Skemp, 1976). In relational knowing, students are encouraged to explore the relations of mathematical concepts with real-world activities and other disciplines. I am

interested in promoting a relational understanding of different ideas by combining various disciplines in the contextual setting.

My Preliminary Visits to the Research Site

I visited the research site (i.e., schools and the community) seven times, a village named *Dapcha* in the Kavre district before I finalized and defended my research proposal. The purpose of the visits was multiple. First, I wanted to observe the activities in the "action school." I have used the terminology ‘action school’ as used by Acharya et al. (2022) for the school where I have worked since the beginning. In fact, two other PhD scholars from the same university/project have been engaging in the same ‘action school’ – and the term ‘action school’ is being used by all researchers. Second, I wanted to explore the needs of teachers and the school for the new academic year. Third, I wanted to be very close to the community people and the activities going on in the community so that I could further explore the strengths of the community for establishing meaningful connections with the school.

I observed the researchers' engagement in the school in different areas, such as enhancing teachers' professional development (Dhungana, 2022), place-based pedagogy (Wagle, 2021), using ICT for effective instruction (Timsina, 2022), and parental participation in students' learning (Giri, 2022). The philosophical standpoint behind such activity was "asset-based" and participatory (Wright, 2015), where the researchers motivate teachers and vice versa to develop their best practices by inviting them to reflect on their own teaching and learning strategies. In the meantime, I was having informal conversations and observations to explore the areas of support to develop themselves as professional teachers. I realized that the school teachers were expecting to have some approaches that motivate students to learn. It was observed that students were not interested in learning the subject matter. One of the teachers (a mathematics teacher) shared that students enjoyed it a lot when he recited poems and shared stories in class. I also shared my experiences of using different strategies, including poems and stories, in teaching mathematics. In this context, I was exploring my position as a researcher to further collaborate with the school teachers. I realized that we needed to collaboratively explore and carefully implement some approaches to create a rich learning environment for meaningful learning. Out of many possibilities, I realized that exploring an integrated learning approach by incorporating various forms of arts (painting, stories, poems) and technology in pedagogical practices could be the next step to move forward. I interacted with the

community people and shared my experiences concerning school education and the roles of the community to enhance it further. I was excited to hear that many community people were ready to support the school with different capabilities. One of the beekeepers explicitly mentioned that he was ready to support the students by sharing his knowledge and skills as a beekeeper.

These incidents helped me to rethink my preliminary ideas, which were more guided by the notion of providing expert support to the school teachers. During my field visit, I was aware of my roles while interacting with the teachers. Having a background as a teacher educator at a university, it was challenging for me to act as a passionate listener. When I became aware of the ideas of radical listening in the context of critical pedagogy (Kincheloe, 2008), listeners understand others' texts in terms of their (who is sharing) standpoints and axiological commitments (Tobin, 2009). However, on many occasions, I suggested (and in some cases, prescribed) school teachers to follow particular approaches to address their problems. This happened during the initial days of my field engagement. Gradually, I shifted towards a radical listener. In this context, I consciously limited myself not to act as an expert from the university.

Myself and STEAM Education

During the introduction session of the 13th International Conference on Mathematics Education (ICME-12) held in South Korea, one of the senior professors from Australia asked, "What do you teach?" I proudly said, "I teach Mathematics in Nepal." The professor said, "Stop Teaching Mathematics! Teach Children." Both of us laughed. This conversation created a humor at that time. But, the moment became memorable forever. The professor's remark was satirical but very powerful. This conversation created a question: what is our focus in school education – "subjects" or "students"? Most school teachers consider different subjects (such as mathematics, science, computers, and Nepali) separate entities. We, as teachers, usually forget that all these school subjects prepare children to tackle their daily life problems and develop the foundations for higher studies. For this, children have to be at the center, and different subjects are to be considered as a way to achieve the goals of education. That moment awakened me to view subjects as "means" and children as "ends." Palmer (2017) argued that teachers may not be able to help students "see" their strengths if they are unwilling or unable to recognize them as whole individuals with

emotional and intellectual vulnerabilities. His ideas align with the principles of an integrated approach to education, which sees students as capable, whole social beings.

As a teacher educator, I observed that the school-level curriculum of Nepal, for many years, has overemphasized the subject matters, which are more segregated in each subject. It has been treated as if they exist distinctly and have no interconnections among different subjects. But, if we are asked to solve our personal, social, and professional problems (such as building a model of a bridge or fixing a mat at home), we need knowledge and skills from more than one discipline. This happens in almost all real-life issues.

Normally, before launching an integrated curriculum in Nepal, I experienced that the connections among different subjects and within the content of the same subject are not well uncovered and recognized in the Nepali education system. Several pieces of literature (such as Mahmoudi et al., 2012) argue that such practices cannot promote holistic education and do not welcome multiple ways of knowing, such as cultural and ethical knowing (Taylor, 2015). In the Nepali education system, educators should focus on treating the child as a whole, addressing their social, emotional, and intellectual development. This approach emphasizes integrating concepts from different disciplines critically and creatively. STEAM education, an integrated and interdisciplinary approach to learning, might encourage teachers to think more broadly and critically about real-world problems. This approach solves real-world problems by creatively incorporating scientific, mathematical, engineering, and technological knowledge. This does not mean that every problem needs all the dimensions of STEAM education. It usually requires more than one area to explore better solutions. For that, our traditional "subject-centric" approach to teaching and learning is disempowering.

Initially, STEAM education has been proposed to promote productive engagement among learners in science, mathematics, and related curricular areas (English, 2016). STEAM education prioritizes an integrated curriculum and pedagogy to use knowledge and skills in creative and imaginative (i.e., artistic) ways. The ‘A’ in STEAM education helps address the unaccounted approaches to integration. For example, arts-based methods (fine arts, literacy arts, language arts, etc.) help teachers and students connect various science and mathematics disciplinary skills. For example, applying the role-play method to discuss various science and mathematics concepts could create a rich learning environment.

Next, the philosophy of STEAM education considers a school as a place for the "production" of knowledge. Here, the notion of production is radical and for the betterment of society. This helps to revise the conventional lecture-based pedagogy through carefully designed sessions in which students actively explore, analyze, evaluate, and create something valuable and related to their academics. Enabling learners to develop something new may increase their engagement in the educational processes.

STEAM-related skills include developing perseverance and adaptability and learning transferable skills (Bertrand & Namukasa, 2020). For this, educational institutions should promote inquiry-based approaches, project-based learning, and digital learning. The inquiry-based approach promotes STEAM disciplines to enable students to engage in meaningful activities that help to improve reasoning skills. By interacting with real-world activities, project-based learning allows students to develop 21st-century capabilities, including resilience, coping with uncertainty, self-reliance, and imagination. Digital learning supports for contemporary learning environment that enables students to develop technological literacy and critical thinking skills. English (2016) also argues that a better focus on STEM integration is desirable, with a more balanced emphasis on each discipline.

Rationale for the Study

Kathmandu University School of Education has launched the project ‘Innovations in Teaching and Learning Through Contextualized Approaches to Increase the Quality, Relevance, and Sustainability of Education in Nepal’ in collaboration with Tribhuvan University, Nepal, and Norwegian University of Life Sciences, Norway, to develop an innovative model in school education to transform the present teaching and learning approaches (Rajbanshi et al., 2021). More specifically, the project aims to create better strategies using an asset-based approach by interacting with the local stakeholders. In doing so, the project has envisaged different stages for the "interventions" and evaluation of the activities. Out of many activities, it aims to develop the capacity of schoolteachers to apply innovative, inquiry-based learning approaches to engage and link schools and local communities to secure the quality and relevance of practical school projects.

Several studies conducted by the Education Review Office found unsatisfactory results nationwide in Mathematics, Science, Nepali, and English (ERO, 2017, 2022). The overemphasis on fragmented teaching and learning activities was

noted for various reasons. It also indicates that the need for STEAM pedagogy is essential in our context.

As a PhD scholar, I am interested in developing a model of STEAM pedagogy with integrated pedagogy and implementing it in schools. Having worked with schools to identify local challenges and potential strategies for improvement, I initiate change in more collaborative ways for program development and implementation. While doing so, various success stories of using STEAM pedagogy were studied. Recent studies (Halliday et al., 2018; Lambert et al., 2018) have shown that schoolteachers have benefited highly from STEAM pedagogy, and Participatory Action Research (PAR) is the most appropriate strategy. According to teachers, the greatest strengths of the program are the STEAM connections (i.e., connecting two or more subjects) through which teachers begin making the changes in their instructional practices; improved attitudes, beliefs, and confidence in teaching; increased comfort with using technology; and the enthusiasm that students exhibit during a STEM lesson (Lambert et al., 2018).

Statement of the Problem

Since the study is based on Participatory Action Research (PAR), the problematization of the issues is usually drawn from the field and useful concepts and theories. Here, I develop this section based on my understanding of different concepts that may appear in my study, and my preliminary visits to the field. As I stated earlier, one of the major problems of school education is the overemphasis on the reproduction of knowledge. My position is that we should "produce" knowledge. Knowledge production should contribute to teachers' professional development and students' performance as holistic human beings (Coady, 2015). The overemphasis on cognitive knowledge and taking children as only a cognitive being, not as a whole (Zigler & Bishop-Josef, 2006), and thereby focusing on rote recall and memorization, have been major hurdles in today's school education. The holistic perspective on education aims to develop every person's logical, emotional, social, physical, and creative aspects. Kolb and Kolb (2009) have argued that learning is a holistic adaptation process. It is not just the result of the thought process but also an integrated execution of the total person, which includes thinking, feeling, perceiving, and behaving. The models of adaptation for holistic development are problem-solving, decision-making, and imagination. For that, the expert-guided professional

development programs for teachers and ready-made resource materials for students do not give enough space for knowledge production.

Over time, every student is expected to develop a broad range of skills needed for different occupations and sectors, including core and soft skills (Luitel & Pant, 2019; Scheerens et al., 2020). For that, STEAM education provides a rich environment for students to develop such transversal skills. I argue that STEAM, as an integrated learning approach, has been the foundation for human development and learning since ancient times. The primary orientation of human development is developing occupational thinking that requires many life-related skills (such as communication, leadership, digital, intrapersonal, and interpersonal). Here, it is necessary but not sufficient. The latest dimension of STEAM education is to prepare critical and creative citizens with enough life-related 21st-century skills (Taylor, 2016).

Parnell (1985), in a book named *The Neglected Majority*, mentioned that the education system, in general, has been negating the majority of the students by serving the interests and requirements of a few "talented" students. In the context of Nepal, the recent study on national assessment results showed that more than 70% of students in Mathematics in grade 5 have achieved only below 28%, and 55% do not have adequate knowledge and skills in Nepali subject (ERO, 2019). This indicates that a huge number of students are underperforming in these subjects. Quality education, one of the highly prioritized goals for sustainable development (UN, 2015), can be achieved through inclusive and equitable practices in school education. Education is one of the most powerful and proven tools for sustainable development, thereby achieving inclusive and quality learning for all (UN, 2015). For that, the sustainable approach of teachers' support and students' engagement - inviting them to the board from the beginning of the study and recognizing their strengths - is necessary. The notion of inclusive practices is multifaceted. My purpose in this study is to encourage teachers by helping them ensure all children’s learning and understanding are not limited to curriculum frameworks or tools for formal assessment. Still, everyone should get opportunities to question and participate in the learning environment (Florian & Linklater, 2010).

One of the major problems I have realized in teacher education is devaluing the needs and power of self-reflection after implementing certain teaching strategies for improvement (Pant, 2017). The most influential question for me is to seek the

response to the question: *How do I improve what I am doing?* (Whitehead, 2008) through the implementation and reflection of professional activities. As a practitioner in teacher education, I am always concerned about my professional development, and this consciousness could improve the ongoing practices. During my initial visits with schoolteachers to the research site, I also sensed that schoolteachers were curious to update their practices by collaborating with university researchers.

The overemphasis on the disciplinary approach of school education is unhelpful to develop students as social beings with enough human values and integrities. The idea of Spivak (2003) is empowering and helpful. Spivak (2003) ignores the academy's standardized "rules" and advocates moving forward from the disciplinary boundaries. The arguments for the death of disciplines (Spivak, 2003) have been very prominent in Nepali school education in recent years. Conventional disciplinary values and such convictions have created a limited and disempowering space in school education. For that, STEAM education and pedagogy can help move forward. I consider STEAM Education as/for transformative education for developing students' transdisciplinary capabilities for developing visionary STEAM educators for designing transdisciplinary STEAM curricula and teaching approaches (Taylor & Taylor, 2022). In this study, the culmination of the PAR process will be a collaborative effort to design and implement transdisciplinary pedagogical approaches. This initiative seeks to address Nepali school education's challenges due to its overly subject-centric instructional methods.

Purpose of the Study

The purpose of this study is to explore the innovative pedagogy that contributes to enhancing teachers' and students' performances. More specifically, I was interested in working with schoolteachers and leaders to develop and implement the STEAM pedagogy from the prospect of an integrated teaching and learning approach. However, as per the principle of PAR, I became flexible to develop and implement other forms of pedagogy (such as applying inquiry-based learning in STEAM Education, promoting transformative teaching and learning approaches, and contextualized pedagogy) as per the needs of the context. During the participatory journey, the purpose of the study turned to the exploration of how co-researchers collaboratively develop, implement, and reflect on the STEAM-based pedagogical approaches at the basic level of school education. The purpose subsequently also

involved reflecting the lead researcher's professional development as a practitioner-researcher during the process.

Research Questions

I have developed the following research questions after several rounds of revision during the fieldwork and writing process:

1. How do co-researchers develop and implement STEAM-based pedagogical approaches to promote students' learning at the basic school education level?
    a. How do co-researchers negotiate and create the needs for the actions in participatory research?
    b. How do co-researchers develop and implement inquiry-based pedagogical approaches for students' engagement in learning?
    c. How do co-researchers develop and implement multidisciplinary and interdisciplinary activities to develop students' meaningful learning?
    d. How do co-researchers develop and implement transformative STEAM projects to develop students' critical and ethical understanding?
2. How do I, as the lead researcher, reflect on my professional development as a practitioner-researcher during and after the implementation of STEAM pedagogy in schools?

Significance of the Study

This research can be useful for schoolteachers, school leaders, resource materials developers, researchers, and policymakers in the transformative process of the educational system by inviting stakeholders to engage in a global, cross-disciplinary dialogue to inform transformative educational practice across its personal, productive, instrumental, emancipatory, and holistic goals (McWhinney, 2003). For this, the schoolteachers and leaders might benefit from the actions carried out in the schools and the reasons behind the success and failure stories concerning implementing STEAM pedagogy at the basic level.

The research might also help material developers (such as curriculum writers, textbooks, and reference book developers) by using the resources that schoolteachers developed in consultation with the researcher and applying them in schools. The research study can assist researchers, especially for participatory action researchers, by using participatory action research to improve pedagogical practices in schools. I hope this study will support policymakers, especially at the local level, by providing some insights into making policies in the modalities of teachers' professional

development and students' support. In a nutshell, this research is helpful to the people involved in school education and aims to improve the educational landscape through a participatory nature of efforts.

Structure of the Thesis

This thesis has nine chapters. The first chapter sets the context and issues of the research and gives birth to the research purpose. The second chapter develops spaces for the study by reviewing relevant literature on different themes, chosen theories, and the studies that have already been conducted. The third chapter demonstrates the roadmap of the entire research study. While developing the roadmap of the study, both theoretical and methodical ideas have been discussed. The fourth chapter presents the details of the collaborative needs assessment addressing one of the research questions. Chapter five aims to share the journey of developing and implementing inquiry-based activities for students' engagement in learning. Chapter six demonstrates the development and implementation process of multidisciplinary and interdisciplinary activities to develop students' meaningful learning. Likewise, chapter seven manifests the journey of implementing the transformative nature of STEAM projects to develop students' critical and ethical understanding. Chapter eight is designed to share the lead researchers' professional development during the research journey by sharing the lead researcher's contributions to the community of practices. The final chapter shows the sustainability of the collaborative actions and the methodological and thematic contributions of the study.

CHAPTER II
SITUATING MYSELF IN THE FIELD

This chapter elaborates on concepts used in my research study that helped me locate my researcher position. I begin with inquiry-based learning and move towards multidisciplinary, interdisciplinary, and transdisciplinary approaches to education. I also spotlight the ideas I use throughout my study concerning STEAM education. I further discuss the major theoretical referents that guide me in developing perspectives to explain different phenomena I observe in the research journey. My position would be as a practitioner-researcher rather than a researcher trapped inside some particular theories. In the end, I developed my territory in terms of the needs of the research study and the focus by reviewing the studies closer to my research issues and the methodology I plan to adopt.

Inquiry-Based Learning

The idea of Inquiry-Based Learning (IBL), by its terminology, aims to engage students in the inquiry and investigation of knowledge and skills students require as per the objectives of the curriculum. IBL has a long history in both Western and Eastern knowledge traditions. Here, Western academia refers to the dominating ideas discussed in the Western Modern Worldview (WMW) and the roots of those ideas in the West. The Eastern wisdom tradition has several traditions. But, I have taken from the perspectives of the Gurukul education system, rooted in the Vedic traditions. I have not used west and east as a geographical separation. Instead, I have used various constructs practiced in these two traditions as our lives are guided by both knowledge traditions.

I reviewed IBL from teaching and learning perspectives in school education. IBL has a long history in the West. To understand the spirit of the inquiry, we need to return to Socrates' questioning method when engaging in dialogue. As per the idea of the Socratic questioning model of exploration, teachers and students engage in dialogue systematically and disciplined to discover the “truths.” In today’s education system, we can sense those truths as knowledge and skills mentioned in the curriculum. For this, teachers act as “sage on the stage,” positioning students as passive receivers of information. However, teachers act as “guides on the side” by encouraging and supporting children to raise and respond to the questions (McLean et

al., 2023). In the same direction, Ross (2003) mentioned that “in the Socratic method, the classroom experience is a shared dialogue between teacher and students in which both are responsible for pushing the dialogue forward through questioning” (p. 1). The most notable part of the Socratic questioning model is to live ethically in the world through exploration, not following the mechanical step-by-step way of formal procedure.

Signaling the beginning of modernity in educational practices, John Dewey argued and implemented the ideas of inquiry as a major entity for experiential learning. Dewey (1938) encouraged students to formulate problems based on their own experiences and explore the possible solutions by testing several hypotheses. This idea became popular in the modern education system, and many educators believe that this is the beginning of progressivism in education. I used several inquiry-based and experiential learning concepts in this study while designing and implementing lessons.

Several pieces of literature suggest various ways to engage students in inquiry-based learning. One of the popular models of IBL is the 5E learning cycle model with five inquiry phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation (Bybee et al., 2006). In this 5E model of learning, learners engage in all steps in meaningful ways and explore knowledge or skills as per the purpose of the lessons. A similar inquiry cycle was also proposed by White and Frederiksen (1998) but labeled with different terminologies: Question, Predict, Experiment, Model, and Apply. After reviewing several articles, Pedaste et al. (2015) concluded that inquiry-based learning starts with orientation and moves through several cycles of conceptualization, investigation, and conclusion. Typically, inquiry-based learning concludes in the conclusion phase. However, the inquiry can happen at any point during the process (discussion in-action) or retrospectively (discussion on-action). The discussions (which include communication and reflection) have the potential to be present at every point during inquiry-based learning and connect to all the other phases. Out of several ways of IBL, the guided nature of inquiry in which students get regular support from the course facilitator is a promising method for science education. One of the reasons for this is the lack of tried-and-tested inquiry-based teaching materials with detailed guides that teachers can readily use in their classrooms (Orosz et al., 2023).

The Eastern wisdom tradition, especially the Vedic tradition, guided me with several instances where inquiry approaches have been used. Śāstrārtha (शास्त्रार्थ) is a well-known and influential scholarly debate and dialogue method in the Vedic tradition. It serves as a platform for intellectual engagement, allowing participants to explore and interpret sacred texts, philosophical concepts, historical events, and other scholarly studies. The primary goal of these debates is to uncover deeper truths, clarify doctrinal positions, and sometimes resolve differences in interpretation. Each argument is reinforced with quotations from authoritative texts like the Vedas, Upanishads, or others. The debate process continues, with arguments and counter-arguments turned, until the Guru (teacher) is satisfied with the student's (Shishya's) intellectual rigor and persuasive ability. I have used this concept during my field engagements with co-researchers to discuss how the inquiry was in place in the Eastern wisdom tradition.

Different Facets of STEAM Education

Scholars have examined STEAM Education from various perspectives. The idea began with the concept of STEM education, and gradually, the importance of arts in STEM was realized. Hence, the idea of STEAM education was developed. This section aims to discuss STEAM in general, the different priorities of STEAM education, the philosophical underpinnings of STEAM education, and the dimensions I plan to choose in my study.

STEM: A Workforce Development Paradigm

The idea of STEM education has been discussed differently at different times and in different places. In 1959, the National Science Foundation (NSF) of the USA recognized and discussed the needs of STEM disciplines by focusing on their scopes and needs in the contemporary context (Chesky & Wolfmeyer, 2015). The major concentration of STEM Education was on developing capable human resources in terms of skills who could work as per the needs of any organization. The knowledge and skills gained from Science, Technology, Engineering, and Mathematics were considered foundations for developing highly skilled human resources. The purpose of school education was also gained with the notion of getting several discrete skills that prepare people for the industries.

The USA also developed the STEM Education Act in 2015 and stated that STEM-related jobs are gaining popularity nationwide. For that, high-tech companies

and industries need a STEM workforce with sufficient skills and knowledge (Guzdial & Morrison, 2016). This act kept the knowledge and skills of computer science at the center as it was a time of flourishing high-tech companies. The purpose of selecting STEM disciplines was to identify the scopes of the disciplines that provide skills for market-oriented workplaces. As a discipline, science is rooted in the scientific inquiry that demands hypothetico-deductive reasoning (Kaplan, 2017). Hypothetico-deductive reasoning is necessary to promote economic rationality. Technology is perceived as a cross-cutting skill that is needed for every job. In general, it helps to develop skills to maximize the individual's performance in their personal and professional workplaces (Jang, 2016). In the industrial era, increasing production for economic growth in the USA was the focus, and technology was used in machine-based manufacturing companies (Hoeg & Bencze, 2017). There are several arguments regarding the scope of engineering discipline in STEM disciplines. However, the frequently discussed argument is the design thinking perspective that aims to develop prototypes of market-oriented products for creating high-rated products (English, 2016). As one of the components of STEM disciplines, mathematics is regarded as the foundational subject needed for developing logical reasoning.

As stated earlier, the primary purpose of initiating STEM disciplines was to develop skillful human resources for the job market. So, STEM Education has also been viewed from the perspective of neoliberalism, in which STEM is developed and promoted as a tool to promote the global economy through market-driven policies and privatizations (Carter, 2017). Economist Stephan (2012) provides a clear explanation for her position, saying, "I have been amazed at the number of people who venture to write about science and science policy without understanding the environment in which research takes place" (p. xii). She emphasized that the naturalistic study approaches should delve into issues related to productivity, resource allocation, and policy influence on outcomes, public good, and efficiency. In this study, I tried my best to become aware of the neoliberal agenda of STEM Education while developing and implementing projects with schoolteachers.

In a nutshell, the discourse on STEM education is dominantly shaped by the workforce development paradigm (Martinez, 2017). This education paradigm is necessary as it has several advantages in industry-based societies. However, only focusing on preparing skillful human resources falls short of cultivating responsible citizens (Taylor, 2018). As a researcher, I have acknowledged the positive side of this

integration of four disciplines under the umbrella of STEM. However, this view is limited as it focuses on skills only without critical understanding and needs to move beyond the focus of STEM disciplines.

Technology in STEAM Education

The growth of technology and technological tools have contributed meaningfully to the ways we perform in our personal and professional lives. Technology has challenged several long-rooted beliefs regarding education (such as the belief that information should be memorized) and ways of educating people (that teachers and students need face-to-face interaction). In this section, I elaborate on technology's role in education and review some attempts at using technology in education. Finally, I share my position as a researcher while using technology as a pedagogical tool and as a process for professional development.

In education, we debate about diverse pedagogical approaches rooted in different learning theories. Different learning theories (such as cognitive, constructivist, and transformative) have suggested that the roles of teachers and students are different for effective teaching and learning approaches. The rapid growth of technology in the last few decades has significantly changed the notion of education and teaching-learning approaches. Realizing the roles of technology, UNESCO (2018) has also argued that ICT has a significant potential to accelerate progress by bridging the digital divide and supporting the development of inclusive knowledge societies to achieve the 2030 Agenda for Sustainable Development. Incorporating techno-pedagogy (Mishra & Koehler, 2006) is gaining popularity in education for teachers' everyday professional actions, such as using digital content and web-based materials. Showing the importance of technology in the STEAM field, Milner-Bolotin (2015) has mentioned, "Technology is viewed as a vehicle for the exploration of science and mathematics ideas permeating the world we live in, a tool for engineering design, artistic expression, as well as a field of inquiry within itself" (p. 142).

Nepal's government and non-government sectors have taken significant initiatives to promote ICT in education and ICT-integrated pedagogy. The need for ICT-skilled human resources and management by establishing ICT in all aspects of education and infrastructure development was indicated by the National Planning Commission of Nepal in 2007. In the same spirit, the Ministry of Education (2009) specified ICT-assisted teaching and learning as a core program in school education in

the School Sector Reform Plan (SSRP) (2009-2016). It focused on ICT as an important tool to improve classroom instruction, increase access to learning resources, and improve the effectiveness and efficiency of educational governance and management (MoE, 2016b). Regarding ICT initiatives in Nepal, the pioneering document is the comprehensive ICT in Education Master Plan 2013 (MoE, 2013). This plan considers ICT an enabler for students to reduce the digital gap and ICT as a teaching and learning tool in different subjects. This provision has significantly contributed to school education by promoting ICT-integrated pedagogy.

UNESCO (2018) has also prioritized ICT-integrated teaching and learning and developed an ICT competency framework for teachers. In this framework, UNESCO proposed three levels of knowledge (acquisition, deepening, and creation) with five aspects (understanding ICT in Education policy, curriculum and assessment, pedagogy, application of digital skills, organization and administration, and teacher professional learning). The teacher's competencies framework developed by the Nepal government kept ICT knowledge in their professional life as one of the components out of eight different competencies. (MoE, 2016a).

I used ICT as a part of teachers' professional learning. As a researcher in the STEAM Education field with a background in mathematics education, I also initiated using some digital content to visualize mathematical ideas. This helped me advance in developing STEAM projects by incorporating technology components in the later part of my fieldwork. During the school closure due to COVID, I used technology to run various teachers' professional development sessions, and I collaborated with schoolteachers to develop lesson plans and project plans with the help of technology. My purpose of using ICT-integrated pedagogy in different subjects was aligned with the ideas of Bidarian and Davoudi (2011), who proposed the application of ICT in three forms: a) it may involve all learners in the learning process; b) it may increase the interests of learners, and c) it may provide variety in presenting ways of learning in a pleasant situation.

I was also aware of the limitations of ICT-integrated pedagogical approaches. After the explosion of technological advancement, people argue that technology is the ultimate solution to several problems and issues in the educational field and beyond. Fernández-Gutiérrez et al. (2020) recommended the conscious use of ICT in education; ICT can positively influence academic outcomes, but not always. It can have various impacts depending on the subject and its application. Therefore,

improving the assessment of policies to enhance ICT use in education is crucial. Future evaluations should focus on how specific programs and technologies affect particular student skills to determine the most effective application methods.

STEAM Education from Critical Theory Lens

One of the arguments behind STEAM Education draws from critical theory. This involves the notion that STEAM Education should be used to critically analyze the current educational practices and act as a change agent to create a better society. I experienced these ideas in the later phase of my doctoral journey. Interestingly, the root of this argument is distant – into the Marxist perspectives. Even Marx did not use the terminology STEAM Education; Gan and Bai (2023) discussed Karl Marx's theoretical contributions to STEAM Education. The author argued that Marxian philosophy is an example to explore critical pedagogy and aesthetics. It concludes with a summary of Marx's theoretical approach to STEAM education. This examines Marx's original works and the contributions of earlier Marxian scholars in applying critical pedagogy to the STEAM paradigm and in the growth of ICT.

Furthermore, critical theory informs structural issues in STEAM education that lead to power disparities, including educational inequalities and digital divisions in the age of digital capitalism. These authors examine art and communication theories through the framework of Marx’s history and writings with a perspective of aesthetic literacy in STEAM education. I sensed that Marx's critical and pedagogical theories encouraged scholars to argue the concept of STEAM pedagogy as multidisciplinary. Marxian critical pedagogy seeks to reject power disparities and foster a continuum of social change through communal activities in the teacher-learner relationship in educational philosophy. This theoretical perspective can be used while designing classroom activities. However, as Marx explained, I am not fully convinced about the prospects of ideal situations in which to reject the power disparity and create a communitarian society in the school system due to the nature of the society and the school system. Gan and Bai (2023) further explained that a Marxian perspective on STEAM education theory can be founded on the thorough and extensive renovation of the capitalist society in the present era of digital capitalism and ICT. Thoroughly examining the outcomes of literary and creative events is an essential and rational key to understanding Marx's ideas on STEAM education.

Extending the idea of Marx and following the same philosophical orientation, Antonio Gramsci argued from the perspective of cultural hegemony, in which he explains how the state and ruling capitalism maintain control over society through cultural hegemony. Mayo (2015) argued that critical pedagogy has been significantly influenced by Gramsci's concepts, particularly those that pertain to hegemony, the role of intellectuals, and the significance of cultural and educational activity. Gramsci underscored the necessity of education as a space for struggle, where transformative ideas can flourish, and dominant ideologies can be challenged. Having said this, the ideas of STEAM education from the critical lens, where students are assumed to develop critical thinking about different social issues, are also connected with Gramsci's critical pedagogy.

Jürgen Habermas, another influential critical theorist, developed the theory of communicative rationality and the concept of the public sphere. In the theory of communication rationality, individuals achieve mutual understanding and consensus through rational discourses and argumentation. The ideas of the public sphere are considered an arena in which people freely discuss different social issues and develop public opinions through critical debate. These ideas are close to the critical lens of STEAM Education, where students and teachers get opportunities to discuss several real-life issues in the educational setting (which can be seen as the public sphere). In addition, the knowledge constitutive interest proposed by Habermas (1971) is important in STEAM Education. The critical lens of STEAM Education acknowledges the technical and practical nature of knowledge as necessary but insufficient and moves towards the emancipatory interest for knowledge formation.

STEAM Education as Transformative Perspective

In this section, I discuss the transformative dimension of STEAM Education. One of the important entry points towards transformative practices is *self-reflection*, where teachers and students examine their deep-rooted assumptions and beliefs regarding their teaching and learning approaches, question the assumptions they hold, and envision better alternatives in teaching and learning (Larrivee, 2000). For example, Pant (2017) mentioned that school-level mathematics teachers are interested in ready-made tips, tricks, and techniques for solving routine mathematical problems. Effective teaching is much more than accumulating skills and ready-made techniques. For this, the entry activity invites students, teachers, and school leaders to reflect on their practices. Critical reflection is the next step, and two concepts of critical inquiry

and self-reflection are necessary for reflective practitioners (Larrivee, 2000). In the same direction, Brookfield (1995) has argued that critical reflection is a matter of stance and dance. The stance represents the inquiry that is always open for further investigation, whereas dance is taken in terms of testing and risks that always look to exploring new possibilities.

It is also argued that teachers are trapped in the reflexive circle in different mental models (Larrivee, 2000) influenced by general beliefs (such as ICT is one of the best approaches in education) and make choices based on such general assumptions in the classroom. Without being aware of such general assumptions and connecting their usefulness in our work context, the so-called successful approach to education (in general) might not be useful in a certain context. The teachers, hence, need to prepare for critical reflection before using new pedagogical approaches, also taken as personal awareness in the discovery process. The teachers can engage in the reflective process by making it an integral part of daily practice. For this, teachers can maintain a "reflective journal" (Larrivee, 2000) that allows them to reflect on their everyday activities and examine the influence of their activities on themselves and their students.

It is widely discussed that teachers should be involved in critical reflection, But, inviting teachers for reflective practice is not easy. For this, the approach suggested by Larrivee (2000) is useful. I used this concept during workshops at my research site. The first step is examining the core beliefs based on the meaning of life, ethics, values, etc. The next step is to organize the framework for the beliefs explored in the first step and include the theories teachers are attached to. The third step is linking teachers' beliefs with the general action plan, such as making lesson plans and assessment items. It is a process in which teachers develop a plan of action or daily practices based on the core beliefs they initially explore. Based on those plans of action, teachers make specific strategies (such as questioning techniques in the class) to implement them.

STEAM education also engages students in transformative learning by exposing them to interconnected ways of knowing, such as cultural self-knowing, relational knowing, critical knowing, visionary and ethical knowing, and knowing in action (Taylor, 2015). Cultural self-knowing aims to recognize our culturally situated selves and the shared values and beliefs that emerge in the cultural identities of our ways of being and making sense of our social and natural worlds. Working in the field

of education, exploring culturally situated values of pedagogical practices, and making sense of those activities are very important for me. The relational way of knowing is also crucial as we engage with culturally different groups (such as teachers and students) in the learning process, which should be empathic and compassionate. As a PAR researcher, I believe that relational knowing is one of the most effective ways of knowing. Next, I use the notion of critical knowing that allows me to understand how and why the different forms of powers (political, institutional) have influenced the social realities by creating apparently natural with deeply rooted categories of class, gender, etc. The most important issue in my study is to explore how those invisible powers influence our life worlds as teachers, teacher educators, and researchers, and our relationships with other community members. To explore better opportunities in pedagogical innovations, the visionary and ethical knowing provided me enough space to imagine and explore better ethical alternatives. While doing so, I became aware of my position and limitations as a researcher in the public education system. We also reflected several times during our fieldwork on what a better world could be like and what a better school should be like regarding STEAM-based education. Lastly, I subscribed to the idea that knowing in action, with a commitment to make a difference in the field, supported me in generating evidence-based knowledge rather than believing in so-called grand theories without implementing them into real contexts.

The transformative lens of STEAM education supported me in envisaging better teaching and learning approaches as pedagogical innovations and in transforming existing teaching and learning practices.

Design Thinking in STEAM Pedagogy

In this section, I discuss Design Thinking (DT) from the perspective of a pedagogical approach, largely in the context of advocating STEAM pedagogy in school education and the need for design thinking in my research. DT is based on creative ways of problem-solving as designers. Culén and Gasparini (2019) have argued that DT is an approach to real-life problem-solving grounded on human-centeredness through creative and multidisciplinary thinking. The idea of human-centeredness demonstrates that humans solve problems for the betterment of humans by exploring a bunch of ideas. The concept of ‘design thinking’ has emerged as a human-centered approach to innovation, also discussed as a team-based approach to innovation, based on how designers think and work (Brown, 2008). It begins with the

collaboration with the people for whom we are designing and ends with a new solution that suits their needs. This design is all about building a deep empathy with the people we are designing for by building different prototypes in the process, sharing what we have made with the people, testing them in the actual situation, and ultimately putting new solutions to them.

Another dimension of DT is fostering creativity among schoolteachers and students, which both teachers and students need in their work. Owen (2007) has proposed a knowledge production approach within the creative domain. According to Owen (2007), creative people engage with the world and develop knowledge in two ways. The first way is inventing knowledge, where they develop new ways of addressing the problems. The second is by discovering the knowledge where they discover the solution approach through the inquiry process. Both ways try to identify the gap between theory and practice and struggle to explore pragmatic solutions to problems through an experiential approach. As I stated earlier, one of the major issues I observed in my field during my initial visit was teachers' expectation of a ready-made solution in teaching and learning rather than expecting pedagogical innovations in the local context. Creativity helps me challenge the deeply rooted mindset of schoolteachers and students who frequently expect pre-developed rules and procedures to tackle and address problems.

DT's most important dimension offers holistic and multidisciplinary spaces to solve problems. Conventional subject-centric thinking does not provide enough space to generate new knowledge. "DT aims to understand the entire system and how different parts affect each other and predict how any particular suggestion affects the whole system" (Culén & Gasparini, 2019, p. 94). Here, the entire system is recognized more than the different subjects taught in school education. A holistic understanding of the context is needed to welcome divergent thinking and solve problems.

Similarly, multidisciplinary spaces promote a rich environment for design thinking. A multidisciplinary team helps to facilitate decision-making processes from different lenses (Chasanidou et al., 2014), and multidisciplinary thinking is required to produce more creative and life-affirming solutions to the problems (Culén & Gasparini, 2019). For that, a living dialogic space perspective is needed. A creative learning conversation is an ongoing process in which teachers and students mutually participate in researching and developing knowledge of their 'lived space' (Chappell

& Craft, 2011). Dialogical spaces offer more intellectual activity to negotiate ideas and make decisions (Meinel et al., 2011). This is essential for mutual respect, where each team member should feel that their input is valued and included. In the third cycle of my study, I collaborated with schoolteachers to design pedagogical activities, and I also engaged students in STEAM projects using the idea of design thinking.

STEAM Education from the Eastern Perspectives

Though the terminology STEAM Education has been coined in the modern era (or/and in the post-modern era), if we reflect on the educational landscape in the Eastern wisdom tradition, the notion of integrated learning with a focus on ethics and values was highly valued and practiced.

Gurukul education system counts among the most popular educational cultures in the Eastern wisdom traditions. Adhikari (2023) mentioned that Gurukuls are primarily concerned with transmitting knowledge to students in a natural environment, where they coexist in a spirit of discipline, compassion, humanity, and brotherhood. The fundamental lessons are imparted in language, science, and mathematics through self-study and group discussions. Additionally, the emphasis is placed on the arts, athletics, crafts, and singing, which foster critical thinking and intelligence. Activities such as yoga, meditation, and mantra recitation fostered a sense of positivity and tranquility, making them more physically and mentally fit.

Additionally, performing daily tasks independently is necessary for instilling practical skills. All of these contribute to developing the individual's personality, enhancing their confidence, discipline, intellect, and mindfulness, all of which are essential attributes for navigating the world that awaits them. Additionally, Gurukul schools are recognized as child-friendly institutions. If we compare the literature on STEAM education in Western academia, it seems that the ideas of the integrated notion of teaching and learning approaches with ethical and moral values can be seen in the Gurukul education system, which was in practice for 5000 years ago.

The ideas of the Gurukul Education System are based on Veda's philosophy. The Vedic philosophy aims to develop a well-rounded individual with strong ethical and moral values and practices of such values in daily life. Through the Gurukul Education System, the teaching of Dharma (righteousness), Kama (desires), Moksha (liberation), and Artha (prosperity) for a balanced and virtuous life is the central part of Education. For this, the notion of self-realization and the search for Satya (truth) are the major components. It seems that several STEAM constructs were practiced in

the Gurukul Education system. Due to the overemphasis on the modern education system and the influence of postcolonial doctrines, Western ideas (such as STEAM Education) have seemingly become popular around the globe. But, if we critically assess the Vedic tradition and the Gurukul education system, we can find that the integration of different subjects and incorporation with values and ethics could be well found in the Eastern wisdom tradition. I examined this notion with the co-researchers during my fieldwork and attempted to contribute as a thematic contribution in the last chapter of my dissertation.

STEAM Education in Nepal

As I conduct research with Nepali teachers, I think reviewing the STEAM discourses and activities in the Nepali education system is mandatory. Nepal is undergoing a comprehensive initiative to enhance the quality of school education by reforming curricula, textbooks, and education policy. The aim is to foster a more integrated approach to education at the early basic level while promoting project-based and practical at the secondary level (CDC, 2019). Though the curricular framework directly does not refer to the idea of STEAM education, the underlying principles and objectives of these educational approaches have been seen in relevant publications, such as the CDC (2019).

Belbase (2019) reviewed several documents on STEAM Education initiatives in Nepal. The Ministry of Education, Science, and Technology has partnered with the Robotics Association of Nepal, Nepal Academy of Science and Technology, BeeCreative, Karkhana, and Nepal Innovation Lab to conduct STEAM challenges named *Bhawisya 2017* (Belbase, 2019). According to a report by the Kathmandu Post in 2018, 180 school teams took part in the challenge program, showcasing demonstrations and models connected to STEAM education. The establishment of partnerships between governmental and non-governmental organizations has created a novel opportunity to advance STEAM education in Nepal. This initiative seeks to foster the growth of creativity, imagination, innovation, scientific reasoning, and problem-solving abilities, transcending the conventional approach of teaching and learning subjects such as mathematics, science, and the arts (Kathmandu Post, 2018). The availability of challenge programs is primarily confined to the capital city of Kathmandu. Nevertheless, the effective execution of Bhawisya 2017 showcases a dedication and potential for integrating STEAM efforts within schools in Nepal. In

this program, much focus was given to making different prototypes using different science and engineering-related concepts.

Furthermore, Kathmandu University School of Education (KUSOED) initiated the implementation of a formal STEAM education program in February 2019, offering an MPhil and PhD in STEAM Education under the Department of STEAM Education. The primary objective of this program is to equip graduates with the ability to select research topics encompassing mathematics, science, technology, engineering, and the arts/humanities while emphasizing an integrated approach. The curriculum emphasizes acquiring information, skills, and attitudes necessary for developing research designs in STEAM education. It aims to foster an understanding of problems and concerns that arise at the local, regional, and international levels (KUSOED, 2019). The program provides a selection of courses focused on STEAM education, including lenses of STEAM Education, Curricula in STEAM education, reflective practice in STEAM education, and teaching and learning in STEAM education. In addition to the MPhil and PhD programs, the department initiated one year of MEd in STEAM and one year of Post Graduate Diploma in Education (PGDE) in STEAM Education in 2020 and 2022, respectively. Launching MEd and PGDE programs aims to develop skillful teachers and teacher educators at the school level.

The STEAM education program at KUSOED offers scholars a framework consisting of four lenses: autobiographical, pedagogical, socio-political, and philosophical (KUSOED, 2019). These lenses enable scholars to analyze and understand the various roles and perspectives related to potential societal challenges in economics, environment, and sustainable development (KUSOED, 2018). Individuals cultivate ethical, attentive, and resilient research and development abilities by engaging in reflective practice through several interconnected epistemological approaches. The acquisition and use of such information and skills necessitate a well-designed and comprehensive curriculum that facilitates the integration of theoretical concepts with practical experiences, allowing for mutual enrichment and informed decision-making. So, curricula of this nature have the potential to yield positive outcomes when implemented within a pedagogical framework that embraces inquiry-based approaches to thinking and practice. Therefore, these courses on STEAM education offered at KUSOED aim to impart theoretical, philosophical, pedagogical, and practical knowledge, skills, attitudes, and scholarly habits.

The discourse on STEAM education is gaining momentum in Nepal. This is mainly due to the efforts of the university, government bodies, and non-profit and private institutions, which have played a pivotal role in advancing STEAM-related activities. Numerous opportunities are on the horizon, including curriculum revision and a greater focus on integrated learning methods. However, several challenges have also emerged, such as the prevailing disciplinary mindset, resource constraints, and the need to institutionalize new practices. To successfully implement the STEAM approach in education, all stakeholders must engage in a meaningful dialogue and act at the grassroots level.

Theoretical Lenses: Experiential and Transformative Learning

John Dewey is the most influential educational philosopher in my academic journey. Dewey (1859–1952) argued the relationship between experience and learning in his popular book *Experience and Education* (1938). His major argument is that experiences could be educative for further growth, intellectually and morally. The genuine experience should benefit the community and the people in the communities. In addition to this, Dewey (2012) also argued the need for democracy in education. He argued that the traditional education system was hierarchical and inherently undemocratic. To develop thoughtful and active democratic citizens in the nation, establishing democratic practices at all levels is mandatory. As I subscribed to PAR in my study, connecting experiences in education and democratic participation is beneficial in the process. The ideas of John Dewey (such as experiential learning and a democratic environment) greatly impacted my personal and professional life, too. The principles of Dewey's ideas highly guided the entire research journey. I have not referred to Dewey several times in my writing. Rather, I used his ideas while conducting workshops, designing activities with teachers, and implementing them in the schools. The Association for Experiential Education (2018) has stated that experiential educators purposefully engage with learners in direct experience and focused reflection to increase knowledge, develop skills, and clarify values.

In terms of experiential learning, the cycle of reflection, as proposed by David Kolb (1984), became very useful for me. The cycle begins with the concrete experience and moves to reflective observation, abstract conceptualization, and finally to the application stage. While doing so, the entire process includes restructuring the previous experience, making connections to prior knowledge, and making decisions to apply the knowledge after carefully considering and testing that knowledge or skills in

a new context. This is especially applicable when teachers and students collaborate to develop and implement projects in schools.

Transformative Learning Theory is another theoretical referent I employed in this study. It was rooted in the work of Mezirow (1991) in adult education. As I collaborated with schoolteachers, the principles of transformative learning were beneficial for me in making sense of their (schoolteachers') experiences with the world from diverse perspectives. I also used the idea of communicative learning rather than instrumental learning, a contribution made by transformative learning theory. Regarding communicative learning, Mezirow (1997) states that it becomes essential for learners "to become critically reflective of the assumptions underlying intentions, values, beliefs, and feelings" (p. 6). As I stated earlier, my entry point in this research would be inviting schoolteachers to reflect on their values and deep-rooted beliefs and practices regarding teaching and learning culture. In this context, the four learning processes discussed by Mezirow (1997) are very engaging in my study context. The first way, elaborating on an existing point of view, allows me to reflect on the assumptions and values of education. The second way, establishing a new point of view, creates spaces to critically reflect on the assumptions for better alternatives (such as STEAM pedagogy). Learning to transform the point of view is the third way that motivates teachers to amend their beliefs and practices on teaching and learning. The fourth way, transforming our ethnocentric habit of mind by becoming aware and critically reflective of our generalized bias, helps teachers to appreciate new insights and thoughts for reshaping their actions from both heart and mind.

Nepali researchers (such as Luitel, 2009; Pant, 2015; Shrestha, 2018) in teacher education have used transformative learning theory as a guiding principle in their research studies, advocating research as a means for transformative learning. In this regard, Taylor (2013) mentioned that researchers as transformative learners draw from several epistemologies such as constructivist, critical social, and arts-based as multiple referents (not a rigid framework) to examine reflectively, critically, and imaginatively their lived experiences for discovering the historical and socio-cultural meanings of their personal lives and professional practices. Delving into these ideas, I realized that transformative learning theory is appropriate in my context. As a citizen of non-Western societies and a nation where neocolonial thinking has influenced people's lives, transformative learning has created spaces to assess the alternative

ways of exploring and researching, acknowledging (with a critical scholarship) the roles of dominant theories of education and learning. The transformative learning was also relevant in my case as I have repeatedly shown commitment to the changes in the research site with a collaborative effort in the school setting.

Review of Previous Studies

This section has been developed to critically review the previous studies that are close to my research agenda. Various studies on mathematics and science education disciplines focus on the need for pedagogical integration of arts and technology. However, the study on STEAM education as a separate construct is very limited. In recent years, the number of publications on STEAM education has been increasing, which has motivated me to research in this field.

Nepali scholars elsewhere consistently argue that mathematics and science curricula and pedagogy are decontextualized and disengaged (Luitel, 2009, 2013, 2019; Pant, 2019; Shrestha, 2018). The authors discussed various ways to make mathematics and science curricula more contextual by incorporating cultural approaches to learning, making teachers aware of the inquiry-based approaches to education, applying art-based pedagogy, etc. The common arguments appear that teachers should move toward innovative pedagogical approaches by connecting school mathematics with students' lives to develop meaningful understanding.

Quinnell (2019) conducted a study to explain his shift from STEM to STEAM by reflecting on educational identity and scholarship. The "select moments" in his career when the scholarly work was informed by the researcher's home discipline of biology and extended into other discipline spaces, specifically the arts, were discussed. The notable part was working across disciplines as fields of practice and connecting with others within and outside of science. The researcher highlighted the important realization that the Science-Art moments greatly contributed to professional life. This research gave me the courage to work in an art-integrated approach at my research site.

Similarly, Lajoie and Poitras (2017) argued for crossing disciplinary boundaries to improve technology-rich learning environments. For this, the researchers reviewed several technology-rich learning environments in different areas. The metaphors of using computers as cognitive, metacognitive, and affective tools are well discussed. This idea gave a wider perspective on considering computers as affective tools by connecting both knowing and feeling perspectives. It was also

shared that these investigations have significant implications for the metaphor of utilizing technology as a means for learners' thinking. This research brought a convincing idea for connecting technology with affection in today's context, where the major challenges were discussed, such as the neglected social and emotional perspectives of learning due to the overuse of technology. In a similar direction, Bundsgaard (2019) mentioned that technology should be used to scaffold learning to create a progressive learning environment. The researcher used a scaffolding interactive platform as a tool, from tacit structures to explicit structures, to transform resources. The researcher used computers in various ways to support more complex teaching practices as a scaffolding tool. The result demonstrated that such practices improved the students' capabilities in STEM and arts fields.

Several countries (Japan, Korea, China, and Australia) have promoted STEAM education nationwide. Kang (2019) investigated the STEAM education initiative in South Korea and examined its effects on learning and teaching. This study found that teacher professional development courses in South Korea increased teachers' recognition of the initiative and their confidence in teaching STEAM education. The coaching in classroom practices within teachers' professional development programs became helpful. The study also stated that many science teachers had implemented STEAM perspectives in their science classes. However, there was a lack of research evidence on how teachers taught STEAM lessons. In 2011, the Ministry of Education of Korea issued a nationwide policy plan to integrate science, technology, engineering, arts, and mathematics education. In South Korea, STEAM education aims to develop a quality STEM workforce and informed citizens for a technologically advanced society by incorporating science, technology, engineering, arts, and mathematics in the educational framework (Kang, 2019, p. 2).

A research study by Padilla (2014) highlighted the emotional ground of four college teachers who teach human rights. The journals, monthly meetings, final reflection narratives, and exit interviews for the emergent themes were considered as data sources. The research concluded that the co-researchers in this study experienced emotional ambivalence (the simultaneous experience of positive and negative emotions). This study also revealed new knowledge and conceptualizations of the roles of emotions in teaching, learning, and honoring the human rights of all beings. Engaging in critical emotional praxis allowed the co-researchers to teach human rights content for transformation rather than simply sharing the information and

concepts about human rights. The co-researchers also discovered that the emotional aspects of teaching contribute to personal, professional, institutional, and societal change.

Kim et al. (2024) conducted qualitative research to observe the early-grade elementary school children's behaviors in a community child center to promote creative problem-solving and interpersonal skills in the STEAM education program. It was conducted at a community child center from May to July 2023. The data were collected from six early-grade elementary school children and investigated to determine qualitative changes in participants' behavior and thinking. This study concluded that the STEAM education program supported the development of creative problem-solving and interpersonal skills of children in a community child center. In addition, a research study by Chen (2024) highlighted the multifaceted benefits of STEM education, including academic and technical skills, innovation, critical thinking, and teamwork. It also emphasizes developing scientific skills and an entrepreneurial mindset. The study proposes a comprehensive evaluation framework for assessing STEM education's cognitive, skill-based, and socio-emotional aspects.

Almost all research studies I reviewed have focused on STEM and STEAM education and the implementation of different pedagogical approaches by teachers and schools. These studies adequately did not present the entire implementation process in the school settings of the low resources of our country. After going through several research studies done in STEAM education and pedagogy in school education, I realized that this is also a new and timely area in the Nepali context. There are various reasons for taking initiatives in STEAM Education in Nepal. A few reasons are the government's initiatives on integrated curriculum, the present disengaged school pedagogy, and the roles of local government in school education.

As I shared before, I am a part of this entire initiative of Rupantaran. I am one of the researchers in this initiative. In this context, my research work is also connected with other researchers as we were on the journey of participatory action research in the same research site, working with the same co-researchers in some studies. So, let me review some relevant studies that were about to be completed during my fieldwork and completed towards the end of my data generation.

Though the needs assessment strategies in the participatory nature of research demand the individual researcher's in-depth involvement from the beginning, the needs assessment conducted for the entire Rupantaran initiative served me to be more

specific in exploring the needs for my research study. In this context, Rajbanshi et al. (2021) conducted a study examining the needs of five community schools in the Kavre district. The research specifically identified the critical needs of the schools and proposed potential interventions (we used the terminology “actions” in our study) to address them. The study employed qualitative methods, including in-depth interviews, observations, and focus group discussions with key stakeholders to gather comprehensive data. Based on the analysis of this data, several school-specific needs were identified. The authors recommend interventions in four key areas: teacher professional development, the implementation of a contextualized curriculum, the integration of technology into the classroom, and the establishment of school gardening projects and urine-diverting toilets. These interventions are also suggested to improve educational outcomes in these schools, which align with the broader goals of sustainable development, particularly Sustainable Development Goal 4, which focuses on ensuring inclusive and equitable quality education for all. This needs assessment report became helpful for me in exploring pedagogical and teacher-professional development issues. Gnawali et al. (2021) made a contribution by showcasing the action research studies of English language teachers in Nepal. It highlights their experiences in applying exploratory action research to address classroom challenges and improve teaching practices. The book provides valuable insights into integrating reflective practices, local contexts, and innovative strategies in English language teaching.

Wagle (2021), a PhD researcher in the same research site, conducted a study entitled “Place Pedagogies, Eco-Spiritual Cosmologies, and Cultural Stories: Wisdom from Dharmashala.” This thesis describes the researcher's emotional, reflective experiences with a participatory action research study. The PAR community created a participatory and generative model of place-informed lifeful pedagogies for one academic session and worked on it. Throughout the study, PAR activities and thoughts confronted many difficulties, doubts, and dilemmas inherent in prevailing indoor instructional approaches that the school had long approved under a seemingly non-ecological and disciplinary context. There was optimism that teachers and students were moving beyond the routine classroom activities. The school's dominating practice architecture of ‘teach and learn for good exam marks’ and its long-standing tendency to accept ‘directions’ from authoritarian expectations of people outside the school reportedly prevented ‘action’ of the ‘talk about’ changes.

PAR partially challenged many of the closed, linear, and disciplinary cultural milieus of the school's dominant practice architecture and fostered perspectival shifts in practice communities. However, the school's long-established ‘teach and learn the prescribed course to pass the exam’ pedagogical metaphor limited innovative pedagogies' organic continuation.

In contrast to linear and disciplinary Western Modern pedagogy, Dharmashala emphasizes ecological relationality. The location of *dharma* is crucial to Dapcha, Dharmashala, like all places. The location dharma, the natural law of emergence, enactment, and transcendence, may have maintained cultural continuity. When the indoor disciplinary practice architecture of school pedagogies endorsed in this place was incompatible with long-held ecological relationality, the school, teachers, students, and community may have lost their authentic ground and ethical responsibility to immediate ecologies.

It also appeared that school teaching and learning were further shifted when outside prescriptions dominated the practice architecture and cultural environment. Many popular but (anti-ecological) postmodern phrases like local, indigenous, or decolonial arose as a disdainful reaction to the prevailing ‘modern’ practice architecture and contributed to school education muddle.

The lead researcher, Wagle, also acknowledged that although the PAR team made efforts and took a ‘messy turn’, he saw many barriers to institutionalizing emplaced, life-full pedagogies in Janahit School's ongoing practice design. Participatory initiations changed stakeholder perceptions and practices, yet the necessity to negotiate indoor design and routine behaviors seemed disempowering. It showed that even "participatory" has limits, and pedagogical innovation's sustainability is greater than human innovation. Perhaps meanings, worldviews, and schooling architecture needed significant renovation. Thus, rather than trying to find life and lifefulness in placeless, lifeless school designs, looking ahead for "ecologically organic" architecture that fits the location seemed a better option. The living school could teach soul-searching now. The journey from "school" to "living school" could be seen as ethically responsible for one's essential value, turning homewards, asking what is my (educators', teachers', students', parents', or researchers') dharma here, now, and flourishing from within. If ‘modern schooling’ is partly non-ecological, displaced, and lifeless, Nepal should start emplaced pedagogies from its own place ecologies. Redefining ‘school’ as ‘living school’ and incorporating

the Hindu-Buddhist metaphor of *Vidhya* (knowledge) and *Alaya* (place) to create *Vidyalaya* (place of wisdom) may be the response. As I closely worked with Wagle during his later part of the fieldwork, his work also contributed to developing spaces to discuss the STEAM pedagogical approach and exploring local wisdom traditions in school education.

Dhungana (2022), a PhD scholar at the same research site, conducted a study titled Developing a Living Model of Professional Development of School Teachers in Nepal: A Collaborative Epistemic Journey. This inquiry aimed to develop a living model of Teacher Professional Development (TPD) aimed at exploring and nurturing harmonious professional learning spaces, both inner and outer, within a community school. Dhungana explained that through this process, she regenerated a new paradigm, *Gyan/Pragya*, which allowed her to perceive the world as *Anandamaya* (harmonious) while participating in various school activities, sometimes taking a step back. She explored her harmonious 'self' from this new worldview as a pathway to continuous professional development. She emphasized that harmony was her core living value, essence, and quality, and the primary aim was to live in harmony as a means of professional development.

As she delved deeper into the issue of teacher professional development, Dhungana came to view it as an integral part of a teacher's life, both as a part and a whole. This study also represents her journey as a teacher, teacher leader, and educator, where she reflected on whether she embodied harmony or was a living contradiction. The study explores a living model of TPD, metaphorically compared to *Ardhanarishwor*, which symbolizes the balance between hard and soft power - Prakriti representing soft power and Purusha representing hard power. Dhungana explained that the asset-based approach to TPD is similar to Prakriti, while the deficit-based approach aligns with Purusha. The living model she developed is not a fixed or perfect standard but a tentative, evolving framework constructed collaboratively with basic-level teachers.

This Living Theory model of TPD influenced not only her learning but also the learning of the teachers and the school's improvement plan, fostering continuous professional development in alignment with the value of harmony. Dhungana described harmony as a collection of three qualities: ignorance, action, and goodness that coexist in equilibrium. Eventually, the Living Theory model of TPD represents a school-based, harmonious model developed by and for the schoolteachers, designed to

align with their needs and strengths. This research provided enough space to continue TPD sessions more specifically while designing STEAM-based activities.

Pant (2023) conducted a study on school gardening on the same research site. He collaborated with a group of students, teachers, parents, and community members to develop school gardening and the production of vegetables using human urine and biochar. In two PAR cycles (plan, act, observe, and reflect), co-researchers planted different vegetables in twelve plots (triplicates of four groups) under four polyhouses. Vegetable production was highest in human urine and biochar. This experimental design provided a strong message to prioritize local resources and knowledge, which are normally undervalued in different societies. The study also suggested that school gardening can be connected to regular courses for learning purposes. Furthermore, this study suggested designing STEAM projects in gardening that help students develop soft skills and self-transform. This activity went side by side as I was involved in the second cycle of my research work.

Several other research studies were conducted at the same research site. However, I felt that the three research studies (Dhungana, 2022; Pant, 2023; Wagle, 2021) were different components connected with my research, and they provided enough background to move forward in my research journey. I am not reviewing these research studies from the deficit model (i.e., exploring gaps for my research study focusing on what the previous researchers did not cover). Rather, I have acknowledged them for creating spaces for my research and continuing some aspects of their research work. For example, the participatory approach of the TPD model, as initiated by Dhunagana (2022), was carried out throughout my research journey while designing and implementing STEAM-focused activities. The ideas of place-based pedagogies and local wisdom traditions (Wagle, 2021) were another component we considered while developing pedagogical activities. The experience of Pant (2023) with establishing school gardening and its connection to the STEAM pedagogical approach was carried out while developing the transformative nature of STEAM projects.

Chapter Summary

This chapter situates the inquiry agenda in the research field. I analyzed different facets of STEAM Education. I also manifested my alignment with the critical lens of STEAM Education for transformative learning from the Eastern and Western perspectives. The experiential learning theory and transformative learning

theory were connected with the research study. In doing so, the roles of that theoretical lens as referents (not as frameworks) were highlighted, and the intent of those theories appeared in the entire research journey through field narratives. The relevant literature was discussed to set the space for the chosen research agenda. Subsequently, research studies conducted outside the country helped to set the global scenario. The studies conducted in the same research site helped to recognize the context of the study and how that context contributed to further inquiries.

CHAPTER III
MAPPING MY RESEARCH JOURNEY

In this chapter, I discuss the philosophical and methodological journey I chose in this study. As I stated in chapter I, my research issue is the overemphasis on the disengaged and disciplinary notion of pedagogical approaches limited to fostering the integrated notion of pedagogy to empower students. I have also problematized the research issues from the perspective of lack of knowledge generation in teacher professional development. In chapter II, I shared thematic and theoretical literature to locate my positionality as a researcher. Now, I discuss the scopes of the research methodology I employ, the nature of knowing I plan to establish, ways of generating knowledge, actions carried out in the field, strategies for meaning-making and discussion of the actions, and lenses to judge the quality of the study, and the ethics I pay attention to during the research journey. The entire research is guided by the ethics of change and becoming through participation. So, I begin with my axiological standpoint in this study.

Axiology: Valuing Participation

As a teacher educator, I believe that the knowledge generation process should value the active participation of individuals facing the issues and benefitting from the constructed knowledge. In this study, I strongly value the participation of teachers, students, and school leaders in my research journey. Richard and Bélanger (2018) have also argued that the knowledge generated through research should prioritize the individuals' perspectives and social contexts when researchers invite people to participate in social research. I also value the knowledge and knowledge systems of the community of research interest (Walter, 1993). In my context, my community is the professional community of action research that values social theory, actions and reflection, critical understating of the context, and improving the existing situations to improve practices (Somekh, 2006). Feekery (2023) shared the key strength of PAR in which co-researchers act as a catalyst to connect the expertise of community people to academic research. I consider the values in this research to promote a way of resisting and rejecting the world's nastiness while not waiting for utopia. It is a way of being in this world, a way of life (Krueger-Henney, & Ruglis, 2020). I also acknowledge the idea of "how do I improve what I am doing" (Whitehead, 2008) as one of the core

values while developing and implementing innovative pedagogical practices in the field. The prolonged engagement of co-researchers in the research site justified such values toward participation from the early stage of needs assessment to reflection.

Epistemology: Co-constructed Knowledge

As I stated in the introduction section of the first chapter, the study aims to explore knowledge by performing actions at the research site and learning through reflection on those actions. I strongly believe that knowledge is always co-constructed and contextual with a possibility of revision. McNiff (2010) states that knowledge produced through dialogue with others equally interested in learning is always effective and helpful. From the perspective of action learning, we all share and acknowledge one another's learning. In this study, dialogues have been held with the stakeholders (such as schoolteachers, students, head teachers, and community members) since the beginning of the study. The people who engage in knowledge construction can also take the lead in transforming society (Maguire, 1987). Brydon-Miller et al. (2020) mentioned that PAR researchers generate deep knowledge in support of what "we" (co-researchers) each hoped to change. In this study, co-researchers hoped to change the existing linear pedagogical practices into an integrated form of pedagogy.

Ontology: Transformative Being

In this research, the ontological standpoint is transformative and activist, as Stetsenko (2017) has argued. Transformative ontology is based on the notion that agency is embodied in human development as an activist stance, and it can be manifested in the form of being, knowing, and doing. The agency is associated with people ready to challenge and move beyond the status quo. The notion of activism believes that all individuals and communities are immersed within and are continuously contributing to the change in practices. In this regard, my ontological position is aligned with the idea of Freire (1970), who emphasized that people do not honestly know reality if they lack a critical understanding of the context and interact with essential elements in the context. The practitioners' central role in the PAR process contrasts with outside professional experts' dominant role in decision-making (Feekery, 2023). So, our existence in this research is rooted in collaborative decision-making within the research contexts and place.

Philosophical Mapping: Multi-paradigmatic PAR

I got to know and somehow engaged in different research traditions during my Master's and MPhil studies and my professional career. I realized that each research tradition has a specific way of establishing knowledge, and no research tradition is superior to others (Denzin, 2019). At first, I learned about action research about two decades back with a popular writer in this field, Kurt Lewin, in 1946. Lewin made a notable contribution to action research in the era where research in general was taken as an "ivory-tower" activity, and practitioners were viewed as consumers of knowledge produced by expert researchers. The major idea of action research was to bring change to societies by observing the problems, making interventions in the field, and reflecting on the results. The concept of Lewin was linear and did not account for the participation of the stakeholders. Moving ahead from the era of Lewin, different scholars have been contributing to the flourishing of the scope of action research. McNiff (2010) argues the need for action research for professional development, and Whitehead (2008, 2018) advocates developing living educational theories using action research methodologies. The ultimate purpose of action research is to improve researchers' practice in their professional contexts. However, improving practice is always a big question. Conventional action research seeks intervention maps from the researchers' experiences or understandings and keeps researchers at the center while implementing the chosen strategies. This process assumes participants are the subjects to be implemented. Such an idea of action research does not help me move forward in my study.

To serve the common interest of improving the pedagogical approach to school education, the knowledge has to be established through a series of dialogue sessions with the research participants, acknowledged as co-researchers due to their active involvement in the entire research journey. As a scholar, I also believe in the participatory approach to knowledge generation. So, I chose PAR as my research methodology. The important part of PAR is that it fully integrates three elements, as it appears in its acronym: participation (i.e., life in society), action (i.e., experiences), and research (i.e., knowledge making) (Chevalier & Buckles, 2019).

I also subscribed to the opportunity to act as an activist-scholar, as PAR provides such opportunities during the process (Mirra et al., 2016). PAR is the belief that knowledge is constructed, and those participating in its investigation can transform society (Padilla, 2014). We, teacher educators, normally claim that we

conduct research for the betterment of society (in my case, school, teachers, and students). However, it is hardly seen that the researchers invite research participants to share their voices from the beginning of the study and involve them in all stages of the research process. During my professional career, I worked with teachers and students. Such experiences of working with the teachers and students made me believe that young and adult people should be able to articulate their views on issues that matter to them, and their opinions should be given weight as per their maturity (Lansdown et al., 2014).

PAR demands insider participation that illuminates the problem under study (Padilla, 2014). For me, PAR seems an ideal approach to research as it uses a collaborative research team that utilizes dialogue and reflection during all phases of the research process. It aims to develop a critical consciousness of the research process and the actions researchers conduct to improve the lives of those involved in the research process. Park (2001) calls PAR the research of the people, by the people, and for the people. Chevalier and Buckles (2019) also mentioned that participatory action inquiry is a practical investigation where the researchers engage in concrete actions and inquiries toward collaborative problem-solving and goal accomplishment.

Within the broader framework of PAR, the psychological-transformative approach of PAR serves my research purpose. The psychological-transformative approach is a pragmatic approach that uses systematic action inquiry using either the existing standard fact-finding and experimentation or collaborative analytics designed to be as user-friendly as possible (Chevalier & Buckles, 2019, p. 44). My position is towards a collaborative approach rather than using pre-existing fact-finding standards.

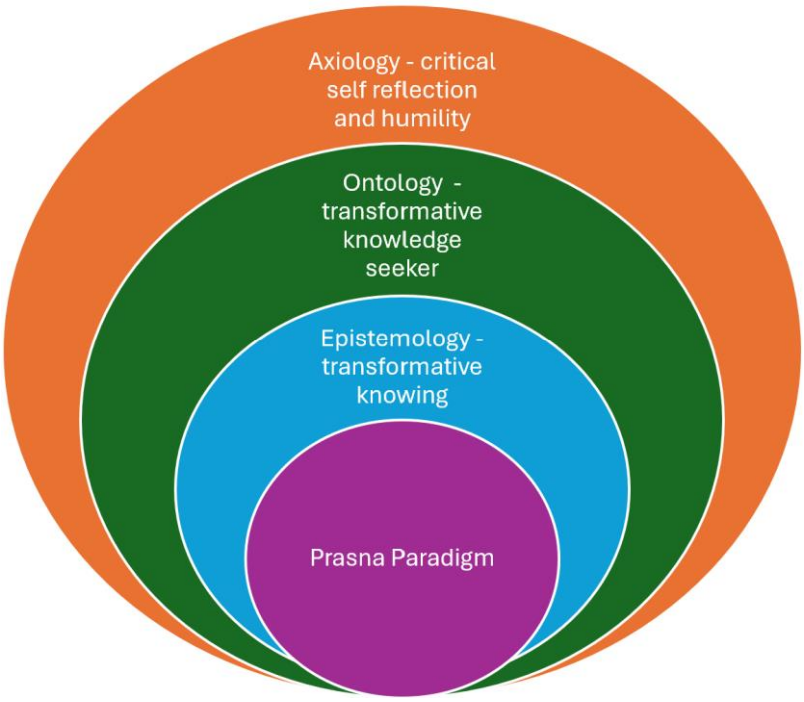
The research agenda in this study seeks multi-paradigmatic transformative research perspectives (Luitel, 2019) to contribute to the researcher's professional context as a practitioner-researcher and to make visible changes in the research site with some pedagogical innovations in collaboration with co-researchers. I used *Praśna*, *Karma*, *Dharma*, *Arthā*, *Kalā*, and *Moksha* as paradigms in my research. I used these paradigms from the perspective of becoming a PAR researcher while engaging in the PAR research journey.

Praśna Paradigm

The etymological meaning of Praśna is “question”. I used the idea of Praśna from the epistemological, ontological, and axiological basis. Here, knowledge is more than an accumulation of ideas through everyday explorations; it is a transformative realization of the phenomena (such as how pedagogical innovations happen in my study). Praśna emphasizes that questioning is a continuous process (as a path) to uncover hidden truths that dismantle illusions to deepen awareness of interconnected realities. From the ontological stance, Praśna as a paradigm considers humans as knowledge seekers who engage with the world for exploration. Praśna cultivates the values of self-reflection and humility. It considers questioning an intellectual and ethical activity that helps make people aware of their preferences and assumptions. This idea helped me raise Praśna (questions) during the research journey. I began the research journey with several Praśna, such as, am I ready to be a PAR researcher? How can I negotiate with my own ego and so-called expertise on the research site? What happens if the co-researchers disagree with a certain set of actions? The nature of Praśna changed, but it remained even today in my dissertation writing phase. Is this a way to showcase all the actions? How do I argue the depth and width of the evidence we collaboratively generated in the research field?

Figure 2

A Drawing to Demonstrate Praśna as a Paradigm



(Source: field work)

While raising several Praśna to myself and for the action and reflections conducted in the research journey, the critical paradigm offered me a critical viewpoint needed to investigate in the field, to invite co-researchers to reflect on their own beliefs and practices on their everyday professional actions (Stinson & Bullock,

2015). In the needs assessment phase, perhaps, this is the phase I used several Praśna with the teachers and myself. Those questions were rooted in exploring teachers' agency and acting with a mindset of making some positive changes in the pedagogical arena. Along the same line, Dhungana (2022) used this paradigm to pose questions to the teachers, encouraging teachers to raise questions that supported us (the lead researcher and teachers) to engage in interaction akin to a critical approach. Barquero et al. (2019) used the "paradigm of questioning" in teacher education. The authors argue that teacher education should be guided by questions rather than predefined answers for the problems teachers face.

Karma and Dharma Paradigm

In the Vedic tradition, *Karma* is the action done by the doer in anticipation of movement or achievement (Panini, 1.4.49). *Dharma* provides guidance for properly performing karma. Individuals who follow their dharma properly can generate positive karma, which benefits their progress and the well-being of the world around them. I have used *Karma* as the principle of action and its consequences, whereas *Dharma* is the moral and ethical code that governs how one should behave. There is a relationship between *Karma* and *Dharma*. *Karma* was meaningless without *Dharma* (Bhangaokar & Kapadia, 2009). The epistemology of *Karma* as a paradigm is the knowledge that is generated through a series of actions and their consequences. The epistemology of *Dharma* is the knowledge that is rooted in the recognition and realization of ethical values of the chosen wisdom traditions. *Karma* emphasizes that the existence of humans is shaped by the dynamic interplay of actions and their outcomes. *Dharma* emphasizes that the self is both an individual and a collective entity that serves the community for a greater goal of togetherness. *Karma* values that an individual is responsible for their actions and outcomes, whereas *Dharma* places moral integrity as the supreme value.

In this research, while working with schoolteachers, *Karma* and *Dharma* were guiding principles for informing their roles, responsibilities, and ethical practices. Simultaneously, as the students developed and implemented transformative STEAM projects in the third cycle (see Chapter VII), they also understood their *karma* and *dharma* after completing specific projects. By embodying these ideas, we, as co-researchers, attempted to create meaningful impacts in their students' lives and contribute positively to the community. Dewey (1998) argues that education, viewed through pragmatism, should be a practical and engaging experience that prepares

students for solving real-world issues. He promotes experiential learning when students interact with real-world issues while fostering critical thinking instead of memorizing. Dewey believes that educational institutions need to foster democratic principles to become engaged, responsible citizens through collaborative learning and engagement in authentic problem-solving activities. I recognized that *Karma* is organically linked to pragmatism, as teachers are inclined to conduct activities within a practical context.

Arthā Paradigm

The Arthā paradigm is used for a meaning-making process. Salagame et al. (2017) argued that the meaning of life and the meaning in life both involve connecting with and relating to the happenings around us, emphasizing the importance of engaging with our experiences. In this study, I used this idea to generate Arthā of the collaboration actions and reflections of the everyday actions of schoolteachers. The knowledge in Arthā paradigm is drawn from the reflective engagement with the context. Ontologically, Arthā views being as a synthesis of material existence and deeper existential reality, realizing the purpose of actions. Arthā values actions as meaningful when they are meaningful to individual aspiration and societal well-being.

Generating Arthā is more than interpreting from the lens of an interpretive paradigm (Taylor & Medina, 2011). The interpretive paradigm enables me to explore the lived experiences of students, teachers, and community members concerning teaching and learning practices in the school and outside (Bryman, 2012). While generating Arthā of any events or actions, we also consider some hidden and unspoken sensations, whereas interpretivism broadly aims to interpret the collected or generated texts. While discussing the several layers of participation of co-researchers, I tried to discuss the Arthā for ignoring the lead researcher's presence at the beginning of the fieldwork.

Kalā Paradigm

Patnaik (2004) argued that the core of the Kalā tradition is the narrative of an oral or written text, and each Kalā strives to achieve a common aesthetic goal, at least in theory. In the Kalā paradigm, knowledge is experiential and generated from engagement with artistic approaches, in which art becomes a medium to access deeper truths. Ontologically, Kalā views being as inherently creative in their actions and expressions. Kalā values both creations and the process, emphasizing that individuals should be allowed to derive meaning from multiple standpoints. The postmodern

paradigm in Western literature captures a few notions of Kalā, enabling multiple genres to portray the various aspects of actions that emerged (Taylor & Medina, 2011). For example, during my fieldwork, I used letter writing as a genre to share my ideas with co-researchers. I also used pictures to demonstrate complex concepts in visual form so that readers could make meaning out of the picture.

I also found that all Kalās can lead one to moksha, or transcendence; at a personal level, many artists transcended ego and thus surrendered their work (Patnaik, 2004). One of the natural purposes of PAR research is to make co-researchers reflective practitioners. At some point during the fieldwork, the notion of *moksha*, which is discussed in the next section, is also required.

Moksha Paradigm

Moksha is also understood as liberation. Spirituality, the ultimate goal of life, is to have moksha, which is liberation, going beyond the cycle of birth and death (Salagame, 2017). But, here, the idea of moksha has been used from the perspective of the realization that getting the meaning of life is also a liberation from that life (Chakravarthi, 1995). Realizing this potentiality lends ultimate meaning to life and helps people find meaning in day-to-day affairs (Salagame, 2017).

The epistemology of the *Moksha* paradigm is knowledge as self-realization through direct experiences. The ontological connection of *Moksha* transcends boundaries through a continuous engagement of actions and reflections. Moksha values liberation, freedom, compassion and engagement in the actions and knowledge generations. In this research context, the realizations made were self-motivated participation and autonomous participation (Pant et al., 2023b) that happened towards the last cycle in this study. Even after completing the research site, I received several requests to collaborate and support the ongoing actions. This is what I understood as the realization of the meaning of life as a teacher.

PAR as Chautari[1]

During the research process, I learned that I was using several practices I used to have during my childhood. I was born in a rural village in Nepal. I used to support my parents in farming in my childhood. I also had to take goats to feed them forest grass. We used to relax in the *Chautari* when we got tired from traveling to and from farms, forests, and school. Chautaris are usually constructed under *Pipal*[2] and *Bar*[3] trees. During my fieldwork at the research site, I recalled childhood memories of being near *Chautari*. I discovered as a teenager that adults met in the *Chautari* to debate social issues, share ideas, and agree on community decisions. After reading about participatory action research, co-researchers, enabling conditions such as trust and respect among participants, a place to share ideas, and the negotiations that go into action and reflection, which involve reaching a shared understanding and agreement, I began to connect with the *Chautari*. I believed I was back to my culture. The place encourages people to connect, exchange stories, discuss issues, and make decisions.

Figure 3

Chautari Drawing

(Source: CDC E-library)

Since I grew up in the *Chautari* tradition, I observed a few connections between PAR and practices at the research site. Being familiar and accessible, *Chautari* naturally attracts varied community members. When I was in the middle of my research journey, I read some ideas from Krishna Yajurveda Taittiriya Upanishad (2.2.2). It is mentioned that;

सह नाववतु । सह नौ भुनक्तु । सह वीर्यं करवावहै । तेजस्वि नावधीतमस्तु मा विद्विषावहै ।

(oṃ saha nāvavatu. saha nau bhunaktu. saha vīryaṁ karavāvahai. tējasvi nāvadhītamastu mā vidviṣāvahai.)

(May the supreme protect us (teachers and students); May we work together with great energy and vigor; may our study be enlightening and give us brilliance.)

---

[1] A place under the tree built to have a rest during the walk or for gathering to discuss some social issues.

[2] The pipal is a kind of tree, which is revered for its spiritual significance, particularly as the tree under which the Buddha attained enlightenment.

[3] The bar is also a kind of tree, commonly found alongside the pipal tree, is revered for its extensive aerial root system and is a symbol of strength and interconnectedness.

The Rig Veda (10.191.2) examined this work together, discussing and comprehending each other's ideas. This is how gods in the past managed their situations: they got to know each other's opinions and worked together smoothly. I realized that collaborative actions and thoughts had been used in the East for ages as a knowledge-generation technique. Furthermore, the Rig Veda (10.191.3) states that people have similar tasks, shared knowledge, and a common goal with shared learning. In this research journey, we have common goals for school improvement and knowledge generation through fieldwork. So, being in Chautari is the best way to achieve the common goal.

Ahmed (2014) used *halaqah* as a research method. The author examines *halaqah*, a traditional Islamic pedagogy, as a potential authentic research method, contributing to critical and indigenous discourses by analyzing the Islamization of Knowledge and other 'critical indigenous' movements among Muslims. A brief qualitative study is performed to evaluate the effectiveness of *halaqah* as an authentic Islamic research method using stated principles. Muslim mother-teachers met in *halaqah* to reflect on their work as holistic Islamic educators, producing a 'critical indigenous' education for Muslim children in modern Britain. This study suggests that *halaqah* is a more authentic research method than group interviews or focus groups, as it allows participants to express themselves within their settings and engage in critical reflection within an Islamic worldview. After going through this idea, I dreamed of using *Chautari* as a research method while I was on the research site.

Methodological Mapping

PAR has several non-linear phases. The phases sometimes become emergent, and the principles behind such phases are rooted in democracy, equity, liberation, and life enhancement, which make it distinct from other generic qualitative methodologies, as noted by MacDonald (2012). So, at this stage, I share the following approaches to be considered in my study. I am influenced by the ideas of Kemmis and McTaggart (2005) when choosing the strategies of PAR in the field. They have stated that PAR is a social process, a practical and collaborative process, and a reflective process that transforms both theory and practice for the emancipation of members of society.

Research Site and Co-researchers

My research site is located in Kavre district, which is around 48 kilometers east-south of Kathmandu Valley. The research team committed to working with five

schools, two of which are secondary and three basic (primary) schools. One of the schools is named an action school, where the actions are done at the beginning with the collaboration of stakeholders. The other schools are named as reference schools where the success stories of the action school were carried out as reference. Since my study is a part of a comprehensive study, there are other researchers as well. We, as researchers, have a collective goal to document the changes that occurred in the schools and the communities and an individual goal to support the collective aim, as each research is a complete study. I have used the terminology of 'lead researcher". The lead does not mean taking the lead in all activities and the decision-making process. As per the principles of PAR, the lead researcher's role is to develop a collaborative environment and ensure that the entire journey moves in a participatory way. The basic level schoolteachers of the action researchers are co-researchers who were involved in the entire research journey from the beginning of the needs assessment phase. The teachers who entirely teach only grades 9-12, and the students were considered participants who were not involved in planning and reflections but were a part of implementing several pedagogical initiatives.

Needs Identification

This is a very important step in my research study. I invested a long time, around eight months from February to August 2019, to sense the status of the field and to explore the areas with the intention of exploring the shared need where I could collaborate with the stakeholders with a vision to make positive changes in the pedagogical approach. The identification of needs in such research studies is an ongoing process. Every time I visited the field, I developed a new level of understanding in relation to teachers' expectations of effective pedagogical approaches. Most of the teachers in the action school were expecting to continue the support from the previous researchers (i.e., two PhD researchers completed their fieldwork by the middle of 2019) in the areas of teachers' professional development by using project-based learning and inquiry-based approaches.

In the meantime, I went through the baseline report, which was also published later (Rajbanshi et al., 2021) and was conducted in 2017/18. The comprehensive report recommended several actions for the schools and communities. The major collaborative action was supporting teachers in developing and implementing rich classroom tasks. Before going to the field, due to my experiences as a teacher and teacher educator, I deeply felt that incorporating STEAM pedagogy is one of the

needs of school education. But I knew my realizations may not be actual in the field. However, as a researcher, I was aware of the territories of my tasks: STEAM education, integrated pedagogy, project-based learning, and inquiry-based learning. After conducting a series of workshops, interviews, and class observations in the action school, I matched the recommendations made by the baseline report within the broader areas of my territories. This provided insight into collaborating with schoolteachers to prepare inquiry-based activities as a pedagogical approach at the basic level. The common goal of almost all schoolteachers is to learn ICT skills and use them in classroom teaching. The details of the need assessment procedure are presented in Chapter IV.

Collaborative Actions

The capacity building of teachers on the chosen strategy is one of the aspects of this study. The capacity development of the teachers and the implementation of the skills they receive during the workshop session go together. As a PhD scholar and PAR researcher, I collaborated and supported schoolteachers in implementing the plan in class, and we collaboratively explored the solutions to the problems that arose during the implementation. During the capacity development and implementation phase, a range of participatory workshops on course development, pedagogical modeling, developing STEAM lessons, authentic assessment, etc., were conducted for the professional development of in-service teachers. Teachers at the action school also hosted workshops for teachers in the reference schools to generate synergistic knowledge-sharing and learning opportunities. More specifically, I completed my field engagement in three different cycles.

Cycle 1. Based on the needs I explored with schoolteachers, I collaborated with them in the first cycle to develop inquiry-based activities for schoolchildren. As per my fieldwork experience during the needs assessment phase, I realized that helping teachers prepare inquiry-based activities would be one of the best entry points for a researcher. In the beginning, I worked with Mathematics and Science teachers of basic level (till grade eight) as I observed students in those subjects are demotivated and disengaged. As per the teachers' expectations, I also helped them use basic computer skills to develop projects. These activities helped develop a good platform to move towards the STEAM pedagogy. The good part was that the schoolteachers of the “action school” had already started to use computers, and they had demonstrated their interest in integrating ICT into their lessons. This cycle was planned for four

months, starting in September 2019. The reason behind choosing a cycle of four months is the traditions of the Nepali school system, where one academic session is divided into three quarters. Normally, the school makes plans for each quarter, and the students are assessed accordingly through the quarterly tests. But it continued for seven months (i.e., September 2019 to March 2020). Due to the nature of PAR, I, as the lead researcher, never forced teachers to complete our agreed tasks on time. Rather, I used to motivate and wait till the activities were completed. So it took a longer time. I had the opportunity to observe the entire process during this time.

Cycle 2. The lesson learned from cycle one helped us to develop cycle two. As a researcher of PAR, I never expected that the initial plan would go the same way as it did. During the proposal development for my PhD study, I planned to incorporate different forms of art (stories, painting, etc.) from the beginning of the second cycle. Story-telling approaches are among the most successful approaches to using arts in mathematics and science in different parts of the globe (such as Korea). Egan (1988) goes beyond the traditional argument that this strategy motivates because stories with mathematics connect students to the so-called real world or how the world is assumed to be. Instead, he argues that by drawing from the historical origins of mathematics, mathematical stories may engage students' different visions by connecting the present with the past. I also gathered information that some teachers in the action school used painting as a pedagogical innovation with the other researchers. I thought I should continue this idea by expanding its horizon with the various forms of arts in mathematics, science, and language-related subjects. While doing so, mathematics and science curricula would appeal to students through a historical perspective.

The Curriculum Development Center (CDC), a government body of Nepal that develops school-level curricula, has also developed an integrated curriculum for grades 1-3 (CDC, 2019). In this context, using various forms of arts and technology could help integrate various subject-centric knowledge and skills. But, this did not happen after we completed the first cycle. COVID-19 has also caused a disturbance in the face-to-face workshops. The reflection meeting after the first cycle suggested working on developing activities for the multidisciplinary and interdisciplinary nature of activities and implementing them. So, the second cycle was dedicated to developing and implementing multidisciplinary and interdisciplinary activities and projects. This cycle went from June 2020 to May 2021. It lasted for a year.

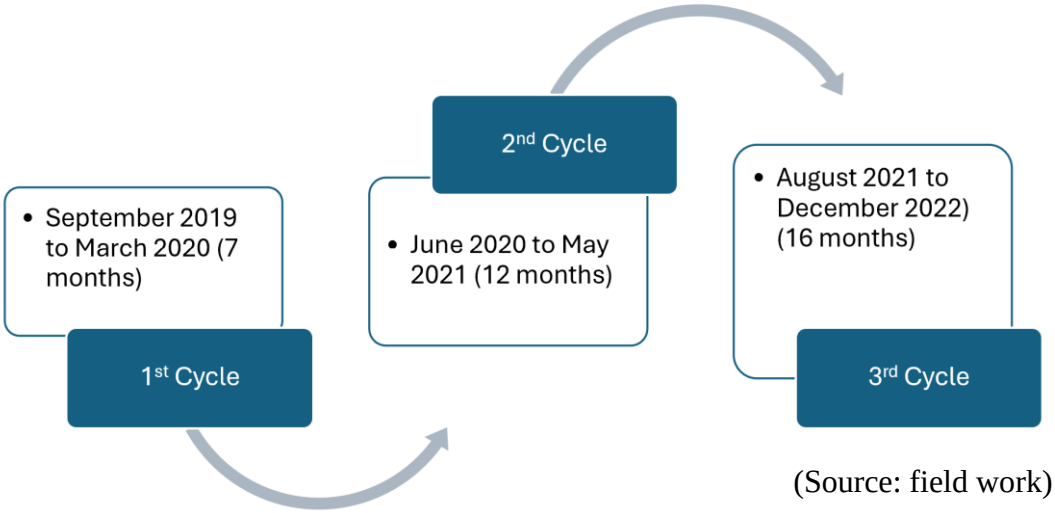
Cycle 3. Before beginning this cycle, a detailed reflection was made with the stakeholders. The reasons behind successful actions and the actions that need revisions were carefully investigated, which is a natural process of PAR (Morales, 2016). The strategies of interventions may not be appropriate over time, and thus may require amendment. Critical reflections on our deeply seated beliefs, practices, and ideologies were necessary. Reflection and lessons learned are iterative and bi-directional in this study. Based on my preliminary visits to the field during the time of proposal development, I planned that this cycle would be aligned with developing and implementing STEAM lessons by incorporating technology-integrated pedagogy (Ge, Ifenthaler, & Spector, 2015), design thinking (Brown, 2008; Culén & Gasparini, 2019), and different forms of arts (Stroud & Baines, 2019). I thought that I would invite schoolteachers and students to develop STEAM lessons based on the national curriculum developed by the CDC in Nepal. I also considered using the conceptual model of STEAM teaching practices as a transdisciplinary learning process (Quigley et al., 2017). This model proposes that instructional content and learning context as two major domains. Instructional content is proposed for different ways the teachers organize, prepare, and deliver the content to the students. The learning context focuses on the rich classroom instruction environment where the students' equitable participation is focused. I considered this a referent because my departure point of the "interventions/action" was based on the issues that demonstrated a lack of students' values and ethics as shared by the schoolteachers.

The idea proposed by Quigley et al. (2017) is a transdisciplinary way of learning, which is useful in the Nepali context as the Nepal Government has developed an integrated curriculum for grades 1-3 in the line of multi and interdisciplinary approach (CDC, 2019). The major contributions of this model are the authentic problems aligned with curriculum, promoting disciplinary integration, teaching problem-solving skills, and supporting teachers for meaningful technological integration. This model welcomes PAR as an approach as the authors mentioned, "Supporting teachers via PD, structural and collaborative consideration (e.g., professional learning communities, common planning time, block scheduling" (Quigley et al., 2017, p. 9) is one of the major implications of the model. I also mentioned keeping doors open to welcome other possible approaches that emerged in the field. As a PAR researcher, one of the intentions is to suggest a new contextual model of STEAM pedagogy, which might take a long time.

After completing the second cycle, we had reflection sessions among co-researchers. We collaboratively decided to work on the transdisciplinary nature of

Figure 4

The Timeline of Field Engagement in the Schools



(Source: field work)

STEAM projects, and we named the Transformative STEAM project. This cycle also lasted for 16 months. This cycle went from August 2021 to the last month of 2022.

Nature of "Data" and Generation Process

My field study ended up lasting longer than anticipated. It was planned to complete the entire field engagement in one academic year. But it has been expanded for three and half years. I generated several narratives and field memos through formal and informal conversations and interactions during fieldwork. Over the period, my understanding of fieldwork (i.e., working only with schoolteachers on the research site) also expanded. In the later part of my engagement with schoolteachers in the research site, I developed an updated understanding of fieldwork, which was my entire engagement as a researcher, and my influences on my own professional development and other organizations rooted in my actions in the research site. In this regard, one of the most influencing ideas was "the death of data" (Denzin, 2013) and "the death of data in the neoliberal times" (Denzin, 2019), in which the author argues that the comprehensive nature of data is rooted in human experiences in the forms of stories and narratives. The author also critiques how neoliberal ideologies have shaped research practices and data like "commodities" generated by the interest of popularization in the research "market." In this regard, Denzin (2019) mentioned;

> After all, we are an empirical, not a text-based humanities discipline. We connect our interpretive practices to events that go on in the social world. That

> is, we do more than read and interpret already published works. We write in ways that evoke experiences in the world. We write stories that can be used, that can be trusted, stories that can change the world. (p. 2).

I became aware of the idea shared by Denzin in the entire research journey. Though an international organization provided financial support for my research, I learned and experienced that there was not any interest supplied to the researchers to promote a certain agenda; rather, the supervisors and the entire research team were trying to make it more reflective and critical by exploring the local knowledge system.

So, for me, "data" are stories shared by my co-researchers, pain and pleasure experienced and felt by the lead researcher and the co-researchers, and the evidence of the realizations during and after the actions by the co-researchers. For this, the data was generated by continuous formal and information interactions and memo writing by the lead researcher throughout the research process. At the same time, as the lead researcher, I also maintained a diary of my involvement as a university academician and teacher educator to map my engagement with different professional organizations concerning my research activities. I considered professional engagement to showcase my professional development as a PAR researcher.

Meaning Making of the Actions and Reflections

This is one of the most important tasks in my study, which begins from the initial days of field work till the end of report finalization. The meaning-making of actions and reflections of co-researchers go simultaneously. The series of collaborative workshops with schoolteachers, interviews with teachers and students, focus group discussions with teachers and students, and other activities that meet the demands of the situation were carefully noted. The narrative analysis of the events (Webster & Mertova, 2007) helped me develop the meanings of the actions and reflections. For that, I subscribed to the different paradigmatic positions that allowed me to make sense of various actions conducted collaboratively in the field. I attempted to use a multimethod restoring framework for narrative analysis where co-creating stories and making co-creation are essential for the progression of stories (Nasheeda et al., 2019). While analyzing the narratives, I critically discussed the events by illuminating the values, assumptions, and deep-seated beliefs and practices of the co-researchers and other stakeholders. For this, I subscribed to the ideas of critical reflection (Mezirow, 1991) and ideology critique (Geuss, 1981), which helped me develop a critical awareness of how ideologies serve interests by analyzing their

historical roots and assumptions. It also discloses the falsifications and mystifications of ideas and events. I believe that capturing complex field works with plain texts is a very challenging task. The roles of co-researchers (i.e., school teachers) during the meaning-making process were crucial. When I developed field notes mentioning the details of the field actions and reactions, I shared my ideas with the co-researchers and got feedback on their understanding. Several times, I revised the meanings of the narratives I developed. For example, during cycle one, when we agreed to develop and implement inquiry-based activities, I initially sensed that school teachers were interested in incorporating a multidisciplinary nature into their inquiry tasks. When I shared my understanding, teachers from grade 4 and above initially expressed a desire to use inquiry tasks in their subjects.

One of my responsibilities would be to take the readers into the field through my writing. For that, I used the paradigm of Kalā and postmodernism, as discussed by Denzin and Lincoln (2018), where I took opportunities to use multi-voiced dialogical texts with the help of performativity and non-linguistics genres to produce oriented, strong, and rich narratives. For example, I used letter writing as a genre (Nevala, & Palander-Collin, 2005) to make sense of how I, as the lead researcher, interacted with co-researchers during the fieldwork. I also used semi-fictive writing, in which researchers can develop narratives with creativity in emotions and dialogues, and the narratives should be based on actual experiences and observations (Satchwell et al., 2020). Ultimately, I landed my study with implemented knowledge after a series of realizations and experiences.

Ensuring Quality in Research

In this section, I discuss the quality criteria I employed in this research. In doing so, I discussed my plans during the fieldwork and writing phase, which helped me understand a broader idea of PAR researchers. I believe this allows readers to frame their positions to view the quality of this research study.

Critical Reflexivity

This is one of the foundational ideas in my research that helped me to be critically aware of the roles of self that play out in a way that challenges the researcher to be able to come across something unknown as they move on (Cho & Trent, 2006). Critical reflexivity provides sensitivity and attention to problems around methodological rigor and ethical research; researchers and their supposed 'own people' are not necessarily complementary, ideal, and beneficial (Ademolu, 2024). So,

the researcher's positionality and publicizing it to the reader are essential. I had multiple roles – as an "expert" in curriculum development and resource materials development, a teacher trainer for a decade, and a university faculty besides a researcher. I was aware of my roles and positions. I consciously assessed my assumptions about learning, teaching, and researching during the study. I also examined how unjust dominant ideologies are embedded in everyday situations and practices, shape behavior, and keep an unequal system intact by making it appear normal (Brookfield, 2017). More specifically, I tried to use three critical reflection phases, as Brookfield (1990) suggested. In the first phase, I identified the assumptions taken for granted in researching and pedagogical practices that influence my thoughts and actions. In the second phase, I assessed those taken-for-granted assumptions regarding how they affect teaching and learning. In the third phase, I developed new assumptions that are more inclusive and empowering, which helped me search for better alternatives in different cycles. In the third cycle, we developed and implemented transformative STEAM projects, critically examining the limitations of existing project-based learning, particularly its overly concentrated content that lacked relevance to everyday problems. We investigated the deeply rooted values behind such project development practices and explored the connections between newly developed projects and students' everyday values and ethics.

Praxis

As my approach to knowledge generation is inductive and rooted in the experiences of the field works, praxis is one of the quality standards. Lather (1986) defined research as praxis, arguing that research is a democratized inquiry process characterized by negotiation, reciprocity, and empowerment. A transformative praxis involves reflexivity, community-engaged research, reciprocity, and action (Thambinathan, & Kinsella, 2021, p. 6). I frequently negotiated with my co-researchers to explore the needs, develop strategies for pedagogical innovations, and implement them in the context. The ideas of reciprocity provided me with space for a balanced pattern of sharing ideas (giving and taking) between co-researchers. As per the nature of PAR, I always invited my co-researchers to challenge their own assumptions of teaching and learning, become aware of the power-action relationship, and search for better options in their professional context, ultimately leading us toward empowerment.

Pedagogical Thoughtfulness

One of the major actions was developing innovative pedagogical approaches (i.e., STEAM pedagogy) and implementing them in the schools by schoolteachers. As stated before, pedagogical innovation was one of the conscious attempts in this study after having several meetings with the co-researchers. For this, I brought the narratives of the prolonged journeys, actions conducted in the field, possible revisions made during the fieldwork, and the reflection we all had during the process and at the end. These all-detailed explanations certainly invite schoolteachers to reflect on their practices and engage in the act of pedagogical thoughtfulness, a way that educators grow, change, and deepen themselves because of reflecting on living with children (Van Manen, 1991), which is essential in preparing self-motivated and engaged teachers.

Maintaining Ethics in PAR

I maintained the ethics and conduct of PAR, as Chevalier and Buckles (2019) proposed. The first principle is to respect the autonomy and freedom of individuals and groups. In my study, I greatly respected the schoolteachers' views and ways of teaching. The teachers, students, and school leaders were always accessible to share their experiences in terms of their professional work. For that, I requested my co-researchers for their free and ongoing consent with prior information. The second principle of PAR is the obligation to protect the welfare of living individuals or groups. I have considered this issue carefully by maintaining confidentiality of the information and narratives of my participants. The idea of confidentiality differs from the generic kind of qualitative research in PAR. The actual names and photographs were used with the consent of the school and the individuals participating in this research, as they are co-researchers rather than passive participants. The third and last principle, according to Chevalier and Buckles (2019), is to work for the justice of the participants and places. Ensuring the inclusions on the research site and with the co-researchers is the most appropriate approach. I ensure that no particular people or group feel discriminated against or overprotected in terms of age, gender, language, culture, ethnicity, disability, etc.

I also maintained the ethical standards per the KUSOED's rules, which were applied to me. The major ethical standards mentioned in the KUSOED's rules were to share the entire research purpose with research participants and not to harm the researcher site and participants.

Chapter Summary

This chapter provides details of the philosophical underpinnings behind the use of several research paradigms from the Eastern wisdom tradition. At the same time, I also connected with the research paradigms discussed in the West to provide spaces for readers to connect both traditions. I also justified the need to subscribe to PAR as a research method and connected the idea of *Chautari* with the PAR process. Then, I moved into the methodological details employed in the research journey. I shared the major focus of each cycle and the nature of the data we collected and generated in the research journey. The meaning-making process of the narratives was also discussed.

The next chapter deals with the detailed process of exploring co-researchers' needs. The need assessment process itself is knowledge, and I kept this a high priority as the co-researchers' conscious and passionate attempt to give birth to the authentic needs in PAR. The entire narrative demonstrated how the collaborative process happened during the establishment of the shared needs and priorities.

CHAPTER IV
EXPLORING NEEDS OF CO-RESEARCHERS

This chapter explores the co-created needs of the schoolteachers and ways of becoming co-researchers. Before arriving in the first cycle, I invested eight months in the research site for needs assessment/generation. I visited the research site seven times in person during the eight months. The needs assessment process is important, and knowledge generation during needs assessment is essential in PAR research. So, this chapter addresses the research question: how do co-researchers negotiate and create the needs for the actions in participatory research?

It aims to explore connecting the school setting with co-researchers' interests to improve pedagogical conditions. I begin with the initial narratives of my school and community visits. Then, I discuss how my co-researchers and I struggled to identify common spaces for working together to improve the pedagogical practices in the school setting. As I shared in the first chapter, the major issues we realized were students' disengagement and inadequate learning resources. It was a preliminary issue commonly established during the initial stages of field engagement. This chapter explores the needs in-depth and co-constructs the necessary actions to solve the felt pedagogical problems.

What an Excitement! No… No… It's Fear, too!

When I was selected as a PhD student, I was asked to develop a detailed research proposal. I was pretty much aware of the overall activities going on at my research site. As a researcher, I was also interested in making notable changes in the schools' pedagogical practices. But, as a PAR researcher, I had to visit the research site, meet my co-researchers, make myself aware of the context in detail, and explore the possible actions for common needs. In this context, it was my first visit to the research site.

It was 21 February 2019. We moved to the research site. I was with two other PhD scholars near the end of their fieldwork. The research site was the same. The school was the same. The teachers were the same. The problems might be the same. But, we, as university researchers, had different backgrounds and agendas within the same umbrella agenda of school improvement. One of the PhD scholars, Ms. Participatory, said.

> Now, Binod sir's[4] journey also begins today. I think you will enjoy coming to the school almost every week and working with schoolteachers for almost a year.

I was about to respond to her. But, another PhD scholar, Mr. Philosopher, quickly added his remarks.

> Binod sir, you might be excited today. But, when you reach the school, you might think that your journey could be difficult. So, do not be overexcited.

On the one hand, I was a bit serious as I was conscious that I was now a PhD student. I was responsible for making some notable changes in collaboration with schoolteachers. How could I move ahead if I could not establish a good relationship with my co-researchers? On the other hand, I thought I had a lot of experience working with schoolteachers. I had the confidence to work with school teachers effectively. I just said.

> Let me see how I can move forward. I need your support and suggestions as this is my first visit, and I am new to the place, institutions, persons, and issues.

With such an informal chat, we were traveling. We reached to the school about 10:10 am. The school assembly was going on. We observed the assembly from the side of the ground. Some students looked at us, and some young children said hello to the other two PhD scholars. All students entered their respective classes. Teachers gathered on the school ground. We exchanged greetings. Ms. Participatory introduced me.

> He is Mr. Binod Pant. Now, we minimize our travel. He will continue with the activities for a few years. You will let him know gradually.

We all went to the staff room. Almost all teachers went to their respective classes with the attendance register. Two teachers did not have class in the first period. They were in the staff room. Mr. Philosopher asked one teacher.

> Sir, what’s going on? Can you manage time to develop some inquiry-based activity as we discussed in our last visit?

The teacher said.

---

[4] In Nepali culture, people use the term "sir" with respect. Therefore, I have utilized this term frequently, as it was observed at the research site.

I planned to prepare four activities. But I managed to make only two. I think these are also not as you expected. Will you please go through it and provide your observations?

The teacher gave his diary to Mr. Philosopher, and Mr. Philosopher scanned his writing and said.

This seems good. What a good beginning. You started with their context. Please keep on developing similar activities. We will discuss it tomorrow in the general meeting.

Mr. Philosopher wrote something in his diary. Perhaps he was taking notes to capture the field data. I also quickly took out my note copy from my bag and started writing my observations shortly afterward. I was observing the staff room - school calendar on the wall, students' numbers in the diagram, names of teachers and class routine, old chairs, tables, racks, etc. After a few minutes, Ms. Participatory and one female teacher entered the staff room. Ms. Participatory said, “Binod sir, she is the head teacher of this school.” We exchanged our greetings. Before I reached the school, my friends had informed me about the recent change in school leadership, and the head teacher was a young lady. The head teacher welcomed me and expressed her interest in working further. I also expressed my deep interest in collaborating with her and the team.

On day one, we interacted with all teachers during their leisure periods. Two friends took the update, and I acted as a passive observer. My purpose was to make myself familiar with the situation.

On the next day (22 February 2019), we reached the school at about 10 am. The school has managed one interaction session during lunch break and one period right after lunchtime. All teachers gathered in the meeting room with a pen and diary. All teachers shared their updates on preparing inquiry-based activities and plans. A few teachers also shared their struggles while preparing for the activities. I sensed that they had developed a good working culture. While listening to their activities, I sometimes felt that they could be further enhanced to make them more inquiry-driven. Mr. Philosopher and Ms. Participatory asked me to observe the teachers' work. But, I didn’t want to take a risk by providing critical feedback on my first visit. I just acknowledged their efforts and thanked them for doing such activities.

On the following day (23 February 2019), I wanted to meet mathematics and science teachers first and listen to their practices in teaching mathematics and science.

I shared this with the head teacher. After observing the class routine, she suggested interacting with the teachers in their leisure time. I waited for that. First, I met one mathematics and science teacher in the staff room. He was Mr. Khanal. I shared my interest in discussing his teaching practices in mathematics and science.

He agreed to it. He said.

> Sir, our teaching style is traditional. I go to the class. I try explaining the mathematical concept first and move on to the problems. Few students can catch the idea and use problem-solving techniques quickly. Some students find them very difficult. Now, I should learn from you.

I quickly replied.

> I am here to learn from all of you. Sir, I also do not have any shortcut approaches to solve such issues. Most probably, we collectively explore better approaches. What are the major issues you are facing in mathematics and science?

Khanal sir further said.

> The notable issue is the lack of foundational knowledge of mathematics and science. A few students in grade seven cannot add numbers. Some students in grade eight do not understand basic ideas of science that should have been learned in the previous grades.

After the interaction with Khanal sir, I sensed he had a good sense of humility. He also welcomed my presence for further improvement. I thought that this could be a good beginning for collaboration.

When I returned to Kathmandu after a 3-day visit to the field, I started to ponder myself. Although I was interested in working on integrated ways of learning in the school, I was exploring the possible platform for working in the area of integrated learning. I was asked to explore the needs. I pondered myself. Whose needs are we taking? How do we establish that these are needs? Do needs vary from time to time? Are there needs? Do all teachers have similar needs? How do we prioritize the needs? Does negation happen? Davies (2016) used the idea of "cognitive justice" to analyze how attention is paid to epistemology in collaboration. The idea of cognitive justice argues the need for epistemic plurality and forms of dialogue among different ways of knowing (Carter, 2017; Visvanathan, 1997). Here, the epistemology is taken as "politics" as people decide in a way that affects their lives. At this stage, I thought about how we, as university researchers, would decide whose interests pertain to

knowledge generation in collaboration with local stakeholders. What are the priorities of the teachers who have been in the same school for several years? Is it for the shift in pedagogical innovation due to the enabling/forceful environment created by the community after the project implementation, or something else? Though my excitement about working in the school setting has increased from the first visit, at the same time, I had a doubt, a sense of fear, and a sort of challenge to be in the school setting for a few years and make visible changes in the pedagogical practices. In the initial days, I was looking into a binary relationship between university researchers and school teachers. Perhaps my limited knowledge of collaboration misguided me in this way. Gradually, when I interacted with different ideas, as Davies (2016) mentioned, "cognitive justice is based on the principle that all knowledge should co-exist in a dialogical relationship to each other" (p. 63), I was gradually encouraged to explore the space for co-existence of our ways of knowing and perceiving.

It's time to Explore Our Needs!

I visited the research site on 15 March 2019, almost three weeks after my previous visit. This time, I was alone. In fact, I wanted to visit alone to dig out some ongoing good practices and issues schoolteachers faced. When I discussed the areas for improvement with schoolteachers in a group, and in person with a few teachers, they wanted to engage with me. I received multiple issues. Though I was expecting the needs related to pedagogy and improvement in the quality of instruction, there were other components, such as infrastructure, governance, parental engagement, roles of local government, etc. In a group meeting with all teachers, one teacher said.

> I have received support in making lesson plans and projects from the researchers at Kathmandu University. However, it is very challenging to implement them due to time constraints.

When the teacher shared such constraints, almost all teachers' facial expressions supported the teacher who shared challenges and constraints during the implementation. I quickly asked the group to share the successful components they had been implementing into the school with the support of the research team of Kathmandu University. One teacher, Adhikari sir, said.

> I think we have started several good initiatives. One of them is preparing lesson plans before we go to the class. The next attempt is to work with gardening in the school, which has not been possible as our plan due to the limited land of the school. The good part is that we teachers have started to

> share our ongoing efforts in our regular Teacher Professional Development (TPD) meeting. I think the head teacher can share in detail on behalf of the school.

When Adhikari sir requested the head teacher to summarize the other activities of the school, I also requested the same, together with their expectations and areas in working with the research team, especially with me as a university researcher in the future.

The head teacher, recently appointed to the position, thanked Adhikari sir and shared her ideas in detail. Her sharing was two-fold: the ongoing activities of the school and the future plan. During her sharing, she also shared that they were interested in working in integrated curriculum and project-based learning. In addition to this, she shared.

> I am also a science teacher at the secondary level. I have been teaching both science and mathematics. I think I am good at mathematics as well. I learned that STEAM education is an innovative pedagogy in the 21st century. So, I think we can now introduce STEAM education in the school.

I was delighted to know that she wanted to introduce STEAM Education in her school. I quickly asked her, "What is your understanding of STEAM Education? How did you come to know these ideas?" She further said.

> I do not know in detail. But, I think STEAM is a way of teaching. The Nepal government has also recently introduced an integrated curriculum. I think integrated curriculum and STEAM education are interrelated.

I was happy when I heard about STEAM Education from the head teacher for the first time in school. I thought we had a space to work together on pedagogical innovations. At the same time, the head teacher shared several components for school improvement, such as parental involvement, lab upgrades, establishment of new lab rooms, and the use of ICT skills, eco-san, gardening, etc. The additional components the head teacher shared motivated me as a researcher as they were also a part of STEAM Education.

Several questions arose when I reflected on my second visit, a part of the need assessment. A few of them were: a) how do we come to the consensus that we all have a similar need? b) Whose interests (university researcher and/or school teachers) dominate in prioritizing the needs of the school, teachers, and co-researchers? c) Do

needs remain the same in a study, or do they keep changing? If it keeps on changing, how do we adjust them?

I returned to Kathmandu with several thoughts that shed light on the STEAM approach that the head teacher highlighted. I shared my field notes and expressions with one of my research supervisors in the weekly sharing session among PAR researchers at the university. Out of several suggestions, my supervisor's remarks made me thoughtful in terms of need identification in community-based research.

> Binod, the needs are explored but not identified. The needs in community-based research are multi-layered and fluid. Needs exploration normally happens on two levels; one is from the research site, and the other is from the contemporary literature. The greater need is to improve the condition of the school through pedagogical innovations in a collaborative manner. For that, your exposure to literature and continuous dialogue with schoolteachers are equally important.

Such a conversation with my supervisor encouraged me to explore various literature on the needs of school education in Nepal in general and public schools of the semi-urban hilly region of Nepal. Nepal's public school system faces several problems and prospects of contextualized teaching and learning in school education (Wagle et al., 2019). One of the most significant challenges facing Nepali public schools is the lack of "trained" and "qualified" teachers. Here are two perspectives: the data of the Nepal government shows that around 85% of teachers who teach in grades 9 and 10 and 75% of basic level teachers received Teacher Professional Development (TPD) training in public schools (MoEST, 2024), and another perspective is that the modality of teacher training has not been effective as the pedagogical skills are not transformed into the school setting. Teachers are named as "trained" if they have an education-related degree from the university and when they receive formal training from the government bodies. But, the effectiveness of teacher education programs and teacher training is always questioned. During my research, I also aimed to explore sustainable ways of teacher professional development. Meesuk et al. (2020) have argued that classroom-based action research strategies for teacher profession development are more sustainable in Thailand. They also concluded that the consequences of the classroom action research-based instruction were significantly higher than the standard requirement instruction. It also demonstrates that if we use already established strategies for TPD that may not work due to the

ever-changing context and complexity of the classroom environment. In this context, I thought one of the needs is to explore the sustainable way of TPD in my context.

Next, coming to a consensus on thematic intervention is not only the needs. The consensus for carrying out the activities is another level of the needs. How do we perform our activities as a university researcher and school teachers? What are our basic assumptions of collaboration? What is the purpose of the collaboration? Do we aim to generate knowledge, make some visible changes in the pedagogical area, or both? Several questions were roaming through my mind. As a PAR researcher, I always wanted to create an environment with a fully autonomous level of participation (Pant et al., 2023b). Such a level of participation is self-mobilization at a higher level of participation (Pretty, 1995). At this stage, people participate by taking initiatives independently of external institutions to change systems. As a result, they gain access to external resources and technical advice but retain control over how resources are used.

A self-initiated mobilization may either challenge or sustain existing patterns of power and wealth. White (1996) argued that such a form of interest, in terms of various forms of participation, is transformative, where participation means empowerment that enables people to make their own decisions and work out what action is to be done. Luitel (2019) also argued that transformation is possible through self-empowerment. At this stage, people take both means and ends as continuing dynamics as per the situation. However, I had doubts about creating an autonomous level of participation and self-empowerment. How long should we invest together to develop such an environment is a big question. But, as a researcher, this is only the approach to move on the path of participation. I agree with the idea of Armstrong and Ludlow (2020), who mentioned, “One of the promises of PAR is that, through processes of co-constructing knowledge, participants become actors in the planning, implementation, and dissemination of research and, through this repositioning, the experience of participation is less objectifying and more empowering” (p. 6). Here, I noticed two important ideas: the importance of co-construction of knowledge in PAR and the empowering experiences among participants rather than objectifying them. The epistemology I used in this research consists of the co-construction of knowledge and ontology, which empowers co-researchers. So, this is another layer of needs: how can we become empowered through our PAR approach as co-researchers and as teachers?

Since my central focus is on participation in the knowledge-building process, the idea of Freire is very pertinent in terms of participation. He mentioned that researchers have political roles to change the existing context, so participation differs from conventional ideas of listening and welcoming all ideas (Freire, 1996). This allowed me to show my flag and explain the intent of that flag. My flag is the pedagogical innovation for the holistic development of school students and professional development sessions for teachers to develop such innovations. Perhaps, at some point, participation might happen, as Bradbury (2015) mentioned, "it goes without saying" in PAR. To make sustainable changes in the educational field, reflecting on the “self” and “context” is necessary (Luitel & Taylor, 2019). So, I kept reflecting on my own actions and the contexts at the center of my inquiry throughout the study. In fact, as a lead researcher, I aimed to create an environment where all co-researcher’s self-direction participation is ensured during the inquiry process, as Cornwall (2008) argued that such self-directed participation is a genuine form of participation. I also sensed that such a genuine form of participation requires a deeper realization of the changes in the existing conditions.

When I visited the school, another issue we realized was the lack of resources and infrastructure. Here, resources mean teaching and learning materials needed in different subjects. Many public schools in Nepal lack essential resources such as reference books, science equipment, and modern technology, which hinders effective teaching and learning. Such challenges are particularly noticeable in rural areas where schools often lack basic facilities such as electricity and good internet facilities. I found a similar situation in the action school. In this regard, one mathematics teacher said.

> A few years before, we had some materials, such as base ten blocks, tangram, and models of solid objects. But these are broken and are not in the right condition to be used. If we can manage or develop resource materials needed for each chapter, we can perhaps make our classroom meaningful.

Similarly, science teachers also shared that they have a science lab, but there are limited materials now. This gave me an impression of the need to further collaborate on developing resource materials using local materials.

Regarding the infrastructure, the school had very limited land, and almost all rooms were occupied for classroom and office purposes. Our research team also wanted to introduce school gardening and several other activities (such as goat

farming, mushroom farming, and fish farming) that can be connected to learning numerous skills and giving orientation towards entrepreneurship. Due to the lack of enough land, the plans have not been implemented. It also gave birth to other needs of the school regarding the management of physical spaces so that we can have many other activities related to life skills.

Based on my initial visits to the school and informal communication with a few schoolteachers, I noticed that there were enough spaces to work on developing and implementing effective teaching and leaching methods. It is argued that many teachers in the school system in Nepal continue to rely on traditional methods of teaching, such as rote memorization and lectures (Pant, 2017; Luitel, 2019). Such approaches are basically ineffective and do not encourage critical thinking and creativity among students. To address this challenge, teachers must be equipped with innovative pedagogical approaches, such as inquiry-based and project-based learning, which promote critical thinking, problem-solving, and creativity. The recently developed and implemented curriculum in Nepali school education (CDC, 2019) provided details of different possible pedagogical approaches in each subject. Such shifts (e.g., integrated curriculum in grades 1-3, projects and practical activities in all grades) in curriculum development in the Nepali context have also created a rich discourse for the reforms in school education. I thought this was the right time to use the discourse for the pedagogical innovations in the school. Teachers can be encouraged to incorporate innovative pedagogical approaches listed in the curriculum (and beyond the curriculum) into their teaching, which can help make lessons more engaging and interactive.

At this stage, I realized there were several needs and spaces for collaboration to keep pedagogical innovations at the center. To name a few, working on integrated plans for learning, improving infrastructure and resources, promoting innovative teaching methods, and establishing collegial relationships among teachers and stakeholders (i.e., parents, community members, etc.) were the major areas for collaboration.

Students are Demotivated! Let's Become Artistic Teachers!

In the third meeting (sometime in April 2019) with schoolteachers, I sensed that most teachers were discouraged due to students' demotivation in learning. One of the teachers of grade 2 said.

> I think I have been trying my best to teach my students. But, in recent years, I found that students are uninterested in learning. I hardly observed their curiosity. The majority of students don't submit their homework in a regular basis.

Similar kinds of voices have been heard. On the same day, one female teacher who teaches at ECD level said.

> Now, we have to teach our students by singing and dancing. I sometimes sing and dance, although I am not good at that. When I take classes by singing and dancing, students seem motivated and become active.

These remarks created a space to develop some engaged pedagogical strategies. Perhaps developing and using art-based pedagogical approaches could be a common space for all of us to address the disengagement in learning.

Generally, in all subjects of school education in Nepal, and mostly in science and mathematics, art-based approaches to pedagogy are not well acknowledged. As per my experiences, teachers consider engaging in art-based activities as additional activities in free time rather than art as a way of knowing. In recent years, many educators (Dietiker, 2015; Eisner, 2002) around the globe have intensely advocated the need for art integration in school education. The fundamental reason behind the integration of art is to create "aesthetically rich learning environments as those that enable children to wonder, to notice, to imagine alternatives, to appreciate contingencies and to experience pleasure and pride" (Sinclair, 2001, p. 26). To begin with, incorporating paintings, poems, and stories in different subjects such as Mathematics and Science could be an effective point of departure. Hunter-Doniger (2018) proposes an empowering model for arts infusion in education that considers all disciplines equally in pedagogy, content, and assessment, collaborates between art and generalist educators, and encourages students to explore subjects through art. I value the technique of encouraging students to investigate diverse disciplines through art integration. Art integration lets students achieve more than memorizing knowledge and problem-solving steps. It helps students to find new perspectives on authentic problems, interpret them, and use them to improve their skills. Eisner (2002) argues that aesthetics is an individual's response to an experience rather than an attribute of an object. Dewey (2005) notes that aesthetics is not an object's attribute but the individual's perception and interaction that is the path of aesthetics. I use this idea in

my research study while developing different projects and activities by incorporating the different attributes of arts.

Art has different perspectives. In general, art is taken as the manifestation of human creativity and imagination expressed in different forms such as visual, performance, and fine arts. Freedman (2005) argues that art should not be viewed in a limited sense for pleasure; rather, it is an epistemology by which knowledge is co-constructed through visual investigations of complex ideas, such as righteousness, environment, exploitation, beauty, democracy, and violence. In the line of art as a knowledge generation approach in the education setting, Kaplan (2019) has mentioned.

> We practitioners know that what they do with children in these early stages not only sets the tone and creates possibilities for future understandings, skills, abilities, and knowledge, but also, we know what we do is deeply connected to the ideas, concepts, and processes of art that students will encounter later in life and that our practices can be adopted and adapted into broader educational policy and practice (p. 124).

During my ten years of teaching at the school and college levels, I have observed that the arts (such as poetry, stories, and painting) are rarely acknowledged in teaching and learning, especially in science and math. One of the possible reasons behind such a scenario could be the over-emphasis on scientific facts and "scientific knowing" in different subjects from early schooling. The voices for integrating the arts in school have been getting louder in recent years. Several educators (such as, Dietiker, 2015; Goldberg, 2016) have been working on arts integration in school education. One of the major arguments behind the integration of arts is to create learning environments that are aesthetically rich where children encounter wonder moments, imagine alternatives, and feel pleasure and pride during learning (Pant et al., 2023a). Furthermore, an aesthetically rich environment always acknowledges multiple ways of knowing. For that, incorporating local stories and students' paintings and dramatizing the situation could be a useful idea of departure in the subjects wherever possible.

I am also mindful that art is not separate from science and vice versa. Vico (1668–1744) explored the history and origins of humans in terms of language and myth. To discuss certain phenomena, humans first create images before they form words. According to him, humans, in their origins, are not rational like philosophers

but imaginative like poets. As New Science argues, imagination and reason are closely related: civilized human beings are rational, yet they did not realize what they were doing when they became such; the first humans created institutions literally without reason, much like poets who follow their imaginations rather than their reasoning. Later, when this knowledge was transferred from generation to generation, these so-called civilizers understood what they had done. Vico's idea is that early humans were non-rational and childlike. Several aspects of art require systems and methods that belong to science. Science versus art has been portrayed simplistically in curriculum development, pedagogical implementation, and assessment (Vico, 2020).

In the arts-integrated education model, there are three strategies: first, all subjects are considered equally in pedagogy, content, and assessment; second, collaboration extends across the arts and general education, and third, students are encouraged to immerse themselves in subjects through art (Hunter-Doniger, 2018). Each of the above strategies is useful. The strategy that calls for collaboration between generalist educators and art educators manifests that arts should not be taken as a separate entity; arts have strengths to collaboration for developing an aesthetically rich learning environment. With art infusion, children can learn more than memorizing routine content and using pre-established methods to solve problems (Eisner, 1965, 2002). Students learn from such approaches by examining different perspectives on problems, generating meaning from them, and applying them to improve their understanding and competencies.

Arts have been discussed as tools for critical pedagogy more than as a social pedagogical process (Peters, 2016). More specifically, the visual arts are central to public attention and critique and have the power to illuminate social injustices and inequalities, which is the main aim of critical pedagogy. Critical pedagogy puts efforts into understanding the world through different subjects such as mathematics, science, technology, and language. It aims to develop critical consciousness (Freire, 1970). Arts has also been viewed as a public pedagogy, as discussed by Giroux (2004), which focuses on the study of media and popular culture, assuming society as an educative force for learners. The projects school teachers design can be borrowed from the media and cultural and local traditions that can make strong connections between school subjects and out-of-school practices. Those projects are always public and have the power to create rich discussions in the learning process. Schuermans et al. (2012) have viewed that public pedagogy scrutinizes the educational processes

involved when issues and interests are made ‘public’ for social interactions and to promote the notions of living together in society.

Perhaps we can plan to begin with the verbal arts, especially in Mathematics and Science, as a culturally relevant pedagogical tool. "The incorporation of such culturally relevant knowledge into STEM education should provide a means by which the linguistic and cultural wealth of the community can play an essential role in the formal education of its children" (Mchombo, 2019, p. 17). As per the needs of the field context, schoolteachers, and students, incorporating visual arts and performing arts could gradually be made as pedagogical approaches.

We Heard about Integrated Curriculum: It’s Better to Begin from There

During my several visits to the research site, teachers from the lower grades (especially from grades 1-3) were expecting support to implement an integrated curriculum. This could be one area for collaboration. In this regard, one of the teachers from grade one said.

> We received a copy of the integrated curriculum last week. I saw there are themes and soft skills. I do not know what they are. How can I teach soft skills in mathematics class? It would be good if we get support on it.

Even teachers from grades 2 and 3 seem worried about the integrated curriculum. After discussing with teachers, I realized that the worry was deeply rooted in the supremacy of subjects. They seem uncomfortable dealing with different subjects in the same activities or classes. This could be another area for collaboration.

Influenced by the philosophy of John Dewey (1938), the progressive movement became popular in education. It promoted an integrated curriculum that would motivate students (Drake, 2012) by following the principles of constructivism. During the late 1980s and early 1990s, the American education system turned to more integrated approaches rooted in real-world contexts to provide a more relevant learning experience. It was a time of standards, standardized tests, and disciplines. The integrated curriculum was popular for a decade after entering the 21st century. With the emergence of the internet, the approaches that many ideas can be learned at once became more prevalent. It was also clear that knowledge doesn’t remain in carefully defined boxes called disciplines.

The new curriculum documents in Ontario mandated an integrated curriculum for grades K to 9. Few people only knew how to develop an integrated curriculum. They were confounded by the lack of clear definitions of an Integrated Curriculum

that was involved in helping people understand design and implement such a curriculum across North America (Drake, 2012). Slowly, the importance of an integrated curriculum was felt at different intervals. So, the Curriculum Development Center of Nepal also developed the curriculum of subjects like Nepali and Social Study in an integrated form in 1985 A.D. In 1993, our surrounding subject was developed and implemented in an integrated form. However, this could not maintain continuity and disappeared after a few years. As per the National Curriculum Framework 2006, subjects like science, environment, health and physical education in grades 1-5, social and population, health and physical education in grades 6-8, and health population and environment in grades IX-X were developed in an integrated form. As per the roadmap of the National Curriculum Framework 2018, the curriculum for grades 1-3 is developed in an integrated form.

The integrated curriculum (CDC, 2019) has envisaged producing creative and critical citizens who can solve real-world problems. Real-world problems require knowledge and skills from multiple disciplines. For example, if a student is asked to develop a model of a house, they need to apply knowledge and skills from various subject areas. This includes designing ideas from an engineering perspective, measuring and calculating different parts using mathematical skills, selecting materials based on contemporary societal perspectives, ensuring strength and security from a scientific viewpoint, and incorporating uniqueness and creativity from an artistic perspective. Our school education culture, referred to as the grammar of schooling (Tyack & Tobin, 1994), has been neglecting the development of such a holistic perspective, which is essential in the personal, social, and professional worlds.

Integrating the curriculum requires incorporating key problems and issues without being confined by the academic boundaries set by teachers. The concepts proposed by Beane (1997) are compelling for two primary reasons: first, his strong advocacy for overcoming the boundaries of disciplinary knowledge segregation, and second, his argument that the curriculum development process should actively engage young people (students) for whom it is intended. Similarly, Barsky (2019) has focused on ethics and values via an integrated curriculum. The division of conventional disciplines has been well-established since the early stages of Nepali educational institutions. The current subject-centric curriculum culture has provided less opportunity for interaction among various curricular elements.

Consolidating the Needs! Now, it's our Needs! We are in the same boat!

I still remember the initial days I visited the school during the PhD proposal preparation in the middle of 2019. One day, I was sitting in the staff room. One of the mathematics teachers came to the office with a textbook for grade eight. He sat near me and opened one chapter, factorization. He said.

> I tried my best to explain the factorization process with rules and techniques. However, students make mistakes on exams. I came to know that you are an expert in mathematics. Will you please share some teaching factorization techniques?

I immediately started explaining to him the different strategies of factorization. I said.

> You can use papers and wooden blocks to help students visualize the factorization process. This can support the conceptual understanding of factorization.

We discussed several teaching and learning issues (such as the student's expectations of a readymade approach) in his leisure period. I reflected on the day when I reached the room in the evening. I started writing the reflective journal of the day. I questioned myself: Did I act as a participatory action researcher? Did I invite a teacher to reflect on his practices? Did I respect him as a co-researcher I was supposed to do? I thought that I could not do it. I should not have explained all the so-called "readymade strategies" of factorization. Why did I not ask him to share his best practices? Why didn't I invite him to explore the possible ways and critically reflect on his assumptions? I felt sorry that I could not be a participatory action researcher.

On another level, I started questioning myself. Why did it happen? Wasn't I aware of the PAR process? My background as a teacher educator for many years has become unhelpful in welcoming new perspectives and thinking of alternatives in the field. Perhaps my deep-rooted beliefs about school education in general and pedagogical worldviews, in particular, unknowingly restricted diverse thinking. Ozkul (2020) argued that it is very challenging for researchers to shift toward the mindset of participation as they have a lot of baggage of ideas and perspectives. I was guided by the thought that "I" as an experienced teacher educator, should "teach" them so they could implement the readymade ideas in their classroom.

I completed writing the daily reflection, and it mentally prepared me to shift my role as a participatory action researcher. The next day, I reached the school with a

sense of guilt as I had not acted in line with my intentions as a PAR researcher on the first day. I went to the staff room. I was searching for the mathematics teacher whom I met yesterday. I came to know that he was in grade 8. I saw the class schedule on the wall of the staff room. As per the schedule, the mathematics teacher had leisure in the second period. I waited for him, and he came after the completion of the first period. When he entered the staff room, he said.

> Sir, namaskar! It was a fruitful discussion yesterday. I got several ideas on teaching factorization. I am also interested in listening to your ideas in other areas. It's my great privilege to get you into our school.

I experienced discomfort as he was expecting more ideas from me. That was not the purpose of the visit. I thought presenting myself as a co-learner was very challenging as my previous communication aligned with the expert-novice relation. His expectation of receiving several readymade solutions was another challenge for me. In this context, I tried to clarify my position. I responded.

> Sir, I no longer teach at the school level. Several years ago, I taught mathematics at the school level. The context in which I was engaged was distinct from where you currently work. I believe my ideas may not be helpful to you. You have extensive experience in this field. Now, we are listening to one another. We collaboratively generate new concepts, test their applicability to the situation, and apply them. I am here to gain knowledge and collaborate with everyone.

He laughed and said, "No, Sir! You know more than anyone knows here." From that day onward, I consciously tried my best to listen to teachers before I shared anything from my side, encouraged them to share their success stories before my stories, and critically reflected on their values before sharing them. I realized that this was my process of becoming towards "we can do" from "I can do."

Armstrong and Ludlow (2020) argued that the locus of the study in PAR shifted from an 'I' to 'we', realizing that our pasts and futures are inextricably bound up together in so many ways (p. 6). When we move towards "we", the "individualized notions of responsibility for past failures and future successes" (p. 6) would gradually move toward communal responsibility. Díaz-Arévalo (2022) argues that the "ontology of participation fundamentally differentiates PAR from other instrumental or top-down forms of people's participation" (p. 16) in which the emphasis on "'action,' and 'participation' capture how people progressively and self-

consciously transform their environment" (p. 16). Armstrong (2019) suggested that PAR is grounded in social constructivism, where people should have the right to equal participation, which is of value and relates to their interests and those of the wider learning community. He elaborated that 'collaboration' and 'participation' merge into the PAR model in all its democratic features.

After several meetings with teachers at the school and with community members during my study, we have explored several areas for collaboration, as shared in the previous section. Out of several areas of collaboration, we needed to prioritize them. To prioritize the school's needs, we agreed to have a 3-day intensive reflection and planning session on 29-31 March 2019 at Dhulikhel. This was the time the academic session ended. This was also the review of the academic session and planning for the new academic session of 2076 BS (2019 AD). It became the most appropriate time to reflect on the actions of the previous academic sessions and envisage the action for the next academic session.

We (school teachers and PAR researchers) gathered at Dhulikhel on the first day of the 3-day workshop. The focus of the three days of workshops was discussed first. Though these were my initial needs assessment visits, I have noticed that the previous PAR researchers from Kathmandu University have developed a sense of participation in establishing agendas and activities. On day one, the reflection of the completed academic session was done, the second day was focused on planning the upcoming academic session, and the final day was dedicated to the inquiry-based tasks development activities. During those days, school teachers also acknowledged their limitations on the personal and institutional levels.

At this stage, we realized we had enough discussions, collaboration, negotiations, and commitments. Summing up the needs and prioritizing them based on the available resources and time, we developed a consensus that we work on developing inquiry-based activities in regular classroom teaching. Those activities would be implemented in the regular classes in a natural setting. This relieved me, knowing that we at least explored opportunities for collaboration to move forward. So, in the first cycle, we agreed to develop and implement inquiry-based instructional tasks for grades 1-8 students. We also realized that the need assessment process took several months to complete, which was not expected initially. We also became aware of our *Karma* and *Dharma,* which are rooted in our context. Our *Karma* was to explore different pedagogical approaches as we collaboratively moved on in the

process, and Dharma was to contribute to school education through some pedagogical innovations.

Chapter Summary

This chapter documents the collaborative needs assessment process in the participatory action research journey. The focus is on identifying and prioritizing co-researchers' needs to perform collaborative actions for pedagogical innovations. The process began with an open and responsible discussion to understand the diverse perspectives and explore the common grounds for the actions. The co-researchers openly shared the challenges and difficulties due to the lack of student motivation and engagement. It was also discussed that the need to incorporate difficult forms of arts in teaching could be the entry point to address the issues of disengagement. The discussion also prioritized the possibilities of using integrated pedagogy by combining the various subjects to better engage students in learning activities. After discussing the different perspectives, we finally consolidated the need for developing and implementing inquiry-based learning. Through reflective dialogue and mutual understanding, the need assessment phase exemplified the essence of the participatory method in fostering ownership and agency among co-researchers for generating collaborative action in the next research phase.

In the next chapter, I share how we, as co-researchers, developed and implemented inquiry-based learning. I also highlight how we co-constructed the notion of inquiry from the Eastern and Western perspectives.

CHAPTER V
JOURNEY TOWARD DEVELOPING AND IMPLEMENTING INQUIRY-BASED LEARNING RESOURCES

In Chapter IV, I shared how we generated needs for the first cycle and developed trust among teachers to collaborate further. This chapter manifests the journey we, as co-researchers, made in developing inquiry-based learning resources and implementing them in the school. This is the outcome of the first cycle. The first cycle ranged from September 2019 to March 2020. This chapter is developed to respond to the research question: how do co-researchers develop and implement inquiry-based pedagogical approaches for students' engagement in learning? While doing this, we learned several dimensions of inquiry-based learning and explored the possibilities of creating investigative tasks, using local resources and examples while developing tasks. In addition, the lessons learned while making and implementing such inquiry-based tasks and co-researchers' participation are discussed. The narratives are presented to make the detailed contexts and the action visible. In doing so, relevant literature was discussed with field narratives to connect with the world of scholarship knowledge.

Do Students Inquire about Knowledge and Skills?

It was any day of September 2019. After several formal and informal discussions (as shared in Chapter IV), we have already reached a consensus on our actions. The entry point we discussed was inquiry-based activities. The teachers agreed that their previous efforts on pedagogical innovations were noteworthy but insufficient. Their journey with the university's research team had led them in the direction of investigations. After discussing the possible activities, several ideas emerged in the meeting. One teacher said that it is better to have some sample activities so that we can take a reference for making our teaching activities. Another teacher was expecting some feedback on the already-developed activities. The next teacher said.

> We should first know what inquiry-based means. I think we can get some reading resources on it. That would help make sense of inquiry-based ideas. We generally know, but I don't believe this is sufficient for us.

We had already developed a culture of listening to each other and prioritizing actions. After listening to a few teachers, I realized that discussing inquiry-based learning would make the upcoming days fruitful in creating and implementing inquiry-based activities. We ended the meeting with an understanding of bringing some ideas and lessons on inquiry-based learning.

When I returned home, several ideas came to my mind. I was pondering possible actions for the upcoming days. These were my initial days as a researcher in the PAR area. More specifically, I was in a dilemma on whether to share my ideas on inquiry-based learning or listen to teachers' ideas. I thought that I, as a researcher, should have some understanding and position about inquiry-based learning, and at the same time, we, as co-researchers, should develop a common understanding of inquiry-based learning in the research context. For that, I had to be ready to scrutinize my beliefs and assumptions in inquiry-based learning. I acknowledged the challenges on multiple levels. First, I have a certain subject orientation, although I am moving toward integrated teaching and learning. My disciplinary notion of mindset might be unhelpful when sharing about IBL among different subject teachers. Next, the teachers' expectations were on some implementable ideas with minimal effort as a part of regular work. In this context, I started to explore different ideas on IBL so that I could contribute to the upcoming meeting in the school.

About two weeks later, we set up a meeting per our established practices of sharing and reflecting. The teachers seemed happy and ready to share their ideas on IBL. The meeting started with a formal greeting, and the floor was open for sharing. One teacher broke the silence with his sharing. It went this way.

> When we met last time, and we decided to share our understanding of IBL, I tried to develop a plan based on IBL. It was not an easy task. I realized that IBL is a process where we engage students to develop knowledge and skills. I am not sure whether I am right or wrong. In my subject, Social Studies, if I have to create IBL in my teaching, I should develop some questions and allow students to explore the responses to those questions. For example, I have to teach about local festivals. In this lesson, I ask my students to explore the responses to some questions from the community members. A few questions could be: what are the festivals you celebrate? How are they important to you? How are they different from the festivals celebrated in other places? When

> students get responses from adult people. This is perhaps known as an inquiry-based approach.

After listening to such responses from a teacher, I became motivated and sensed that the discussion would go in the right direction. Another teacher shared the plan this way.

> I made a small plan, which is an inquiry-based approach. While teaching living things and non-living things for lower grades, I ask students to write the names of any five things they see daily and categorize them into things that have life and things that don't. I gradually ask several questions such as; which of them can prepare food by themselves? Which of them can move from one place to another? I think …..this is based on the ideas of IBL.

After she spoke, the room went quiet. Also, I had something to share. To put it another way, I asked her how she would teach if she weren't an inquiry-based teacher. She smiled and told me:

> Before I became a teacher, I did the same thing. I would write what "living things" and "nonliving things" meant on the board and use examples to show what I meant. Then, I would tell them to write down the meaning and some examples from the board to study for the tests. I learned later that this way of teaching doesn't help my students learn. It would be great if you could share the steps for applying IBL in our context.

At the same time, another mathematics teacher raised his hand and asked if using the IBL approach in all contents and subjects was always applicable. There are several areas in my subject (mathematics) where IBL might be used, as shown in the examples of living and non-living things lessons. He focused on the possibilities of IBL in social science subjects (such as social studies and language) but not in mathematics and science. This was a good situation for creating disorienting dilemmas for the group (Mezirow, 1991). Perhaps bringing such seemingly different perspectives (whether PBL can be used in some or all subjects) is a rich condition for discussing the various forms and possibilities of IBL.

I sensed that teachers were expecting my responses/perspectives on this matter. I also wanted to share different examples and some literature regarding IBL. Below is the modified (semi-fictionalized) form of my sharing. I needed to use this sort of writing in letter-writing form to capture the discussions at different times. This sharing did not go one way. There was interaction within the sharing of ideas. It lasted

roughly a month and included three face-to-face meetings with teachers. The essence of the message looks like this.

Dear teachers, inquiry-based learning (IBL) is rooted in the ideas of investigation. There are different schools of thought behind IBL. IBL is based on the idea that students learn best when they are inquisitive. To apply IBL, teachers should push students to question, explore, and ponder about what they are doing. This makes the classroom a dynamic place where students' interests and queries drive towards learning. The credit goes to John Dewey (1933), who substantially contributed to experiential learning through inquiry. Dewey's notable idea is to connect learning with reflection. The concept of reflection is to make students aware of the ongoing actions and the reasons behind such actions. The learning will be meaningful only when we, as teachers, engage our students in investigation and reflection. Smith (2000) argued that inquiry-based learning is the best approach to engage students more meaningfully rather than merely memorizing facts. This method goes beyond the fact-memorizing process. The content-driven curriculum promotes the fact-memorization process, and the assessment is designed to evaluate whether one can memorize information. The entire loop has produced a high-achiever group of students. However, those high achievers have gone through a content-driven curriculum, memorization-focused pedagogy, and information-driven written tests. It creates a kind of false consciousness among people due to the cycle of content-driven curriculum, memorization-focused pedagogy, and information-driven written tests. So, as teachers, we should be aware that the system produces high achievers without producing people who can engage in the investigative process.

Esteemed educators, it is widely acknowledged that soft skills, often equated with transversal and 21st-century skills, constitute a principal focus in the integrated curriculum of Nepal (CDC, 2019). One of the assumptions behind keeping such soft skills is to enable students to develop several life-related skills (such as thinking and collaboration), which were not well acknowledged by the existing school-level curriculum for several years. The integration of soft skills into the academic curriculum was initiated upon recognizing that an exclusive emphasis on factual knowledge and technical abilities may prove inadequate for equipping students with the necessary life skills to direct real-world challenges and various global crises effectively. Soft skills transcend conventional subject matter discussion. Rather, they comprise a suite of competencies that should be cultivated among students through

deliberate pedagogical strategies. For instance, educators across any discipline can foster collaborative skills by designing curricular activities that promote group work and encourage knowledge sharing. For that, the inquiry-based activities not only help students to explore the knowledge but also help to develop soft skills in the long run.

Likewise, inquiry-based learning is based on the idea that students learn best when involved in their learning process, asking questions, and looking for solutions. Smallhorn et al. (2015) argued that inquiry-based activities can improve student engagement and learning outcomes as they foster the development of independent learners. When students engage in exploration, the quality of engagement is enhanced. Such engagement ultimately fosters learning outcomes. The notable aspect of IBL is developing independent learners who take responsibility for their learning. In this direction, a study conducted by Matz et al. (2012) proposed that hands-on laboratory activities are crucial for developing learners, enhancing their ability to become independent learners and future professionals. The next benefit of IBL is that it engages students with active learning methods. This method helps students understand and explore the ideas in a better way. Active learning has been discussed as:

> Active Learning argues that the struggle for equality in education must focus on securing an engaging and empowering curriculum for all students that can promote critical thinking, student voice, ownership over learning, and agency to shape their own futures. (Wright, 2015, p. 10)

The ideas of critical thinking and ownership over learning have been widely discussed in the educational arena. However, there is a big challenge in the process that ensures critical thinking, ownership, and students' voices. For that, if teachers develop a rich environment for an inquiry-based approach, the students ultimately develop a culture of active learning. Furthermore, Wright (2015) mentioned that active learning has four components: first, it should be interactive, participatory teaching, egalitarian connections, and incorporating students' prior knowledge and experiences into curricular content. Second, active learning lets students examine, explain, and develop knowledge. Third, students can contextualize their knowledge by analyzing power in various contexts, including geography, sociocultural, politics, economics, and history. Fourth, it encourages students to collaborate by applying their analysis to real-world issues and participating in democratic activities to make their communities and society more equal and just.

A study by Prince and Felder (2007) shows that active learning methods, such as IBL, make a big difference in how well students do in math, science, and engineering. When students ask questions, they are not just taking in information but actively building their knowledge, making learning more important.

IBL keeps students interested and pushes them to solve problems and think seriously. In this method, teachers help students understand how to approach difficult questions by acting as guides. Dewey (1938) argues that students learn essential life skills during such inquiry processes. He further says that education should prepare students for the difficulties they will face in the future by teaching them how to think critically and solve problems. The focus on asking questions and exploring in inquiry-based learning helps build these skills, preparing students to deal with problems in the real world. One more benefit of inquiry-based learning is that it encourages students to work together and talk to each other. Students often study questions, share what they've learned, and talk about what they think the answers are. This way of working together, backed up by research like Johnson and Johnson (1999), improves social skills and prepares students for work-life. Students learn how to share what they think, listen to others, and build on different points of view by interacting with each other. This creates a community of lifelong learners, an essential component for everyone.

Next, in the education sector, the idea of differentiated instruction has been widely discussed. Each student is from a different cultural socioeconomic background and has diverse needs. Developing different instructional strategies to meet their diverse learning needs is challenging. For this, IBL could contribute to tailoring different pedagogical approaches to different students. Kuhlthau et al. (2015) argue that guided inquiry helps to identify and support each student's hobbies and ways of learning. Personalization ensures that each student's learning is relevant and interesting, which is essential for keeping them motivated and helping them do well. Students take more responsibility for their learning when they focus on things that interest them and get teachers' support as per their needs. This makes them more interested in and excited about their education.

There are several ways to create an environment for IBL. One of them is the availability of technology-enhanced classrooms. Technology has a lot of tools for studying and working together, which allows students to investigate their questions. Greenhow et al. (2009) argue that students can get different points of view using

technological tools available in a classroom. This can make questioning better. Students can use online libraries, virtual labs, and tools to work together to improve inquiry-based learning with the help of technology. It does not mean that IBL cannot be used without technology. Rather, technological advancement can further support students to lead into the path of inquiry.

Dear teachers, I remember one of you asked about the steps of using IBL in teaching and learning in our last meeting. Educators and researchers have recommended several steps. But I suggest you do not follow the same strategies offered by others. It's good to know different ideas, but the ready-made steps and strategy might not work in our context as those strategies were developed at different times and contexts. However, some elements in our IBL approach might enhance teaching and learning activities.

First, it would be good if teachers could present (develop) some authentic situations that would create curiosity among students. Once students are curious to learn or explore something, they develop their path for inquiry. So, starting lessons with questions or situations that make them think is better. Next, students should be encouraged to map the available resources and context for the exploration. The most notable aspect is that it helps students develop a culture of questioning. When students are involved in a culture of questioning, they use several tools and techniques for the exploration. Students should be encouraged to reflect on their ideas and actions during the process. Reflecting on what they've learned and how they got there helps them observe how valuable the questioning process is.

Finally, I have a sincere request for you to explore IBL more. With inquiry-based learning, classrooms become lively places where students actively seek knowledge and develop skills by participating in the inquiry process. IBL helps students prepare for the real world by showing them how to think critically, solve problems, be personalized, work together, and use different tools and techniques. When students engage with an inquiry-based method, they find their way through the substantial depth of knowledge and make sense of it instead of telling them what to do. In this way, we share information and encourage students to keep learning throughout their lives.

We will discuss this further as we move on. I hope that this letter, through email, serves as food for thinking and critically reflecting on inquiry-based learning.

Let's Begin with Inquiry-based Activities in the Early Grades!

It could be any day in October 2019. I was with grades 1-5 teachers in the action school to discuss the possible ways of making inquiry-based activities for grades 1- 5 students. Our gathering was informal, and we had had similar sessions before. Due to the integrated curriculum implemented in the first grade, the teacher seems confused about developing classroom activities. One lady teacher broke the ice by sharing her difficulties while creating classroom activities.

> I have to teach all subjects in the first grade. It was said that we have to teach in an integrated way. There are different themes. It has become difficult for me to connect with the themes and other subjects.

The facial expressions of teachers demonstrated that other teachers also faced such difficulties. Another teacher who teaches in the fifth grade added.

> In my grade, connecting the subjects with themes and other subjects is not mandatory as per the existing curriculum. However, it has been like *falamko chiura chapako jasto* (like chewing iron pieces, meaning that it is difficult to achieve). I tried my best, but the students' learning was not satisfactory. What should I do?

He seemed helpless. There were six teachers altogether. Almost all teachers were helpless due to their students' weak performances (especially in the class tests and terminal examinations). As this was the initial meeting with teachers regarding collaborative actions, I, as a PAR researcher, wanted to explore their existing practices of making and implementing classroom activities. From the teachers' facial expressions, I sensed that they expected me to speak to carry on the discussion. I said,

> We have a long way to go together. This is just the beginning. In our several previous meetings, we agreed to start with inquiry-driven classroom activities. But, I think we should discuss further what inquiry means in the context of classroom teaching and learning. Developing a consensus on our inquiry-based activities might take a few more days. Before that, let's choose any subject from any grade you teach and think about the possible activities that might go in the direction of inquiry-based.

The teachers seemed puzzled. They were expecting some readymade activities so that they could use the same patterns to make other activities. In Nepal, it is usual that several teachers in the school expect some readymade tips and techniques from the trainers or seniors (Pant, 2017). But our approach was different. As we were

conducting research with the ideas of participatory action research, our contribution to knowledge generation was based on shared values (Whitehead & McNiff, 2006). We shared ideas, reflected on them, and developed collaborative creativity (Guyotte et al., 2015). Collaborative creativity comes through social interaction, sharing, and working together. So, I again requested teachers to share their existing practices vividly. I invited them to share how they presented in the most recent class. One teacher in fourth grade shared this way.

> Yesterday, in the first period, I taught solid objects in mathematics. First, I entered the class. I asked students to open the page number of the solid object chapter. I shared a few ideas about solid objects. I also shared the differences between plane objects and solid objects. It seems that students understand solid objects. Now, they can define and give examples of solid objects.

When I heard such responses from a teacher whose way of teaching mathematics is like sharing the mathematical contents, I noticed that this approach was not aligned with the ethos of inquiry-based learning. It was like a transmission of information from teachers to students. I was about to share my observations on it. But another teacher in grade one raised his hand and said.

> I want to share my experience. I teach in grade one. My teaching style is different than what the previous teacher shared. I taught “my family members” last week. I went into the class. I wrote, “My family members” on the board. I discussed this topic today. Then, I asked them to share the names of family members and their relations with them. I also asked them to write the family members' names and the total numbers. Many students wrote the names wrong. I corrected them in their copies. The homework was given to correct their classwork. The bell rang. I left the class.

After listening to the responses of two teachers, we discussed for a few minutes. I further asked to differentiate the two approaches. Nobody was ready to comment on those approaches and the differences between them. It is a common culture that teachers do not want to share critical comments in the meeting in front of the same people. Again, I emphasized that providing critical feedback is also our professional responsibility. One teacher who teaches social studies in grade five wanted to share. I then asked him to share his observations on the examples shared by their colleagues. He added.

> For me, both approaches have advantages and limitations. The first approach is straightforward, and teachers can complete the course on time. The other approach is more activity-based and might contribute to better learning. However, the second approach cannot be used every time. It is time-consuming.

After listening to such a response, I felt the discussion was heading in the right direction. The teacher started to explore the advantages and limitations of different approaches. We agreed to discuss it for 90 minutes. The time was over. Teachers needed to go to the class. We stopped the discussion. The teacher, who shared the advantages and limitations of different approaches, said they expected my ideas on inquiry-based learning with some examples. I quickly told them that I would share it with them tomorrow.

When I went to the residence, I reflected on the conversation we had in the school. The teachers were hesitant to share their practices. They might have felt that their plans were not good for the showcase. Whoever shared their practices was also not confident. The culture of expecting ideas from others (specifically, so-called experts and researchers) still prevails. I provided some reading materials to those teachers and asked them to read. Based on the reading materials, we might start a focused discussion. Although I had several published papers on inquiry-based learning, those papers were highly academic, with several academic terminologies and philosophical jargon. So, it would be better to write it again with everyday terminologies and basic examples. I opened my laptop and started to develop a reading resource for the next session. I was confident that the reading resources would help them to reflect and rethink their practices. I was not taking it as the “capsules.” Instead, it was a resource material to start the discussion. My letter looks like this.

Socratic Model of Questioning and *Śāstrārtha*: Inquiry-Based Approach

Dear teachers, thank you for actively participating in the sharing meeting. We discussed essential components with the lived experiences of teachers in terms of using inquiry-based activities. In my last writing, I shared about inquiry-based learning. After reading the texts on inquiry-based learning, the feedback you provided me motivated me to write about another idea as some of you shared about the previous letter guided by several Western literature. This time, I try to use some Eastern concepts as well. Though I have limited knowledge of Eastern wisdom traditions, I try to share some events and connect them with possible pedagogical approaches. I focus on two concepts: a) the Socratic model of questioning and b) *Śāstrārtha*, which can be considered powerful approaches in pedagogical practices. You might have thought these two are ancient concepts, and we are discussing several new constructs, such as inquiry-based learning and investigation. Those ideas were rooted in several ancient ideas, such as the Socratic questioning model in the West and *Śāstrārtha* in the East. These two ideas are different in many ways but have some commonalities. The Socratic questioning model aims to uncover the responses through a series of questions-answers. But, *Śāstrārtha* is used to explore the deeper meaning of the truths, which is more far-reaching than the Socratic questioning model.

Figure 5

Socratic Model of Questioning Drawing

(Source: Socratic Method)

Elkowitz (2021) described Socratic inquiry as a systematic method of evaluating and applying knowledge using an organized set of interactive, flexible, and focused questions. This could be akin to questions posed in the Praśna Upanishad, which delves into the questions about the why of the Universe, among others. Socratic inquiry is a tool and approach that converts conventional learning environments into a dialogue between a teacher and students. This form of conversation is commonly known as Socratic dialogue. The facilitator of the Socratic discussion engages solely in the practice of posing inquiries using a methodical and organized approach. When

Socrates proposed such ideas, it was controversial as well. Several people disagreed that asking questions does not contribute to learning. Later, this was highly acknowledged as a powerful way to create a rich learning environment through dialogue. I kindly request teachers to reflect on this idea: how can the Socratic questioning model be used in today's classroom teaching? Let's use it and reflect on whether this approach is helpful. We, as teachers, should not accept any ideas blindly. Instead, we should practice and observe its usefulness. Elkowitz (2021) further mentioned that Socratic questioning has three types: spontaneous, exploratory, and focused. Spontaneous Socratic questioning is not planned. It can stimulate a contemplative discourse on a particularly engaging subject when a significant matter is brought up or to divert or energize a conversation. Conversely, engaging in exploratory and focused Socratic questioning necessitates prior preparation. Exploratory Socratic inquiry is used to engage in discussions on various subjects. Focused Socratic questioning guides discussions on a single issue with thoroughness and depth.

By employing exploratory and focused Socratic inquiry, the learner is responsible for first acquiring basic content knowledge. Let's consider all three types as alternatives and use them per our needs. Next, the Socratics question addresses conceptions and minimizes misconceptions. In our several meetings, one issue was handling the misconceptions students developed in different subjects. One mathematics teacher shared that we had not taught the wrong concept, but how did students develop such misconceptions? For me, having misconceptions is a natural way of learning. Such misconceptions can be clarified with a series of exploratory questions.

Next, in the Vedic tradition, the concept of *Śāstrārtha* is a popular and powerful construct for scholarly debate and discussion. It usually provides opportunities to engage in intellectual discussions to understand and interpret sacred texts,

Figure 6

Śāstrārtha Demonstration Drawing

(Source: Śāstrārtha)

philosophical ideas, events, and other scholarly concepts. Such intellectual debates aim to uncover deeper truths, clarify doctrinal ideas, and sometimes resolve interpretive clashes. During such practices, each argument is supported by some powerful quotations from authoritative sources such as Vedas, Upanishad, or other established texts. The practice of argument and counter-arguments continues until the *Guru* (teacher) is convinced by the argumentative power of *Shishya* (students). I am not forcing you to use this approach in your classes as an inquiry approach. Instead, I am offering this as an alternative idea to use some aspect of it, possibly in our educational contexts. Perhaps the idea of presentation and viva as internal assessment practices, which have been practiced these days in the Nepali school education system, was guided by the notion of *Śāstrārtha* of Eastern tradition.

Let me share an example of Satyakam Jawala, as mentioned in Jha (1942), who was the son of a maid (Daasi), and was very intelligent and gentle since childhood. At that time, there was also a self-questioning culture. Several questions kept on rolling in the mind of Satyakam, such as:

> Who am I? Do I have any other forms like the two banks of the river? There is heat in my body and heat in the fire, too. So, am I also fire? The Sun also has heat. So, do I belong to the Sun? A drop is in the water, the water is in the stream, the stream is in Ganga, Ganga is in the ocean, and then what is the ocean in? What in return? What is there in the sky? There are drops in the clouds and in the water. Then, where do I come from?

He used to wander here and there with such questions. He also approached many Acharyas for the favor of becoming their disciple. But they sent him away because he was the son of a maid. Once Haridrumat sage Gautam came there. Satyakam saw him, and the next morning, as soon as Gautam Rishi came out of the river water after taking a bath, he fell at his feet. After obeying Rishi Gautam, he asked, ' Can I become your disciple, Acharya?'

Rishi Gautam smiled. He picked up the little boy and said, 'It is a very good habit to ask questions. But your father had to make this request to me. ‘Hearing this, Satyakam said - 'Acharya, I don’t have a father.'

Gautam Rishi said, “Then, go and ask your mother about your father. Also, ask your clan and your gotra. The superiority of clan and clan is mandatory to become my disciple. Only then, I make you my disciple”. Hearing this, Satyakam reached his

home smiling, and after going home, he asked his mother, “Mother, what is the name of my father, clan, and gotra”?

His mother asked Satyakam, “why do you want to know this?’ So, Satyakam shared the entire story and also said that it was possible that he could make her his disciple. Satyakam's mother told her son, “Satyakam, go and tell your teacher that my mother has served many people. Therefore, I can't tell you the name, clan, and gotra of your real father. Go and tell your Acharya that I am the son of Satyakam Jabal”.

After listening to their mother’s argument, Satyakam was surprised and headed toward the Gurukul. After walking for a few days, he reached a Gurukul. The Guru asked for his Gotra, a Hindu identity pattern, but he had no Gotra. So, as the mother said, he claimed that he did not know the tribe, but he introduced herself as Satyakam and her mother's name as Jawala. Thus his identity was Satyakam Jawala. Guru was happy to hear him. There was no doubt that the student was a gentleman and truthful. He also found plenty of other qualities a student should have, such as politeness and humility. Therefore, intending to test patience, he said, "Dear Satyakam!" It is not difficult for me to become your guru, but I have a rule to fulfill one condition before starting the study. Do you agree?” "Gurudev! It is accepted! I will try to complete as much as possible." he answered.

Then, the Guru ordered, "Take a hundred cows and go to the forest. Come back to Gurukul only after you have a thousand cows.” Following the Guru's orders, Satyakam went to the forest with a hundred cows the next day. He built an ashram there and began grazing and caring for cows. Years later, when there were a thousand cows, he returned to Guru’s ashram with the cows. Now, his patience was also tested. After that, the Guru gave him his *gotra* and completed the Upanayana rites, and made him proficient in Vedas, Vedanta, etc.

Let me share another event as well.

The name of a Shishya (student) of sage Uddalak was Kahod. Kahod's son's name was Ashtavakra. One day Kahod reached the court of King Janak. There, he was defeated in a debate by the sage Bandi. As a result of his defeat by Bandi, he was put in jail. Due to his father's absence, he started living in his maternal uncle's house. He considered his maternal grandfather Uddalak his father and his maternal uncle Shwetaketu his brother. When he grew up and learned Vedas from his grandfather, he came to his mother and inquired about his father. Mother told all the truth to Ashtavakra.

After listening to his mother's version, Ashtavakra and his uncle Shvetketu reached the Yajnashala of King Janak to debate with Bandi. King Janak tested Ashtavakra. He asked who that knowledgeable person was about thirty components, twelve parts, twenty-four festivals, and three hundred and sixty letters. Ashtavakra replied - King! May the knowledgeable person, Samvatsara of a month with thirty days, a year with twelve months, a day with 24 hours, and three hundred and sixty days protect you? King Janak again asked, “Who is the one who does not keep his eyes closed even while sleeping? Who remains unable to walk even after birth? Who is heartless? And who is going to grow faster?” Ashtavakra replied, “Fish do not keep their eyes closed during sleeping. The egg cannot move even after birth. A stone is heartless and a fast-moving river.” King Janak was pleased with Ashtavakra's answers, which allowed him to debate the scriptures with the Sage Bandi.

The Bandi asked Ashtavakra that one sun illuminates the whole world, Devraj Indra is one brave, and Yamraj is one. What is more than one in the world? Ashtavakra said that Indra and Agnidev are two gods. Narad and Parvat are two Devarshis, and Ashvanikumar is also two. The chariot has two wheels, and the husband and wife are two companions. What are more than two in the world? The Bandi said that the world takes birth in three ways. Three Vedas explain Karmas. Yajna is performed in all three periods with three worlds and three lights.

What is more than three in the world? Ashtavakra said there are four Ashrams, four Varnas, four directions, and four types of speech, namely Omkar, Aakar, Ukaar, and Makar. What are more than four in the world? They continued the *Śāstrārtha.*

Bandi said there are five types of yajna: the fire of yajna is five, the sense organs are five, the nymphs of the five directions are five, the sacred rivers are five, and there are five stanzas in a line. What are more than five in the world? Ashtavakra said giving six cows as Dakshina (donation) is best. There are six seasons and senses, including the mind, Kritikas, and Sadhakas. What are more than six in the world? The Bandi said that domestic animals are seven best, wild animals are also seven, there are seven best verses, Saptarishis are seven, and the strings in Veena are also seven. What is more than seven in the world? They continued the *Śāstrārtha*.

Ashtavakra said there are eight Vasus and eight pillar angles of the Yajna. What are more than eight in the world? Bandi said that in the Pitti Yajna, nine Samidhas are released, there are nine types of nature, and the letters in the Brihati Chhanda are also nine. What is more than nine in the world? Ashtavakra said that

there are ten directions and ten philosophers, and the child is born in ten months. What are more than ten in the world? The Bandi said that there are eleven Rudras and eleven pillars in the Yajna, and animals have eleven senses. What are more than eleven in the world? Ashtavakra said there are twelve Adityas, there is a Prakriti Yajna of twelve days, Jagati Chhanda has twelve syllables, and the year is also twelve months only.

What are more than twelve in the world? The Bandi said that Trayodashi is the best. There are thirteen islands on the earth. Saying this, the Bandi forgot the next line of the verse and became silent. On this, Ashtavakra completed the verse and said that in the Vedas, the thirteen syllables are called Ati Chhanda and Agni, Vayu, and Surya. All three are present in the thirteen-day Yajna. After that, Ashtavakra won the *Śāstrārtha*.

The great scholar Rishi Ashtavakra had shattered the pride of an arrogant Acharya at an early age. Rishi Bandlai forgave his father for punishing him. He set the example that forgiveness is worth whatever it takes.

Dear teachers, I share these ideas to invite you to ponder our ideas of interaction in the classroom. The power of questioning the self and others is a powerful pedagogical approach. For now, please explore such powerful debate as a part of our lives that might happen in our everyday lives. We will discuss these ideas further once we meet in the school.

Best Regards

Binod

The above genre is rooted in the ideas of Praśna paradigmatic worldview in which the purpose of conversation is to explore the deeper truth, and knowledge generation. The questions were not aimed at getting information on established ideas; rather, they aimed to examine the existence of humans and other entities. Engaging in such Praśna leads to the exploration of knowledge.

Is Inquiry-based Learning Useful in the Higher Grades?

It was any day of November 2019. We set up a meeting with teachers of grades 4 to 8. This was a Friday, and we agreed to discuss it for about 2.5 hours. As always, we had informal conversations with teachers to reach common needs, take possible actions, and reflect on the journey. We agreed to start the pedagogical interventions with inquiry-based activities, but we still had to develop a shared understanding of inquiry-based activities. Though it was not the first meeting to

discuss IBL with grades 4-8 teachers, we aimed to share some sample activities on IBL on this day and develop some inquiry-based activities for the implementation. Here, grades 1-3 are taken as lower grades, and 4-8 are taken as higher grades.

The head teacher shared the purpose of the meeting, and she invited me to carry on the discussion. As the lead researcher, I reminded the needs we collaboratively developed in the several meetings. I requested the team to share their sample plans for inquiry-driven activities. It seemed that almost all teachers were hesitant to share their ideas. They were looking at each other. One teacher broke the silence and said.

> Though we agreed to develop and implement the inquiry-based activity in the first cycle, this approach benefits lower grades, such as grades 1-3. Using this approach won't be easy as we progress to higher grades. We have to cover the entire syllabus, and if we follow such approaches, it is challenging to complete the courses on time.

Such responses are the most frequent in almost all training and workshop sessions I encountered on other occasions. I could sense the different reasons behind it. The possible reasons could be the overemphasis on subject-centric knowledge, poor preparation of teacher education programs, and the overemphasis on paper-pencil tests. During that time, the head teacher said.

> I also have thought of one inquiry-based activity for grade six students. I teach science, and the activity is based on the content “simple machine.” I ask students to explore at least one example of each type of simple machine around their home. I encourage them to think creatively and look for simple machines in the objects they use every day. I also provide some hints, such as the following: You can think of objects used in the kitchen or farming. Students will search for objects in their own homes that contain simple machines. In the upcoming class, students will discuss objects and explain their classification as machines. If necessary, I will provide support during this time to identify which objects are simple machines and why. During the discussion, I gradually shared the features of simple machines. At first, I do not focus on formal definitions, but I connect the features of objects to the definition of simple machines. I also asked students to write a short paragraph on which simple machine they found most interesting and why. They might

> also reflect on how understanding simple machines helps them appreciate everyday technology.

Listening to such activity made me happy as a co-researcher. I also wanted to hear about similar activities. But I wanted further discussion on it. So, I kept one clarifying question; “this looks great to me. But why do you consider it as an inquiry-based activity?” She clarified it.

> For me, this is an inquiry-based one. In the initial days of my teaching career, I used to start with the definitions of any concept and explain them one by one. Later, I tried to connect with some examples. Over time, I realized that we, as teachers, should develop a culture of investigation in the inquiry process. In this example, I do not begin with defining a simple machine. Instead, I ask my students to explore devices you or your family use at home.

The clarification made by the science teacher seemed convincing to many teachers in that room. Other teachers also shared their ideas regarding IBL.
We were running out of time and wanted to make a concrete plan for the next meeting. At the same time, a language teacher (Nepali subject) showed her interest in sharing one idea by raising her hand. Almost all teachers were ready to listen to her ideas. She presented this way.

> During my initial years of teaching, I thought that students should not make any mistakes in their copies. The answers to the questions should be perfect without any errors. So, I used to write the correct answers on the whiteboard and commanded them to copy the answers. Most students used to recite the answers and write in the examination. Later, I realized that such practices seemed good in preparation for the written tests, but students cannot develop free writing skills.

The take-home message was multilevel. One message was that IBL is suitable for engaging students in learning, but it is challenging. The next message was that IBL is more beneficial to lower grades, not in the higher grades as compared to the lower grades. The final message we made was that IBL is a time-consuming approach. I realized that we were in the right direction with several ideas. We agreed to make a few IBL-based activities and implement them in the classes before we come to the next sharing meeting.

Due to the time constraints, I could not share my ideas. I thought I had to share my ideas in some form. So, I developed a small write-up and shared it with the

teachers. I requested them to read my write-up before the next sharing meeting. I made the write-up more invitational rather than declarative.

Dear co-researchers and my friends,

We had a great sharing today. It was a good beginning. You shared a few ideas on the existing lesson plans. Today, I want to share a few things in writing. I expect you to read it, and we will discuss it in our next meeting. You might agree or disagree with the ideas I share. However, I sincerely request you to reflect on your ongoing teaching practices with the ideas I share.

This is the age of the 21st century. Society has changed. The nature of tasks, services, and jobs are drastically reformed. Teachers prepare our kids to serve in society after 15/20 years. In this context, we cannot guarantee that the same knowledge and skills we have today will be useful. So, the existing teaching and learning strategies should be carefully examined, and we should explore better alternatives in the context of our society.

First, I think we should discuss the purpose of teaching and learning. One of the fundamental purposes of teaching is to lead students toward investigation. Once we develop a culture of investigation, students can explore the knowledge and skills by themselves. For that, inquiry-based learning could be one possible approach to making classroom activities. Inquiry-Based Learning (IBL) is an educational approach that prioritizes student inquiry and questioning, moving the emphasis from teacher-led instruction to student-driven investigation (Edelson et al., 999). This instructional methodology promotes a student-centered learning environment emphasizing exploration, cultivating a more profound comprehension of the content. The importance of inquiry-based learning lies in its capacity to foster the development of critical thinking skills, increase student engagement, and nurture a lasting passion for lifetime learning. Let me share one example. There could be different approaches to teaching living and non-living things. A teacher who believes in inquiry-based learning might ask students to ask the names of things that students see or observe daily. Once students list out the names of different things, teachers might lead students in groups or individually to categorize them based on different characteristics, such as objects that can make food by themselves and that cannot; objects that can breathe and that cannot, objects that can be grown and cannot. During this process, students might come up with different ideas, argue from different perspectives, and explore new ideas and perspectives. Such activities not only develop

content-specific knowledge (such as categorizing living things and non-living things), but also develop several soft skills, such as thinking and communication skills, which is one of the major purposes of the school curriculum in Nepal (CDC, 2019). Integrating soft skills in regular teaching and learning activities is essential as it provides opportunities to cultivate different interpersonal and intrapersonal skills, which are foundations for lifelong learning (Luitel & Pant, 2021).

Inquiry-based learning is distinguished by the active involvement of students in the investigation of authentic questions, issues, or difficulties, which facilitates knowledge acquisition (Justice et al., 2007). When the knowledge is developed through an inquiry-based approach, such knowledge will be long-lasting, and people take ownership of such knowledge. The development of lifelong learning is one of the long-term effects of IBL. The basis for lifelong learning is inquiry-based learning, which fosters a sense of wonder and curiosity (Bruner, 1961). When kids take responsibility for their education, they are more likely to grow up with a positive view of learning and remain lifelong learners (Dewey, 1938). There are different approaches for letting students in the inquiry-based learning journey. The process of inquiry-based learning (IBL) often entails the identification of questions, the collection and analysis of relevant materials, the synthesis of discoveries, and the formulation of conclusions (Pedaste et al., 2015). For identifying questions, the authentic situation is considered a rich context for learning. Ning (2023) argued that inquiry-based teaching encourages students to actively pose questions, conduct investigations, and experiment to discover answers. This teaching model stimulates students' curiosity and desire to explore, cultivating their independent thinking and problem-solving abilities.

Dear teachers, for example, yesterday, one of the teachers shared about “my family members” as a rich context to teach different vocabularies and number sense. Perhaps connecting with the family context could be the best approach for early grades. That could be the best alternative to engage students in inquiry-based activities.

Orosz et al. (2023) argued that inquiry-based learning creates a new and complex classroom situation compared with traditional learning. So, both students and teachers need time to adapt to a more open learning situation. In the example of “my family members,” there could be several discussion areas. Students are open to sharing about their family members. This not only leads toward the exploration of

knowledge and engaging in developing skills but also connects classroom learning with real-life situations. There are several ways to create inquiry-based learning. One of these is guided inquiry-based learning, which supports the development of science-process skills and may also be a promising tool in applying knowledge and shaping attitudes (Orosz et al., 2023).

Now, let me share a few things about making inquiry-based activities. These are based on my knowledge and practices. It might or might not be truly applicable in y/our case. However, you can reflect on them and perhaps use some approaches. We will discuss this idea as we have a long way to go together. If the lesson is “Different Professions” and you, as a teacher, are facilitating this lesson. Perhaps you can ask students to visit neighboring houses and collect information on neighbors' professions. The same can be started from students’ houses. This helps students to engage in the inquiry process.

IBL is Useful in Higher Grades, Too!

After 15 days, we gathered to discuss further. It was also the day we agreed to share their understanding of my write-up. As always, we met in the meeting room. We started sharing observations of my write-up with teachers, which had been shared a few days before. “I sensed that I was reading a paper. You wrote with your heart. But I liked some examples you presented in your writing:” A teacher shared. An English teacher at the secondary level said that he enjoyed reading the texts and wanted to develop similar activities. As a PAR researcher, I sensed that such an approach is also useful when collaborating with teachers. This is like an opportunity to interact with our ideas and develop a common place to act in the pedagogical aspect.

One of the dominant concerns discussed in the last meeting was whether IBL is useful in the higher grades. I also wanted to deconstruct this concern with some examples. It demonstrated how we co-constructed the ideas of inquiry-based learning and how we negotiated our ideas during the process. The quality of participatory action research lies in the quality of participation. The journey of PAR was not linear in the first cycle, nor did it happen as per the mutual understanding we developed at the beginning. More specifically, the journey we made was back and forth. For example, even when developing consensus among ourselves, sometimes, I took the lead in the discussion and provided several materials as food for thought. Sometimes, teachers offered several ideas that made us rethink our temporary arrangement in the

implementation. In the initial phase, during the need's generation and exploration, I did not think of bringing ideas from the Eastern Wisdom tradition. As I interacted with teachers and community members, I was motivated by their alignments with Eastern texts such as Vedas and Upanishads. That made me explore further.

In the second part of this chapter, I shared how teachers implemented inquiry-based activities in the classroom and the changes the students experienced during the implementation. Here, I present three out of them in detail and a few more briefly.

Mathematics and Scientific Knowledge are like facts! But also, we used IBL!

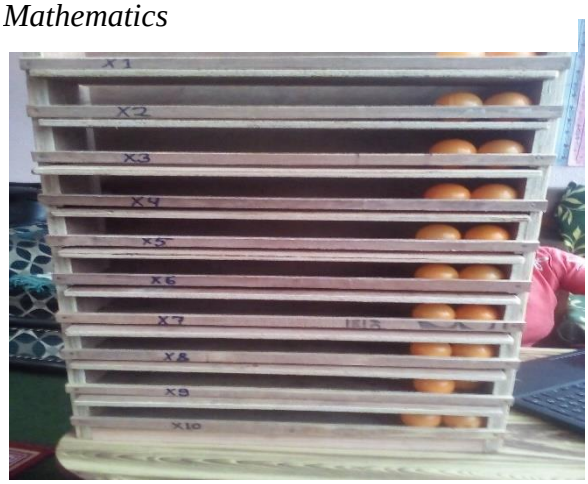
Since the early days at the research site, mathematics and science teachers have seemed to be more involved with me. It might be the reason for my background in mathematics. In general, I have experienced several mathematics and science teachers who believe that math and science are universal and we should explain every concept minutely and support them in solving problems. In the first part of this chapter, I also mentioned a similar conversation while we were struggling to internalize the inquiry-based approach in school education.

It was a day in March 2020. We were gathered in the room to share our experiences implementing IBL-based activities. First, mathematics teachers shared this way.

In the last few months, I tried several lessons with the ideas of IBL. First, the four fundamental operations (addition, subtraction, multiplication, and division) were discussed through the concrete objects. We developed materials by cutting and folding paper and using wooden blocks. Previously, I used to focus more on rules and already established procedures. But, in this journey of research, I explored myself. I also collaborated with other teachers and researchers who came from the universities. The notable part I implemented is the three stages: a) fundamental operations with concrete objects, b) fundamental operations with pictures, and fundamental operations with symbols. While using concrete materials, students explored different approaches, and came up

Figure 7

A teacher-made Resource for Teaching Mathematics



(Source: field note)

with some exciting ideas for composing and decomposing the numbers to develop a concept of place values.

The mathematics teacher shared examples of sets, geometric shapes, and experimental verification. The most notable example was teaching factorization using paper sheets. There was no wooden block at the beginning. So, teachers prepared it by cutting and folding paper. Later, we all contributed to forming a mathematics lab in which teachers developed few materials, and few were collected in society.

In this sharing session, the core message supplied by the mathematics teachers was that though mathematical facts and knowledge are somehow the same (although I do not entirely believe this statement), we can help students construct knowledge and skills by creating a rich inquiry-driven environment. Out of his several realizations in the process, he added, “I invested almost six months to understand this idea – IBL is useful in mathematics classes, too.” This statement demonstrated his strong perception of the dominant mathematics pedagogy: "Teaching mathematics is transferring the mathematical knowledge from teachers’ minds to students’ minds.”

Out of several realizations made by the mathematics teacher, one was very touchy for the teachers who were presented in the session. The mathematics teacher said.

> I taught perimeter and area with formula after explaining the basic concept for many years. But, this time, I did not explain the concept at first. I engaged them to measure the length and breadth of the objects available in the room and asked them to explore the area and the perimeter. I observed students’ engagement and motivation during this process.

Figure 8

A Student’s Engagement in the Classroom

(Source: field note)

At the same time, the mathematics teacher shared students’ engagement during those activities while implementing them. The overall observations of the mathematics teacher were in three areas: a) improvement in conceptual understanding of mathematical knowledge, as he noticed through observation and interaction with students. b) Increased students’ engagement as he noticed the participation level of students while applying IBL; c) improved student-teacher professional relation – the

teacher noted from the quality of conversation the students had in the activities and their behavior with teachers after the activities.

In the same sharing session, we listened to the science teacher. The science teacher was energetic and dedicated to using several innovations in teaching. She shared several examples, and one notable example was like this.

> I was teaching simple machines for grades 6 and 7 students. Till last year, I used to explain the simple machine, their examples, and their advantages, and make them ready to solve the questions of the textbooks. When we agreed to develop and implement IBL in our teaching, I explored myself, divided students into three groups, and assigned different tasks for each group. One group was assigned to interact with community members and explain the machines they used daily. Another group was tasked to explore the local technologies used for many years in the village areas, and the next groups were assigned to explore the latest machines used in modern life through the internet. When they shared their findings in class, I observed their work quality and connection with the ideas of machines and the community. I enjoyed the entire process.

At the same time, both teachers also shared the difficulties and challenges faced in this process. As they shared, time and resource management were the most challenging for them.

IBL Seems more Appropriate in Social Science!

I worked with all teachers at the basic level. When we had sharing sessions, all teachers usually shared their progress. There was no compulsion to develop and implement inquiry-based activities in all subjects, but there was a commitment and dedication. It was natural that the commitment and dedication were on different levels. Some teachers were more dedicated in the first cycle, and some were dedicated in the second. Few teachers were devoted highly since the beginning and maintained the same energy level towards the end of the third cycle. A social studies teacher has also had a high level of commitment since the beginning. He had a long narrative of developing and implementing the lessons for grades 6, 7, and 8. Let me share one narrative he presented.

> I (social studies teacher) have been teaching in the school for over two decades. I also have been using several projects and activities for the last few years. But at this time, when you shared Socratic dialogue and *Śāstrārtha*, I

> thought that our tradition is rich in teaching and learning. Out of several lessons I presented in the last few months, let me share one example from the lesson "Our Society." I think it is easier to apply in my subject, social studies, than other subjects, such as mathematics and science. In this lesson, I asked students about their societies and explored different aspects of the society, such as the occupations of the members, issues faced by the society, education, and health status of the members. Interestingly, all students explored these aspects in depth, which was beyond my expectations. I thought students brought basic information about those entities, but the quality of data and their engagement were notable. For example, a group of students came up with the details of the education status of all family members of that village. It made me think that students should be allowed to explore ideas independently.

After his sharing, we briefly discussed how social science is a good discipline for exploration, as per his claim. The social studies teacher further clarified that several societal issues can be directly connected with social issues. In addition to this, he also added that social events and day-to-day societal practices can also be linked to subject matters. At the same time, he noted that time constraints are the major challenge to implementing such activities in all lessons due to the heavy course content.

At this stage, all teachers at the basic level were engaged in developing and implementing inquiry-based activities. I have shared a few narratives to represent the status of this cycle and how the activities were carried out at the research site. For this, let me share one more narrative shared by language teachers (Nepali and English.)

IBL in my Language Class: A Great Experience!

The co-researchers in this PAR journey were language teachers as well. There were several activities language teachers made while teaching vocabulary, grammar, paragraph writing, story writing, essay writing, etc. In our several sharing sessions, we also discussed students' struggles in reading the texts and writing simple paragraphs. For that, a language teacher in grade three developed one strategy and shared it this way.

> I teach English language for grade three students. Many students are weak in this subject. In the beginning, I used to pronounce the words loudly in the class and ask them to repeat. I also used to ask them to remember the spelling by rote memorization for the frequent spelling tests. I used to believe that

> repetitive exercise made my students good at language teaching. Once I engaged in such activities, I developed several activities to learn vocabulary. One of them is to “make words by using alphabets” and “explore words from the picture.” While doing such activities in the class, students were found to be active and engaged in exploring words and even trying to make some new words they had not learned before. Regarding making sentences, I showed a few pictures, shared a small event, and then encouraged them to write about the picture and event in their own way. It was an opportunity to express their ideas. Despite several errors, students tried by themselves, which also helped them develop writing skills. For me, this is an inquiry-based writing activity.

In this example, an English language teacher shared how she tried to make a shift towards developing activities inquiry-based activities in her language class from a rote memorization way of teaching language. During her sharing, other teachers also added their ideas on the shift teachers need to take in teaching language and other subjects. More specifically, the major argument was towards letting students engage in the process of investigation. At this stage, as co-researchers, we observed the changes in students’ learning from the perspectives of engagement and curiosity while being involved in investigation and inquiry. In this direction, another language teacher who teaches Nepali language for grades 4 and 5 students shared.

> In my Nepali language class, I had a few issues, such as reading simple words, writing basic sentences, and pronunciation, as the English language teacher shared previously. My strategies were similar to those just shared by my fellow teachers; however, I also tried a few approaches within the inquiry-based approach. One notable approach was developing jigsaw puzzles for difficult words from the passages. While I developed a few puzzles and used them in classroom teaching, the students' attention to the tasks notably increased, and it helped them to learn the punctuation and meaning of the words. Previously, I also asked them to read several times and memorize the words' meanings. When my students play with puzzles, they engage in exploration, an approach to inquiry-based activities. Next, I asked my students (of grades 4 and 5) to explore different words from their short tour of the school and develop a small paragraph using those terminologies. I had never used such strategies before. This time, it made students active in the exploration of words and also in developing small paragraphs using the

terminologies they explored in the school compound. When they composed a paragraph, they read it loudly in class, and other students were invited to share their observations. I used this strategy several times and observed that students' language skills had improved.

Such sharing from the teachers developed a rich environment for professional development. Though teachers teach different subjects, when they listen to other approaches in various subjects, they are curious to know the approaches in detail and try to use whether this approach used by my fellow teacher is helpful in my context and subject. As a researcher, I have observed their commitment and efforts to make such inquiry-based activities and implement them in teaching and learning activities.

Based on the above field texts, I further discuss how we collaboratively engaged in IBL from different perspectives.

The inquiry-based approach to personal and professional life is everyday action. In a study conducted by Boaler (1997), it was discovered that problem-based learning positively impacted student engagement. The research revealed that students exposed to a project-based approach to mathematics experienced reduced anxiety towards the subject, developed a greater perception of mathematics as applicable to daily life, and exhibited an increased willingness to tackle mathematical challenges with a positive mindset. Here, the focus is on learning mathematical skills through an inquiry-based approach to supporting students to think differently in everyday personal and community-related tasks. Shifting from a content-centered education system to one prioritizing inquiry and discovery, students will still study core disciplines like language arts and mathematics. However, these courses will require an interdisciplinary investigation of problems incorporating a broader range of subjects, including the arts (Alberta Education, 2010). As education in Alberta is organized around 21st-century learning, there will be a change away from transmitting information, retaining facts, and developing specific competencies. Teachers will encourage their students' inherent curiosity and plant the seeds of lifelong learning. Students will be invited to collaborate to generate new knowledge on how to "think critically and creatively, and how to make discoveries—through inquiry, reflection, exploration, experimentation, and trial and error" (Alberta Education, 2010, p. 19).

One major benefit of inquiry-based learning is that it engages teachers and students with 2030 Sustainable Development goals. As per my understanding, SDG

not only searches for the products we achieved through measurable outcomes, but it is also a way of life that connects with those SD goals. A sustainable lifestyle begins with inquiry-based learning. A study by Amos and Levinson (2019) suggested that socio-scientific inquiry-based learning (SSIBL) would benefit from co-designed frameworks involving the collaboration of cross-disciplinary groups of teachers through reflection and performance on previous SSIBL activities. In addition, the same study added that SSIBL enables practitioners to establish engaging contexts for science knowledge development and to become more informed citizens. Because the SDGs are so complex, science teachers need to have a wide range of teaching skills to help their students do meaningful SSIBL while still focusing on providing scientific knowledge that helps students make informed decisions (Lester et al., 2006, as cited in Amos & Levinson, 2019). It can be hard to develop and refine personal, exploratory inquiry questions and question information sources while understanding the points of view of different stakeholders, thinking about the trustworthiness and quality of data and evidence, and improving scientific literacy and socio-scientific reasoning. Because of this, teachers are told to think about and act out problems they came up with in past SSIBL activities. I believe that the SSIBL way of teaching is meaningful because it helps teachers connect the ideas of science in the lessons with ideas about science that support citizenship.

When IBL is seen from the perspective of learning theories, it comes under many theories depending on the inquiry process one uses. If the inquiry is more connected with thinking, cognition, and mental processes, it lies under cognitive learning theories. Kuhn et al. (2000) argued that establishing the value of inquiry learning as an educational method through a detailed knowledge of cognitive skills is necessary. For that, the mental models, as representations of the reality being investigated in inquiry learning, influence strategies applied to the task. In this research, the authors investigated that students at the middle school level, and sometimes well beyond, may have an incorrect mental model of multivariable causality that hinders the causal analysis involved in most forms of inquiry learning. So, the findings of this study suggest that a developmental hierarchy of skills and understanding inspires and should be identified as an objective of inquiry learning.

If we interpret IBL from the constructivist approach, it focuses on the collaborative nature of the investigation in which teachers develop activities such that students contribute to the path of inquiry in a group by actively participating in

classroom discussions and constructing knowledge through critical inquiry-based learning, rather than just the theoretical knowledge gained from lectures (Danish & Gresalfi, 2018). The learners' responses would help drive lessons, shift instructional strategies, and alter content as necessary and relevant, as Gross and Gross (2016) mentioned. The guiding questions the course facilitators and peers raised would help drive learners' curiosity and explore their practices through critical self-reflection to generate their interest in the subject matter. Inquiry-based learning helps students learn through real-life situations and allows them to use what they've learned to solve daily problems that come up in their personal and professional lives. Moreover, learning also needs to occur through conversations between learners and teachers (Gross & Gross, 2016). It demonstrated that the rich discussions among students and teachers played an important role in applying an inquiry-based approach to learning.

Chapter Summary

This chapter demonstrates the journey of developing and implementing inquiry-based activities. The chapter began with the initial skepticism about students' readiness and the use of inquiry-based learning. The co-researchers shared their experiences of integrating inquiry-based approaches in the lower grades, emphasizing the importance of cultivating curiosity and critical thinking. The first cycle provided us with several lessons. The professional bond among co-researchers became strong, and we started to feel comfortable sharing and negotiating ideas. It was a great beginning to connect several Eastern constructs (such as *Śāstrārtha*) for developing inquiry-based activities. However, we encountered numerous challenges throughout the process. Though we, as co-researchers, were mentally aware of the participation process, walking in a team with the same spirit was challenging. We noticed that few teachers were making a conscious effort to join in the decision-making process, and the remaining were together as followers. After several rounds of reflections during cycle one and the dedicated reflection session at the end of cycle one, we, as co-researchers, established the agenda for the next collaborative action. The collaborative action aimed to develop and implement multidisciplinary and interdisciplinary activities and projects. The next chapter demonstrates how co-researchers collaboratively designed and implemented multidisciplinary and interdisciplinary activities and projects.

CHAPTER VI
JOURNEY TOWARD MULTI/INTERDISCIPLINARY ACTIVITIES/PROJECTS

Chapter V shares the journey of developing and implementing inquiry-based learning activities. During the reflections conducted in the first cycle, we, as co-researchers, explored the needs for the second cycle – developing and implementing multidisciplinary and transdisciplinary activities. So, this chapter is developed to respond to the research question: how do co-researchers develop and implement multidisciplinary and interdisciplinary activities to develop students' meaningful learning? While doing this, the ideas of multi and interdisciplinary learning are analyzed among schoolteachers, and possible ways of making inter/multi-disciplinary projects are discussed. In doing this, the collaboration among teachers, the participation in the journey, the success stories, and the struggles while making and implementing are discussed. More specifically, this chapter addresses the research question: how do co-researchers develop and implement multi-disciplinary and transdisciplinary activities to develop students' meaningful learning?

What Went Well and Where Are We Now?

Cycle one aimed to develop and implement inquiry-based activities in different subjects. The activities in cycle one were done according to the needs we collaboratively generated. Though all teachers were engaged (however, the engagement of all teachers was not the same) in developing inquiry-based activities and implementing them in schools, it was observed that the collaboration among teachers in preparing the activities was minimal. From my field note, I have recalled the moments when teachers focused on possible activities in their respective subjects. This might be the reason that we agreed to develop subject-specific inquiry-based activities. As per the plan of the PAR cycle, we also critically reflected on the successes and limitations of the first cycle. The teachers shared their thoughts in the reflection sessions. The notable aspect they mentioned was that the students liked the activities they designed, and teachers also enjoyed them during the implementation. The teachers seemed happy and satisfied. A Nepali teacher who occasionally discusses the Sanskrit language and Eastern wisdom traditions said he liked *Śāstrārtha*'s ideas. Other teachers noted the combination of the Socratic questioning model with *Śāstrārtha*. However, one teacher expressed difficulty understanding the

events and concepts I offered in writing. One teacher told me that you might share the entire Veda in the second cycle, as you shared a few of *Śāstrārtha*'s ideas in the first cycle in a satirical tone.

At the same time, during our reflective sessions, we, as co-researchers, realized that two or more teachers could also develop such inquiry-based activities by connecting with two or more subjects whenever possible. Such realizations were counted as the needs of the second cycle. The teachers in grades 1-3 have emphasized connecting two or more subjects in classroom activities and projects. The teachers of grades 4-8 also felt the need to connect subjects in designing projects but not at the level of grades 1-3, where the curriculum provided rich integration spaces. We decided to develop multidisciplinary and interdisciplinary activities, implement them, and reflect on the journey for the next year.

What do Inter and Multidisciplinary Activities and Projects Mean to Us?

As co-researchers, we agreed to discuss the multi and interdisciplinary nature of the project. At the same time, we must agree on some principles of multidisciplinary and interdisciplinary projects. As we performed in the first cycle, we met to discuss these ideas. It was a day in October 2020. We gathered in the ICT room to discuss the agenda that had already been developed. We all were excited about this journey. Arriving at this stage, I was convinced that the co-researchers' level of interest and dedication had increased. There were about 12 teachers in the room. The head teacher took the lead in the discussion. She shared the purpose of the meeting and asked me to share something about the second cycle and multidisciplinary and interdisciplinary activities. I immediately added.

> I am just here to listen to you. We have completed one cycle and gathered rich experiences from the collaborative journey of cycle one. As you know, we are on a journey of action and reflection for knowledge generation. It's not that I, as a university researcher, should take the lead. I am one of the collaborators among us.

Though we are cognitively aware of the ideas we all contribute without any hierarchy, they appear in different forms, such as, "I am a math/science teacher. So, I know many ideas". "I am one of the senior teachers in the school. So my experiences are authentic." I am a secondary-level teacher. I know many ideas." In the same way, many teachers still think that the researchers are from the university. So, they know better than us.

Normally, I consciously invite coresearchers at first to share their ideas and thoughts on the issues we are taking. I also keep my understanding from the perspectives of offering ideas rather than ruling by the ideas. When I invited any teachers to share ideas on multi and interdisciplinary activities, a teacher who teaches in grade three shared this way.

> Last month, I attended an integrated curriculum orientation session in the municipality office. I learned that the present national curriculum for grades 1-3 has been developed from the principles of multidisciplinary and interdisciplinary nature. The subject, *Hamro Serophero* (Our Surrounding), was developed as per the ideas of interdisciplinary and other subjects like the Nepali language, English language, and Mathematics, which are developed as per the ideas of multidisciplinary.

Other teachers also shared their understanding with some examples. We had a few discussions on these two ideas. The understanding of teachers on multi and interdisciplinary was too limited. Also, many teachers were expecting my understanding as well. I wanted to share my understanding. During my doctoral study's proposal development phase, I explored a few ideas on multi and interdisciplinary. I shared in this way.

> In recent years, the conventional way of teaching subjects in isolation has been increasingly challenged by the need for a more connected educational experience. This shift has given rise to two essential approaches: the multidisciplinary and interdisciplinary approach to education.
>
> The multidisciplinary approach integrates knowledge and skills from multiple disciplines around a common theme or issue. For example, when studying climate change, students might explore the scientific causes of global warming in their science class, analyze environmental policies in social studies, and express their understanding through literature. Each subject maintains its distinct identity here, but a shared focus connects to different subjects. In the case of an integrated curriculum of grades 1-3, there are several themes, such as “me and my family” and “our school,” and different contents from different subjects are kept under those themes. It is also suggested that teachers connect with the themes while dealing with subjects of mathematics, Nepali language, English language, and our surroundings.

> Let me share something about the interdisciplinary approach. The interdisciplinary approach goes further by blending the boundaries between subjects (i.e., disciplines) to create new ways of thinking and problem-solving. In this approach, subjects are connected by a theme and integrated to the point where they enrich each other. For example, in a project on “family tree,” Students learn within multiple subjects in this activity, promoting a holistic learning experience. Students explore their family's history, traditions, and cultural backgrounds. This helps them understand their families' historical background, migration patterns, and cultural diversity. Students write narratives about their ancestors and family traditions to enhance their writing and storytelling skills. Students can also present their family tree to the class, which helps improve their speaking and communication skills. In addition, if you ask students to develop a family tree, that develops skills of organizing information systematically. Analyzing the relationships and patterns within the family tree can introduce concepts of sets and relationships. Students can create attractive family trees using various art designs to develop artistic skills. Students can also use basic computer software to create digital family trees and learn about digital design and technology tools.

Having said this, I invited teachers to contribute to this discussion with their understanding. A social studies teacher said.

> It is good to hear from you, but it seems challenging if we see it from the assessment perspective. How do we assess different knowledge and skills in a single activity and project and keep a record of them.”

I took this concern seriously. However, I wanted another teacher to speak about assessing such interdisciplinary activities. I encouraged other teachers to respond to it. After a slight pause, a Nepali language teacher said.

> I think we can’t do such activities regularly. We can perhaps plan to conduct such activities occasionally in collaboration with two or more teachers.

When the Nepali teacher shared such ideas, all teachers seemed convinced. It was also discussed that such activities were more aligned in the lower grades (till grade 3) and less applicable in the higher grades.

In this sharing meeting, we also discussed a few ideas on its importance and advantages. The central take-home message from this session was like this.

> By integrating different disciplines, we can discuss different contents by connecting with real-life problems that do not fit directly into one subject area. This helps students develop a meaningful understanding of their learning, connecting with real-world issues that are complex and multifaceted. When students are encouraged to draw connections across subjects, they create the ability to think analytically. They learn to assess evidence from different perspectives, which is necessary for problem-solving. An integrated nature of curriculum often involves project-based learning in which students actively participate in their learning process. This inquiry-based approach in project-based learning fosters engagement among students to take ownership of their learning. The ability to think and work across disciplines is gradually essential in today's society, in which most careers require knowledge and skills from multiple areas. In this context, an integrated nature of pedagogical practices prepares students to tackle future challenges by providing context-specific knowledge and skills.

For this, as teachers, we need to reflect on how we can incorporate multidisciplinary and interdisciplinary activities into our teaching in the context of our schools in Nepal. It's time to develop activities and projects that align with the spirit of the Nepali curriculum and connect them with the knowledge and skills of different subjects. For this, we, as co-researchers, work together across subjects to design and implement these activities. This is not an easy task, but it is an excellent opportunity to learn collaboratively and contribute to the knowledge-generation process of school education. By accepting these ideas, we create more dynamic and responsive educational surroundings that prepare our students to see the connection between two or more subjects. We are about to close the session, and one teacher said.

> Sir, today we discussed several practical examples of inter and multidisciplinary activities that seem useful in our context. As a teacher, I (and perhaps many of us) want to explore these ideas further and use them in our teaching and learning process. So, if possible, please develop a short article with some theoretical ideas and share it with us in the next meeting for further discussion as you used to do in the first cycle.

All teachers in the sharing session agreed that my write-up in the first cycle was helpful for them and became food for thought in the upcoming discussion, and they wanted a similar approach in this cycle.

When I returned to my residence from the field visit, I started developing a write-up on the interdisciplinary and multidisciplinary nature of the curriculum and pedagogical approach. I was motivated by teachers who were expecting such reading materials. One of our primary goals was to develop skillful, ethical, and responsible teachers. When teachers showed interest in receiving resource materials for their professional development, I thought we were in the right direction to reach the ultimate goal of teacher professional development. With this realization, I developed a short write-up that looks like this.

Multidisciplinary and Interdisciplinary Curriculum and Pedagogy

In this section, I present an argumentative literature-based write-up to share with co-researchers in the journey of PAR before we develop and implement multidisciplinary and interdisciplinary activities and projects.

Dear co-researchers,

It was a great sharing session this week. I feel privileged to be a part of this team as we all grow together in performing innovative pedagogical activities and improving our actions based on continuous reflection. As you all were interested in reading and discussing some ideas on multi-disciplinary and interdisciplinary curriculum and pedagogy, I want to share some theoretical foundations behind these ideas. These philosophical ideas will help us develop activities later in our study.

One of the most vital foundations for multi and interdisciplinary curricula is Dewey's (1938) advocacy for education that connects knowledge to real-life experiences. For this reason, students should have access to an environment where they can learn by participating in real-life challenges and reflecting on their entire educational experience. Dewey is credited with developing the well-known ideology known as progressivism. In this kind of education, it is stated that students learn through an interdisciplinary approach in which they connect with knowledge holistically and meaningfully.

Next, the notion of social constructivism (Vygotsky, 1978) believes learners construct knowledge and skills through experiences and interactions with society. It also supports the multidisciplinary and interdisciplinary nature of education. From this perspective, interdisciplinary pedagogy aligns with this philosophy by allowing students to draw connections between different subjects to construct a more integrated and comprehensive understanding of the subject matter. When students are provided with several authentic projects in a group, students connect two or more subjects in

project-based learning. So, one of the assumptions of social constructivism is that students learn in a rich context. Support systems such as scaffolding and mediation are also necessary for learning, depending on the needs and contexts.

Parker Palmer is another influential educator who argues for holistic education for the development of the whole person, consisting of social, emotional, intellectual, and spiritual aspects for ethical human resources. For that, Palmer (2017) also advocated for the multi- and interdisciplinary nature of education as it encourages the integration of various domains of knowledge to address the complex needs of learners.

Let me share one example of Finland. Finland has revised its education curriculum to emphasize 21st-century capabilities. The school curriculum requires one transdisciplinary learning module every year. A case study conducted by Braskén et al. (2020) examined the views of head teachers, science teachers, and math teachers on implementing such a curriculum in grade 9. The study demonstrated that stakeholders need research-based support and time for sense-making to transdisciplinary teaching issues. Similarly, Munkebye et al. (2020) conducted a multi-case study to examine Education for Sustainable Development (ESD) teachers' interdisciplinary approach and the Sustainable Backpack Programme (SBP) teachers' assessments of how their curricular modules support environmental, social, and economic sustainability. This study enriched knowledge of primary school teachers' ESD techniques across topics. The content analysis showed that the modules used various ESD subjects challenged students' reasoning and critical thinking further. The modules partially achieved a holistic approach.

In the case of Nepal, as we discussed in our last sharing session, this approach to education and pedagogy has already been introduced formally till grades 3. From grade four onward, there is a provision of project work and practices in each subject. Teachers can collaborate to design relevant multidisciplinary and interdisciplinary activities and projects based on the nature of the subject matter. We will discuss several examples in the days to come.

Best Regards

Binod

I shared the above write-up with all teachers, and we agreed to read and further explore the multidisciplinary and interdisciplinary nature of education and pedagogy. We met after a week as per our schedule. We further discussed those ideas

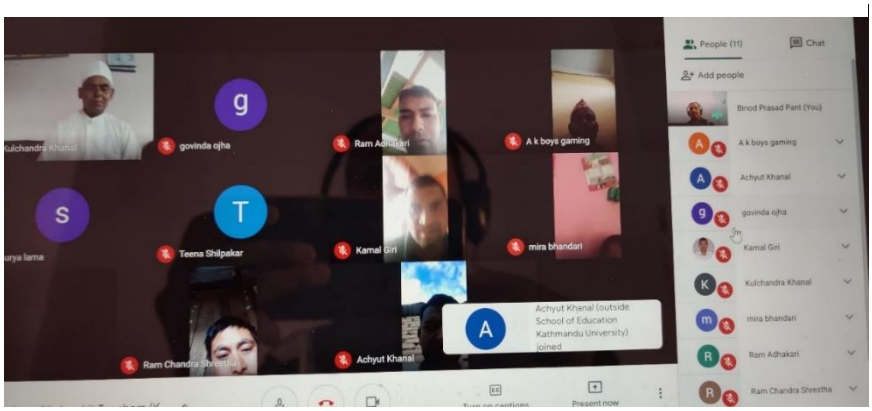
and developed a shared understanding of developing and implementing the multi and interdisciplinary nature of activities and projects. We also developed a consensus between two terminologies: multidisciplinary and interdisciplinary activities and projects. Based on our several rounds of collaborative discussion and literature, we decided that we consider activities as classroom activities that can be conducted for meaning-making purposes comparatively in a short period. However, projects mean connecting subject matters with real-world issues that can be inside the class or mostly outside, aiming to develop a meaningful understanding of the subject matter and some level of soft skills/21st-century skills development. Keeping this in mind, we all agreed to create at least one activity/project, implement it in the learning process, and reflect on it in a group. I had several rounds of meetings individually as well. Now, I present some project development and implementation processes as sample cases.

It's COVID Time! Let's Develop IT Skills and Develop Resource Materials

Due to COVID-19, the schools were closed, and we, as co-researchers, were also disturbed due to several cases of health emergencies in our home and the community. There were a few cases of mortality as well. We could not concentrate on our ongoing fieldwork. At one point, I was completely hopeless about whether I could continue my fieldwork or stop the ongoing actions and think of alternative fieldwork for my doctoral study. But I did not share it with anybody. After about two months of such a situation, several ideas were discussed for alternative arrangements to continue the students' learning. The government was also exploring some alternative ways, such as making phone calls, gathering small groups in the Community Learning Centre (CLCs), and using virtual learning. I also contacted schoolteachers and SMC members. I sensed the school was also expecting our collaboration during this difficult time. As a researcher, I also intended to support

Figure 9

A Virtual Meeting with Teachers During COVID



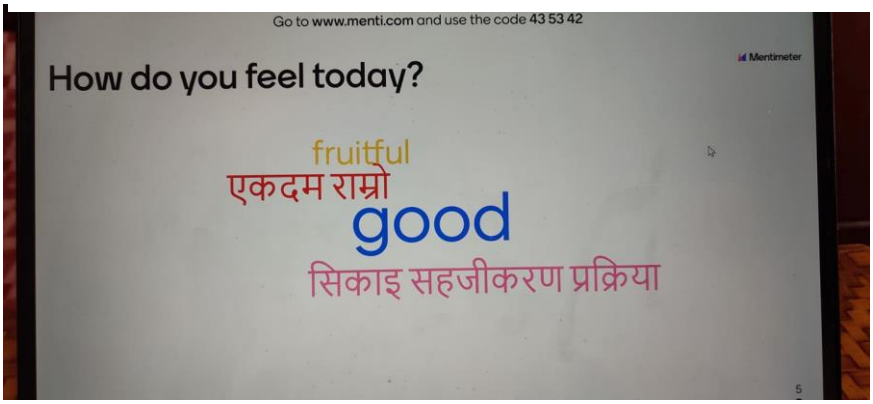
(Source: field note)

students in any form (not necessarily connected with the research agenda) so that teachers can support students in continuing their learning.

We had an online meeting with schoolteachers. The first virtual meeting happened on 13 June 2020. After discussing several issues, we agreed to run weekly online meetings and develop some ICT skills teachers can use for virtual teaching. At the same time, it was agreed that teachers should develop and share some resource materials in the online meeting. In this discussion, schoolteachers seemed very proactive. Their plans and commitment made me realize that this was an excellent time to continue our fieldwork, even in difficult times.

Figure 10

Teachers' Reflection in the Virtual Workshop



(Source: field note)

Teachers' Competencies in IT Skills

One of the significant achievements obtained in the second cycle is the enhancement of teachers' IT skills competencies. In this regard, almost all teachers reported that their skills had improved notably. I observed that the progress in developing competencies is not uniform. But teachers have made remarkable progress. In this regard, one teacher said.

> I learned both English and Nepali typing. I can now type and print exam questions. Most importantly, I'm ready to use slides to teach. At first, I wasn't sure about how to use ICT tools. Now, I'm confident that I can use them. And we learned a lot from each other's sharing.

On another day of the virtual session, I shared the procedure for making an assessment tool using Google Forms. The teachers faced cognitive overload due to the first-time exposure to online tools. Nevertheless, one female teacher developed and shared the Google Form in the virtual session. When she shared the Google Form with her peers, other friends were motivated and realized they could also make such forms. The form was on exploring students' pre-requisite knowledge of science. She

developed this form to test the students' existing status on the subject matter so that she could plan the lesson by connecting it with the pre-requisite knowledge.

Next week, we demonstrated the collaborative use of Google Docs with the teachers. We asked them to write about their experiences during COVID-19. The teachers were amazed that all collaborators could simultaneously work on the same document. When I conducted an interview, one teacher shared.

> It was just like magic in which we all could read, write, and comment on the document simultaneously. I think I will try to use it in the computer lab once the school opens.

Teachers also faced different difficulties in this journey. Regarding the difficulties, one teacher shared.

> It was enjoyable and challenging. Online learning was not my cup of tea. Due to an unreliable internet connection, there was a communication barrier that hindered my ability to learn. We learned how to develop presentation slides for teaching purposes. Importantly, we learned how to use Google Meet to conduct online classes. Also, we were able to connect with the students. However, a few students could not enroll due to a lack of technology access.

In the following weeks, I shared my experiences using presentation slides for online instruction. I used PowerPoint slides to discuss multi and interdisciplinary teaching and learning. I provided examples of asking the questions by illuminating images on the slides to estimate the students' comprehension. The next day, they also worked on slide creation on a mobile set. I discussed incorporating Google Earth into teaching and learning activities next week. We took a virtual tour of Nepal, using it to teach social studies in various classroom settings. It was also connected with the ideas of mathematics (i.e., direction and angles) and science (lives of animals and plants in different places). This event became very interesting to teachers.

During the interview, one teacher said.

> It was exciting to use presentations to teach. I have always had a strong desire to learn about technology. I was interested in finding out how to use the presentation to teach. I gained more excellent ideas about creating slides for instruction and using them in the classroom. It produced amazing results. I can now adapt my traditional teaching to a changing world due to technology. Using technology in the school increased students' engagement, as per my experience.

After our conversation, I realized that she was self-motivated to learn technological skills for education. She concurred that using technology in the classroom significantly increases student involvement and learning enjoyment, as Heafner (2004) argued. In a similar line, I requested another teacher who was heavily involved in the virtual session. He shared his experience in this way.

> I learned how to create slides with internet-sourced images using a mobile phone. I also attempted to insert a video but was unable to do so. I finally tried to teach sixth graders about our society in the classroom for the first time. I utilized the question-asking method I learned from you during our online meeting. I found the classroom productive since every kid was attentive to the photos and engaged in the discussion. I asked the students to discuss their image interpretation, and they responded enthusiastically.

According to his perspective, such authentic activities are particularly valuable for learners as part of engaged activities, as discussed by Vygotsky and Cole (1978), and they are highly relevant to teaching and learning, allowing teachers to attain students' ZPD. It provides substantial support that learning is a social process involving interactions with peers and more proficient adults, as argued by Vygotsky's ideas of ZPD.

The usage of presentation slides with pertinent images has aided in the comprehension of classroom questions. It has produced a classroom climate conducive to learning. Frey and Birnbaum (2002) also showed that PowerPoint presentations helped students maintain their focus throughout lectures. TPACK knowledge was exhibited by harmonizing PowerPoint and inquiry-based learning to teach cultural components within the social studies curriculum.

Teachers' Engagement in Project Development

Another remarkable development is teachers' engagement in project-based task development. During the school's closure due to COVID-19, the local government and parents also advocated for developing projects for the students so that students could learn through such projects conducted at their homes. So, I invested in 12 virtual sessions for project development activities. Teachers developed sample projects, shared them in the virtual sessions, received feedback from their peers, and finalized them.

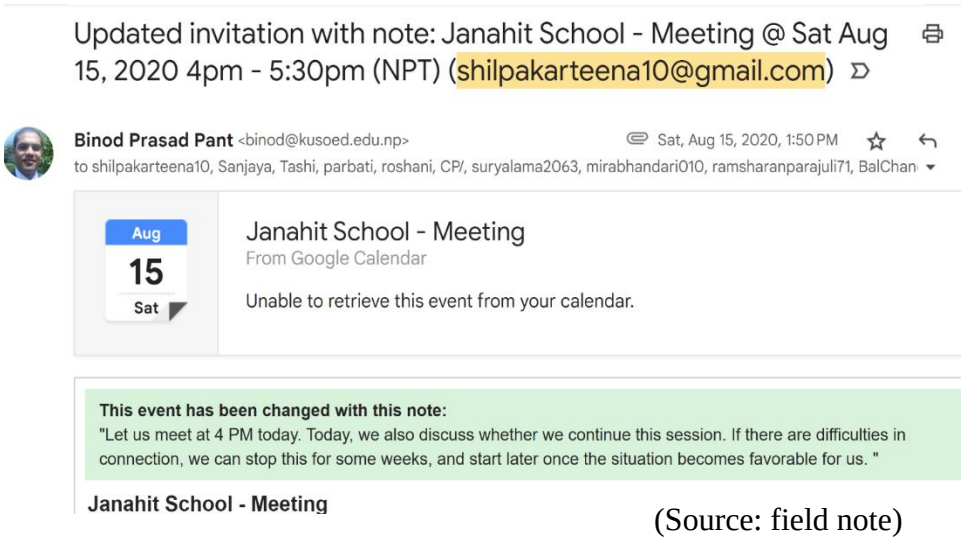
Teachers developed projects and distributed them to students. Students completed projects per the instructions and submitted them to teachers in person. As

the teachers and students were from the same community, meeting students and teachers in small groups was possible despite the school closure.

Let me share one sample project that was developed during this period. Out of several projects, a science teacher developed a project entitled “My Food Chart,” in which the teachers connected with mathematics and English. There were four learning goals: a) make learners familiar with the different healthy and unhealthy foods, b) integrate the content with the real context of the learner’s day-to-day life. c) familiarize learners with the connection among different disciplines, and d) develop creative writing skills. The major suggested steps were as follows: a) prepare a list of food items for three days with their prices on paper, b) show the addition of those prices on the same paper. c) Draw the food items on a chart paper. It needs to be drawn under the different categories according to the nutrients they provide (potato gives energy, so it needs to be drawn under energy-giving food, and so on), d) categorize the food into healthy and unhealthy categories, and also provide reasons behind this, and e) write about your favorite food in a paragraph.

Figure 11

An Email Communication with the Teachers



(Source: field note)

When three teachers collaborated to develop this project under the leadership of a science teacher and implemented it during COVID-19, the teachers reported that about half of the students from grade five submitted the project online. It was the first experience of conducting projects during COVID-19. One of the participating teachers shared the experiences of engaging in teacher professional development sessions this way.

> In the virtual session, I learned ICT skills and how to develop the project. The project I developed was more interdisciplinary. It helps my students learn different subjects like mathematics, science, and language.

This reflection of the teacher shows that the teacher has developed skills in developing projects for the students. Project-based learning has been mentioned in the recently developed curriculum at the school level in Nepal. It is a good time for teachers to learn how to create and implement projects in their school setting. During the interview, another participant shared.

> The projects we developed during our virtual session have significantly helped during this time of COVID. At least our students got engaged and learned something even during school closure.

As a lead researcher, I observed and experienced that this activity was timely as teachers got opportunities to implement and refine them. Almost all teachers admired their involvement in the virtual sessions. Nepal's 2019 national curriculum framework identifies different uses of ICT in education: as a means of communication in school administration, as a tool to facilitate teaching and learning, as a medium to improve the competence of stakeholders, including teachers, and as a separate subject to be incorporated into the curriculum to improve students' life skills. As one of the guiding principles for managing learning outcomes in curriculum creation, the ability required to use ICT has been prioritized. The teachers' competencies framework of Nepal (MoE, 2016) specifies eight competencies for managing and selecting teachers at school levels: content knowledge, pedagogical knowledge, knowledge of learners, learning environment and classroom management, communication and collaboration, continuous learning and professional development, legal-based and professional conduct, and information and communication technology.

The Ministry of Education's 2013 ICT in Education Master Plan mandated the use of ICT in our profession, and we must improve our ICT integration skills. I also participated in many trainings to enhance my pedagogical expertise. Nonetheless, I sensed a glaring lack of expertise regarding the appropriate use of technology in classrooms. The curricula emphasized technology (Microsoft Word, Excel, and PowerPoint) without providing considerable assistance to increase students' learning. I felt much more emphasis was needed on ICT pedagogy (McCarney, 2004).

The UNESCO ICT Competence Framework (2018) emphasized that teachers should have ICT competencies to integrate ICT into their profession and achieve

equity and quality education. In Nepal, ICT is reaffirmed as one of eight domains of a teacher competency framework, as outlined in the National Curriculum Framework. The TPACK framework (Koehler et al., 2013) articulates the harmonious interaction between three bodies of knowledge (Technology, Content, and Pedagogy) for effective technology integration. ICT has become a cross-cutting issue in Nepal's teacher education. Technology significantly simplifies and enhances teaching and learning by providing accessible information and creating enjoyable learning opportunities. (Khalid et al., 2024). Due to COVID-19, the discourses on using ICT in emergencies have become pertinent for continuing education activities, even if such conditions arise in the future. The development of projects using different technical tools and making them accessible through different learning management systems can be further explored. In this context, this research study is beneficial for teachers and educators interested in using ICT instructional practices.

The teacher development workshops conducted virtually during COVID-19 became effective. Participatory Action Research (PAR) became helpful from the beginning of the study to the reflection of the entire process. Teachers developed several IT skills during the virtual session and developed several projects. The teacher-made projects became helpful in times of emergency. Teachers reported that students were involved in learning through projects and different IT tools. However, different challenges were faced during the fieldwork. A few challenges were internet connections and a few teachers' unwillingness to participate virtually.

The ICT workshops were not on my study's list of needs. Due to the terrible situation of COVID-19, we were not mentally prepared for virtual sessions. But, after a few weeks of school closure, we realized that it is our *Dharma* to support school teachers in this difficult time. Initially, I did not plan to consider these activities as "fieldwork." Later, I realized that the TPD sessions served the purpose of co-researchers' professional development and helped develop several learning resources. So, I counted the activities as fieldwork for research purposes as well. Here, I intend that we do not always perform routine-based and planned work to get some immediate return. In PAR, we also perform actions for the betterment of the community, which is aligned with the ideas of *Dharma*.

Designing and Implementing Multidisciplinary Activities and Projects

In this section, I shared a few activities and projects collaboratively developed and implemented on the research site. During the second cycle, we developed around

20 activities and projects by teachers at the basic level. However, I share a few activities and projects as representative cases to share with the readers the nature of our actions. Then, I analyze and discuss its influence on the teachers' professional development and students' learning, as reported by teachers.

My Bag: A grade two teacher developed a project named “My Bag” and implemented it. The design of the project looks like this.

Theme: Me and My family

Sub-theme: Our Belongings

Activity: My Bag

1. Bibisha has the following items inside her bag.

   Pictures of pencils, books, copies, sharpers, erasers, color pencils
2. Write down the items you have inside your bag.
3. Write the names of items both Bibisha and you have.
4. Count the number of items Sita has. Write it in numerals and words.
5. Count the number of items you have. Write it in numerals and words.
6. Who has more items? Who has fewer items?
7. How do you keep the items in your bag?
8. Have you ever lost items in your bag?
9. If you lose any items from your bag, what do you do?
10. Draw a bag that you like most and color it. Why did you like that bag?
11. Make a model of nag using waste material available in your home.

When she shared this with me and other teachers in the sharing session, I asked her why and how she developed it. There are all questions, including how you claim this is a project. She replied.

> I developed this project in a worksheet format using an inquiry-based approach as we discussed the Socratic questioning model in the first cycle. I divided students’ expected responses into different parts and made several questions so that students explored different responses individually.

I wanted to know more, so I asked why you called it a project, not just an activity. She explained this way.

> I am still unclear about the exact differences between classroom activities and projects. As per our discussions in our last sharing meeting, I sensed that the classroom activities are for short periods of time and normally are designed to discuss certain knowledge and skills that are directly related to the learning

> objectives of the day. For example, if we ask students to measure the length of a book and write in a notebook, it might be an activity. But, if we ask students to measure the length and breadth of a bedroom and calculate floor area and the number of marbles we need to cover the entire floor, that might come as a project as students develop several soft skills while doing this activity. Several small activities can be related to a real-life issue in a project.

This sharing made me happy as she rightly identified these issues. Here, my focus is not on distinguishing between classroom activities and projects; there is no clear distinction. However, in recent years, when the national curriculum introduced the provision of projects and practicals in different subjects (CDC, 2019), in the name of projects, several routine kinds of classroom activities have been named projects in many cases. So, we discussed these issues at the beginning of this cycle.

The teacher who developed and implemented the project "My Bag" for grade two students shared the entire journey this way, which became groundbreaking sharing for other teachers to move ahead.

> I brought content from Mathematics, Nepali, and Creative Arts to this project. I made a blend of small activities in a connected way so that overall, it relates to the ideas of Bag, which is itself connected to students' sentiments in the early grades. I also revised this project as per the suggestions of other teachers. When I conducted the project, students seemed active in exploring information. It also became interesting as there were no readymade and single responses. When students shared their responses in the class, all students were curious to listen to other friends' responses. I found this to be an authentic situation that fostered discussion in the class. When students developed an art and a model of the bag, they demonstrated their creativity with several outputs. We conducted a small exhibition in the class. It was the most notable aspect of the entire project.

We discussed in detail the success and limitations of developing such projects. The involvement of students in all phases was different, and the teacher was struggling to make things happen. The strategies that could be used to ensure the participation of the maximum number of students were also discussed. Out of several ideas, it was concluded that individual level of support and follow-up could be the best alternative to ensure students' participation.

My Daily Life - Yoga: Our next project focused on yoga, also part of the school curriculum. A third-grade teacher took the lead in this initiative. Throughout the project's development, we explored one specific approach to structuring and implementing projects effectively. I shared Stripling's (2009) idea as an alternative way to design a project in one sharing session, and many teachers liked these ideas and decided to develop activities and projects. As per Stripling's (2009) ideas, we discussed six steps for the inquiry-based nature of projects. The first step is "connect," in which the subject matter should be connected with some local contexts, practices, and previous lessons. Here, students should be able to explore the knowledge within familiar contexts. The second step is "wonder," in which teachers should provide an investigative question(s) related to the context so that students prepare themselves for the exploration; the third step is "investigate," in which students explore some knowledge and skills based on some authentic questions. After investigation, the next step is "construct," in which knowledge and skills are developed for the purpose of the project. The fifth step is to "express," in which students should get opportunities to share the constructed knowledge or/and skills in any form, such as oral, drawing, written, or role-play. Finally, the last step is "reflect," in which students are encouraged to reflect on the entire learning journey from the perspectives of what went well and what areas for improvement were noticed.

One significant discussion was that learning does not occur simply by repeating routine activities multiple times. Engaging in hands-on experiences and reflecting on those experiences is essential. This concept gained attraction, and teachers began encouraging students to reflect on their learning to identify and address weaknesses and errors in future attempts. Based on this idea, all teachers developed and implemented one project. One of the projects is mentioned below.

Project's Name: My Daily Life (Yoga)

1. Connect: Hurry! It's time for YOGA. Is it like exercise? What do you think?
2. Wonder: Watch a video of yoga (Child Pose - shisu aasan) and follow it
3. Investigate: Write the steps of yoga (shisu aasan); when do you prefer this?
4. Construct: Draw a picture of shisu aasan, and ask someone to take your photograph while conducting shisu aasan.
5. Express: Keep the picture and photographs on a page
6. Reflect: Write about your experiences doing yoga. If you have to do it again, how do you do it?

We also engaged in discussions after implementing the project. The teacher who initiated and led the implementation phase shared experiences in this way.

> This was one of the student's favorite activities. Students watched a video of Yoga, explored different stages, made a drawing of it, developed a photograph, and shared their experiences in a written form. There was a good blend of exploring, conducting, and expressing meaningfully. I observed that students were happy when conducting Yoga and reflecting on their practices. I noticed that two students who usually did not come forward to speak and share seemed very active in this activity. Perhaps the nature of the activities motivated them to participate actively. However, some students faced difficulties due to their weak foundational skills in writing.

We discussed this activity from different lenses, such as pedagogical approach, classroom management, and assessment, and finally agreed that such activities help students develop subject-specific skills in specific contexts.

A teacher who teaches science to grade four students initiated the development of a plan on “Plants and Their Characteristics.” Since we discussed several possible approaches for making plans, he came up with his own format and shared it in the sharing meeting. He also received feedback in the sharing meeting. I want to share this in detail with the plan as to how the PAR approach is initiated to develop, revise, executive, and reflect the entire process.

Plants and Their Characteristics

Major Subject: Science

Connected Subjects/Domains: Language, Social Studies and Art

Objectives:

a) Write the names of plants found in the kitchen garden

b) Differentiate plants by their types

c) Draw pictures of herbs

Materials: note copy, A4 paper, color, etc.

Activity:

i) Observe the kitchen garden of the school.

ii) Write the names of plants found in the kitchen garden.

iii) Differentiate plants in the table by their types.

iv) Draw a picture of herbs and color them.

When the science teacher shared his plan in this way, some other teachers raised a few questions, such as; where is the component of social studies? Are there any activities related to language subjects other than writing the names? Teachers also provided suggestions for making this plan more multi and interdisciplinary. I observed a focused discussion to improve the plan. The science teacher initially did not consider it positively but later realized that this project could be further developed and more engaging. He added a few aspects, such as; what roles we can play in saving the plants in the kitchen garden. How can we use those for medicinal purposes, if possible?

Once the science teacher implemented this project, he was excited to share all the reflections on the implementation. In brief, he realized that content mapping should be done and that the specific learning outcomes from different subjects should be well connected while designing such inter and multidisciplinary projects. Teachers from different subjects should be together during the planning phase.

Let me share one more project a social studies teacher developed in grade eight. The title of this project is “Exploring Occupations of Our Society”. The expected completion days are 10. The objectives of the project are as follow:.

a) To develop a list of occupations in the community.
b) To share the tasks, problems, and challenges of each occupation.
c) To share the positive impact of occupations in society and
d) develop a picture demonstrating the major tasks of the occupations.

The teacher developed the following list of activities to achieve the above purpose.

a) Interact with a few (at least 25) community people. List out at least ten occupations done in your community. If there are not ten occupations in your nearby community, collect them from the neighboring community as well.
b) Classify the occupations under different headings such as; agriculture, industry, and service). Also, classify the occupations done within the country or outside the country. Develop a pie chart to show the classification.
c) Explore the tasks of each occupation and make a list.
d) Explore and write about the problems and challenges of each occupation.
e) What impacts have been made by any two occupations to your society from the economic and social perspectives?

I shared some sample plans for projects to provide a message that we didn’t develop and follow the readymade template. We discussed several ideas, and teachers

were encouraged to come up with their own ideas. I am sure those plans (mentioned above) are not excellent without any errors. This is how we developed the entire process of action. I believe this is a natural way of TPD and approach for the gradual changes in the pedagogical approach.

We, as co-researchers, reflected on the entire journey of developing and implementing this project and made a few realizations: a) how do teachers adopt new methods by taking feedback from colleagues? b) How do teachers reflect on the area of improvement after implementing the project? We also concluded that we all are on the right path of professional development through the principle of action learning.

Let's Gather to Develop Games

It was the day of December 2020. I was in one of the reference schools. The teachers were busy arranging the test papers. After the completion of the exam-related activities, we had snacks together. During our snack time, the school head teacher and other teachers shared their teaching experiences, government policies (unclear!), parents' expectations, medium of instruction, students' attitudes, etc. We all enjoyed the informal discussion.

We all went to the ECD room. Teachers seemed motivated to develop resource materials. I distributed papers, scissors, markers, and scales. There were only five teachers, including the head teacher. The head teacher was in and out frequently during the session due to some administrative tasks, such as preparing letters for the municipality. I asked them to sit in two groups. Without any long explanation, I asked them to develop a game, like jigsaw. One group prepared activities for Nepali subject, and the other chose Science. After they had developed jigsaw, one group was asked to play the game developed by the other group and vice versa. They found it very interesting. One of the teachers, Ms. Chandra, shared, "Sir, this can be useful for any grade and

Figure 12

Teachers' Engagement in a Workshop

(Source: field work)

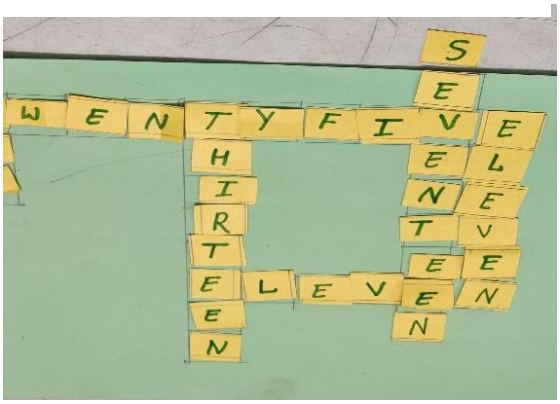
any subject. It is very interesting." The Nepali language teacher said, "Sir, I am facing difficulties in teaching the meaning of Nepali words. Now, I use such techniques."

Another teacher, Mr. Tamang, said, "Yes, this is truly an inquiry-based approach." I immediately asked him (Mr. Tamang), "Sir, why do you think it is an inquiry-based approach? He replied, "Sir, students have to search and make decisions with reasons." Again, the head teacher said, "This makes group learning." The head teacher added, "If all teachers develop such games in each unit, this can be useful if some teachers remain absent. I always faced difficulties managing classes when the teachers were on leave."

I also wanted to have another activity as per my plan. But it was almost 3:30 PM. I asked teachers, "Do you want to develop one more activity, or is this enough for today? "No, sir, we still have half an hour left for 4 PM, and we can sit for 10-15 minutes more if needed. So, let us make one more." I was delighted to receive such an enthusiastic response. I distributed sheets of paper and asked them to develop a puzzle demonstrating the number of students in their school, from ECD to grade five. Some teachers were preparing the questions and the boxes for the puzzle. Some were looking for beautiful patterns for up-down and right-left. Two teachers were preparing the alphabet (in small pieces of paper of the same size as the box). After they had prepared the puzzle, they played in groups. They enjoyed it a lot. Although they shared good remarks regarding the use of such puzzles in the teaching and learning process, they also shared that they are time-consuming and need to be developed in advance.

Figure 13

Teacher-made Jigsaw



(Source: field work)

Ultimately, all teachers were happy and agreed to develop such activities for the lessons. The teachers also shared that the same activities can be used to teach subject matters of different subjects. As the lead researcher, I was happy when I observed teachers connecting the ideas of an inquiry-based approach (discussed in the first cycle) to make games that can be multidisciplinary and interdisciplinary.

Multidisciplinary and Interdisciplinary Discourses in Education

The disciplinary nature of curriculum development has existed in the modern education system for centuries. Its purpose is to develop a curriculum based on the established body of knowledge from different areas (i. e., disciplines), assuming that each discipline has a specific structure and mode of inquiry, as well as knowledge and skills that are connected within the same disciplines with a vertical level of sequencing (Schwab, 1973). Over the period, the discourses on the integration of two or more than two disciplinary knowledge and skills to solve real-life issues (Pinar, 1978, 2023) and the death of disciplines (Spivak, 2003) gave rise to the ideas of multidisciplinary, interdisciplinary, and transdisciplinary curriculum and pedagogical approaches, especially in the school education.

A popular book, Conceptual Foundations for Multidisciplinary Thinking, written by Kline in 1995, provided important theoretical contributions to the needs of multidisciplinary thinking. Kline (1995) used the terminology "truth assertions," which denotes statements that we assert (that is, claim) describes accurately some portion of physical, biological or social nature." The physical, biological, and social should be understood in a comprehensive sense. The author presented three starting hypotheses in the book: a) A meaningful multidisciplinary discourse is possible. b) In multidisciplinary work, we need to honor all credible data from wherever they arose from various disciplines. c) There is no one view, no one methodology, no one discipline, no one set of principles, and no one set of equations that provide an understanding of all matters vital to human concerns. In this way, Kline emphasized the necessity of a multidisciplinary approach to address the completed social problems that cannot be solved from a single disciplinary perspective. One of the arguments made in this book is that integrating different disciplines into the curriculum is necessary. Such integration provides opportunities for students to develop critical thinking skills and encourage collaboration.

Interdisciplinary teaching and learning are also termed curricular integration, cross-curriculum teaching, STEM education, and STEAM pedagogy in different documents. It was also discussed as multidisciplinary, interdisciplinary, transdisciplinary, and cross-disciplinary as different approaches to curriculum integration (Darbellay, 2019). Though these ideas have different levels of integration when discussing them separately, all of them have a component of integrating two or more disciplines. Holley (2017) sees interdisciplinary education as a broad endeavor

that involves knowledge, values, and competencies, while curricular integration focuses on the single aspect of curriculum building. If we argue from the perspective of Vygotsky's (1978) idea, the sociocultural nature of learning (D'Ambrosio, 2015) is rooted in human activities, inseparable from the context, action, and histories where the actions are taking place. Vygotsky's ideas also promote interdisciplinary learning in many ways. One of the assumptions in Vygotsky's ideas is that learning occurs through social interaction and collaboration with more knowledgeable others (MKO), such as peers, teachers, and adults. This approach blends knowledge and skills from multiple disciplines and perspectives.

In the educational sector, it is often discussed that the present education system does not prepare designers and innovators. In this context, Nguyen and Mougenot (2022) made a substantial review of several research works and concluded that multidisciplinary design collaboration is central to innovations, and for that, shared cognition in design work is needed. While solving complex social problems, participants do cross their knowledge boundaries and synthesize practices from each other's disciplines (Kleinsmann et al., 2012). In the 21st century, co-creation and knowledge generation for complex issues are in the front row of innovations. Professional networks, living labs, and maker spaces are needed for this. Interdisciplinary and transdisciplinary are integral to technological innovations that bridge the gap between research, industry, and education. (Ehlen, 2015, as cited in Klaassen, 2018).

The ideas of multidisciplinary and interdisciplinary education are being increasingly discussed in many countries' curricula. The Next Generation Science Education Standards (NGSS), developed by the National Research Council in 2013, introduced the interdisciplinary concept in school education. The concept of interdisciplinary in NGSS seeks to establish meaningful connections between several disciplines, including the physical sciences, life sciences, earth sciences, and engineering, to promote interdisciplinary competency among students (National Research Council [NRC], 2013). It also encourages the integration of science with other subjects, such as mathematics, language arts, and social studies. For example, students might use mathematical models to analyze scientific data, explore scientific innovations' social and ethical implications, and write argumentative explanations of scientific phenomena.

Another education system that is considered one of the best school education systems around the globe, Finland's basic education curriculum reform in 2014 made multidisciplinary education compulsory in basic education (Mård, 2020). The national curriculum sets competency-based learning as a main goal of education to support values of personal development, lifelong learning, sustainable living, and comprehensive knowledge with a set of transversal competencies. According to Finland's national curriculum, multidisciplinary studies enable students to connect and contextualize knowledge to develop meaningful understandings of the subject matter and its contexts. All students should participate in at least one multidisciplinary learning module every school year. The modules' aims, content, and implementation are to be decided by local municipalities and schools (Finnish National Agency for Education [FNAE], 2014). Mård (2020) investigated how history teaching was perceived and implemented within a multidisciplinary learning element in Finnish primary schools and found that historical content can be holistically studied through multiple perspectives. History content can also provide a base for developing central competencies and skills related to other subjects. This also indicates that schools should promote multidisciplinary thinking from early grades.

Similarly, Education for Sustainable Development (ESD) in Norway provides significant opportunities for students to be involved in complex sustainability issues. Norwegian schools have the Sustainable Backpack Program (SBP), which supports teachers in developing projects that promote a holistic understanding of sustainable development across school subjects (Eli et al., 2020). The SBP program is an initiative in which the notion of sustainability has been incorporated into the education system, where students develop a deeper understanding of sustainability by engaging in hands-on activities and project-based learning relevant to their communities and environment. Interdisciplinary work has been part of the curricula for the past 80 years in the Norwegian school system. Eli et al. (2020) concluded that schools' approach to sustainable development is somewhat holistic. The curriculum units emphasized and linked the environmental and social dimensions, whereas they focused less on the economic dimension. While the curriculum units were applied in several subjects to sustainable development, there is untouched potential, especially in the Norwegian language subject, in which teachers could have challenged the students' reflection to a greater extent. There were several challenges as well, especially in the collaboration among teachers. It was identified that there was unused

potential for different subjects regarding exploration, argumentation, critical thinking, and ethical issues.

The practice of STEAM education is also gaining popularity in Asian countries. Isozaki (2024) mentioned that Japan views STEAM Education as a cross-curricular education through which students use the learning achieved in each subject to discover and solve real-world problems. Further, the author mentioned that education is also a social and cultural product, so STEAM Education is also influenced by a nation's culture and educational traditions. Similarly, the discourse of STEAM Education is also happening in the Indian Education System. Ratnam (2023) advocates for implementing STEAM education in Indian schools to move beyond rote learning and cultivate critical thinking and creativity in students. She critiques the existing retrospective teaching methodology, prioritizing memorization and predefined objectives, limiting students' engagement and adaptability. STEAM education enhances students' abilities for significant, lifelong learning by cultivating inquiry-based, experiential learning. Ratnam (2023) observes that adopting a STEAM-oriented, collaborative model necessitates overcoming established traditional norms in Indian education.

Pinar (2023) argues that curriculum integration can be done through *currere* (i. e. personal experiences and autobiographical inquiry) and the academic contents. He argues that integration should be organically based on the interaction between personal narratives and social and cultural contexts. For doing this, Pinar also acknowledges the threat of the so-called "standardization of curriculum," which normally does not allow personal narratives and reflection as a part of the curriculum. He also emphasizes that the roles of teachers appear at the center of curriculum integration by connecting students' autobiographical narratives with different subject-specific knowledge and skills.

In the era of modern education, I, and perhaps many of us in the university system, are un/knowingly dominant by Western ideologies. When I was exposed to the ideas of curriculum integration and the multidisciplinary and interdisciplinary nature of activities, I was brought up with the literature of modern educational philosophers of the West. Gradually, I turned to my own place, culture, and ideologies of the East. I realized that several so-called innovative education ideas had been practiced in the Eastern Wisdom transition for ages. Even in the initial years of my doctoral journey, I was not interested in exploring such an eastern construct much. As

I moved on with schoolteachers and community members of the research site, I gradually explored and started to connect our works with different Eastern philosophical ideas. The Gurukul education system does not only focus on knowledge from specific disciplines; instead, it aims to develop compassion, humanity, and a sense of belongingness with the natural world (Adhikari, 2023). I sensed that these ideas are truly transdisciplinary in nature.

Chapter Summary

In this chapter, I shared how we struggled and continued teacher professional development sessions during the COVID period. I also highlighted some multidisciplinary and interdisciplinary projects co-researchers developed and implemented in the second cycle. This cycle's major take-home message is the skills necessary to accommodate the situation (as we planned the activities during COVID-19). We also observed that teachers' collaboration in developing and implementing different activities and projects develops a strong professional relationship, ultimately promoting a collaborative culture of actions and reflections. At the same time, we experienced challenges and difficulties as well. One of the difficulties was fostering a sense of collaborative planning by connecting two or more subject-related contexts. This was perhaps due to the mindset of disciplinary egocentrism and the weak curricular spaces for collaboration. The continuity of the actions was the next challenge. We committed to developing and implementing several collaborative actions in the meeting, but they did not happen as planned.

During our reflection sessions in this cycle, we were ready to move on to the transdisciplinary nature of projects, which we named transformative STEAM projects. The next chapter is dedicated to sharing our journey of developing and implementing transformative STEAM projects.

CHAPTER VII
JOURNEY TOWARD TRANSFORMATIVE STEAM PROJECTS

In this chapter, I critically assess our journey in preparing and implementing transformative STEAM projects. The term “transformative STEAM projects” was used as a transdisciplinary project that provides opportunities for positive changes in students' personal lives, family lives, and as members of society, and that is across and beyond curricula disciplines such as ethical reasoning, problem-solving, communication, and collaboration skills. Ethics and values were incorporated into the pedagogical approaches while implementing the projects. This chapter addresses the research question: how do co-researchers develop and implement transformative STEAM projects to develop students’ critical and ethical understanding? The entire collaborative effort was put into the third cycle of fieldwork. The third cycle went from August 2021 to the end of 2022. Even after the formal completion of the cycles, the schoolteachers and students have continued the tasks we used to have before. In this context, this chapter also manifests some of the pedagogical actions taken by schoolteachers and students independently after the engagement of the lead researcher. The narratives of teachers and students are being presented in different projects.

Regarding the meaning-making of the stories, the approach of social constructivism (Vygotsky, 1978) is used to facilitate the learning of both students and teachers. Critical pedagogy (Freire, 1970) fosters a critical comprehension of the subject matter and the learning process. Transformative learning (Mezirow, 1991) is utilized to elucidate the process of personal development and change experienced by students and teachers throughout and after the projects' completion.

Time and Gender Issues: Why Don't You Cook Food, Dear Father?

It was a day in June 2022. The teachers who teach at the basic level were gathered in the meeting room. We had a regular sharing and planning meeting. Almost all teachers shared their efforts in making and implementing the integrated projects, which were the focus of the previous month (May 2022). On this day, we assigned one dedicated teacher to share the plan for the coming month. The focus was on the STEAM projects as per our reflection towards the end of the second cycle. The mathematics teacher of grade three, Mr. Khanal, shared his plan this way.

I have to teach how to read time on the clock this week. I am planning to connect it with different subjects. Obviously, time is kept in the mathematics curriculum, and I also have a background in mathematics. So, the content of mathematics might come at the center. In addition to this, I ask my students to develop a model of a clock. It might come in the engineering area. I asked them to discuss the need for standard time and the time differences between Nepal and neighboring countries. This might be part of scientific evolution. During my class, I also shared some videos that clearly explained different ways of reading the time. With the help of the video, I also shared indigenous ways of guessing time with the support of sun shadows and the location of stars in the sky. This might develop a sense of respect for indigenous practices of time reading. This can support technology in the lesson. This is how I planned to conduct lessons using the STEAM approach.

Listening to such innovative ideas from the mathematics teacher, I became happy. Suddenly, a Nepali language teacher spoke.

This seems interesting for now. Let's see how it goes. We will definitely listen after you implement it. I haven't found the "A" component of the STEAM approach. Is it missing? Last time, we also discussed possibly incorporating ethics and values into the lesson. Are there such components in this plan?

The facial expressions of the mathematics teacher indicated that he was uncomfortable responding to this question. As a lead researcher, I thought I had to provide support as needed. This is the right time for support. I shared my ideas this way.

The plan the mathematics teacher shared was excellent, and the queries and expectations the language teacher kept for incorporating ethics and values are noteworthy. We can invest one or two days in classroom discussions on how to read time and ensure that students learn to read time. In addition, one project can be formed as an extension of this activity. Let us ask students to collect information about their family members' timetables, their tasks, and the time they invest in their household work and office.

When I gave such examples, the mathematics teacher quickly said he understood. He said he was thinking from the perspective of mathematics only, thereby committing to adding the components of ethics and values and sharing the plan at the next meeting. The teachers had developed several subject-specific and

multidisciplinary activities (see chapters V and VI). Those experiences helped them quickly recall what they had learned in previous cycles.

After two weeks of our regular sharing activity, we met again to share updates on the progress. One agenda was to share the experience of the preparation and implementation of the project related to “time.” We met in the same room. There were only seven teachers on that day. Some teachers were busy with other activities, and it was not compulsory for all teachers on that day. The mathematics teacher of grade three, who took the initiative to develop a project entitled "Time," shared the project he developed.

> In the first phase, this project aims to make students read “time” on the clock. As per my plan, the students will be divided into four groups. Each group will receive a wall clock with an hour hand and a minute hand. At first, I will demonstrate the clock and share how to read the time correctly. After I share the basic procedure of telling the correct time, I will go to each group and ask them to tell the correct time on the clock. If they need it, I will support them. In the second phase, I plan to connect time with ethics. Once the students learn how to read the time on a clock, I will engage them in the following projects.

The following is the project made by the teacher. It is kept as a sample of the teacher-made project in this study.

Project: Time and Gender Issues

Purpose: The purpose of this project is to explore the daily work schedule of family members and the investment of time in the work.

Materials required: paper, colors, masking tape.

Actions: The students perform the following actions. The students ask each family member the following questions and collect the information.

1. When do you wake up in the morning? What activities do you perform in the morning? How many hours do you work in the office? At what time do you return home from the office/business? What do you do at home after you return home?
2. Develop a chart that demonstrates the time and actions of all family members.

Reflection: Students share the entire process in the class and critically reflect on the actions taken by each family member. A few questions for the reflections are as follows:

a. Did you notice any differences in the work and workload of males and females?
b. Who is more engaged in performing household work?
c. Why do you think so?

After the mathematics teacher shared the plan, we agreed to implement the project. We had a short discussion about it. The Nepali language teacher raised one issue regarding the usability of such issues in the mathematics class. However, other teachers agreed that this was the right way to connect social issues in mathematics. We agreed to meet in the next meeting to reflect on the experiences of the implementation.

Fifteen days following this project's implementation, we gathered in the staff room. The teacher who had implemented the initiative welcomed us with a gentle smile. The language teacher remarked that he seemed happy that day, implying that the strategy had been effective and that he was enthusiastic about sharing the project's success stories.

The mathematics teacher said it was his first attempt at connecting mathematics with ethics. He also added that he experienced it differently. After this informal communication, the mathematics teacher tried to make it more formal. The mathematics teacher shared this way.

> The journey of implementing the project entitled “Time and Gender Issues” was a great learning experience for me as well. The first phase of the project focused on reading time on the clock. I tried to use the interaction and discussion in the class. It went well. It was almost the same as what I used to do the previous year. I added one component. I showed a short video showing different clocks, and the students were asked to tell the time. A short online game was played in the computer lab. This activity made the classroom interactive. I gathered notable experiences from the second phase. All students collected information from their family members. The sample questions we discussed last time became useful for them.

The mathematics teacher also conducted informal conversations with the students involved in this project. One of the female students in grade three shared that she had learned that her father worked only in the office and did not do anything at home. When she asked him why he didn't support her mother with household work,

he replied that her mother was good at household tasks, but he was not skilled at cooking or doing work at home.

Another male student shared that he had calculated the total time his father and mother worked. He noted that his mother worked 12 hours a day (8 hours in the office, 2 hours in the morning, and 2 hours in the evening) while his father only worked for 8 hours in the office. He added that his father spent the evening watching wrestling on TV and reading the newspaper in the morning, whereas his mother was busy with household tasks.

Next, a female student shared that her mother woke up at 5 a.m., while her father woke up at 6 a.m. with her elder brother and her. She explained that by the time she and her father woke up, her mother had already prepared breakfast after worshipping God and Goddess. She noted that this routine occurred almost every day. When she asked her father why he didn't cook for them, he replied that he could not make delicious food and that his parents had not taught him how to cook.

The mathematics teacher also shared how to guess time with Sun Shadow's help. The mathematics teacher shared that students were very interested in them. The experimentation was done on the school grounds. The discussion of the relationship between the length of shadow and time was fascinating. The mathematics teacher mentioned that he also shared his own childhood story, where his mother used to observe the location of stars in the early morning to make sense of time so that she could decide the appropriate time to wake up. Such sharing developed a rich space for cultural ways of knowing (Taylor, 2015) and the importance of traditional practices before the scientific method came into practice.

The students shared sample anecdotes, which we collected. One of the parents was the mathematics teacher's friend. One day after the project implementation, the parent called the mathematics teachers to inform them that he had begun assisting his wife in the kitchen. The parent explained that her daughter's question during the project implementation sparked this change.

This narrative demonstrates that the mathematics teachers used STEAM projects in the mathematics class. This project has several components of STEAM education. The project entitled “Time and Gender Issues" effectively incorporated multiple facets of the STEAM approach, with a specific focus on the "A" component, which encompasses not just the arts but also larger humanities and social themes such as ethics and values. The short video was shown during teachers’ explanations on how

to read time engaged students through a game, which integrates technology into learning. Here, the role of technology was to motivate students to lead toward meaningful understanding connected with the subject matter (Maharjan et al., 2022).

Profit And Loss: Is It Ethical to Make This Profit?

It was the day of May 2022. I was sitting in the staff room of the action school. All the teachers were in the class, and I looked at the routine posted on the wall. I wanted to know if teachers have leisure periods on that day. Normally, during leisure, we developed a culture of discussing during my field visits when we did not have dedicated discussion sessions with all teachers. The mathematics teacher had leisure in the second and third periods. Normally, mathematics teachers (who also teach science in some grades) seem motivated to discuss different pedagogical issues during our visits. I also used to enjoy having professional discussions with him. It might be due to my background in mathematics. I waited for the second period. Mr. Khanal, a mathematics teacher, came to the staff room after the first period. We exchanged greetings and started our discussion. He said that he was teaching profit and loss for grade 6. He said.

> It was easy to discuss the basic ideas of profit and loss. I also developed and implemented one project last year where students went to the shop nearby, collected the cost and selling prices of different items, calculated profit and loss, and shared their reports in the class. It went well. However, it was more focused on exploring mathematical ideas. This time, I want to make it a bit multidisciplinary and interdisciplinary. I am thinking about how I can make it a more STEAM-focused project.

As a PAR researcher, it was a good moment for me because my co-researcher was interested in a STEAM-focused project based on his past experiences of implementing disciplinary projects on mathematics. He invited me to contribute to his idea. Pant et al. (2023b) argued that “autonomous” is the highest level of participation in which co-researchers take initiation by themselves without taking it as a burden. Gaikhorst et al. (2015) argue that sustainability is crucial for a teacher professional development program at educational institutions, and fostering an open culture of sharing is one critical aspect of achieving this sustainability. The open culture allows teachers to exchange experiences within a network, which was seen as its most useful component. Such initiations have the potential to continue as a pedagogical culture,

even after the researchers' direct involvement in the field. I took his response as the right time to probe him with follow-up questions. So, I continued this way.

> Khanal sir, you raised a valid question. Do you see any possibility of incorporating the objectives of any other subjects while developing the projects on profit and loss? Are there any contents on science, language subjects, and social studies that can be addressed while doing projects on profit and loss?

At the same time, I also shared that such initiatives are time-consuming but fruitful. To justify this, I shared one piece of evidence from the research: Diego-Mantecon et al. (2021) studied the implementation of the STE(A)M-PBL approach by novice teachers to improve mathematics learning and identified the elements of PBL they prioritize. During four years, teachers executed 25 mathematics-centered projects, of which 22 enhanced cognitive demand and fostered student mathematical identity. The study advocates for combining conventional pedagogy with interdisciplinary methodologies, enabling students to utilize mathematical principles while understanding required rules and procedures. After a small pause, he added.

> Sir, students should write a report on the project. I, as a mathematics teacher, do not have a good understanding of how to help students write reports. At this time, I think I can take the help of language teachers (both Nepali and English) so that they can help students write reports. The language teachers might assess the report from a language perspective; I evaluate the project from the perspective of mathematical content in profit and loss.

I was, in fact, happy after I received such responses. We (I and the schoolteachers) invested a remarkable amount of time to reach this stage. This is just an example from a teacher. I have been receiving several other examples from other teachers. Khanal sir asked me again.

> Don't you think this (collaborating with a Nepali teacher) is a good idea, sir? But, I am trying to see whether ethics and values can be incorporated into math and science classes. As we have discussed this aspect in our several recent meetings, my mind has always gone into incorporating some ethical components. I found it challenging to connect with ethics and values in such content as profit and loss.

The eagerness demonstrated by the mathematics teacher was notable. I wanted to take this moment to contribute to his plan. So, I added.

> Your idea is excellent for connecting with language subjects, and I am happy you are exploring other possibilities. You are trying to connect mathematics and science with ethics and values. Don't you think that making profit and loss is a part of ethical discourse? How much profit is legal, and how much is ethical? Can we explore some of its legal and ethical aspects?

When I said this, it became like a catalyst for him. As a lead researcher, it's my responsibility to contribute to the discussion. I remembered one event discussed in one of the recently completed Teacher Professional Development (TPD) I conducted at the Educational Training Centre (ETC), Dhulikhel. ETC is a government body that conducts in-service teacher training. I was invited to deliver a few sessions on STEAM Education, and we (myself and the trainees) developed one teaching activity. I shared this with the mathematics teacher.

> Khanal sir, I got an opportunity to facilitate a few sessions on STEAM Education at ETC Dhulikhel. We developed one activity in the form of a story, which is given below.
>
> *Bibek reads in grade six. He went to a stationary shop to buy pencils. He purchased five pencils. The shopkeeper asked to give him 100 rupees in total. Bibek calculated and said that the cost of one pencil is 20 rupees. I bought a pencil for 10 rupees last week in another shop. The shopkeeper said that the price had increased drastically this week. Bibek gave 100 rupees. But he was not convinced of the high price of the pencil. On the way to his house, there was a police station. He thought that I should complain about it. He shared it with the police, who were at the gate. The policeman went to the shop with the boy. The policeman asked the shopkeeper to show the pencil bill. The cost price of one pencil was 10 rupees. The policeman reminded them of the rule that the maximum profit could be made by 30 percent. Bibek calculated the amount of money he should get back from the shopkeeper. It was Rs. 35. The shopkeeper returned Rs. 35 to Bibek. The shopkeeper also said sorry to Bibek. The policeman reminded the shopkeeper not to make an illegal profit.*

Khanal sir silently listened to the entire story and quietly smiled. His smile indicated that he liked this story. Further, he said to me that I got the point. I will make a similar project and implement it now. I will share my experiences in the next meeting.

After three weeks, we met again. The agenda was to discuss the completed project, "Profit and Loss." This time, I was unaware of the activities Khanal sir developed and implemented in the project. After working with Khanal sir for several years, I was confident that he might have done some interesting work by connecting the ideas of profit and loss with some social issues. My expectations turned out to be true after listening to his evidence-based experience. He said.

> It was a challenge for me to connect mathematical content with ethics and values. The last meeting we held was helpful for me. It provided me with food for thought. The story you shared was great. But I tried to develop something else. I developed a project this way.

The students in grade seven were divided into four groups. Each group was assigned different tasks within the broader idea of profit and loss. A few instructions are given below. Apart from this, they had to make several other calculations as well.

Group A: The first group was assigned to visit three shops nearby and was asked to collect the cost price and the selling price of the daily items used, such as rice, soap, and noodles. In addition to this, this group was asked to explore their observations on other social, legal, and ethical issues if they were found during the observation.

Group B: The second group was assigned to visit the three shops, which are 2 km from the school, and asked to collect the same information that had to be collected by group A.

Group C: The third group was asked to observe the three local products (such as milk and vegetables) developed by the community members and sold in the local market. They were also asked to calculate the tentative prices used to grow/make that product and the selling price while selling them in the market.

Group D: The fourth group was asked to observe any three industrial products, such as mobile phones, laptops, and noodles, and explore their unit price of manufacturing. Also, explore the selling price of them in the local market.

Mr. Khanal further explained that all group members went to the field as per the instructions. One week was given to them. All group members also used Saturday for their fieldwork. The journey with my students regarding this project became notable. This was my first experience using the idea of mathematics and other contemporary issues. Though a week-long time frame was given to them, two groups submitted their reports in a week, and the remaining two groups took two additional

days to submit the tasks. Khanal sir shared the major notable outcomes of this project. According to him, the project was a success, and he could observe the students' progress. He said.

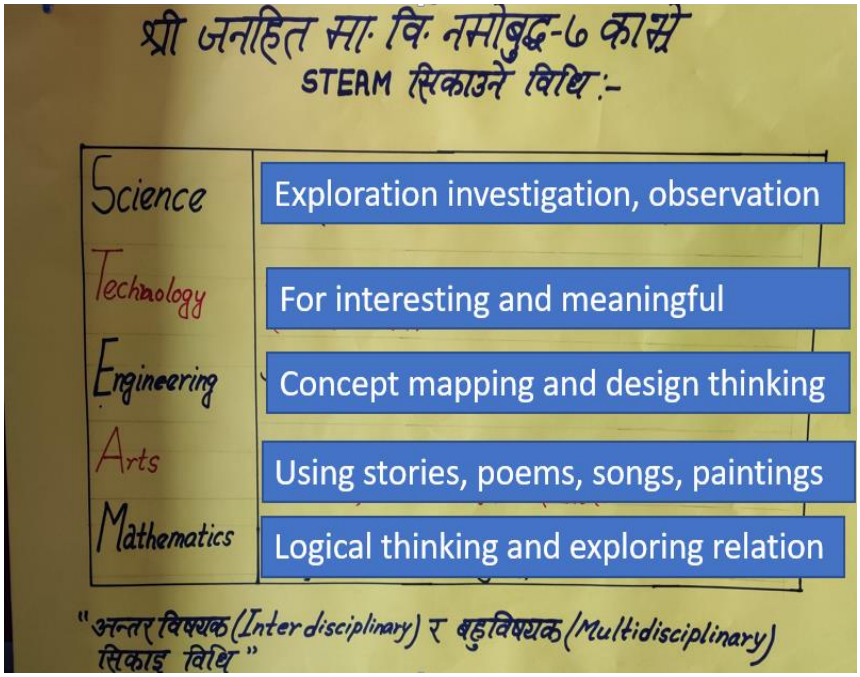
> Groups one and two were provided with similar tasks but in different places. These two group tasks aimed to compare the prices in different places. Interestingly, it was found that the cost prices of the objects collected by both group members were the same. However, there were notable differences in the selling prices of the items near and far from their community. All members of both groups calculated the profit percentage using the details. In addition to this, they analyzed a few contemporary issues. For example, it was observed that the selling prices of noodles near their community are comparatively high. The group members also shared the possible reasons for this. As per their sharing, the reasons might be that there are only two shops and no competitive market. Many young people and children prefer noodles these days. One student from group one said that I had never noticed that the price of noodles was 3 rupees higher in my community than in the city area. He also makes the argument that the local government should monitor the prices. There was another issue with date-expired noodles. A few items were found to be date-expired, and students shared that we should now see the manufacturing dates when buying any food items from the market. As a teacher, I noticed that my students did not only learn calculations related to profit and loss. The students are also raising social issues, ethical issues, legal issues, and the roles and responsibilities of government bodies and then the community to address those issues.

Similarly, the third group explored the prices of milk, honeybees, and tomatoes. These were all local products made by the farmers in the community. This group divided the tasks among the individuals so that they could explore the investment in-depth and the stories behind such production. One student, named Suman, explored the prices of milk; another, named Sagar, was given responsibility for honeybees; and Sangita explored the production stories of tomatoes. Later, all three students shared their observations and draft reports with the team and received feedback from each other. As per the teacher’s observation, who was in charge of this project, all groups came up with s with their critical observations. The farmer selling

milk at the local dairy is more satisfied as he regularly receives a good profit. The milk market was good, and the profit percentage for an average of four families was found to be around 20 percent. But, at the same time, students noticed that equating farmers' time with money is very challenging. Suman shared that it was easy to calculate the book's problem, which is straightforward. But, when we asked local farmers to share their investment in money. It was difficult. The farmers have invested time and effort, and their rupee equivalent is difficult to calculate. This shows mathematics is not only pure calculation but is more than a calculation. This perhaps justifies the nature of mathematics as social (Ernest, 1994) and im/pure (Luitel, 2013), where the construct of societal practices is both pure and impure. Teaching mathematics at the school level should not only guided by ready-made rules, tips, and techniques that are necessary but insufficient. A deep understanding of the subject matter should be promoted (Lai & Murray, 2012).

Figure 14

STEAM Education at Janahit (Made by Teachers)



(Source: field work)

One person in the community had been producing and selling honeybees for many years. Sagar, a student from grade seven, took the lead in exploring the stories behind it. He first tried to explore the investment and return of that person concerning the production of honeybees. Sagar easily calculated the returns as the farmer recorded total honeybee sales in the last year and its rate at different times. But, when it was asked for the investment, again, it was difficult as there were several informal investments, and no record of time was kept. Other family members have also contributed to this task. In this regard, the farmer said.

> I did not keep a detailed record of my expenses in this profession. But I am happy as I produce honeybees every year. This year, I made honeybees weighing almost 250 kg. I sold one kg of honeybee for Rs. 500, which is my side job. I make money by selling milk and goats as well. I am happy in this profession.

This is how I, as the lead researcher, observed the informal economy in the village, which is also sustainable. Time and again, people in Nepal usually blame education for not being connected with productivity. Here, productivity is more aligned with the financial return. Recently, some schools in Nepal have also started to connect school education with earnings. The Nepali government has also initiated the Learning by Earnings program under the Presidential Educational Reform Program. In the 2078–79 (BS) fiscal year, the Ministry of Education, Science, and Technology (MoEST) selected 140 schools to implement the Learning-by-Earning program. MoEST provided some financial and technical support for taking initiatives to connect vocational activities as a part of learning. I was wondering whether the skills obtained by the honeybee farmer in Dapcha could be connected with the school system. Since the entire research journey is participatory, we, as co-researchers, continuously reflect on the ongoing actions and possibilities of welcoming. In the later part of the research, where several entrepreneurial activities (such as fish farming, school gardening, and mushroom farming) were also included, the honeybee maker was also invited to the school to share his experiences.

I learned that Group D explored the prices of industrial products normally found in the market. This group chose a smartphone and laptop generally found on the market. The group member reported that it was challenging to explore the cost of the shopkeeper. They went to three shops, but the shopkeepers in all shops denied giving the exact cost of laptops and smartphones. One student from group D expressed concern about the high potential profit they could make from selling those gadgets. Later, this group assured one shop that this was a part of their study, and we did not disclose the report publicly, nor did we keep the real names of the shops. Once the members of group D convinced the shopkeeper, only one shopkeeper became ready to share the exact price. The students observed that there was a high margin for such gadgets. The students also explored that few shopkeepers force their customers to buy low-brand gadgets with false promises, such as that these are new and have many facilities. The students shared in the project-sharing session that this was because

new-brand gadgets normally have a higher financial margin, and shopkeepers get other additional facilities if they reach their selling target for such gadgets.
In this regard, Khanal Sir shared.

> I also have never noticed the politics behind shopkeepers' unusual preferences for certain products. My students explored this. This is how I sensed the connection between mathematics and societal practices.

As the lead researcher, I also had the opportunity to listen to students' sharing on these four projects as I was in school during that time. I quietly observed students sharing different components. Apart from sharing the mathematical part, they also captured societal practices and moral and ethical aspects. The good part I noticed was that the students were active and shared their happiness among themselves for exploring different hidden traditions and practices in the communities. At the same time, the math teacher also shared that those students who were not considered good students academically in the classes were also involved equally with the other group members, and they gradually developed confidence in mathematics.

The above action, which we collaboratively conducted from the inception of ideas, project development and execution, and sharing the reflection, became remarkable for the entire school. In our regular meetings in the school, mathematics teachers shared the entire process with other teachers, and teachers demonstrated their interest in carrying on such projects in other subjects, too. This was the right time for further action, we sensed.

During the reflection session at the school, I was also invited to share my experiences as part of my research journey. I shared my observations this way with all the teachers.

Dear friends, you all have been doing a wonderful job. I don't have specific feedback on it. However, I want to share my understanding of one idea read many years ago, perhaps in 2015. This was a turning point in many ways in my professional and academic life. Eric Gutstein published a book entitled "Reading and Writing the World with Mathematics: Toward a Pedagogy for Social Justice" in 2012, in which the author argues for incorporating social justice principles into mathematics education. The book supports the notion that mathematics is an instrument that has the potential to comprehend and potentially revolutionize the world, as opposed to merely a collection of neutral, abstract ideas. Gutstein argues that mathematics has the capacity and should have the responsibility to be utilized for examining social,

economic, and political issues. This idea challenges the conventional perception of mathematics as a neutral and apolitical discipline. Students can progress in their comprehension of mathematics and the world by relating mathematical principles to practical concerns such as poverty, inequality, and discrimination. In today's sharing by the mathematics teacher, you might have noticed that students in these projects did not only learn basic mathematical operations and calculations. Instead, they explored several hidden practices that had never been noticed before.

Another important issue is critical pedagogy and mathematics. The author advocates for an educational approach that fosters students' inquiry and exploration of societal injustices and established norms, drawing inspiration from the principles of critical pedagogy. In addition to emphasizing technical skills (like calculating profit and loss and doing other mathematical calculations in the above projects), Gutstein argues that mathematics education should equip students to apply these skills critically and creatively. This requires instructing students to become aware of the established norms and invite possible societal transformation. In the recently shared examples by our mathematics teacher, students become aware of unusual profits made by the local shopkeepers and their realizations of such ongoing actions. The reflections shared by the students in the last sharing session demonstrated that they will now educate their parents as well about the unethical practices of shopkeepers. In the same way, they also realized that all shopkeepers are not bad. This is the right direction for procuring critical human beings.

Furthermore, Gutstein emphasizes the vitality of making mathematics accessible and applicable to students from marginalized communities, thereby empowering them. These students are frequently alienated from traditional mathematics education because they may fail to recognize the practical application of abstract concepts in their daily lives. We can observe that several mathematical and scientific concepts are being practiced in our communities (such as making traditional houses). However, we usually fail to connect them with the school curriculum. That is what Cornbleth (2013) said about the gap between school curriculum and community practices. By connecting mathematics, science, and other subjects with social justice, teachers and students both develop the ability to inculcate the subject with greater significance. Such practices ultimately encourage student engagement and also increase their performance. In addition, there are several practical applications of social justice in mathematics. The book also provides practical examples of how

mathematics education can be composed to align with principles of social justice. These instances demonstrate the feasibility of deconstructing complex social matters into manageable steps, making them more tangible and explicit. As a result of this approach, students develop their mathematical abilities, awareness, and involvement with social issues.

In Nepal, we are having a debate on the assessment system. Some people prefer externally driven assessment in the name of standardized testing and a standardized curriculum. In contrast, others argue from the perspective of a continuous assessment system based on evidence of students' regular performances. In this regard, Gutstein (2012) prefers regular assessment in the context of mathematics education, where students develop both mathematical ability and the ability to connect with the real world. The so-called standardized assessment and curriculum may jeopardize critical thinking and creativity and fail to account for students' varied requirements and backgrounds. That is why the author said reading and writing the world with mathematics. Here, "reading the world" refers to understanding society through the lens of mathematics, and "writing the world" means advocating for the betterment of society by raising the issues and attempting for transformation. In the recently shared examples, students said they would now see the expiration date when buying noodles and other food items from the market. This is an example of writing the world through mathematics after being aware of the existing situation: reading the world with mathematics.

To create such an environment, we, as teachers and teacher educators, should create a more contextual teaching methodology for teaching and learning mathematics. Researchers (such as, Luitel, 2019; Pant, 2017) have argued that decontextualized approaches have guided school education in Nepal. There could be several approaches to contextualizing teaching and learning. One is that teachers should develop and customize their lessons per the students' individual interests and life circumstances to empower them.

Going back to the book written by Gutstein (2012), establishing a community of learners is essential for both teachers and students to achieve social justice through mathematics education. In our case, the entire class or/and school can be a community of learners as we share some common values. Here, our values are collaboration, support, integrated learning, etc. Similarly, Delong & Whitehead (2023) also argued that the primary purpose should be clarifying individuals' values in the educational

process. One of the values in the above-completed projects is to unpack the existing practices in the local market and become aware of un/ethical markets.

Dear friends, It has been a long lecture from my side. I kept on speaking as you remained silent. It's time to hear from you all now. Finally, it is essential to note that I focused more on social justice through mathematics. But, it can be done by all other subjects too. It is a journey for both teachers and students to learn new perspectives. Perhaps we need to establish a conducive learning environment that values diverse perspectives and encourages critical thinking and inquiry. Certainly, there are different challenges and obstacles. Gutstein also acknowledges that the challenges that may occur while implementing a social justice pedagogy in mathematics (as well as other subjects) are worth considering. The hurdles encompass resistance from educational institutions, the need for teacher training in this approach, and the difficulty of assessing learning through non-traditional methods. Nevertheless, the author also argues that it is worthwhile to overcome these barriers to develop a fairer and just society.

Thank you all!

After I shared my observations with the teachers, I invited them to keep their observations on the projects completed under the leadership of a mathematics teacher. The purpose of this sharing was to receive other teachers' feedback and to motivate all teachers to develop and implement similar projects in their lessons. We also expected collaboration among different teachers to prepare for the transdisciplinary nature of the projects where knowledge and skills from different subjects could be integrated.

A science teacher, who was also the head teacher of the school, wanted to share her observations. She said that she also witnessed the activities conducted by all four groups under the leadership of the mathematics teacher. She further said

> I was also interested in learning from the process followed by students and mathematics teachers. I am also doing similar projects in the science subject. However, I have also tried to incorporate some content from mathematics and language. My subject, science, is more fertile ground for developing and implementing such projects. The good parts I noticed in these projects were the critical understanding of the subject matter and the conceptual understanding of the subject-related contents. The examples were taken from daily lives, and students' engagement was notable regarding their fieldwork

report writing and sharing. I will share the implementation journey in the next meeting once I complete it.

When she said, science is my subject. This hit my mind, and I said, “Madam, is science your subject or our subject?

She laughed and said that this is my habit. We used to say that this is my subject, and that is your subject. I think this is highly rooted in everyday language in the Nepali education system. On one hand, telling my subject is not problematic, as it gives a sense of belonging or attachment to the subject we are attached to. On the other hand, it also shows a separation of “my subject” and “other subject.” This is rooted in disciplinary egocentrism (Richter et al., 2009), where people are confined within their mono discipline. We sometimes have fun with some ideas in the sharing sessions. In the journey of long fieldwork with schoolteachers, I realized that having informal communication and a bit of fun during the conversation positively impacts our thinking. This is why Wright et al. (2021) argued that having fun in participatory action research is necessary, in which the analytical value of such emotions, as a key component of participatory research design, supports the analysis of the context and knowledge production.

Other teachers also shared their observations on the completed projects. The majority of the responses were encouraging remarks to the teachers. They thanked the mathematics teachers for demonstrating the example so they could use a similar approach in other subjects. However, two teachers shared that this is challenging to implement in all subjects due to the load of the contents and time pressure to complete the courses on time. In fact, this issue has been a permanent problem for school teachers in Nepal. Finally, we all agreed to make such projects in the future and implement them. Teachers also showed their interest in transdisciplinary projects.

Journey of Vegetables from Farmer's Land to the Kitchen of Kathmandu Valley

It was a day in March 2022. The entire school was in the discourse of creating and implementing the transdisciplinary nature of STEAM projects. Teachers shared different ideas in our regular sharing and reflection meetings, and we all tried to materialize them. One of the ideas raised by one teacher was very appealing to many teachers, including myself. The ideas were related to the vegetable market and exploring the journey of vegetables from the farmers' land to the kitchen. Farmers cultivate and sell vegetables in Bhakunde Besi near the Dapcha area. Normally, it reaches Kalimati, the most popular and biggest vegetable market in Nepal's capital city, Kathmandu. From Kalimati, the retailer and other vegetable shopkeepers take vegetables to sell to the customers. It seems that there is a chain of markets that begins on the farmer's land and reaches the final users/customers. We all agreed to develop this project and implement it in the school. In this project, we collaborated with four school teachers and about 15 students in grade 8.

After several rounds of discussion, co-researchers named the project "Journey of Vegetables from Farmers' Land to the Kitchen of Kathmandu Valley." Normally, we developed a culture where one subject teacher becomes the focal person to carry on and coordinate all the activities of the project. For taking on the role of focal person, the meeting was used to make decisions based on the nature of the project and its alignment with the subject. For example, if the project were related to science, the teacher who teaches science would take the lead. It was practiced in several other projects, too. But this time, it became challenging to explore the alignment of this project. Language teachers (Nepali and English) also argued that we can include several language functions in this project, as students have to go into the field to interact with people and develop reports. The science teacher said that the entire plantation process and the use of pesticides could be studied in this project. It is perhaps close to various science-related contents. Similarly, the mathematics teacher also kept his arguments focused on the mathematical contents during the implementation of the project. He further said that each transaction has profit and loss, and we can also connect this with several statistical analyses exploring the prices of vegetables. In this way, almost all teachers claimed this could be well connected with their subject. I became happy to listen to such arguments from teachers. Finally, it was decided that science teachers would take the lead on it. We made this decision process participatory. At the same meeting, we also agreed on the project's purpose.

The objectives of this transdisciplinary nature of the project were to explore the chain of cost and selling prices of vegetables and argue from the perspectives of social justice (who invests more amount/time and who receives more profit?), identify whether those vegetables are good for health, make aware of present vegetables where maximum pesticide has been used, and envision/build the alternative supply system if possible.

We named it a STEAM project. Students were involved in this project for a month, doing fieldwork with the community farmers and exploring the entire journey of vegetables. After completing the project, we had a reflection meeting with all teachers. The teachers reported that students learned several subject-related contents, soft skills, and 21st-century skills. Teachers shared those students learned writing, speaking, and listening skills in language (Nepali and English) subjects. They learned percentages, calculations, a few ideas of statistics, and profit and loss in mathematics. In science, plantations and pesticide issues were discussed. The social behaviors of farmers and vegetable markets, which were sometimes unethical, were discussed. Several moral issues were discussed. This project became transdisciplinary as a group of teachers and students discussed the real context. Later, students connected different subject-specific contents by themselves. During the process, several soft skills were developed, and we all realized that the transdisciplinary nature of STEAM projects helps social transformation by making students and pupils aware of different social issues.

Out of several aspects, we, as co-researchers, observed that teachers and students both exercised a kind of autonomy in this entire journey. When students practice autonomy with a sense of responsibility, engagement in learning can be ensured. Hellerich (2024) argued that if teachers are provided autonomy to engage their students in PAR projects, students are expected to benefit by strengthening student-teacher relationships for student empowerment. Such learning can influence their instructional decisions, and the entire school community can benefit from the lessons that students develop. In this project, students questioned the existing practices of growing and selling vegetables.

No Soil, No Problems: Do Plants Grow Without Soil?

The title of the project is "No Soil, No Problems," I got an opportunity to contribute to the "STEM toolkit" developed by a few organizations under the initiatives of World Learning (the name of the organization). I shared some of the

projects with school teachers. This was an invitational activity that demonstrated some resource materials. After a few days of material sharing, one teacher came to me and said that the “No Soil No Problems” project was appealing to him, and he wanted to implement it with a few teachers. I had a meeting in a school with basic-level school teachers. We localized the plans by updating a few materials and purposes that were aligned with the national curriculum of science, mathematics, and language areas. The primary objective is to develop 21st-century skills (specifically, thinking and collaborative skills) and subject-related content from mathematics, science, and language. This project was accomplished by a group of 16 students from grades 6, 7, and 8. The students got opportunities to rethink the various alternatives to soil utilized in agricultural techniques. A group of four students was given the task of constructing a plant model by making use of some of the raw materials that were available from the local resources. The schoolteachers and I managed a few materials needed to build the model of the plants. Those materials were plastic cups, a few colorful pieces of cloth, ropes, and paper. In addition, they were instructed to use a few extra resources that were locally available to them if necessary. The next day, every group was required to bring a plant model, and they were allowed to discuss their creations with their respective peer groups.

Figure 15

Members of Janahit STEAM Club

(Source: field note)

When the other groups presented their models to the class, they exposed themselves to the advantages and disadvantages of their own models and had more time to consider how to strengthen the areas where their prototypes were deficient. Later on, students submitted their prototypes with a more critical and creative perspective. In the meantime, we started developing the hydroponic unit while the students were designing their prototypes. The STEAM club members discussed the appropriate size of a greenhouse that could be placed on the school's rooftop. At long

last, we completed the construction of a greenhouse that measures 16 feet by 13 feet by 6 feet. Learners, including teachers and students, participated in planning and building the greenhouse, during which they gained knowledge in mathematics and science and issues on the surroundings and social studies.

After the greenhouse's construction, we built a wooden framework to support the hydroponic unit. The four-inch-diameter pipes were bored to cultivate the vegetables at a predetermined interval. The pipes were then heated to connect them to the cap. Each of the eight pipes was first connected to the socket and then fastened to the wooden scaffolding. The next stage in cleaning was to give the hydroponic unit a thorough water wash. We kept cleaning the coco-peat while building the hydroponic framework so that it would have a substitute substance for plant attachment.

Figure 16

A Prototype of a Tree Using Design Thinking

(Source: field work)

A range of seeds, such as spinach (Rayo-march), lettuce, and tomato, were planted on coco-peat, which acted as a planting substrate. The students were involved in every step of the seed germination process with the science and math teacher. After two weeks, the seedlings grew to one and a half inches. They were then exposed to hydroponic pipes to aid their further development.

In the hydroponic unit, the process of formulating the nutrients was something that both the teachers and the students participated in collectively. During their time, students were able to grasp the concept of the Potential of Hydrogen (PH) value and become acquainted with its function in the plants' developmental process. The measurement of the required nutrients and the calculation of the Total Dissolved Solute (TDS) were some of the daily activities carried out consistently by teachers and students.

Over each day, the seedling begins to mature to its full potential. The students increased their knowledge because of their constant engagement in the hydroponics system and communicated the idea of hydroponics and the practice of hydroponics

with various people in the community. "It was absolutely incredible to notice and learn that plants can grow without soil," remarked one of the teachers. In addition to this, the same teacher added:

> It was amazing. I gained very valuable knowledge on PBL. PBL is a strategy that can be applied to teach many chapters in science and mathematics to children who are enrolled in the basic level. At this precise moment, I feel confident in developing and implementing such projects in other chapters in collaboration with teachers.

"Germination of Plant" and "Acid, Base, and Salt" were science-related content during the project work designed by the head teacher, who is also responsible for teaching science to students. She would bring students to the rooftop, which was the location of the hydroponics system, and the students would be delighted while participating in the project work. During my conversation with the head teacher, I inquired about the value of such a STEAM project in her teaching and learning endeavors. She stated that it was highly beneficial and vital for the student since it utilizes the skills necessary for the 21st century, which we should strive for. The students developed thinking skills as there were several authentic situations while developing prototypes and engaging in the entire plantation process. Sutiani (2021) established that merging inquiry-based learning approaches with science literacy is a strategy to promote critical thinking skills in students, particularly in the context of science education. As a PAR researcher, during my participation in hydroponics construction, I had the epiphany that STEAM projects might be used to teach not just sciences, mathematics, and language we planned at the beginning but also other disciplines, such as economics and social studies, in the most effective manner. Though the research was not focused on the secondary grades (9-12), the activities we conducted in the school

Figure 17

Students' Engagement in No Soil No Problems Project

(Source: field work)

started to have a ripple effect among the secondary grade teachers. This is perhaps the outcome of the participatory action research, as mentioned by Parkhouse et al. (2021), in which the researchers focused on equality and culturally relevant education, and schools adopted equity-focused practices, which became a means to transform schools. Similar to this, in our PAR research, a teacher who teaches in grades 9-12 shared:

> I teach economics to grade 12 students. Despite not receiving any instructions to integrate the teachings with the hydroponics setup, I believed it was feasible. I created a project where students analyzed the economic viability of cultivating and selling vegetables using a hydroponics system. They computed the total expenses and market prices. Ultimately, they determined that the concept benefits semi-urban and metropolitan regions, with profitability achievable only one year after the first investment. I was impressed by the student's interest and motivation throughout the exploration process.

While this study concentrated on basic-level school teachers up to grade 8, the school's activities also significantly impacted teachers and students in grades 9 to 12. As a lead researcher, I learned that the successful activities conducted in the school premises by a few teachers and students make positive events for other teachers and students.

Developing a lesson plan and engaging students from the perspective of project-based learning (PBL) would be the most effective way to engage students. I realized this during our participation in the STEAM project "No Soil, No Problems" over approximately four months. As a result of our collaborative efforts in this project, which began with the inception phase and continued through the reflection phase, I have collaborated with both the teachers and the students. It was also observed that students were taking themselves as knowledge creator. Zeni et al. (2024) mentioned that participants saw themselves as creators of knowledge by seeing themselves as change-makers in elementary school when they engaged in a critical participatory action research study. Consequently, our capacity for analysis and critical thinking was substantially enhanced, and we better understood the underlying nature of STEAM initiatives. Sangwaranatee (2024) concluded that the STEAM-based learning approach and the engineering design process stimulated student creativity and innovation. The students' analytical skills were evident as they assessed the context through brainstorming, designing various pieces, planning the

implementation process, selecting appropriate testing methods, evaluating their work pieces, making improvements, and ultimately presenting and refining their creations.

Save the Species: I Keep Water Plates on the Roof for the Birds

Out of several collaborative activities, the "Save the Species: I Keep Water Plates on the Roof for the Birds" project was developed and implemented as a part of the transformative STEAM project. We used the collaborative approach (as used in the previous section) while designing projects. During this project, we, as co-researchers, worked in teams and used our skills as communicators, researchers, collaborators, and creative problem-solvers by developing a prototype that protects species (birds in this case) in the designated areas.

The lesson had three objectives. We initially focused on developing solutions tailored to the requirements of a designated conservation area through design challenge activity. Secondly, our goal was to enhance ideas by incorporating feedback from another team, and thirdly, to articulate how the solution tackles the problem and conveys an impact narrative.

The project was implemented in the action school. A group of students from grades 7 and 8 was selected after discussing with them. They were excited to participate in this activity, as they said that they love species and are motivated to save them. The students realized several birds and other species were nearby the school when they were children. Gradually, the trees were cut down, and the houses were made. As a result, the birds started to disappear. They were very motivated when we asked whether they were interested in developing some inhabitants that support birds.

First, they were asked to create a model of birds' inhabitants using paper and other local resources. While doing this, each group provided feedback to the other group. They developed the updated one by addressing the feedback received from teachers and other students. Finally, they collaborated with carpenters to build nests of

Figure 18

Students' Engagement in Designing bird's Habitats

(Source: field work)

birds and kept them in the school's gardening. They were also asked to explore different ideas associated with the nest of birds from the perspectives of STEAM Education. Students shared the entire process of developing the bird's nest and the product. The details of the activities are listed below in different stages as per the lesson plan developed by the lead researcher and schoolteachers.

At first, we conducted one brainstorming activity. Initially, a discussion question was presented for silent brainstorming. The inquiry was related to the functions of species in human existence and the necessity for conservation. Students presented their anecdotes, preferences, and dislikes. It created a comprehensive context for the lesson plan. Each group explored environmental conservation and sustainability challenges while actively engaging in brainstorming exercises. Participants were allotted 10-15 minutes to go around the room and write or draw their thoughts on a piece of paper based on a given word, like conservation or sustainability. Students were instructed to utilize sticky notes to write on and attach to the paper. The entire group reflected and generated multiple ideas regarding appropriateness and preservation. For example, one group shared that the birds are needed to maintain the ecosystem.

The second activity involved watching a video. The video was shared with the students in the computer lab classroom. The purpose of showing videos was to connect their preliminary ideas with the others' ideas while conserving birds and other species. Watching the video helped raise awareness about the importance of conserving birds and other species, as it presented numerous data and evidence that demonstrated the impact of species loss on human life.

The third activity was the "Design Challenge". One of the major purposes of this activity was to provide opportunities to engage with design challenge activities. In this stage, students were asked to share different ideas for conserving birds and other species. They were asked to think from the perspective of a sustainable environment. One reference material also allowed them to read and explore similar activities that can be performed in their context. The introduction to design challenges was made with several real-world life examples. Finally, they were asked to explore the issues (how to save the species). They were also asked to connect with reading resources and videos shared before.

On the next day, revisions were made to their preliminary design of the bird habitat. Some students came up with different ideas, such as we can perhaps work on legal provisions for plantations around our house. We asked them to develop a solution with the available materials in the room, and we provided a few materials, such as paper, glue, and scissors. The students were divided into four groups, and all groups started to work on making a nest for the birds. They presented models of different nests for low-flying birds.

Figure 19

Refined Birds' Habitats in the Save the Species Project

(Source: field work)

Once they prepared different models of nests, they were ready to collaborate with carpenters to prepare nests of wood. Some said that we do not need support from the carpenter. Some said that we need some support to cut and make good shape for birds. Finally, each group developed a small nest. The students shared those birds will stay if we prepare nests and provide food and water for them. The birds will reproduce more birds, and the entire environment will be sustainable.

Each group kept their nests in the school garden. They also discussed different concepts of mathematics (area, perimeter, volume) and social studies (such as preserving nature, and making the world a home for all creatures) used while preparing the nests and the entire project. One of the students shared that we should also make such nests in our houses.

Several challenges appeared at the beginning. When we first asked schoolteachers about implementing such an innovative project, several teachers responded that these activities were not necessary for students. It is time-consuming, and we cannot cover the courses if we allow students to participate in such activities. Gradually, when teachers observed all the activities conducted by their students and their motivations and creativity, they realized that this was a promising approach for experiencing real-world tasks. Another challenge is to fight against the culture of expecting tips, tricks, and techniques from teachers and students. A male teacher who was working as a focal person in this project shared.

Figure 20

Students' Exploration in the Birds' Habitats

(Source: field work)

> In the beginning, when a researcher from Kathmandu University shared about this project, I thought this was not needed. This was like an additional burden as we had a lot of content in our textbooks. But, later, when I became a part of the project "Save the Species," I was amazed by the interaction of students and their creative and critical understandings of the subject matter. I never thought that my students could engage in such a level of confidence. Thanks to the entire research team.

Similarly, a female teacher who was involved in this journey said.

> When I learned about this project, save the species, I went through them. I found the implementation ideas to be rich and useful for children. The details of the activities with a list of materials helped me a lot in implementing them. I listened to STEAM-based projects several times on different platforms but have not received such a rich platform.

Other teachers who have closely observed the entire process of making bird habitats seemed very motivated. The students involved in this process shared several encouraging remarks during the project implementation. In this regard, one student from seventh grade shared that;

> It was a great learning experience to participate in the lesson "Save the species." I developed a model of bird's nests at school and later refined it at home. I have also planned to do the same for my home. I wish our regular teachers' similar activities, too.

Another student from eighth grade shared.

> The product we developed (birds' nests) was not so new for me. However, the group work and sharing provided me with rich opportunities to increase my confidentiality. I liked the ideas of design thinking. It became beneficial for me to think outside the box.

Similarly, another student shared that this project touched my heart. I gradually started to care for the birds. I discussed it with my parents and kept a plate with water on the roof. I have seen a few birds come to drink water in winter. I think it's our responsibility to save animals and birds, too.

From the above actions and reflections of students and teachers who participated in the entire project implementation, I realized that the implementation of the STEAM project is challenging but useful. The entire activity became like being in the *Chautari*, where we shared our ideas, had debates, made a consensus, and moved ahead for the implementation, followed by reflective sessions. Utami et al. (2024) conducted research and concluded that by incorporating themes such as environmental sustainability, social justice, and economic development into the curriculum, teachers can promote a more holistic approach to education and empower students to become active global citizens. The integration of STEAM-based projects and SDGs has broad implications for the future. For conducting such activities, teachers should be aware of the deeply rooted notion of disciplinary egocentrism, which most teachers normally do not acknowledge, and that they do not acknowledge the presence and contributions of other subject matters in project-based learning. According to Connor et al. (2015), disciplinary egocentrism develops in educators who focus solely on the content of their disciplines without understanding the relationship between their subject matter and that of other disciplines. Pant et al. (2020) state that disciplinary egocentrism prevents students and teachers from thinking beyond their disciplines. It may deter instructors and students from embracing alternative modes of knowledge. In the context of STEAM project implementation, school pupils develop rich learning experiences. In the case of routine-based tasks, students memorize pre-established ideas and exhibit a lack of

creativity, resulting in a procedural understanding of the topic (Baker et al., 2004). Rittle-Johnson et al. (2015) found that only concentrating on procedural understanding, which involves the ability to execute action sequences (i.e., previously learned step-by-step solution method) to solve routine problems, does not support the development of students' relational and conceptual knowledge. Several studies (e.g., Manandhar, 2018; Shrestha, 2018) have also demonstrated that the Nepali school education system lacks relational knowledge because it emphasizes a fragmented approach to learning.

The current debate on curriculum integration (and thus in the pedagogical arena) has provided researchers and educators with food for thought regarding accepting alternative methods of knowing. According to Slattery (2013), academic disciplines are heavily influenced by positivistic (i.e., scientific) tendencies toward fixed categorization that lack the potential for multiple interpretive possibilities and assist students in viewing the world through novel and diverse lenses. In the same vein, Beane (1997) has argued for curriculum integration, in which significant problems and issues must be incorporated into the curriculum design without much regard for the subject boundaries identified by educators. Beane's ideas are primarily persuasive for two reasons: the first is his argument for the need to cross the boundaries of disciplinary segregation of knowledge, and the second is that young people (especially students) should be involved in the curriculum's development process. Similarly, Barsky (2019) argues that an integrated curriculum should incorporate ethics and values. The concepts of ethics and values are highly congruent with an arts-integrated approach to education. In this initiative, students learned that our responsibilities to conserve species are related to traditional school subjects (mathematics, science) and ethics.

There are three distinct cultural ways of understanding nature, as argued by Aikenhead and Ogawa (2007). One approach is indigenous, which could utilize the artistic way of knowing as it is based on myths, spirits, and ancestors. Another approach is the neo-indigenous way in which a concept is proposed to recognize the unique ways in which many Asian nations use this way of knowing nature. Next, the Euro-American scientific approach considers science as a rational, empirically based way to explain and describe nature, partly based on descriptions and explanations. Nepal indeed has several indigenous practices, and indigenous ways of knowing should be placed at the center, but in the name of scientific knowledge, the Euro-

American scientific ways of knowing have become dominant (Lamichhane & Luitel, 2022). Regarding the teaching and learning activities, the collaborative approach, as per the ideas of social constructivism (Vygotsky, 1962), became useful while making bird's nests and keeping them in the garden. I, along with schoolteachers, supported students, keeping the idea of scaffolding (Vygotsky, 1962) at the center by providing individual support as per their needs.

Critical Moral Pedagogy has been considered an educational approach that integrates the principles of critical pedagogy (McLaren, 2023) and moral education (Berkowitz, & Oser, 2013). The notion of critical moral pedagogy directs to the development of ethical responsibility and a commitment to change society by maintaining social justice among learners (Darder et al., 2023). It emphasizes moral agency and empathy by addressing systemic injustices and global challenges (Auh & Kim, 2024). It encourages learners to critically examine their deeply rooted values and assumptions while understanding ethical issues from diverse perspectives. In the project, "Save the Species: I Keep Water Plates on the Roof for the Birds," we, as co-researchers, observed that students' responses towards the preservation of birds in their community indicate the beginning of the examination of their assumptions about birds and other species.

While developing and implementing the above project, we created several dimensions of transformative STEAM projects. As coresearchers, we discussed that the construct "transformation" has been used and misused in several places. The arguments for the transformative STEAM project are multifaceted and multilayered; they are connected and interrelated. I try to unpack those ideas based on my experiences working in the field and interacting with several pieces of literature.

Transformation is Thinking

The transformation process, especially when considering personal and societal change, originates inside the domain of the mind. It is a cognitive process that entails restructuring our cognitive schemas, convictions, and viewpoints. From this lens, transformation is also a mental process. It involves questioning established beliefs, assumptions, and values and substituting them with novel and more advanced ones. This process is essential for human development, acquiring knowledge, and adjusting to new contexts or circumstances.

Innovation serves as the driving force behind change. They encourage us to challenge our existing comprehension and expose us to alternative viewpoints. It is

not solely about gaining new knowledge but rather about welcoming and acknowledging new perspectives to incorporate and merge this new knowledge in a noteworthy manner. Another critical concept is cognitive dissonance and its role in transformation. Cognitive dissonance is a crucial factor in the process of transformation, and the transformation approach involves inducing cognitive dissonance to prompt individuals to rationalize and accept change (Çalışkan, & Gökalp, 2020). Cognitive dissonance is a psychological condition that makes people feel uncomfortable and confused, which makes them rethink what they believe or how they see things. We feel uneasy when we come across thoughts that contradict our current views. The experience of discomfort can serve as a potential catalyst for change. It compels us to resolve the contradictions between our current beliefs and attitudes by modifying them. In the same direction, Jack Mezirow's (1991) conceptualization of a disorienting dilemma is a crucial element in the transformative learning theory. The concept of a disorienting dilemma is the initial stage or aspect of transformative learning, in which humans modify and reinterpret their overall perspective on the world once they encounter a disorienting dilemma with the existing conditions and situation. An inexplicable dilemma refers to an encounter that cannot be comprehended or addressed within one's existing understanding or worldview. A transformative experience is usually an extremely difficult, significant incident or circumstance, leading the person to carefully challenge their deep-rooted assumptions and beliefs. This also demonstrates that transformation is thinking, and transformations begin with thinking.

Hoggan (2023) critiques Transformative Learning (TL) scholarship in the editorial "The 7 Cardinal Sins of Transformative Learning Scholarship". Transformative learning is commonly linked to Mezirow's theory of perspective transformation, although contemporary critiques rarely address TL's broader breadth. Failure to identify change, excessively employing Mezirow, and ignoring contemporary scholarship are major mistakes. Other concerns include not critically engaging with theories, claiming that all learning is transformational, claiming that educators can transform others, and assuming that the primary objective of education is transformation. Hoggan encourages researchers to deepen the TL dialogue and interact with novel thoughts to ensure the discipline grows more productively. The paper emphasizes clarity, theoretical engagement, and critical thinking as crucial for transformative learning theory and practice.

So, it is essential to exercise critical thinking during the transformation process. The notion of critical thinking begins with a mental process. It entails more than simply accepting new ideas without question but actively examining and questioning the existing actions and systems. Such mental activities contribute to developing a more refined understanding of events and society. There are social aspects of transformation as well. Stetsenko (2017) places significant emphasis on the social dimension of transformation by participating in social activities to co-create knowledge. Our cognitive processes are not formed independently but are profoundly shaped by our interpersonal exchanges and cultural atmosphere. Therefore, it is important to be involved with many different points of view if we want to understand things better and encourage revolutionary thinking. Education is a key part of making change possible. The goal is not just to impart knowledge; it's also to develop the skills and attitudes needed for critical thinking and being open to new ideas. Schools need to encourage students to question, discuss, and look into different points of view. For this, thinking towards the betterment of society is the point of departure for the transformation. The projects (such as No Soil No Problems and Journey of Vegetables) developed by co-researchers and implemented in the school provided several opportunities for students to develop critical thinking.

Such opportunities are also known as authentic contexts for critical thinking. Solving challenges and problems that are unclear, complicated, and closely reflect real-world problems is highly valued in authentic learning (Herrington & Kervin, 2007). A study by Dolapcioglu and Doğanay (2022) presented several viewpoints on mathematics education by emphasizing the development of the critical thinking abilities required to comprehend mathematics. Six cycles of the study were conducted using an action research method. The information was gathered from students' written papers and journals, their CTR (Critical Thinking Rubric) ratings, and unconstructed observations. The study's findings demonstrated how activities grounded in real-world learning standards enhanced students' critical thinking abilities in understanding, comparing, verifying, coming up with original ideas, and considering how they solved problems. It also demonstrated that rich activities lead to critical thinking. People tend to be resistant to change by nature. To get around this, it takes a conscious effort to remain open to new ideas and to be ready to examine and adjust our beliefs as they stand. It is a continuous process of self-reflection and development.

In summary, transformation mostly focuses on how our cognitive processes evolve and progress. This process involves embracing new ideas, challenging deeply rooted beliefs, and continuously working to increase our understanding of the cosmos. This process is not just a personal enterprise but a socially integrated one, needing involvement with a wide range of ideas and notions.

Transformation is a Conscious Attempt

While working with co-researchers for several months in the initiation stage of the fieldwork, I, as a lead researcher, sometimes realized that the time and effort we gave to the research field had not produced any remarkable changes. There were several such moments I went through where I had a fear of whether my/our attempts would be meaningful. I was expecting the visible changes in a short period of time during the initial stage. My limited understanding of PAR initially forced me to conduct activities that make a loud noise in the community and might get media coverage.

But, lately, I realized that PAR is not a quick-fix approach (Pant et al., 2023b). Naturally, it takes considerable time to show the visible changes in the community. From this perspective, I sensed that transformation is a conscious attempt. The attempt was made to make changes in the direction of transformation. In action research and PAR, we do not claim any ideas as knowledge until they are implemented and reflected. Knowledge is claimed once it is demonstrated with actions and reflection (Chevalier & Buckles, 2019; Chiu, 2006). As a PAR researcher, I am aware of the ongoing nature of actions and their influences or impacts on the field. But, at a certain point in time, towards the middle of the second cycle, I developed a view that the actions are being implemented with a purpose and all efforts are conscious attempts. Such conscious attempts (whether they positively impact the research site or not) always give lessons for co-researchers and the communities closely observing the actions. If the actions bring positive impacts (such as improving students' performances, enhancing teachers' capabilities in making and implementing pedagogical plans and connecting community practices into the school system), we might use similar approaches in the other institutions (such as reference schools in case of this study). If the expected outcomes are not reached from our actions, we will learn many things that ultimately lead us toward the path of transformation. First, it provides us evidence of the failure to succeed. This is also knowledge we require from all attempts. Second, it helps us to develop another set of

actions for further implementation. Third, as researchers, we receive knowledge and realizations that develop our professionalism. In this research study, we, as co-researchers, developed several skills and knowledge throughout the entire journey. There were several attempts that did not happen as planned, such as the development of local curriculum and maker spaces with indigenous equipment and practices. However, I sensed that it was a conscious attempt for transformation. One of the dimensions of transformation is to have a conscious attempt. As Tripp (2005) argued, the term action research is often loosely applied to any attempt to improve or investigate the practice. The conscious attempt also relates to *Dharma*, in which we do not always expect changes overnight. However, we, as humans, make persistent efforts for the betterment of societies.

Transformation is a Process

It was a day in June 2023. I was sharing our actions on the research site in one of the national webinars. I received a question in the chat,

> You shared several things that confused me. Will you please share the exact output or impact in bullets?

It was a public forum. I shared a few specific outcomes that were achieved through our actions. But this made me thoughtful of myself. Why do people expect to listen only to the product or output? In an educational setting, what is the importance of input and process? Can the product (i.e., achievements) be independent of input and process? As per my understanding, the process means the entire journey (path), an important aspect of PAR and the most crucial aspect of the transformation. Grounded on the ideas of continuous engagement for transformation and multiple ways of knowing, Taylor and Taylor (2022) argued that

> Transformative learning involves students developing a range of *transdisciplinary capabilities* in conjunction with STEM-related disciplinary knowledge, skills, and values. Transdisciplinary capabilities expand students' ways of knowing about and valuing their inner worlds, especially how their valued belief systems frame or limit their understanding of the outer world and their participatory relationship with it. (p 11).

For this, we should engage students in the process of learning. Sometimes, engaging in the process cannot be well documented by official learning, such as grades and results. However, the skills and knowledge learned from the entire process might help students develop critical sensibilities about societal issues. More

specifically, in one of the projects (i. e., Time and Gender Issues) we implemented, when a child asked, “Father, why don’t you cook food for us?” it was a great learning experience for students, teachers, and community members. Apart from time-related knowledge, students develop questions about the unequal distribution of household work at home. This helped students uncover deeply rooted beliefs about gender issues at home and in the community. This might or might not be able to support the grades in the subjects (mostly valued in the conventional education system). However, such opportunities to gain insight into the investigation process will certainly help students develop a critical understanding of societal issues.

Transformation is a Product

The idea of transformation is multifaceted, as I shared in the previous section. One of the dimensions is several achievements (normally considered products) during the journey. These can be viewed as products in the continuum of the transformation. Those products are not the ultimate; instead, these are the basics for another achievement. This is one of several milestones in the journey of transformation.

As a product, transformation is seen in the tangible outcomes gained through the collaborative actions taken in schools. One of the products we experienced was the improvement made to instructional methods. The change in instructional methods is one of the most obvious outcomes of the transition that has taken place. Teachers began implementing inquiry-based, project-based, and STEAM pedagogy to transition from conventional lecture-based approaches to more interactive and investigative exercises. This transition is not solely a process but also a visible outcome reflected in the quality of classroom interactions, lesson plans, and the pedagogical approach.

The next product is students’ performances. Performance is more than learning outcomes defined in the curriculum. The impact of transformative STEAM projects on student learning is another significant result of change. Using integrated teaching approaches frequently results in enhanced critical thinking, problem-solving abilities, and a more profound comprehension of the ideas being discussed. The narratives presented in the above sections of the same chapter demonstrated that students started to think from the perspective of social justice and their responsibility to make their families and communities a just society. This is what Freire (1970) mentioned: education aims to help students develop a critical awareness of the subject matter and connect with the ongoing practices of societal activities. Assessing students, having them work on projects, and observing how well they can apply what

they have learned in real-world situations are all ways to measure the products. One of the most obvious outcomes of the transformation is the improvement in the level of engagement and learning among students.

One of the transformation results is the creation of learning resources that combine approaches such as inquiry-based learning, project-based learning, and transformative STEAM education. All teachers in the action school developed several disciplinary, interdisciplinary, and multidisciplinary projects, convincing examples of school teachers' transformation. The learning resources were kept in the schools, and the visitors from different schools and organizations praised the quality of materials teachers prepared during the entire PAR journey. In the development of those learning resources, few teachers reached the level of autonomous participation, as Pant et al. (2023b) mentioned. Autonomous participation is the higher level of participation where co-researchers themselves take the initiative to improve the actions. This includes the development of new curricula, course materials, and other resources that align with these methodologies. The curricular materials are tangible products that show the transformation in educational techniques that have taken place.

Next, the transformation happened in the nature of teachers' professional development activities. The conventional methods of teacher training (i.e., sessions delivered by experts) have been challenged since the beginning of the projects. This part of my work was an extension of Dhunagana's (2022) efforts to create a living model of professional development in the action school. The fellow researchers who were a part of the entire initiative have started a culture of sharing ideas and contributing to the sharing and reflection sessions. When I joined the team, I also followed the same principles. The expectation of receiving readymade techniques by university researchers has already been minimized. In this context, I sensed that school teachers were on a journey of transformation in the areas of their professional development. The development and implementation of transformative STEAM projects and participation as co-researchers in the PAR journey were the instances that contributed to the ongoing professional development of teachers. The evidence can be noticed in the confidence level of teachers while sharing their ideas, pedagogical expertise, and the ability to share/influence other teachers for their professional development. These were the concrete products of their involvement in the transformation process.

In a larger sense, transformation can result in institutional change within educational systems or institutions. This change can be a consequence of the transformation. Croeser et al. (2024) offered insights into how funding agencies and project teams can design demonstration projects to improve chances of replication and thereby progress towards transformative change using action research. In this research journey, I collaborated with the entire research team to lead schools in the journey of transformation together with the professional development of co-researchers, including myself. The changes in educational institutions can be seen in the modification of educational policies, the reorganization of educational programs, or the implementation of new teaching standards that are supportive of engaged learning approaches, which were discussed in the narratives of this chapter. These kinds of institutional shifts are important goods that are the result of the transformation process. As a lead researcher, I have initiated, guided, and witnessed this transformation journey of the school and teachers.

Next, the change could influence people outside of school and in the community. This includes making links with local groups, getting people in the community involved in school projects, and helping people in the community understand education better overall. Change has led to several important results, and one of them is that towns and schools are now better able to work together. Eccles and Roeser (2015) examined the consequences of educational institutions as essential environments for the progress of society, with an emphasis on their influence on diverse facets of the lives of children and adolescents, encompassing not only educational achievement but also the formation of morals and character. The authors acknowledge the complexity of these influences and the necessity for comprehensive approaches to study them by drawing on interdisciplinary perspectives. In this regard, I have experienced that the transformative STEAM projects conducted in the school system provided a ripple effect on the community level in terms of farming and other entrepreneurship activities.

Transformation is a Basis for Sustainability

One frequently raised question in the entire research journey, including the conference presentations, was how do you ensure the ongoing actions will be sustained after the research works? In fact, this was one of my questions until the middle of my field engagement. As we progressed, the collaborative actions and the discourses we created in the schools and community developed confidence in

sustainability. One of the major evidence for the sustainability of the actions was the teachers' demonstration of self-initiative in activities, which signifies a sense of ownership and empowerment concerning the educational process. This is of the utmost importance for sustainability, as it transforms the initiative's motivation from external to internal (Taylor & Taylor, 2022). Furthermore, during the process, we, as co-researchers, realized that teachers are more inclined to innovate, adapt, and maintain activities that hold significance within their context when they experience a sense of empowerment.

Another important aspect of sustainability is due to community engagement and support for continuing the school's initiatives. The parents and community members observed the pedagogical innovations of garden-based learning, project-based learning, and teachers' involvement in making several resource materials. A robust community engagement is indicated by the local community's active participation and the support received. This is a fundamental element of transformative actions, in which local support for the activities guarantees that they remain grounded in the requirements and values of the community, thereby increasing the probability of their sustained relevance and continuity.

During the fieldwork, teachers from the action schools received several opportunities to share their practices with the teachers at other schools in the programs organized by the local government. It also signified that teachers' efforts and achievements were recognized at the government level. Such an environment motivates teachers to continue their practices so that their actions will get attention and be valued in the future. Such actions contributed to a more sustainable and transformative educational environment by disseminating the principles of empowerment and community engagement, thereby potentially generating a more extensive influence. Wamsler (2020) discussed the issue of how sustainability doesn't pay enough attention to the inner aspects and skills necessary for good sustainability learning and decision-making. It gives an in-depth look at a unique class called "Sustainability and Inner Transformation," which shows a strong connection between changing oneself on the inside and being environmentally friendly in school. The results show that focusing on inner aspects can help people think more critically and make better decisions when it comes to sustainability. The paper sets an innovative example for other universities and training institutions, giving them ideas and lessons for making sustainability education more comprehensive and effective.

Chapter Summary

This chapter highlights the journey of development and implementation of transformative STEAM projects, emphasizing their potential to address societal and environmental issues while nurturing critical and creative thinking. The journey began with the connection of time with gender issues, in which students explored the causes behind deeply rooted gender roles and social equity by exploring the unequal distributions of household work. Several such projects were developed and implemented to emphasize how transformative STEAM projects can contribute to sustainable practices and long-term societal benefits. After sharing a few narratives of implementing the STEAM project, the chapter examines the philosophical underpinning of transformation, beginning with "transformation is thinking" and lasting with "transformation is a basis for sustainability," with a few ideas in between. The purpose of unfolding different dimensions of transformation in the context of education was to share the idea of the transformation of the multifaceted nature. We, as educators, should understand these dimensions while performing the actions to lead in the journey of transformation of individuals and institutions. Overall, this chapter demonstrates the use of STEAM pedagogy to address real-world issues and drive toward transformation of the individual and the society. Through collaborative and reflective efforts, the researchers showcased the roles of STEAM pedagogy for positive change.

The next chapter is designed to share the professional development of the lead researcher resulting from engagement in the PAR journey, along with the contributions made by the lead researchers to the community of the practice.

CHAPTER VIII
CONTRIBUTIONS TO THE PROFESSIONAL COMMUNITY: A LEAD RESEARCHER'S SPACES

This was a long journey. Several valid and viable reasons forcefully made my research journey a bit longer than it was planned initially. The journey became longer due to COVID-19. Though we conducted several virtual sessions during COVID-19, we had to wait for some face-to-face interactions for several months. In addition, it became longer due to my own limitation of time management between my studies and work. However, I am more than happy as I have had opportunities to interact with several people and work collaboratively with a commitment to shift pedagogical practices. However, it's time to reflect on what exactly happened to me, to us, to the research site, and to the professional community. I critically reflect on my entire journey with a higher level of professional honesty. First, I share how this research journey became useful and also frustrating at different times. I also manifest the co-researchers' ever-changing identities and positions during and at the end of the research. In addition, I try to bring up the discourses and fears created on the research site.

Most importantly, I wholeheartedly share my/our contributions to the professional community during and after the research journey in terms of fieldwork. I share how our research contributed to the community from the perspective of "communification" of research activities in higher education institutions. This chapter addresses the research question: How do I, as the lead researcher, reflect my professional development as a practitioner-researcher during and after the implementation of STEAM pedagogy in schools?

"Expert I" Transformed into "Co-Learner I"

I have multiple hats in my professional life. On the one hand, I am a full-time faculty member in the department. In addition to that, I am serving as Head of the Department at the university. As a university faculty member for more than a decade, unknowingly, I have a deeply rooted belief that I am an expert in the field of teacher education. As the head of the department, I have several responsibilities, such as managing and deciding on several departmental events. On the other side, as a subject expert, I have also been involved in various government bodies (such as the

Curriculum Development Centre, CEHRD, and Education Review Office). Due to my engagement in the professional bodies of mathematics and mathematics education and my role as an expert in government bodies, thousands of people recognize me as one of the experts in mathematics education and STEAM education. Besides this, I am a PhD candidate on a part-time basis. There was a great crisis in my identity and actions at the beginning of my fieldwork. As a PAR researcher, I think I am somehow aware of my roles and responsibilities in the knowledge generation process. But, sometimes, conflicts within me and my ideas appeared. The conflict in me was of interaction, among the ways of collaborating with schoolteachers as co-creators of knowledge. Gradually, as I engaged in the field process and PAR research cycles, I could distinguish my roles and responsibilities in different places and positions. This was, in fact, a journey to becoming a PAR researcher. As I shared in the earlier chapters, this journey was not short-cut and only enjoyable. It was also painful and challenging. In fact, I never consider myself an "expert" today. Even if people acknowledge me as an expert in different public forums, I sincerely request them not to consider me an expert. I consider myself as a learner for my entire life. More specifically, I consider myself a reflective practitioner. As Brookfield (1990) argued, reflective practitioners constantly act and critically reflect on their actions to develop a critical understanding of the context and improve their actions the next time. As a professional, this is the great outcome of this research journey.

I could realize how my "ego" as an expert gradually dismantled, and I developed an attitude of being a co-learner. Let me share a few events in the journey of becoming a co-learner. In the initial stages of the PAR journey, my behavior with schoolteachers was not as a PAR researcher. I used to share my ideas initially and invite them to contribute to validate them. In fact, it was completely against the ideas of PAR. Reflecting on those events, my roles as the university faculty un/knowingly created such actions. The layered identities, which are complex, negotiate among themselves (Alcover, 2018) and execute. When teachers were discussing some pedagogical issues in the staff room, I immediately responded in some cases. Later, I realized that it was due to the identity of "expert I." Over the period, when I reached the second and third cycles (even in the second half of the first cycle), I critically assessed my roles during the development and implementation phase of several inquiry-based activities, interdisciplinary and transdisciplinary nature of activities,

and I found that I am working with the school teachers as a co-learner by listening to them and acknowledging their ideas and encouraging them to contribute all the time.

Self into "Conscious Self" and Us

The notion of self is complex. Superficially, the self is described as the individual person with personal beliefs and values. But what sort of *self* is it? Who is the *self*? How is the *self* developed? How does the *self* influence the inner and outer actions? What is the share of inner and outer parts that constitute the self? In this PAR journey, who is the *self* as the researcher? I vividly noticed different selves in myself and my co-researchers. Let me share how I shifted from one nation of *self* into a conscious self and *self* as a part of us. Also, sometimes, I feel that the *self* is fluid and travels here and there in a continuum in different times and contexts. Sometimes it becomes too personal, and sometimes it becomes communal. When it becomes personal, I feel that this is my own action, and I am responsible for it. When the *self* is more communal, I feel part of a more extensive community. Whatever I am doing comes under shared responsibility.

Mead (2023) mentioned that the concept of the self is dynamic; it does not exist at birth but emerges through social experience and activity; that is, it develops in the person due to his interactions with both the process and other people involved. So, when I engaged in the research site for several months, the self was shaped and transferred to different selves. At first, the *self* was cognitively aware of the PAR researcher, but emotionally, the *self* was like an explorative kind of conventional qualitative researcher. Gradually, I felt that I had moved into a conscious self. Here, the conscious self is being aware of the responsibility and actions within the given conditions and also exploring the response to the questions, who am I doing this work, and why am I doing this work?

I also have evidence that *self* has merged with *us*. At some point in time, as a university researcher, I used to think that I had an obligation to complete the research work on time. So, I used to believe I was responsible for leading the research tasks. Later, when I became familiar with the schoolteachers and the community members, I observed that the schoolteachers and community members were conscious and committed to collaborating with the university researchers. In one of the sharing meetings, the school management committee chair said,

> This is our responsibility to lead the entire work. The researchers from the university are here to support us. We are the ones who live in this society and

belong to the school permanently. Suppose we cannot make some positive changes in the pedagogical approaches. In that case, we should be able to give answers to the parents and the community.

This made me feel that *myself* has been merged with *ourselves*. The feeling of "we-ness" needs trust, mutual commitment, shared responsibility, and respect among co-researchers. At this moment, I also realized that this is an outcome of practicing *Karma* and *Dharma* in the entire research process as a PAR researcher and beyond. Whenever I gained new knowledge and skills through reading and professional visits, I shared them in the professional communities. Perhaps I was un/knowingly following my *Dharma* as a teacher educator.

Different Layers of Participation: Ignoring to Autonomous[5]

It was a difficult and challenging journey to become a co-researcher. In fact, after reading a few pieces of literature on PAR, my mind was conditioned to tell co-researchers and share in the public forum that we call co-researchers to the schoolteachers, not participants. But, my "heart" was struggling to cope and act with the notion of co-researchers. One of the most notable achievements in this research journey was to internalize the notion of co-researchers and act as per the principles of co-researchers in the research site.

As a PAR researcher, I realized that establishing relationships with co-researchers through participation in each step is very challenging. Orlando Fals-Borda made a substantial contribution to the term PAR in 1977 and argued the notion of participation "with" the people from well-established ideas of "by" the people (Díaz-Arévalo, 2022).

Ignoring

In the initial days when I visited the schools, I realized that the teachers ignored my presence. It seems schools run in structures, and we, as university researchers, do not directly fit into the school system structure as the government bodies' work. Perhaps several other organizations might have visited schools in the past with the agenda of improving the condition of the school. As a PAR researcher, I

[5] The part of this section is published; "Ignoring" to "Autonomous" Participation: Narratives of a Participatory Action Researcher. The Canadian Journal of Action Research, 24(1), 38-55. Retrieved from https://journals.nipissingu.ca/index.php/cjar/article/view/661

was not in a hurry. I wanted to ensure participation from the beginning of the needs assessment. Though I had some ideas for “interventions,” I was open to other ideas and ready to adjust the tentative action plan I had developed initially. However, the teachers' responses, body language, and gestures indicated that they were neglecting the educational problems and possible solutions that might be achieved through collaborative efforts. Smith et al. (2010) argued that neglecting is a micro-politics in PAR where expected co-researchers do not seem ready to move on the same board. Freire (1985) also argued that breaking the “culture of silence” is the first step to ensuring the participation of community people. Perhaps “ignoring” is the first step where adults often follow the culture of silence to continue the status quo without accepting the challenges of reforming the situation.

Agreed But No Action

At another layer of participation, people seem to agree with the ideas in the discussion and meeting but do not perform as per the consensus. We used to have a monthly review and planning meeting in the school. School teachers used to share ideas and also demonstrated their commitment to conducting activities (such as preparing projects and organizing community-based activities). However, teachers shared several excuses when we had another round of sharing meetings. Teachers seemed to be not internally prepared and convinced to perform the tasks. However, it also had a good aspect. Teachers, at least, shared ideas in the meeting. They participated in the discussion, which was better than the previous “ignoring " stage in the participation continuum. White (1996) mentioned that this is the weakest form of typology of interests and is named “nominal”, where participation means demonstrating that they are doing something. Perhaps, participating in the discussion is a good beginning in moving toward the action. Larrea (2021) argued the notion of participation as “a participatory process between territorial actors in the conflict, where action researchers, embodying the role of university/academia in territories, are participant facilitative actors” (p. 121). As a researcher at the university, my major role was to facilitate the process by encouraging them to participate in the activities.

Other-directed Participation

Another layer I noticed was other-directed participation. When I realized that we (myself and the teachers) were lagging in collaborative tasks, we discussed the possible solution with major stakeholders, such as the headteacher and school management committee members. We decided to have a combined meeting with

teachers, parents, and school management committee members. Once we had such a meeting, the participation of stakeholders (mostly schoolteachers) increased. When I analyzed this situation, it was other-directed participation. Teachers were forced to participate in the teacher professional development activities when the parents and school management committee members were present in the meeting. Such approaches were context-specific as per the needs of the schools and communities (Dhungana et al., 2022). Pretty (1995) labeled such participation as "passive participation" and "participation by consultation". In passive participation, people participate by being told what has been discussed. In "participation by consultation", participation is achieved through consultation or answering questions. The analysis is controlled by external agents who define problems and gather information. In such a process, people do not contribute to decision-making, and professionals do not have to consider their views. The voices for participation are loud in PAR. There are some ethical and political questions about whose voice 'counts', what research is for, how we position ourselves and carry power, and what happens when research ends (Armstrong & Ludlow, 2020). In this layer of participation, the voices of people in power (such as university researchers, school management committee members, and parents) are counted.

Autonomous Participation

When teachers realized that the innovative pedagogical practices supported students' learning and they were acknowledged for their efforts, their participation increased. They started envisioning new approaches to making and implementing resource materials. According to Pretty (1995), such a level of participation is self-mobilization at a higher level of participation. At this stage, people participate by taking initiatives independently of external institutions to change systems. As a result, they gain access to external resources and technical advice but retain control over how resources are used. Non-governmental organizations and governments can facilitate self-mobilization by providing an enabling environment. A self-initiated mobilization may challenge current power and wealth distributions or may not. White (1996) argued that such a form of interest, in terms of various forms of participation, is transformative, where participation means empowerment that enables people to make their own decisions and work out what action is to be done. Luitel (2019) also argued that transformation is possible through self-empowerment. At this stage, people take both means and ends as continuing dynamics as per the situation.

Armstrong and Ludlow (2020) mentioned that “one of the promises of PAR is that, through processes of co-constructing knowledge, participants become actors in the planning, implementation, and dissemination of research and, through this repositioning, the experience of participation is less objectifying and more empowering” (p. 6). Freire's idea is also very pertinent in terms of participation. He mentioned that researchers have political roles to change the existing context, so participation differs from the notion of conventional listening and welcoming all ideas (Freire, 1996). Arriving at this stage, participation is treated in such a way that "it goes without saying" in PAR (Bradbury, 2015). To make sustainable changes in the educational field, reflecting on the “self” and “context” is necessary (Luitel & Taylor, 2019). In my research journey, teachers started sending emails and contacting each other even if nobody asked them to do so. I had a similar experience to that of Black's (2021) research, which indicated that while utilizing action research in a teacher preparation program, teacher candidates may initially be resistant, but upon reflection, they will recognize and appreciate their growth in achieving their goals. Cornwall (2008) argued that such self-directed participation is a genuine form of participation. Such a genuine form of participation requires a deeper realization of the changes in the existing conditions.

My understanding of participation in participatory action research made a substantial shift in many ways. First, my limited understanding of participation in the initiation stage was aligned with the ideas of gathering people, sharing ideas in groups, and making some decisions. But, as I interacted with the teachers, I realized that the number of people and so-called decisions made in the meeting might not ensure the participation of individuals involved in the sharing sessions. The power dynamics in the organizations, the identity of the individuals, influences made by a few members in the meeting, the priorities set by the organization, the hidden interest of people, etc., were the major factors that affected the entire notion of participation. Next, as a researcher with a background in mathematics, I expected some linear ways of progress in the journey of participation. But it did not happen, and I realized that the PAR journey is not linear. Even if the different ideas on participation that I tried to theorize in this section from the intensive field study seem to appear as layers, they are not linear, and in my case, all co-researchers were not at the same pace. Few teachers are still in the first or second layer, and I noticed that two teachers have been in the “autonomous participation” layer since the beginning of my fieldwork. I used to

think that when we were in a group of co-researchers having similar activities and sharing meetings, we had to move at a similar pace in designing and conducting the activities. This was my limited understanding in the context of the participation of co-researchers. Though we all were in the research field from the beginning to the end of the research journey, co-researchers participation varied from person to person. Technically, we all agreed to participate and contribute to the research journey. However, as we moved on, we developed an idea that participation is invitational with choice, not as imposed communal activities.

Now, I share how this PAR initiative contributed to the educational community. Let me remind it again that the discourse on PAR as a methodological approach and STEAM as a pedagogical approach in my community of practices has been increasing day by day, and I have tried my best to contribute to these discourses and initiatives. It does not mean that all these discourses and actions are due to the research activities I am engaged in, but the evidence I gathered and the experiences I had during my research journey contributed to some extent. I have considered this as "communification" of higher education institutions' research.

"Communification" of Research through Transformative Approaches

The widely accepted purpose of educational research is to generate knowledge through research and publications. When we call research and publications, the nature of research and how such research and publications contribute to our society are the authentic questions these days. Traditionally, universities were much guided by the notion of generating theoretical knowledge, assuming that the only university academics were the knowledge generators and universities, in many cases, were like "ivory towers." Thus, academic research has been focusing on theory generation. This is necessary but insufficient to address several societal issues. Today's society has been facing several challenges, and the nature of problems seems to have several commonalities with humankind at one level. Due to the differences in societies, the nature of problems is also different from that of other levels. In this context, the roles of universities cannot remain the same as they were before. So, the academic research's purpose, process, and ongoing actions should be critically reexamined. The point of departure for academic institutions could be examined through the knowledge generation process, in which the focus could be on collaboration among university academicians and community members. Collaborative actions among community people and university academics can ultimately develop evidence-based knowledge

with some forms of actions in the community. Such action can be called communification of research. Jørgensen (2019) mentioned that,

> While in everyday language, "community" appears as a descriptive term, in the present context, people use communication as a strategic tool in the negotiation of rights and ownership and an instrument in their quests toward certain desired futures (p. 1).

Communification of research refers to making research a shared, participatory, and inclusive activity where knowledge is generated and shared in a manner that resonates with the community's sociocultural dynamics. Jørgensen (2019) posited the concept of communification as a series of processes that establish connections between individuals and certain emotional economies to achieve a desirable future for the entire community. Emotional economies are very useful and pertinent in the context of community-driven actions. For the betterment of society, the knowledge we create by/with the involvement of the community people becomes sustainable and long-lasting. If we connect university research with the community, the community people should be invited to the roles of co-researchers rather than simply participants. At that time, the emotions of co-researchers can be an asset in creating societies a better learning environment for everyone. The researchers from the university side had no bureaucratic authority, which normally creates a sense of compulsion through bureaucratic power to participate in the actions. In this situation, the emotional economy we (university researchers and community people) share became a strong bond to set common goals and move together in the research journey. The community-based participatory research philosophy provides a helpful foundation for comprehending the advantages of incorporating community members in academic research and activities, which strongly emphasizes co-learning, mutual gain, and cooperative, equitable collaborations between researchers and community participants. This method ensures that study findings are pertinent and helpful to the community while also enhancing academic research with local knowledge and viewpoints.

When I engaged in the journey of Participatory Action Research (PAR) with several other research students, school teachers, and community members for several years, I gained a lot of knowledge and skills through this process. In the context of PAR in the education sector, the community comprises schools, teachers, students, and parents. Where they negotiate their rights, duties, and ownership for bringing

certain desired futures (such as skilled teachers, engaged students, the continuous exploration of new pedagogical practices, and increased parental engagement), the idea of agency (Freire, 1970) enables changes over time. Those people engage narratively what Schulz-Forberg (2013) has termed uchronotopias. These narratives break with the past and envision fundamentally different interpretations of history and projects of a better society in the future. In their work, Schulz-Forberg (2013) examined the theory of temporal layers (Zeitschichten) beyond linear and circular metaphors. This work presents the concept of spatial layers, also known as Raumschichten, and investigates the interplay between historicization and its interaction with spatialization and temporalization. The study examines the influence of intricate global spatial and temporal dynamics on comparative and conceptual history. In addition, the paper presents a conceptual framework consisting of three distinct tensions in global history: normative, temporal, and spatial tensions. This framework serves to elucidate historical research inquiries within the context of global conceptual history. The author suggests a departure from the dichotomy between linear and circular conceptions of time and recommends an actor-centered means to enhance the comprehension of spatio-temporal behaviors. In this PAR study, we kept the actions at the center, which is also collaborative, with several layers of participation, from ignoring to self-directed participation (Pant, 2023b). While engaging in thoughtful actions collaboratively with the community members, the entire knowledge generation process became communification of research. We realized that one of the ways of communification of educational research is to foster a participatory process in the research activities.

Another important component of communification of universities is cultivating transformative minds among university faculties and community people. The transformation process, especially when considering personal and societal change, originates inside the domain of the mind. It is a cognitive process that entails restructuring our cognitive schemas, convictions, and viewpoints. Stetsenko (2017) thoroughly examines this notion in her work, "Transformative Mind." Stetsenko explores the concept that transformation involves more than simply embracing new ideas; it entails radically changing our cognitive processes and perceptions of the world. At its essence, transformation is a cognitive process. It entails questioning established beliefs, assumptions, and values and substituting them with novel and more advanced ones. This process is essential for human development, acquiring

knowledge, and adjusting to new contexts or circumstances. For example, the conventional notion of universities as theoretical knowledge generation can be critically examined if we take the transformative stance; otherwise, we, as academicians, become an agent to serve the status-quo thinking and actions.

Next, the purpose of the communification of universities is to lead the community toward sustainability. Let us share an example from the participatory research activities I engaged in. One of the frequently raised questions in the entire research journey, including the conference presentations, was ensuring that ongoing actions are sustained after the research works. In fact, this was one of the questions in our minds during the entire research. As we progressed, the collaborative actions and the discourses we created in the schools and community developed confidence for sustainability. In our context, one of the major pieces of evidence for the sustainability of the actions was the teachers' demonstration of self-initiative in activities, which signifies a sense of ownership and empowerment concerning the educational process. This is of the utmost importance for sustainability, as it transforms the initiative's external and internal motivation (Taylor & Taylor, 2022). Furthermore, during the process, we, as co-researchers, realized that teachers are more inclined to innovate, adapt, and maintain activities that hold significance within their context when they experience a sense of empowerment.

Another important aspect of sustainability is due to community engagement and support for continuing the school’s initiatives. The parents and community members observed the pedagogical innovations of garden-based learning, project-based learning, and teachers’ involvement in making several resource materials. A robust community engagement is indicated by the local community's active participation and the support received. This is a fundamental element of transformative actions, in which local support for the activities guarantees that they remain grounded in the requirements and values of the community, thereby increasing the probability of their sustained relevance and continuity.

During the fieldwork, teachers in the action school received several opportunities to share their practices with the teachers at other schools in the programs organized by the local government. It also signified that teachers’ efforts and achievements were recognized at the government level. Such an environment motivates teachers to continue their practices so that their actions will get attention and be valued in the future. Such actions contributed to a more sustainable and

transformative educational environment by disseminating the principles of empowerment and community engagement, thereby potentially generating a more extensive influence. Wamsler (2020) discussed an issue with the way sustainability doesn't pay enough attention to the inner aspects and skills that are necessary for good sustainability learning and decision-making. It gives an in-depth look at a unique class called "Sustainability and Inner Transformation," which shows a strong connection between changing oneself on the inside and being environmentally friendly in school. The results show that focusing on inner aspects can help people think more critically and make better decisions when it comes to sustainability. It demonstrates an innovative example for other educational researchers, giving them ideas and lessons for making actions sustainable even after the research activities.

The university-community partnership exemplifies a paradigm transition towards a more engaged, inclusive, and socially responsible approach to higher education. Yonfa-Medranda et al. (2024) emphasized the significance of establishing connections and relationships between the university community and society, ensuring the importance of working in transdisciplinary teams and achieving a comprehensive intervention that would significantly improve the community. By cultivating these connections, universities can enhance their academic pursuits, positively contribute to community development, and equip students with the necessary skills for active citizenship. However, for these partnerships to flourish, it is critical to employ strategies that foster mutual respect, understanding, and benefit while navigating the obstacles. In essence, the potential for constructive transformation is vast when universities and communities collaborate, yielding advantages for the immediate participants and society. Let me share how I contributed to and became a part of several initiatives of the Nepal government.

Contributions to the Government Bodies

When I enrolled in the PhD program and started to work in the research site and share our engagement in the professional networks such as meetings of professional associations, conferences, and social media, many people and organizations contacted me to share STEAM Education and possible ways to incorporate STEAM approach in the school education. I consider that involvement in other organizations is the ripple effect of our work in the research site and an excellent opportunity to contribute to the larger society as a teacher educator and PAR researcher committed to contributing to the teacher education fraternity. I don't claim

that all of these activities are entirely due to my research work. However, my research has remarkably influenced the creation of STEAM Education discourse in the nation. I considered these to be my *Karma* and *Dharma* as a researcher and educator.

STEAM Education in Educational Training Centre (ETC)

I used to get opportunities to deliver training sessions for public school mathematics teachers in the Educational Training Centers (ETCs) under the provincial government. In one training session, the chief of the training unit requested me to develop one material in the form of an article that provides basic ideas on STEAM-based mathematics teaching. He told me he was impressed by the social media posts I made while developing and implementing STEAM-based activities on my research site. He also assured me that ETC would publish a manual incorporating several such articles that could be useful for mathematics teachers. I thought this was an excellent opportunity to contribute to government documents. I developed an article in the Nepali language with basic ideas of STEM Education, art integration in STEM Education, and the roles of STEAM pedagogy in mathematics classes. I also provided a few specific examples and projects that mathematics teachers can use in mathematics classes and in collaboration with other teachers, as some activities were more multidisciplinary. One of the activities I presented in this article was.

> गणितमा कलाको प्रयोगको उद्देश्य गणित सिकाइ मार्फत विद्यार्थीहरुलाई सही मूल्य, मान्यता र संस्कार सिकाउनु पनि हो । उदाहरणको लागि एउटा पसलेले एउटा कापी रु. २० मा किनेर रु. ४० मा बेचेछ भने उसले कति प्रतिशत नाफा कमायो ? भन्ने प्रश्नमा सजिलै १०० % (सय प्रतिशत) नाफा कमायो भन्ने आउला । तर के रु. २० मा किनेर रु. ४० मा बेच्नु राम्रो कुरा हो ? भनी छलफल गराउनु पर्दछ । यसको लागि कथाको माध्यमले एकजना ब्यापारीले रु. २० मा किनेको सामान रु. ४० मा बेच्नुभएछ । त्यो किन्ने मान्छेले नजिकैको प्रहरीलाई उजुरी दिनु भएछ । प्रहरीले उहाँलाई शुरुमा सम्झाउनु भएछ । त्यस बस्तुमा बढिमा २०% मात्र नाफा लिन मिल्ने रहेछ । अब, उक्त ब्यापारीले आफुलाई २०% मात्र नाफा राखी बेच्दा कति रुपैया क्रेतालाई फिर्ता गर्नुपर्छ ?
>
> यस उदाहरणमा विद्याथीहरुले नाफा र नोक्सानका धारणाहरुमात्र सिक्दैनन् । समाजमा कसरी बेथितिहरु भएका छन् र त्यसलाई कसरी सच्चाउन वा समाधान गर्न सकिन्छ भन्ने कुराको पनि बोध हुन्छ । गणितिय शिक्षणमा STEAM विधीको प्रयोगको एउटा महत्वपूर्ण आयम भनेको आलोचनात्मक चेतना भएका विद्यार्थीहरुको निर्माण गराउनु पनि हो ।
>
> English Translation:

> Using art in mathematics also aims to teach students the right values, ethics, and morals through mathematical learning. For example, in the question, "If a shopkeeper buys a notebook for Rs. 20 and sells it for Rs. 40, what percentage profit did they make?" the straightforward answer might be 100% profit. But is it good to buy something for Rs. 20 and sell it for Rs. 40? This question needs to be discussed.
>
> For this, through a story, one could explain how a shopkeeper bought an item for Rs. 20 and sold it for Rs. 40. The buyer complained to the nearby police station. The police initially advised the shopkeeper, saying that making a maximum profit of 20% was only permissible. How much money should the shopkeeper return to the buyer if they keep only 20% of the profit?
>
> In this example, students not only learn the concepts of profit and loss but also gain awareness of how certain malpractices exist in society and how they can be corrected or resolved. One important aspect of storytelling methods in mathematics education is developing students' critical consciousness.

Several teachers liked such ideas when I shared this article with schoolteachers and conducted workshops and teacher development sessions. More specifically, teachers liked connecting mathematical problems with real-life issues. Such examples became popular in the training sessions. I also learned that mathematics teachers shared such ideas with other teachers and invited them to develop such activities in their subjects. I witnessed that such examples provided a rich discourse among teachers from the government training units.

STEM/STEAM Education in CEHRD

The Center for Education and Human Resource Development (CEHRD) is a government body under the Ministry of Education, Science and Technology of Nepal that is responsible for school education from the federal government. Though most school education rights have been kept as the responsibility of local-level governments (i.e., municipalities), CEHRD also conducts activities for teacher professional development. One of the activities of CHERD for 2079/80 and 80/81 BS was the orientation towards STEM approaches to schoolteachers of public schools in a few places. One day (someday in July 2022), the CHERD representative called me and said.

> We have an approved program for the orientation of STEM education to schoolteachers and education staff of local-level government. We need to

> conduct a 2-day workshop in different places, and the total number of teachers would be around 300. We try to cover all seven provinces with 40-45 participants from each province. We know you have conducted research in integrated learning and STEM Education. Though we call it STEM Education, as it was approved using the same terminology in our formal document and budget, our intention is the same as you are doing about STEAM Education, which is considered a pedagogical approach to school education.

"I might not be able to contribute to all workshop sessions. However, I try to contribute in a few sessions." I replied.

I thought this was a good opportunity for me to share the activities conducted at my research site, and this is also a great recognition for my co-researchers and me as we have invested several years in developing and implementing STEAM-driven pedagogical approaches. In two academic sessions (2080 and 2081 BS), I conducted almost ten sessions where I shared how I collaborated with schoolteachers and community members to develop and implement STEAM-based activities. I also shared the challenges (e. g., time management, collaboration among teachers, connecting lessons with ethics and values) I faced in my research journey. The notable part of those workshop sessions was designing similar inquiry-based and multi/inter-disciplinary activities and commitment to use those lessons in the schools. A few local-level government staff who are also responsible for supporting and monitoring teachers' pedagogical practices shared that such workshop sessions became useful for supporting teachers when they go back to the school for professional visits. I received several suggestions on this journey. The examples I shared in the session were from my research site. When I shared examples such as the "Journey of Vegetables from the Farmers' Land to the Kitchen" and "No Soil No Problems" projects we conducted on the research site, teachers from the public schools reflected on whether these activities could be done in their workplaces. I still remember one response from one trainee.

> These activities have already been completed in collaboration with schoolteachers. The school where the activities were conducted seems similar to our school – the school is in a remote area with limited resources.

Even before my fieldwork at the research site, I used to share some sample activities in different training sessions conducted by other organizations. However, the activities I shared were not tested in the field. In such cases, schoolteachers and

teacher educators used to ask me several questions regarding the applicability of such an integrated nature of activities and projects. But, this time, when I got opportunities to contribute to teachers' professional development activities from CHERD, the evidence was rich and the implementation experiences developed a kind of authenticity for the teachers. Such verified actions also motivated them to try from their side. I did not share only the successful part of the implementation. I also shared the limitations and challenges we faced during the implementation. Out of several challenges, I shared the mindset of people who run after the readymade techniques rather than exploring ourselves and implementing them before concluding that the particular pedagogical approach is useful or useless in the specific context. The notion of action learning can solve complex problems and significantly increase the speed and quality of individual, team, and organizational learning. (Marquardt, & Waddill, 2004). In the name of globalization and established learning theories, many teachers and educators consider them the ultimate truths. For this, Mughal (2021), in a study, argued that action learning helps to connect global and local practices to become more sensitive toward the subjective positioning of learners. In addition to this, the author mentions, “public reflection in action learning groups creates dynamics resulting in three broad participant responses that trigger realignment with cultural norms: dissonance, aversion, and ambivalence” (p. 65). In the area of education in general and teacher education in particular, my learning from this research is to develop thoughtful, collaborative actions and execute those actions. We continuously reflect on the entire process and the products and conclude whether a certain pedagogical approach is worthy.

In the context of Nepal, it was often discussed in teacher training sessions that the trainers usually offer are too theoretical, and the majority of such ideas mentioned in the training sessions cannot be utilized in the practical classroom setting (Schaffne et al., 2021). The applicability of the expert-driven training sessions has been questioned. The practitioner-driven sharing of ideas has been popularized in different contexts, such as by schoolteachers from different professional organizations. In this context, my recommendation, which is based on my research journey, is to create training modules that are evidence-based and participatory. These modules would provide teachers with opportunities to design and perform different pedagogical approaches and support and feedback throughout the development and implementation phases.

Action Research Curriculum in CEHRD

Another responsibility of CEHRD is to develop a curriculum for TPD and conduct a Training of Trainers (ToT) of ETCs and roster teachers who serve as trainers in ETCs. In Nepal, each permanent teacher from a public school should submit a report of action research and a performance evaluation sheet every year as per the provisions of the Teacher Service Commission 2057 BS (with amendment). However, the nature and the quality of action research studies are questioned. However, CEHRD planned to develop a 5-day refresher training curriculum on action research. I was also invited to be on the curriculum draft committee team. I was told that I was invited due to my experience conducting action research during my PhD study. In the first meeting, I proposed this way.

> Till now, we have practiced conducting action research by an individual teacher, assuming that the action research should solve the teacher's professional problems, which are largely individual. But, these days, several approaches have not been practiced in the domain of action research. Educational issues are believed to be complex and multi-layered, and they come under shared responsibility. In this context, there are ideas of collaborative and participatory nature of action research where two or more people can collaborate with each other and perform action research projects. This is a good opportunity to introduce the ideas of Collaborative Action Research (CAR) and Participatory Action Research (PAR) in our training curriculum.

After a series of discussions, all team members agreed to keep individual, collaborative, and participatory action research in the training curriculum, and we also developed resource materials for trainees where we kept some basic ideas of all three types of action research, their advantages, and steps for conducting the research studies with few examples. This was a great opportunity to contribute to the government system based on learning about PAR in my research journey and practicing during my extensive fieldwork. I was assigned to develop an example for PAR, and I kept one example implemented in my research site. For example, we kept the following in the Trainer Guide (TG).

सहभागितामूलक कार्यमूलक अनुसन्धान

शिक्षाका क्षेत्रमा देखा परेका विभिन्न चुनौतिहरूको उचित समाधानका निमित्त अनुसन्धानकर्ताहरू, शिक्षकहरू, विद्यार्थीहरू तथा अन्य सरोकारवालाहरूको सक्रिय सहभागितामा गरिने अनुसन्धान नै सहभागितामूलक कार्यमूलक अनुसन्धान हो । यस किसिमको अनुसन्धानले शिक्षा क्षेत्रका विभिन्न समस्याहरूको पहिचान, समाधानका निमित्त उचित योजना निर्माण, कार्यान्वयन तथा मूल्याङ्कन सम्बन्धि विषयहरूमा सरोकारवाला पक्षहरूको सक्रिय सहभागिता तथा साझा निर्णय लिने प्रक्रियामा विशेष कार्य गर्दछ । यसले विशेषतः अनुसन्धान र शैक्षणिक अभ्यासहरू एकीकृत गर्ने कार्य गर्दछ । उदाहरणका लागि सामूदायिक विद्यालयमा एकीकृत स्टीम विधी (STEAM Approach) किन आवश्यक छ ? यस विधी कसरी कार्यान्वयनमा ल्याउने ? जस्ता विषयमा केन्द्रित भई अनुसन्धान गर्न सकिन्छ । (CEHRD, 2024)

English Translation:

Participatory action research is conducted with the active involvement of researchers, teachers, students, and other stakeholders to find appropriate solutions to various educational challenges. This type of research emphasizes stakeholders' active participation and collective decision-making in identifying educational issues, planning appropriate solutions, implementing those solutions, and evaluating the outcomes. It particularly works to integrate research and educational practices. For example, one could conduct research on why the integrated STEAM approach is necessary in community schools and how this approach can be implemented.

Right after the curriculum and resource materials development, a ToT was also conducted for all trainers from the ETCs of seven provinces, including a few roster teachers, to receive feedback and observe the effectiveness of training manuals. The feedback from the participants was positive for incorporating different alternatives for conducting action research. It was also said that teachers can collaborate with other teachers, SMC members, PTA members, and even other stakeholders who are associated with the school system to explore some educational issues, make a plan to solve the issues and conduct actions to solve the issues and reflect the entire journey for knowledge generation and professional development. However, the participants also put several concerns, such as a 5-day training is insufficient to develop skills to conduct all three types of action research. Detailed practice exercises should be done in a real context.

I took the training curriculum development activity of CEHRD as an encouraging initiative to introduce and acknowledge new approaches to action research in the system of TPD. I analyzed this event in two ways: one, the government system is flexible in adopting new ideas and practices in their existing practices, and the other is collaborative practices among university researchers. In fact, when I was invited to be a part of the team, I proposed incorporating CAR and PAR into the curriculum. However, I was not hopeful that these ideas would take space in the context where the individual nature of action research was highly embedded in the system and practices. However, the team members and the CEHRD leadership took it in a welcoming manner. Next, it was normally blamed that the bureaucracy and academic system did not seem well connected enough to make some reforms in the school education system. In several formal and informal gatherings, I/We heard that the academician largely argues/debates with several ideas at the discourse level and does not really see the issues and possibilities to implement in the contexts. The bureaucracy is conditioned to reproduce the existing set of practices and less motivated to explore and implement new and innovative actions. However, in this activity, I observed and experienced a thoughtful blend of academic researchers and bureaucracy, both of which stand together and come up with the implementation action of new ideas. I think this is an example of moving ahead in the direction of educational transformation.

STEM/STEAM Education in the Provincial Government

As per the existing government structure in Nepal, the Educational Training Centre (ETC) is under the provincial government. The training modalities of the ETCs are more aligned with the training based at the training centers as a part of Teacher Professional Development (TPD). In addition to the training activities of ETCs, the provincial government also develops and organizes various professional development activities. During the academic year 2078/79 (2021/22 AD), Bagmati Province, where my university and research site are located, started programs introducing STEM pedagogy in a few selected schools. From the Kathmandu University side, I was assigned as the focal person. I was given this role as I actively worked with public school teachers in my doctoral research study in STEM Education. This was another exciting opportunity to contribute to the public system by sharing our collaborative efforts that happened on the research site.

The Bagmati province gave us full authority to design and implement the activities in 27 public schools. Based on my own experiences working with schoolteachers in Janahit School, I developed different modalities in which the school principal, school management committee chair (or any one representative), teachers and students get involved. A team from Kathmandu University provided continuous support to teachers via virtual mode and also visited the school to observe and monitor the activities teachers perform in their workplace. We developed four activities connected to each other with a commitment to make some changes in the schools.

Activity one: Sharing with the School Management Committee (SMC) Chair and HT
Activity two: Workshop for Math/Science Teachers (3-day each)
Activity three: Virtual Support (6 months), teacher implement in the schools
Activity four: School Visit for monitoring and support

I kept the list of activities we designed rooted in the epistemology of public participation (Healy, 2009), in which people are promoted as a means to encourage open and inclusive discussions. Here, we invited school management committee members to share and listen to the ideas of different innovative pedagogical approaches. We shared STEAM approaches and learned from context-specific issues and concerns from the members of SMC. Following this event, we organized 3-day sharing sessions with schoolteachers in which we shared different practices we conducted in our research site in Kavre. This entire process was guided by the notion of a participatory model of teacher professional development (Dhungana, 2022). Though some specific activities were decided before as they were a part of approved government programs, we tried to develop several flexibility and rooms for alternatives to ensure the differences and localizations of the activities. This is how we should follow a middle way to balance the structured/official/approved and unstructured/local/emergent activities. It is also widely discussed that teacher training in Nepal is more aligned with the ideas of expert-led training centers, not as a scaffolder and mentor in the natural classroom setting (Schaffner et al., 2021). In this context, the modalities we used in this activity are more aligned with the ideas of mentors, where we organized a weekly sharing session in the virtual mode where teachers used to share their actions of designing and implementing the integrated nature of activities and projects. We received a mix of experiences in the weekly sharing sessions. About half of the teachers were active in the sharing session as they

produced some evidence to share their practices of designing and implementing the integrated nature of classroom activities and projects. However, the remaining half of the teachers did not join the sharing session as they seemed to have not engaged in doing projects as committed in the face-to-face sessions. I analyzed this event in two ways. On the one hand, we have a group of motivated and dedicated teachers who use such opportunities to improve their practices. On the other hand, many teachers participate in training activities organized by different originations, including the training offered by the government system, but do not use the knowledge and skills in their workplace.

As per our plan, we also visited more than 20 schools to observe, monitor, and support teachers in their workplaces. I visited five schools, and other friends visited the remaining schools. When I visited the schools, I had opportunities to observe teachers' work and interact with students. The notable part was students' enthusiasm for learning while engaging in project-based activities and teachers' efforts to connect with other subjects. For example, in one school, a science teacher designed a project to make a Water Mill (Pani Ghatta) and demonstrate how the Water Mills operate in the nearby running river. While doing this, the science teacher invited both Nepali and English language teachers to support students in writing an article for a newspaper explaining the entire process of designing a water mill. It was also connected with the local technologies and local knowledge systems. The social studies teacher was also invited to connect their lessons on social values and culture in the Water Mills, where people meet each other and exchange their ideas. The science teacher named this the STEAM project. I was impressed by this activity. As the teacher reported, the seed of this idea was the face-to-face training we had and the examples I shared different projects as a reference in the face-to-face sessions from my ongoing PhD work. This is how a ripple effect of our work was extended to the teacher education community.

I did not gather only such pleasant events in my school visits. I also had several disappointing events where teachers did not do any remarkable projects and tried from their side. I critically observed the contexts in which teachers were not enthusiastic about trying new pedagogical approaches. A few aspects I noticed were the weak instructional leadership of head teachers, the school culture where teachers normally do not share their pedagogical approaches, and the unavailability of teaching resources such as (chat papers, scissors, wooden blocks, and any other materials needed for project execution). I recalled several research findings, such as those of

Pradhan (2011) and Schaffner et al. (2021), in which the effectiveness of teacher training in Nepal was questioned. This is a great learning experience while working with public school teachers in collaboration with the provincial government. As a critical PAR researcher committed to positively influencing pedagogical innovation, I thought this was how I made a small effort in the teacher education community outside the research site. This might not directly contribute to the core research purpose of my study. However, I believe this is also one of the subsidiary purposes for which the lead researcher in PAR should develop wings to positively influence the territory of the research site based on the experiences of the research journey.

STEAM Education in the Local Level Government

As I shared before, the local level government is responsible for managing the school system in Nepal in many ways. The local level government develops educational policy as well. Several local governments have mentioned the STEAM approach as one major pedagogical approach to be implemented at the school level. For example, Kathmandu Metropolitan City (KMC) invested a huge amount in STEAM-based school activities and organized professional development sessions for schoolteachers. I also got opportunities to collaborate with schoolteachers in TPD sessions. KMC initially nominated science teachers as the focal persons for STEAM teachers, and it was a kind of understanding that STEAM is more aligned with science-related concepts. Even in the STEAM project development and exhibition event, only science teachers were more active, and most projects were related to science-related content. In the workshop sessions, I shared several real-life related projects we conducted in Kavre, and teachers reflected that STEAM is all about connecting different subject-specific ideas in a meaningful way to solve real-life issues. We also created a discourse that STEAM is not only for science teachers; it is an educational approach.

All teachers can use the ideas of integrated learning and incorporate ethics and values in their lessons from the perspective of transformative learning. In connection with teacher professional development programs, we also had another opportunity to support the preparation of STEAM curricula for KMC. This was an initiative for "Book-free Friday." During the curriculum development of STEAM Education, we debated from different perspectives and landed on the idea of project-based learning from the lens of integrated nature. The experiences were also rooted in the experiences of my PhD field study. This was also a great learning for me, and I

became satisfied with my engagement with KMC teachers. However, several people are engaged in KMC's STEAM integration initiatives. I was also a part of it, and the tasks we conducted in our research journey were shared as references for teachers, which became useful.

Apart from the KMC, several other local-level governments took initiatives to improve their pedagogical practices in collaboration with other organizations. I also joined as a resource person in some events. These activities demonstrate that STEAM Education is popular in Nepal's educational sector. In one way or another, I am also connected to several such initiatives and have opportunities to contribute based on my PhD fieldwork.

Now, I share how I contributed to several national and international conferences to become STEAM Educators and researchers.

My Contributions to the National and International Conferences

Another notable professional development of myself as a PhD scholar and teacher educator is through several conference presentations in Nepal and outside. The first conference where I shared my preliminary findings of the collaborative efforts in the journey of PAR was the eighth International Conference to Review Research in Science, Technology, Engineering, and Mathematics Education held in Homi Baba Centre for Science Education, Mumbai, in 2020. The title of my presentation was "Incorporating STEAM Pedagogy in Teaching Mathematics", also published in the conference proceedings. I shared the ideas of inquiry-based mathematics activities from the perspectives of the STEAM approach. This conference gave me a sense of belongingness to the international community as a PhD researcher. I also had opportunities to discuss mathematics, science, and technology education with researchers. During the interaction, I received several encouraging remarks on my ongoing fieldwork, especially on the power of PAR to innovate in pedagogical areas of mathematics, science, and technology education.

During COVID-19, I had the opportunity to share my ongoing research issues at different international conferences in virtual mode. One of the most prestigious conference series where I shared my ideas was the Collaborative Action Research Network (CARN) in 2020 (virtual) and in 2023 (face-to-face in the UK). When I shared my early stages of fieldwork in October 2020 with my research supervisors, I was in the stage of exploring several concepts of PAR and community participation. I learned several ideas on participatory action research and, most importantly, the

theoretical depth of participation and passions researchers had in the research process – a sense of frustration, doubts, success, connections, included, excluded. This made me strong enough to continue the journey of balancing the theoretical understanding of PAR and the practical implementation of different theoretical ideas in the school setting.

I thought I was fortunate to meet some of the best scholars in action research and PAR when I had the opportunity to attend the same conference series in person again in 2023. I shared my PAR journey and interacted with groups of people whose scholarships helped me grow to this level through their papers and books. For the past five or six years, I have become familiar with the newest ideas in action research and PAR. I felt I was now a part of this global network of PAR, and I tried to add to the conversation about PAR through my study.

Similarly, Kathmandu University conducted an International Conference on Technical and Vocational Education and Training with the theme, "*Deeper Links, Stronger Institutions, Decent Jobs - Building Better TVET System,"* in September 2023 in Dhulikhel, Nepal. I presented a paper entitled STEAM pedagogy in the TVET field. Initially, we (the schoolteachers of the research site and I) were unaware of the need to incorporate STEAM pedagogy in TVET sectors. But, as we completed gardening-related activities and project-based learning while making gardens and selling the vegetables from the school garden (Pant et al., 2023), the schoolteachers came up with the idea that STEAM is also for technical and vocational education. Then, I explored some literature and found several publications on STEAM pedagogy in the TVET field. This is how the ideas kept unfolding during the research site, and I also presented at the conference. In this presentation, I argued that STEAM pedagogy can be effective and engaging in technical and vocational fields. It encourages students to reflect critically on their involvement in the vocational field by integrating various STEAM-focused pedagogical methods. Specifically, I explored how approaches like experiential learning, art-integrated approach, and design thinking can be applied both within the classroom and beyond to enhance student engagement. Vargas et al. (2018) also argued that project-based learning improves the professional education of skilled workers and technicians to solve their diversity of professional problems. Warren and Ott (2016) mentioned that implementing project-based learning in TVET areas fosters sustainable learning. In the same direction, in the context of the Caribbean, Dixon and Hutton (2016) argued that combining both paradigms in

education and training provides a breakthrough in preparing the workforce to be far more successful and productive in today's knowledge-based economy. While there has been a greater emphasis on the necessity of STEM in curricula and for a globally competitive workforce, teaching integrated STEM has received little consideration. This was another learning experience at the conference rooted in the ideas of vocational activities in schools and later connected with TVET and STEM/STEAM approaches to education.

When I reflect on the experiences with the conferences, the Transformative Educational Research and Sustainable Development (TERSD) conference organized by Kathmandu University School of Education (KUSOED), Nepal, is very close to my heart as I was heavily engaged in the entire journey of planning and execution of all series of conferences. The first series in 2016 promoted theoretically informed discussions on the need for relational ontology and multi-paradigmatic epistemologies in education and research. The second series in 2018 focused on collective transformation through context-responsive wisdom and knowledge heritage. Both conferences expanded awareness of our situatedness and created a harmonious space by strengthening and enlarging an international network of transformative practitioners.

The third series, held in 2022, aimed to unite researchers and practitioners to share scholarly narratives about their transformative educational research and pedagogical practices. The major theme of this series is Sustaining and Thriving Transformative Educational Research and Practice in Challenging Times and Contexts. I had the opportunity to present papers in all series. In the third series, I presented a joint paper with my friends. But, I kept several concepts that were used in my research site. The presentation title was Breaking, Making and Sustaining the Tradition: Auto Ethnography as/for Border Pedagogy for STEAM Education. In this paper, we discussed the possibility of thinning the borders of Eastern Wisdom Traditions (that has more elements of mythopoeic traditions) with the Western Modern Worldview (which has more elements of the logos-centric view of the world) as a source of conceiving and applying imagination as an epistemic technique in researching the researchers' experience of culturally decontextualized STEM education (Taylor & Taylor, 2022). Using imagination as a necessary quality to be a human, we demonstrated how it can represent otherwise neglected, excluded, and ignored voices of STEM practitioners that can contribute towards realizing a just,

equitable, and inclusive educational process (Luitel, 2022). We also discussed how different epistemic metaphors (research as advocacy, questioning the status quo, and voice giving) contribute towards liberating the research enterprise from a disempowering view of researching STEM education as reproducing the dominant Western Modern Worldview (Luitel & Taylor, 2019). In the presentation, I shared how I, in collaboration with schoolteachers, developed and implemented transformative STEAM education projects to develop ethical and creative sensibilities among students. At this conference, I realized how the quality of conversations contributes to creating a rich understanding of transformative education. I also received several valuable ideas when I shared my ongoing research activities with some scholars at the conference. For example, one scholar from Australia suggested this to me.

> You are more ambitious in your fieldwork. Do not focus too much on visible changes in your PAR journey. Focus on the aspect of knowledge contribution to PAR and STEAM Education.

It made me think about whether I should focus more on measurable outcomes in the system or create a learning culture that might go on for years, even after my research engagement. I reflected on it and developed an updated understanding of the nature of the research site in PAR. This is an instant (there are many in my several years of PAR journey) that demonstrated how a PAR researcher has been connected with the networks of schools and getting helpful suggestions at different times. Normally, researchers present their field experiences and findings at the conference, but in my case, conference sharing also became useful in updating my ongoing plans. This is a two-way engagement in the research fraternity as a PAR researcher.

The next remarkable opportunity I received was a Norway visit and scholarly engagement during the visit in August-September 2022. It was the time I had almost completed my formal field-related activities as a PAR researcher. The purpose of the visit was to interact with the supervisors on the manuscripts for the paper and the chapter plan, to participate in small-scale workshops on the campus, and to visit the schools to get a sense of the overall school system, as we also worked in the schools in Nepal. This visit became unforgettable due to the scholarly engagement it involved. Specifically, I gained valuable insights during multiple meetings with research supervisors from Nepal and Norway. I had the opportunity to discuss the successes and challenges I encountered at the research site and during the development phase of

the manuscripts. The entire sharing session centered on clarifying and inviting diverse ideas rather than imposing the supervisors' ideas. In this manner, I was fortunate to find that all three supervisors were not only cognitively aligned with the ethos of participatory action research but also deeply committed to the academic principles of PAR. Due to these hidden aspects of the supervision, I attempted to learn several human qualities rooted in the concepts of participation and change agent. These qualities included active listening to others instead of dictating one's own ideas, leading the discourse towards these ideas, and offering alternatives to actions instead of dictating specific steps to complete them. I still remember discussing the idea that PAR aims to provide a fulfilling way of life (Borda, 2006), not only a research approach. Next, during the school visits, I got an opportunity to compare the school cultures of Nepal and Norway and critically reflect on how things happened differently. I observed several positive aspects of the school system in Norway, such as emphasis on critical thinking, creativity, the well-being of individuals, and sustainable development. At the same time, I reflected on several good aspects of the Nepali school system. Being rich in cultural diversity and natural resources are the notable aspects of Nepal's education system. I also observed that the teacher-student relationship is often characterized by the thread of respect and mutual care in Nepal.

Next, I sensed that, in Norway, in my limited observation, the teacher-student relationship was often looked at from the perspective of official responsibility. The one notable thing I noticed is that I became aware of the colonized mindset that low-resourced countries are often perceived as inferior and should learn from the so-called developed countries, which are seen as having perfect systems and practices. I think this realization was achieved during several discussions on the ideas of transformative learning and observing the practices in both countries. I acknowledge that this is also a good experience that I internalized during this journey. Finally, I participated in several workshops and seminars conducted at the university. In these seminars, the culture of sharing ideas among participants and respecting one's views and presence was noteworthy, though it was not completely accepted. As I mentioned, the principles I learned on PAR - deep democracy and participation - could be observed in the seminars. As a researcher and practitioner, this culture influenced me a lot. Next, such international exposure gave me the self-confidence to advance in professional practices.

I also had the opportunity to deliver a keynote speech at Phenikaa University, Honai, Vietnam, at the International Conference on STEAM, which was organized in July 2023. I was invited as a keynote speaker due to my contribution to STEAM Education through PAR in Nepal. I took it as a great learning opportunity and an acknowledgment of our research work. I shared the entire journey of PAR within the topic, "Transformative STEAM Education: Practices, Opportunities, and Challenges in the 21st Century," and how transformative STEAM Education got involved through a series of inquiry-based activities and inter and multidisciplinary nature of classroom activities and projects. I highlighted the notion that knowledge is the result of collaborative effort, highlighting that individuals who participate in its exploration have the power to bring about societal change (McNiff, 2010). To motivate participants to build a critical knowledge of their reality (Freire, 1970), I shared how we emphasized the concept of transformative being and pedagogical activism (Stetsenko, 2017). Wals et al. (2024) argued the need for Whole School Approaches (WSA) to sustainability, connecting it with various educational research and practical implementation areas. It targets educators, policymakers, and researchers, emphasizing the integration of sustainability into teaching and school systems, connecting with Sustainable Development goals of quality education. The authors critically examine successes, challenges, and emerging trends in fostering sustainable education through principles, perspectives, and practical case studies. I sensed that the ideas of WSA can be connected with transformative STEAM initiatives.

Following up on this, I emphasized the need for such research studies in Nepal and other nations, in which knowledge is generated through collaboratively carrying out activities and critically reflecting on those actions. I also emphasized the significance of identifying the knowledge systems of the community (Walter, 1993) and valuing participation (Richard & Bélanger, 2018) as important to the process of generating change that is both meaningful and impactful. This was, in fact, the first keynote speech I ever had in my professional life. I was motivated by such contributions to the professional community. I thought my ongoing PhD work got national and international recognition due to the nature of the study in which we, as co-researchers, were committed to making a difference in pedagogical innovations. Even in the informal conversations with the conference participants after my presentation, many scholars kept their remarks for the successful completion of the

entire journey and also raised the issues of sustainability once the research fieldwork ended. Such remarks provided me with both motivation and awareness of the sustainability of the actions in the future.

I participated in several national-level conferences and shared my ongoing PhD activities. Such conferences contributed to my research journey and professional development in two ways: a) I used to feel that I was connected with the research community and that this is our collective efforts to contribute to research and publications for the betterment of education and society; b) I also got several ideas on the domain I was working on such as in STEAM Education and PAR. The interaction between the integrated nature of learning and participatory approach to teacher education, which were the major ideas I was working on, was discussed through several lenses in the conferences, and those discussions helped me to reflect on my own knowledge and actions. For example, in one of the conferences in Nepal, one participant asked, 'You are talking about the integration of knowledge and skills of different subjects to develop ethical and creative human citizens. However, most school students who are in grades 4 and 5 cannot read and write simple paragraphs and cannot add and subtract basic mathematical problems. Don't you think that you are moving far away from the existing conduction of Nepali school?" (International Conference on Technical and Vocational Education and Training, 2023, Dhulikhel). I have received such feedback several times at conferences. I got opportunities to clarify my position and intentions during such conversations. In this case, I responded, "I am also aware of students' poor performance as per the ERO study. We should collaborate and work on this aspect as well. However, in my research, I took one specific aspect. I intend to explore pedagogical approaches in integrated learning. This is an attempt to learn how to collaborate with schoolteachers and community members to implement the integrated notion of learning." I did not know whether my response convinced the person who raised this issue. But, even in this conversation, I sensed how people were taking my research journey and how I should present myself in a professional context.

Influence of My Research Journey to the University

As I shared before, I had two hats; one is a PhD researcher, and the other is a full-time university faculty. As a PhD researcher, I engaged in fieldwork activities as a PAR researcher. I invested time in collaborating with several researchers in my area to enhance my knowledge and skills in PAR and STEAM Education. As a full-time

faculty member at the same university, I have to take courses and engage in other departmental activities, such as developing and implementing the courses. My engagement in the research site as a PAR researcher helped me professionally. I think I made a shift in terms of my own teaching strategies. I share more applicable and practical aspects of teacher education together with a minimal theoretical background to understand the latest ideas on teacher education. I still remember the nature of the assignments I started to provide by connecting with the school curriculum for pre-service and in-service teachers. As a teacher educator, I think such realizations and changes in the teaching and learning approaches help develop more responsible and ethical teachers with implementable skills.

During my PhD fieldwork, I also had the opportunity to contribute to designing a new educational program, MEd in STEAM Education, at the university. If we analyze it superficially, it is the regular work of the university as an employee, and it does not relate to my PhD research work. However, I could also observe the remarkable influences on my regular job. Though there was a team in curriculum development, I contributed substantially and proposed several components for the field-based nature of work and evidence-based reflection. Finally, we proposed several hands-on activities in different subjects where students get opportunities to visit and interact with the school system and generate knowledge and skills by being in the school system and engaging with schoolteachers and students.

Next, several students in the Department of STEAM Education were motivated to conduct action research, CAR, and PAR, and it created good vibes among research students to critically become aware of the educational contexts of different contexts and take the lead to make some influences with a commitment to improving the pedagogical approaches of the schools. I do not mean that conducting only action research makes researchers professional. But, I strongly believe that future teachers and educators should develop skills in identifying professional issues and take the initiative to improve the situation by developing critical self-reflection skills (Brookfield, 1995). In this context, as a researcher working in PAR and school education, I would prefer promoting action learning and critical thinking to improve the existing situation, for which action research would be a great alternative.

Chapter Summary

The PAR journey significantly heightened my professionalism as a researcher and university faculty member. This chapter reflects on my transformative journey

and contributions to the professional community, demonstrating the evolution of roles, participation, and influences. The shift from a conventional authoritative stance to a collaborative and humble approach was discussed, emphasizing the lead researcher's journey toward self-awareness and collective consciousness. The chapter also shares how the different layers of participation appeared in the PAR process, which is rooted in the field engagement of researchers. Those layers highlight the journey of empowerment and ownership during the PAR process. At the same time, the lead researcher also shares the hindrances and difficulties at the beginning, which provides a message that the PAR journey is a challenging one. The chapter highlights the lead researcher's contributions to the various government bodies to establish STEAM Education and PAR initiatives in teacher professional development.

CHAPTER IX
REFLECTING THE CONTRIBUTIONS AFTER THE COLLABORATIVE FIELD ENGAGEMENT

In Chapter VIII, I discuss how my engagement in the research site provided opportunities to engage outside the research site in my professional network and how the entire journey contributed to enhancing my professionalism. This was discussed from the perspectives of ex-situ. In this chapter, I share the engagement of my co-researchers in the research site even after the completion of the fieldwork. While sharing it, I collected information from telephone conversations, two visits, and interactions with other stakeholders directly connected with the school system. I also share how I made a methodological contribution, PAR as *Chautarai* and STEAM as *Pancha Tattva*. In addition, I offer some implications of the study and its limitations.

PAR Journey Ignited Fire in Our Minds

I met one co-researcher at one professional event and wanted to know how co-researchers were taking after my formal engagement in the research site. It was a day in February 2024. During our conversation, the co-researcher shared his view this way:

> I don't know how much we contributed to the school in recent years in collaboration with people like you who came from Kathmandu University. But I realized that it ignited the fire in our minds. I think we all developed a mindset that we achieved few notable things in our professionalism, and there is a long way to go to gain further achievements.

Since this was a long collaborative journey, I gathered evidence that significantly changed teachers' mindsets. I noticed that the ideas of human agency among co-researchers became popular in which people adapt to new circumstances (Walker et al., 2004, as cited in Píša & Hruška, 2023). The concept of change agency also appeared in the research field, which refers to the capacity to recognize a need or opportunity for change, the belief that change is feasible, and the determination to pursue it, and the readiness and competence to utilize resources smoothly (Brown & Westaway, 2011). This idea has been integrated into professional actions among co-researchers rather than relying on the larger system to initiate change. For example, in the initial phase, the teachers used to ask for some readymade templates for inquiry-

based activities and project development. When we were in the middle of the second cycle, teachers came up with their own ideas and templates, arguing that we could develop templates by ourselves, which is not permanent.

The PAR journey with schoolteachers empowered and led toward the path of transformation in both co-researchers and educational practices. This collaborative and reflective procedure allowed teachers to critically assess their practices, issues, and the educational situation. They acted as change agents in their community of practices by contributing to a few workshop sessions. The evidence was the teachers' involvement in offering workshops with other schoolteachers in the later phase of the research journey. The phrase "PAR Journey Ignited Fire in Our Minds" captures the mindset shift during this journey.

The PAR process provided teachers with a new sense of motivation and purpose, as they were frequently constrained by teaching as the top-down approach. They felt like they had a lot of control over the educational practices they were learning about during their journey. This sense of ownership helped them devise creative ways to address their pedagogical issues. The PAR method also helped teachers think critically and keep learning. They were no longer just doing what they were told; they were now actively thinking, moving, and evaluating. This approach helped them improve their work and make their presence more meaningful as teachers. Other teachers in the neighboring schools were also inspired to think about and act on their contexts.

PAR Journey's Contributions to Developing, Implementing, and Sharing Resource Materials

The next remarkable contribution, continued even after our fieldwork, is developing and implementing the resource materials. Teachers prepare math labs and STEAM labs in collaboration with other professional organizations. In all three PAR cycles, all co-researchers developed several projects that were shared in the precious chapters. I learned from my post-field visit that teachers gather in the staff room after a certain time to share their activities, project plans, and implementation experiences. The school has already decided to develop and implement projects and implement them in each terminal examination as per the needs of the subject matter and students' interests.

I want to narrate an example in which co-researchers from Janahit School made a significant contribution to other institutions in a different district. In June

2023, NORHED-Rupantaran conducted a one-day workshop on STEAM approaches to education for teachers and educators at one school in the Ramechhap district. The primary goal was to disseminate stories of Janahit School regarding the implementation of STEAM Education to the surrounding districts. In addition, two educators from Janahit - one male and one female- contributed to this workshop by providing a variety of examples of what they have implemented in their schools. I realized such sharing would be more authentic and fruitful than sharing by so-called experts outside the school system. The teachers from Ramechhap appreciated this action, and teachers from Janahait School appeared to be delighted and motivated after they shared their own school practices.

Similarly, there was another event where teachers from Janahit School were exposed to this journey. The department of STEAM Education conducted a webinar in June 2023. Around 80 participants were from Nepal and a few other countries. Two teachers (besides those who presented in Ramechhap) shared their actions and reflections on making integrated projects. The good part I noticed was they celebrated the journey's success and openly shared the difficulties and challenges they faced regarding resource management and overloaded content. I sensed that they were on the path to becoming critical reflective practitioners (Brookfield, 1995).

In addition to the resource materials developed by the subject teachers individually and in collaboration with the other subject teachers, Janahit School developed resource materials for grades six, seven, and eight in the form of books and named the Janahit Curriculum. They also planned to use the Janahit curriculum every Friday, which covers topics like beekeeping, gardening, fish farming, mushroom farming, and Eco-San. This is not only an outcome of my research initiative. This is an outcome of all research studies conducted under the Rupantaran initiative. Janahit Curriculum was shared in the NORHED-Rupantaran International Knowledge Dissemination Conference held on November 2023 in Kathmandu. This significant event served as a platform to showcase the transformative outcomes of the five-year initiative and each research study's contribution. We highlighted the holistic approach to education, covering various activities such as school gardening, health and livelihood programs, STEAM education, teachers' professional development, classroom pedagogy, school entrepreneurship, parental engagement, and local curriculum development. The participants recognized particular research design as critical, ensuring a data-driven decision-making process for targeted resource

allocation. The action-reflection approach employed by the Rupantaran initiative, involving continuous cycles of taking action, reflecting on outcomes, and making informed adjustments, played a pivotal role in creating a dynamic and responsive educational environment.

Community Connection in PAR Journey

Another important aspect of this journey was the school and community connection. The community refers to parents, community people, and local government. We developed a group of members from parents, the Parent Teacher Association (PTA), the School Management Committee (SMC), and a local government representative. We named it “PAR Community.” The PAR Community normally meets twice every six months to reflect on the ongoing actions. We continued these actions for the entire fieldwork. When I inquired about the status of the PAR Community following our research activities, the germinated ideas we obtained this time from the PAR community produced fruit. The fruits are the frequent parent-teacher meetings and the concerns that keep parents involved in the ongoing school activities. I think this loose structure building for improving the school system is necessary.

The involvement of the local government, although not as strong as expected, was a significant step towards sustainability. The ward chair's engagement during the research period demonstrated the potential of local government involvement in supporting school initiatives. At the same time, there were some gaps in the level of support provided in the post-research phase. The broad awareness and positive concerns shown by the local government were promising. This awareness can act as a foundation for future collaboration and support. For sustainable impact, it is crucial to keep the local government informed and involved in ongoing activities. Their involvement can potentially unlock supplementary resources and support that the school and community alone might be unable to manage.

The sustainability of actions also depends on the continued engagement and motivation of the schoolteachers and SMC members. The sense of ownership cultivated during the PAR process needs to be nurtured and sustained beyond the project's duration. This can be achieved by ensuring the community continues to see substantial benefits from their involvement. For example, the parent-teacher meetings that became more frequent due to the PAR process are a clear outcome that parents can directly relate to. These meetings notify parents and give them a voice in the

ongoing educational activities, further strengthening the bond between the school and the community.

To ensure that the actions taken during the project continue to be sustained, it is essential to maintain the momentum generated during the PAR process. This can be achieved by institutionalizing the PAR Community or similar structures within the school system. These structures do not need to be rigid or formal; in fact, they have a flexible and adaptive approach, as demonstrated by the PAR Community. It is likely to be more effective in responding to the dynamic needs of the school and community. By implanting reflective practices and community involvement into the school's regular activities, the impact of the PAR project can be sustained and even expanded over time.

The sustainability of the actions initiated during the PAR project heavily relies on the community's continued engagement and local government support. The community can sustain and build upon the positive changes started during the research journey by encouraging strong connections, promoting ownership, and ensuring ongoing critical reflections.

PAR as *Chautari* and Collaboration is Rooted in Vedic Tradition

I was born in a remote village in Nepal with a typical farming practice. When I was a child, I used to support my parents (farmers) in farming activities. I also had to take goats to feed them grass in the nearby forest. When we were tired during our everyday travels while going and returning from the farms, forests, and even school, we used to rest in the Chautari. Normally, the *Chautari* is built under big trees such as a pipal and bar. I still remember being very close to the *Chautari* in my childhood. When I turned into a teenager, I found that the adults gathered in the *Chautari* to discuss various social issues, exchange their ideas and perspectives, and come to a consensus on the community's decisions. Once I started to read the literature on participatory action research, the roles of co-researchers in PAR, the enabling conditions such as trust and respect among participants, the place to share the ideas, and the negotiations that go into the process of actions and reflection, which involve reaching a shared understanding and agreement, I started to connect with my childhood memory of *Chautari*. I began to explore *Chautari*. I thought I was back to my own cultural practices. The space itself is open and inclusive, encouraging people to gather, share stories, discuss issues, and make collective decisions. I found several connections between the ideas of PAR and our actions at the research site, as I had

experienced being in *Chautari* during my childhood. *Chautari*, being a familiar and accessible space, naturally invites participation from diverse community members. It is also an informal setting that reduces barriers to engagement, making it an ideal venue for sharing ideas and reaching a consensus. The familiarity of the setting in *Chautari* helps participants feel comfortable and respected to develop trust among people who are present in the *Chautari*. Another important idea is the nature of collective decision-making.

I also started to explore the events in the Vedic tradition regarding the presence of *Chautari*. In the Vedas, holy trees are often mentioned as places where sages and rishis performed rituals and meditated. These trees were natural gathering places for devotees to learn and engage in spiritual discourses and practices. The pipal tree, in particular, is considered sacred and is often a focal point for such activities. The Chandogya Upanishad describes a scenario where Sage Narada approaches Sanatkumara for knowledge. Their discussion occurred in a natural setting, an open-air learning space similar to *Chautari*. These settings foster deep, continuous discussions on philosophical ideas. In the Bhagavad Gita, the dialogue between Krishna and Arjuna is famous and has a profound message for the community. The Bhagavad Gita is a conversation between Lord Krishna and Prince Arjuna, which takes place on the battlefield of Kurukshetra. Although this was not under the tree, the essence of this discussion is rooted in the ideas of the open, honest, and natural setting like a *Chautari*. The Gita emphasizes the significance of dialogue and learning in natural and rich environments.

In the Mahabharata, the Yaksha Prashna is a dialogue between Yudhishthira and a Yaksha (a nature spirit) that takes place near a lake in a forest. This situation, where critical questions of *dharma* and ethics were discussed naturally, is similar to the *Chautari* tradition of gathering under a tree for meaningful discussions. In many Eastern texts, sages and their devotees often gather in forest hermitages (tapo-vana) for spiritual practices and discussions. These hermitages typically have large trees that provide shade and a natural setting for meditation and dialogue, similar to the *Chautari* concept.

The *Chautari* tradition is deeply rooted in the traditions and practices described in Eastern texts like the Vedas, Upanishads, and the Bhagavad Gita. Still, it is practiced in the villages. By integrating this culturally echoing practice as participatory action research, researchers can foster a sense of community that ensures

trust and respect for the work, grounded in the community's rich cultural legacy.

Chautari, as both a place and a concept, holds significant potential for enhancing the participatory approach to action and reflection. Its cultural significance, openness, and tradition of collective decision-making make it an ideal venue for fostering community participation, discussion, and consensus-building. In this context, *Chautari* is a methodological contribution to my research as we, as co-researchers, had a series of interactions in different places such as school grounds, Dharmasala (Chautari near the school), shops, and in the community.

The rigor of collaborative actions is often discussed louder in PAR. When I was a student at my master's level, I read the ideas of collaborative learning and social constructivism of Lev Vygotsky (1978). In several pieces of literature from the West, I found collaboration in the domain of learning theories. I used to wonder whether these ideas were well discussed in the Eastern texts. I did not give much emphasis to exploring that part at that time. During my PhD journey, I tried to explore a few ideas on the collaborative nature of knowledge generation. I found that collaboration has been defined as mutual livelihood, teamwork, and the search for knowledge with a nonviolent and encouraging insolence in the Vedic tradition.

The Rig Veda (10.191.2) investigated this work in unison, communicating and comprehending one another's thoughts. This is how gods from the past handled their situations by getting to know one another's thoughts and working together cooperatively. I realized that collaborative actions and thoughts were used for centuries in the East in the knowledge generation system. Furthermore, the Rig Veda (10.191.3) mentioned that individuals have similar tasks, shared learning, a common purpose, and a common desire. In our research journey, we have common purposes for school improvement and knowledge generation from fieldwork.

According to the Rigvedic hermeneutics, Sanatana Vidya is related to eternal Brahman, wisdom, and birthless truth (Upaddhyaya & Timilsina, 2024). According to Vidya's self-embodied viewpoint, knowledge (Vidya) has no meaning if it is not cultivated; however, from another side, if Vidya's teaching is not done, its purpose will not be fulfilled. So, the study argued that Sanatana Vidya has an out-of-box thinking with the concept of Para, Apara, and Parapara Vidyas. In the Sanatana tradition, there is a co-existence or presence of two seemingly opposing entities. For example, in the Vedas, there is often antagonism (Upaddhyaya & Timilsina, 2024), like in the family of Mahadeva. Mahadev's Vahan (vehicle) is Nandi, and Parbati's

Vahan is a lion in the form of Mahakali. Lion and Nandi are symbols of mutual opposition. The snake is around Mahadev's neck. Mahadev's son is Ganesha, and his Vahana is the mouse. It seems that snakes and mice are also symbols of mutual opposition. The snake and Kumar's Vahana Peacock are also the antagonists. Thus, the Vedas argue the concept of companionability of binary opposites. I found similar ideas in the Western literature of PAR in which the relationship with co-researchers and stakeholders is not linear, and several seemingly opposite ideas also go together.

Pancha Tattva and Gurukul as an Epistemology in STEAM Education

When I was at the research site in the middle of 2022, we created a rich discourse on the transformative nature of STEAM education. We developed and implemented multidisciplinary and transdisciplinary activities such as transformative STEAM projects in the schools. One co-researcher (who teaches mathematics and science) said, "I think the idea of STEAM education is like Pancha tattva (Pancha MahaBhuta) (classical element); a) earth; b) water; c) fire; d) air; e) sky." I got an unexpected response from him, and I wanted to know his argument in detail. So, I requested him to explain in detail. He further explained.

> As I understand, STEAM is an integrated idea with several other seemingly different constructs. In this case, I think Earth is like science grounded in the physical world and natural laws. The fire represents energy and the driving force to change, closely related to technology. Today, technology is a symbol of power, and it can destroy people if we cannot use it properly. The air symbolizes freedom and movement without any shape. This is closely associated with the ideas of engineering, which contribute to designing systems and structures with several possibilities that generally do not have any fixed and pre-defined set of rules. Water is a fluid and ever-changing element that can take any shape. This idea is similar to art, a symbol of expression and creativity that can be explained and transferred into countless forms. Finally, the sky symbolizes infinite, abstract, and unbounded. Mathematics is also considered a universal language with an abstract nature of knowledge. So, the sky is like mathematics.

I really liked the ideas of the co-researcher, especially the ability to connect one set of ideas with another set of ideas logically. I thought I needed to explore it further. Though I was a little bit aware of the idea of Pancha tattva, I was not aware of it in detail regarding it on a philosophical level. I started to explore it. Singh (2016)

mentioned that various religious philosophies in the world differ in many ways. However, they all emphasize the essential unity of the universe through the recognition of Pancha tattva as the basis of the creation of the universe. The ancient Greeks also described four classical elements of creation and life. They are earth, water, air, and fire. Plato used the term “element” for the first time in reference to earth, water, air, and fire. Later, Aristotle added “asther” with an argument that starts must be made of a different substance. Prasad (2016) argued that Pancha tattva is a basis for sustainable agriculture. It is established that solar energy, carbon dioxide from the air (wind), and water from the soil are three essential ingredients needed for photosynthesis in plants, which are responsible for the growth of plants that directly or indirectly provide food for humans and animals on the earth. Water and oxygen are essential for plants, animals, and humans. Overusing coal and fossil fuels for generating electricity and driving vehicles has led to global warming, and scientists and governments worldwide are turning to hydroelectric (water), wind, and solar power for generating electricity and driving vehicles. Prasad (2016) concluded that for sustainable living on Earth, more and more reliance has to be placed on the efficient use of Pancha tattva (five elements) of nature. Sharan and Pathak (2017) compared the composition, properties, and functions of Pancha Mahabhuta, especially of Prithvi, with elements of the earth and concluded that the ideas of Pancha Mahabhuta (Panch tattva) are proved to be highly scientific, and the human body is one form of existence in this universe that contains earthly matter. Therefore, all the elements on Earth are naturally present in the human body in varied concentrations.

I realized that Pancha Mahabhuta can be considered as a reference point for transformative STEAM education. The arguments for sustainability in education and the roles of education in sustainability can also be fostered by recognizing the presence and contribution of earth, air, water, fire, and sky. If we can save those five elements and connect students with these substances, the students will develop a sustainability mindset. When we, as co-researchers, developed and implemented the transformative nature of the STEAM project in the third cycle, I felt that we tried to connect with those elements, and students' responses indicated that they developed a mindset of responsible people to save nature.

As co-researchers, we argued about STEAM education as an integrated approach to teaching and learning in our fieldwork; we also discussed the perspectives of incorporating values and ethics in our pedagogical approaches. More specifically,

we developed and implemented the transformative nature of the STEAM approach in the third cycle. One day, during our third cycle, a Nepali language teacher shared that the true nature of integrating mathematics, science, languages, virtues of ethics, and values was in our Gurukul Education system. Though I also had this idea in my mind to some extent, I was not taking it seriously and was not interested in exploring the Gurukul System in this research journey. But, when one of my co-researchers shared such ideas during the research journey, it made me thoughtful and motivated to explore it further, and we had a few rounds of discussion on the research site.

Vedic philosophy is the foundation for the Gurukul Education System. The Vedic philosophy aims to cultivate humans with strong ethical and moral principles and the ability to exercise these values in their daily lives. In the Gurukul Education System, the teaching of Dharma (righteousness), Kama (desires), Moksha (liberation), and Artha (prosperity) to live a life that is balanced and virtuous is at the core of education. With regard to this, the concept of self-realization and the pursuit of Satya, which explains "truth," are the primary components. In the field of STEAM Education, which is initiated on the principles of the transdisciplinary notion of curriculum, it appears that the Gurukul Education system implemented an integrated nature of educational constructs discussed in the 21st century. Several apparently Western ideas, such as STEAM Education, have gained popularity worldwide due to the overemphasis placed on the modern education system and the influence of postcolonial philosophies. However, if we conduct an in-depth analysis of the Vedic heritage and the Gurukul education system, we can discover that the Eastern wisdom tradition is an excellent place to look for the incorporation of a variety of disciplines, as well as the incorporation of values and ethics (For details; transformative STEAM projects discussed in chapter VII).

Chauhan (2021) mentioned that the major objectives of the Gurukul education system were holistic development, personality growth, spiritual awakening: awareness about nature and society, passing on knowledge and culture through generations, self-control, and discipline in life. In the Gurukul system, there is the concept of “Acharya,” a person who demonstrates the same behaviors internally and externally. Here, the internal means the knowledge one has in terms of “aacharan” (knowledge of right behaviors, actions, ethics, a way of life), and the external means the demonstration of such “aacharan” that was known and explained to others. It was believed that the students learn from the demonstration of the Aacharya not only from

the knowledge he/she shared orally but also through the everyday actions Aacharya performs. I connected this idea with the knowledge generation system in PAR. Here, as co-researchers, we do not only theoretically argue what does work and what does not in the education arena; instead, we try to generate knowledge by demonstrating our knowledge and action in a real-life context. At some point, we can refer to co-researchers as Acharya, who demonstrate their knowledge and actions in the community to develop positive vibes for the transformation of society.

Connecting cultural constructs is also beneficial for knowledge generation. Gjøtterud and Ahmad (2018) explored the transformative power of cross-cultural supervision for both supervisees and supervisors. Using a five-year supervisory relationship between a Tanzanian PhD student and a Norwegian supervisor as a case study, the paper follows an action research approach to analyze supervision practices. The study emphasizes the need for research on cross-continental supervisory collaborations, particularly between Scandinavia and Southern Africa, where such studies are limited. Findings uncover seven factors crucial to mutual transformative learning, including trust-building, navigating cultural differences, and shared experiences of language and context. The study concludes that recognizing and embracing cultural differences within supervision fosters mutual learning and enriches perspectives for both parties. In my study, I also sensed that I benefited a lot due to the cross-cultural supervision among Nepali and Norwegian professors. More specifically, I learned how to capture Western and Eastern perspectives and develop evidence-based writing in my doctoral journey.

Implications of the Study

We, as co-researchers, have drawn several implications from this study. The implications are for me as a university researcher, schoolteachers as co-researchers, the government, and PAR researcher. As a university researcher, this PAR journey has been groundbreaking for me personally and professionally. We, as coresearchers, felt that we developed several soft skills in this journey. Arriving at this stage, I want to share how this research became helpful to me and my co-researchers. One of the major implications for us is that developing communication skills is more than simply keeping one’s ideas. Effective communication is rooted in context, people's mindset, and individual priorities. For that, before sharing our ideas, active listening is a must. In this PAR journey, in the initial days, we shared our ideas, but active listening did not happen. As we moved on, we realized that active listening helps us to understand

others' perspectives and needs. In the school system, there are different stakeholders, and the blaming game does not help improve the system. Active listening and the right communication among stakeholders can improve any organization's existing situation.

Next, the important implication for co-researchers is to develop empathy among ourselves. The issues in the education field are complex and multi-layered. If we understand each other's feelings, understand them, and act accordingly, the relational ontology becomes strong, and we can work beyond the formal mechanism. In several cases, such as developing and implementing transformative STEAM projects, we co-researchers took the initiative and moved forward, which was beyond our common understanding, which was developed at the beginning of the study. Adaptability is another lesson we learned during this journey. We need to develop adjusting skills when we engage with new situations and contexts. In the education sector, this is needed for both teachers and researchers. The next implication for all stakeholders is to develop a sense of collaborative actions to plan, act, and reflect on the entire journey to improve the situation.

Next, the implication for all people working in the education sector is looking back to our wisdom system. This is mostly useful for teachers directly connecting with students through teaching and learning activities. For example, in this study, I explored the Gurukul system and several other constructs as I grew up in a Hindu family, and I learned several such concepts in my childhood from my parents and the community. We have several such traditions in Nepal, which are rich in culture and wisdom. As teachers, educators, and researchers, we should explore our roots and critically examine the usefulness of those ideas in today's work, being aware of their limitations. My argument is not that we should go back to the Gurukul system and entirely adopt those ideas. As it has several interdisciplinary and multi-disciplinary natures of educational practices connected with ethics and values, we can refer to them and attentively use some of them in our pedagogical practices. I shared it from the perspective that we should not feel colonized in the knowledge-generation process while designing and implementing curricula, pedagogical practices, and assessment strategies. Though STEAM was named in the West, these ideas were practiced for many centuries in our communities in the form of the Gurukul education system, family values, and *karma* and *dharma*. We can learn several concepts and ideas which were practiced at that time.

For PAR researchers, this research is helpful for many reasons. First, PAR is a long process, and the different layers of participation are natural. The researchers should acknowledge and become aware of them. Next, PAR researchers should have some agenda for change. Sometimes, PAR researchers are responsible for developing an environment where co-researchers can join the university researchers for collaborative actions to improve the situation.

For the government system, this research is helpful in two ways: a) implementing an integrated pedagogical approach and b) designing the participatory nature of TPD. Though Nepal has a disciplinary curriculum from grade 4 and above, there are enough spaces to develop and implement integrated lessons and projects to achieve the students' competencies as stated in the national curriculum. The integrated nature of teaching supports the development of critical and creative human resources. Next, the TPD sessions should be school-based and rooted in the philosophy of participatory action research. Teachers should feel that the educational issues can be solved collaboratively and collaboratively. In that case, the quality of collaboration and participation will increase, and the educational issues can be solved through participatory actions and reflections.

Limitations of the Study

This research has several limitations. One limitation is the time constraints that practitioners face when conducting such an intensive research study. Typically, schoolteachers face busy schedules in the classroom with the weight of the official curriculum. Finding time for in-depth discussions and comfortable implementation of activities can be challenging. I initially believed I had minimized power dynamics throughout the PAR process, but I discovered that these dynamics persisted throughout the research process. Therefore, the limitation lies in the power dynamics that prevail within the PAR during the participatory actions. The power dynamics manifest in the form of head teachers and other teachers, permanent teachers and temporary teachers, secondary level teachers and primary level teachers, male teachers and female teachers, teachers with political party connections, and teachers without any connections. The lead researcher should be aware of it and try to minimize it.

Next, the bureaucratic barriers to making the actions sustainable are another limitation of such a study. The local bureaucracy was aware that the entire research was being conducted in the schools. However, we could not engage them

meaningfully beyond occasional school and program visits. In such a study, resource management could be another limitation. In my case, the financial and other forms of resources were managed by the Rupanataran initiative. Therefore, I extended my fieldwork and allocated school resources for pedagogical innovations. Conducting this type of study would be challenging if we couldn't manage the resources effectively.

Finally, the limitation I observed is the community members' in-depth level of participation. Even though government-funded schools in Nepal are referred to as "community schools," the community member's participation in improving schools did not meet expectations. In our case, several researchers were involved, and there were some motivations (such as exposure visits to the head teacher and community members), so we had a moderate level of community engagement. However, when an individual conducts intensive fieldwork, boarding the community during the research process is complicated. Not only did I discuss the limitations of my study, but I also shared potential limitations that other PAR researchers may encounter based on my personal experiences.

Coda

The formal research journey is almost over, but it became more than an academic milestone for me and perhaps for my co-researchers as well. On the one hand, I think I learned several things and developed skills and attitudes during this research journey. On the other hand, this is the beginning of my research journey for the rest of my academic life. In the field of education, teaching and research are inseparable and continuously move side by side. The teaching approaches should be supplemented by teacher-initiated research activities, and knowledge (i. e., through research) should be generated through actions (teaching and reflection). This research journey motivated me to continue collaborating with stakeholders in the education field to generate shared knowledge through collaborative actions. The improvement of Nepali public schools is a challenging task, but it is not impossible. The problems are multifaceted. However, working with or for teachers to model a better pedagogical approach can result in a visible change. The professional development of teachers can be participatory and sustainable, empowering them to become life-long learners and researchers. Nepal boasts a multitude of wisdom traditions from which the modern education system should draw inspiration. School teachers and university faculties can explore our cultural values and contexts (like the integrated approach in the Gurukul education system or the knowledge generation in *Chautari*) and use them

without neglecting the positive side of the modern education system. The implementation of STEAM Education can begin by analyzing the existing pedagogical approach and gradually moving to an inquiry-based approach to teaching followed by multidisciplinary, interdisciplinary, and transdisciplinary pedagogical approaches.

REFERENCES

Acharya, K. P., Budhathoki, C. B., Bjønness, B., & Devkota, B. (2022). School gardening activities as contextual scaffolding for learning science: participatory action research in a community school in Nepal. *Educational Action Research*, *30*(3), 462-479. https://doi.org/10.1080/09650792.2020.1850494

Ademolu, E. (2024). Birds of a feather (don't always) flock together: Critical reflexivity of 'Outsiderness' as an 'Insider'doing qualitative research with one's 'Own People'. *Qualitative Research*, *24*(2), 344-366. https://doi.org/10.1177/14687941221149596

Adhikari, T. N. (2023). Inclusiveness in Gurukul education system. *Gyanjyoti*, *3*(1), 95-103. https://doi.org/10.3126/gyanjyoti.v3i1.53040

Ahmed, F. (2014). Exploring halaqah as research method: A tentative approach to developing Islamic research principles within a critical 'indigenous' framework. *International Journal of Qualitative Studies in Education*, *27*(5), 561-583. https://doi.org/10.1080/09518398.2013.805852

Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, *2*, 539-620. https://doi.org/10.1007/s11422-007-9067-8

Alberta Education. (2010). *Inspiring education: A dialogue with Albertans*. Alberta Education.

Alcover, C. M. (2018). Who are 'I'? Who are 'we'? A state-of-the-art review of multiple identities at work. *Psychologist Papers*, *39*, 200-207. https://doi.org/10.23923/pap.psicol2018.2858

Amos, R., & Levinson, R. (2019). 'Socio-scientific inquiry-based learning: An approach for engaging with the 2030 Sustainable Development Goals through school science'. *International Journal of Development Education and Global Learning*, *11*(1), 29–49. https://doiorg/10.18546/IJDEGL.11.1.03

Armstrong, R., & Ludlow, A. (2020). What's so good about participation? Politics, ethics and love in learning together. *Methodological Innovations*, *13*(2). https://doi.org/10.1177/2059799120927339

Association for Experiential Education. (2018). *What is experiential education?* Association for Experiential Education.

Auh, Y., & Kim, C. (2024). Global citizenship education: Towards a critical moral pedagogy. *Social Education Research*, *5*(2), 450-471. https://doi.org/10.37256/ser.5220244897

Baker, W., Czarnocha, B., & Prabhbu, V. (2004). Procedural and conceptual knowledge in mathematics. *Proceedings of the North American chapter of the international group for the psychology of mathematics education annual conference*, Toronto, Ontario, Canada.

Barquero, B., Florensa, I., & Ruiz-Olarría, A. (2019). The education of school and university teachers within the paradigm of questioning the world. In M. Bosch, Y. Chevallard, F. J. García, & J. Monaghan (Eds.), *Working with the anthropological theory of the didactic in mathematics education* (pp. 189–212). Routledge. https://doi.org/10.4324/9780429198168-12

Barsky, A. E. (2019). *Ethics and values in social work: An integrated approach for a comprehensive curriculum*. Oxford University Press.

Beane, J. A. (1997). *Curriculum integration: Designing the core of democratic education.* Teachers College Press.

Belbase, S. (2019). STEAM education initiatives in Nepal. *The STEAM Journal*, *4*(1), Article 7. https://doi.org/0.5642/steam.20190401.07

Berkowitz, M. W., & Oser, F. (2013). *Moral education: Theory and application*. Routledge.

Bertrand, M. G., & Namukasa, I. K. (2020). STEAM education: student learning and transferable skills. *Journal of Research in Innovative Teaching & Learning*, *13*(1), 43-56. https://doi.org/10.1108/JRIT-01-2020-0003

Bhangaokar, R., & Kapadia, S. (2009). At the interface of 'Dharma' and 'Karma': Interpreting moral discourse in India. *Psychological Studies*, *54*, 96-108. https://doi.org/10.1007/s12646-009-0018-1

Bidarian, S., & Davoudi, A. M. (2011). A model for application of ICT in the process of teaching and learning. *Procedia-Social and Behavioral Sciences*, *29*, 1032-1041. http://dx.doi.org/10.1016/j.sbspro.2011.11.336

Boaler, J. (1997). *Experiencing school mathematics: Teaching styles, sex, and teaching.* Open University Press.

Borda, O. F., Reason, P., & Bradbury, H. (2006). Participatory (action) research in social theory: Origins and challenges. In *Handbook of action research: Participative inquiry and practice* (pp. 27-37). Sage.

Bradbury, H. (Ed.). (2015). *The Sage handbook of action research*. Sage.

Braskén, M., Hemmi, K., & Kurtén, B. (2020). Implementing a multidisciplinary curriculum in a Finnish lower secondary school–The perspective of science and mathematics. *Scandinavian Journal of Educational Research, 64*(6), 852-868. https://doi.org/10.1080/00313831.2019.1623311

Brookfield, S. (1990). *The skillful teacher*. Jossey-Bass.

Brookfield, S. (1995). Adult learning: An overview. *International Encyclopedia of Education, 10*, 375-380.

Brookfield, S. (2017). *Becoming a critically reflective teacher*. John Wiley & Sons.

Brown, K., & Westaway, E. (2011). Agency, capacity, and resilience to environmental change: Lessons from human development, well-being, and disasters. *Annual Review of Environment and Resources, 36*(1), 321–342. https://doi.org/10.1146/annurev-environ-052610-092905

Brown, T. (2008). Design thinking. *Harvard Business Review, 86*(6), 1-10.

Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review, 31*, 21–32. https://doi.org/10.12691/education-7-12-5

Brydon-Miller, M., Kral, M., & Ortiz Aragón, A. (2020). Participatory action research: International perspectives and practices. *International Review of Qualitative Research, 13*(2), 103-111. https://doi.org/10.1038/s43586-023-00214-1

Bryman, A. (2012). *Social research methods*. Oxford University Press.

Bundsgaard, J. (2019). Using technology to scaffold progressive teaching. In Z. Babaci-Wilhite (Eds.), *Promoting language and STEAM as human rights in education* (pp. 109-124). Springer.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins and effectiveness.* BSCS.

Çalışkan, Ö., & Gökalp, G. (2020). A Micro-Level Perspective in Organizational Change: Cognitive Dissonance, Sense-Making and Attitude Change. *Kuram ve Uygulamada Eğitim Yönetimi [Educational Administration: Theory and Practice]*, 26(4), 719-742. http://dx.doi.org/10.14527/kuey.2020.016

Carter, J. A. (2017). Epistemic pluralism, epistemic relativism and 'hinge'epistemology. In A. Coliva & N. J. L. L. Pederson (Eds.), *Epistemic pluralism* (pp. 229-249). Palgrave Macmillan, Cham.

Carter, L. (2017). Neoliberalism and STEM education: Some Australian policy discourse. *Canadian Journal of Science, Mathematics and Technology Education, 17*(4), 247-257. http://dx.doi.org/10.1080/14926156.2017.1380868

Center for Education and Human Resource Development (CEHRD). (2024). *Action research manual.* https://cehrd.gov.np/

Chakravarthi, R. P. (1995). A classical Indian philosophical perspective on ageing and the meaning of life. *Ageing & Society, 15*(1), 1-36. https://doi.org/10.1017/S0144686X00002105

Chappell, K., & Craft, A. (2011). Creative learning conversations: Producing living dialogic spaces. *Educational Research, 53*(3), 363-385. https://doi.org/10.1080/00131881.2011.598663

Chasanidou, D., Gasparini, A., & Lee, E. (2014). Design thinking methods and tools for innovation in multidisciplinary teams. *Innovation in HCI: What can we learn from design thinking*, 27-30. http://dx.doi.org/10.1007/978-3-319-20886-2_2

Chauhan, S., Singh, N. K., & Agarwal, S. (2021). Gurukul education system for better life: Bharatiya education stem. *A Multidisciplinary Journal of Empowering Research, 6*(2), 265-271. https://doi.org/10.61227/jetti.v1i2.65

Chen, J. (2024). The impact and evaluation of STEM education methods on the comprehensive development of students. *The Educational Review, USA, 8*(5), 657-661.

Chesky, N. Z., & Wolfmeyer, M. R. (2015). *Philosophy of STEM education: A critical investigation*. Springer.

Chevalier, J. M., & Buckles, D. J. (2019). *Participatory action research: Theory and methods for engaged inquiry* (2nd ed.). Routledge.

Chiu, L. F. (2006). Critical reflection: More than nuts and bolts. *Action Research, 4*(2), 183-203. http://dx.doi.org/10.1177/1476750306063991

Cho, J., & Trent, A. (2006). Validity in qualitative research revisited. *Qualitative Research, 6*(3), 319-340. https://doi.org/10.1177/1468794106065006

Christians, C. G. (2205). Ethics and politics in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The sage handbook of qualitative research* (3rd ed., pp. 139-164). Sage.

Coady, M. J. (2015). From Houle to Dirkx: Continuing professional education (CPE), a critical state-of-the-field review. *The Canadian Journal for the Study of Adult Education (Online)*, *27*(3), 27-41. https://doi.org/10.56105/cjsae.v27i3.3900

Connor, A., Karmokar, S., & Whittington, C. (2015). From STEM to STEAM: Strategies for enhancing engineering & technology education. *International Journal of Engineering Pedagogy*, *5*(2), 37-47. https://doi.org/10.3991/ijep.v5i2.4458

Cornbleth, C. (2013). Curriculum in and out of context. In E. R. Hollins (Ed.), *Transforming curriculum for a culturally diverse society* (pp. 149-161). Routledge.

Cornwall, A. (2008). Unpacking 'participation': Models, meanings and practices. *Community development journal*, *43*(3), 269-283.

Croeser, T., Clement, S., Fernandez, M., Garrard, G. E., Mell, I., & Bekessy, S. A. (2024). Action research for transformative change. *Sustainability Science*, *19*(2), 665-670. https://doi.org/10.1007/s11625-023-01458-2

Culén, A. L., & Gasparini, A. A. (2019). STEAM education: Why learn design thinking? In Z. Babaci-Wilhite (Ed.), *Promoting language and STEAM as human rights in education* (pp. 91-108). Springer.

Curriculum Development Centre (CDC). (2019). *Integrated Curriculum for grades 1-3, 2078*. Curriculum Development Centre.

D'Ambrosio, U. (2015). From mathematics education and society to mathematics education and a sustainable civilization. In S. Mukhopadhyay & B. Greer (Eds.), *Proceedings of the Eighth International Mathematics Education and Society Conference:* Vol. 1(pp. 19-30). Ooligan Press.

Danish, J. A., & Gresalfi, M. (2018). Cognitive and sociocultural perspectives on learning: Tensions and synergy in the learning sciences. In F. Fischer, C. E. Hmelo-Silver, S. R. Goldman, & P. Reimann (Eds.), *International handbook of the learning sciences* (pp. 10–21). Routledge. https://doi.org/10.4324/9781315617572

Darbellay, F. (2019). From interdisciplinarity to postdisciplinarity: Extending klein's thinking into the future of the university. *Issues in Interdisciplinary Studies, 37*(2), 90–109.

Darder, A., Hernandez, K., Lam, K. D., & Baltodano, M. (2023). Critical pedagogy: An introduction. In A. Darder, K. Hernandez, K. D. Lam &M. Baltodano (Eds.), *The critical pedagogy reader* (4th ed., pp. 1-30). Routledge.

Davies, C. J. (2016). *Whose knowledge counts?: Exploring cognitive justice in community-university collaborations* [Unpublished PhD thesis]. University of Brighton. https://research.brighton.ac.uk/files/4756051/WHOSE%20KNOWLEDGE%20COUNTS_CJDavies%20PhD%20FINAL%20JUNE16.pdf

Delong, J., & Whitehead, J. (2023). *You and your living-educational theory: How to conduct a values-based inquiry for human flourishing.* Routledge.

Denzin, N. K. (2013). The death of data? *Cultural studies ↔ Critical methodologies, 13*(4), 353–356. https://doi.org/10.1177/1532708613487882

Denzin, N. K. (2019). The death of data in neoliberal times. *Qualitative Inquiry, 25*(8), 721-724. https://doi.org/10.1177/1077800419847501

Denzin, N. K., & Lincoln, Y. S. (2018). *The SAGE handbook of qualitative research*. Sage.

Dewey, J. (1938). *Experience and education*. Macmillan.

Dewey, J. (1998). *The essential Dewey, volume 1: Pragmatism, education, democracy* (Vol. 1). Indiana University Press.

Dewey, J. (2005). *Art as experience*. Penguin.

Dewey, J. (2012). Education and democracy in the world of today schools (Original work published 1938). *Studies in Education, 9*(1), 96-100

Dhungana, P. (2022). *Developing a living model of professional development of school teachers in Nepal: A collaborative epistemic journey* [Unpublished PhD thesis]. Kathmandu University.

Dhungana, P., & Luitel, B. C. (2022). Gyana/Pragya paradigm for professional development of teachers: A socio-cultural perspective. *Journal of Interdisciplinary Studies in Education, 11*(2), 95-102.

Díaz-Arévalo, J. M. (2022). In search of the ontology of participation in participatory action research: Orlando Fals-Borda's participatory turn, 1977–1980. *Action Research, 20*(4), 343-362. https://doi.org/10.1177/14767503221103571

Diego-Mantecon, J. M., Prodromou, T., Lavicza, Z., Blanco, T. F., & Ortiz-Laso, Z. (2021). An attempt to evaluate STEAM project-based instruction from a school mathematics perspective. *ZDM–Mathematics Education, 53*(5), 1137-1148. https://doi.org/10.1007/s11858-021-01303-9

Dietiker, L. (2015). What mathematics education can learn from art: The assumptions, values, and vision of mathematics education? *Journal of Education*, *195*(1), 1-10. https://doi.org/10.1177/002205741519500102

Dixon, R. A., & Hutton, D. M. (2016). STEM and TVET in the Caribbean: A framework for integration at the primary, secondary and tertiary levels. *Caribbean Curriculum*, *24*, 1-26. https://journals.sta.uwi.edu/ojs/index.php/cc/article/view/760

Dolapcioglu, S., & Doğanay, A. (2022). Development of critical thinking in mathematics classes via authentic learning: action research. *International Journal of Mathematical Education in Science and Technology*, *53*(6), 1363-1386.

Drake, S. M. (2012). *Creating standards-based integrated curriculum: The common core state standards edition*. Corwin Press.

Eccles, J. S., & Roeser, R. W. (2015). School and community influences on human development. In *Developmental science* (pp. 645-728). Psychology Press.

Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *Journal of the Learning Sciences, 8*(3-4), 391-450. http://dx.doi.org/10.1207/s15327809jls0803&4_3

Education Review Office (ERO). (2017). *National achievement of students' achievement 2017*.

Education Review Office (ERO). (2019). *National achievement of students' achievement 2018: Main Report*.

Education Review Office (ERO). (2022). *National achievement of students' achievement 2020: Main Report*.

Egan, K. (1986). *Teaching as storytelling: An alternative approach to teaching and curriculum in the elementary school*. The Althouse Press.

Eisner, E. (2005). Two visions of education. *Teachers College Record*. https://www.tcrecord.org/Content.asp?ContentId=12234

Eisner, E. W. (1965). Curriculum ideas in a time of crisis. *Art Education*, *18*(7), 7-12. https://doi.org/10.2307/3190712

Eisner, E. W. (2002). What can education learn from the arts about the practice of education? *Journal of Curriculum and Supervision*, *18*(1), 4-16.

Eli, M., Scheie, E., Gabrielsen, A., Jordet, A., Misund, S., ... & Øyehaug, A. B. (2020). Interdisciplinary primary school curriculum units for sustainable development. *Environmental Education Research*, *26*(6), 795-811. https://doi.org/10.1080/13504622.2020.1750568

Elkowitz, D. E. (2021). Socratic questioning to engage learners. In *How-to guide for active learning* (pp. 107-119). Springer International Publishing.

English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education*, *3*(1), 3-11. https://doi.org/10.1186/s40594-016-0036-1

Ernest, P. (Ed.). (1994). *Mathematics education and philosophy: An international perspective*. Routledge.

Feekery, A. (2023). The 7 C's framework for participatory action research: inducting novice participant-researchers. *Educational Action Research*, *32*(3), 332–347. https://doi.org/10.1080/09650792.2023.2234417

Fernández-Gutiérrez, M., Gimenez, G., & Calero, J. (2020). Is the use of ICT in education leading to higher student outcomes? Analysis from the Spanish *Autonomous Communities. Computers & Education*, *157*, 10-69. https://doi.org/10.1016/j.compedu.2020.103969

Finnish National Agency for Education. (2014). *The national core curriculum for Finnish basic education.* Finnish National Agency for Education.

Florian, L., & Linklater, H. (2010). Preparing teachers for inclusive education: using inclusive pedagogy to enhance teaching and learning for all. *Cambridge Journal of Education*, *40*(4), 369-386. http://dx.doi.org/10.1080/0305764X.2010.526588

Freedman, K. (2005). Art education: Epistemologies of art. *Studies in Art Education*, *46*(2), 99.

Freire, P. (1970). *Pedagogy of the oppressed*. Continuum.

Freire, P. (1985). *The politics of education: Culture, power, and liberation*. Bergin and Garvey. https://doi.org/10.1007/978-1-349-17771-4

Frey, B. A., & Birnbaum, D. J. (2002). *Learners' perceptions on the value of PowerPoint*. Harvard University Press.

Gan, F., & Bai, Q. (2023). Karl Marx's thoughts on critical pedagogy, reproduction, and aesthetic literacy in STEAM education and praxis. *Educational Philosophy and Theory*, *55*(13), 1513-1525. http://dx.doi.org/10.1080/00131857.2023.2197208

Ge, X., Ifenthaler, D., & Spector, J. M. (Eds.). (2015). *Emerging technologies for STEAM education: Full STEAM ahead*. Springer.

Geuss, R. (1981). *The idea of a critical theory: Habermas and the Frankfurt school*. Cambridge University Press.

Giri, K. (2022). *Increasing parental engagement to enhance students' home and school-based learning: Participatory action research in a public school, Nepal* [Unpublished MPhil dissertation]. Kathmandu University.

Giroux, H. A. (2004). Cultural studies, public pedagogy, and the responsibility of intellectuals. *Communication and critical/cultural studies*, *1*(1), 59-79. https://doi.org/10.1080/1479142042000180935

Gjøtterud, S. M., & Ahmad, A. K. (2018). Transformative power of cross-cultural PhD supervision. *International Journal of Doctoral Studies*, *13*, 441–456. https://doi.org/10.28945/4140

Gnawali, L., Laudari, S., & Shrestha, S. (Eds.). (2021). *Exploratory action research: Stories of Nepalese EFL teachers*. Nepal English Language Teachers' Association (NELTA).

Goldberg, M. (2016). *Arts integration: Teaching subject matter through the arts in multicultural settings*. Routledge.

Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Learning, teaching, and scholarship in a digital age: Web 2.0 and classroom research: What path should we take now? *Educational Researcher*, *38*(4), 246-259. http://dx.doi.org/10.3102/0013189X09336671

Gross, K., & Gross, S. (2016). Transformation: Constructivism, Design Thinking, and Elementary STEAM. *Art Education*, *69*(6), 36–43. http://dx.doi.org/10.1080/00043125.2016.1224869

Gutstein, E. (2012). *Reading and writing the world with mathematics: Toward a pedagogy for social justice*. Routledge.

Guyotte, K. W., Sochacka, N. W., Costantino, T. E., Kellam, N. N., & Walther, J. (2015). Collaborative creativity in STEAM: Narratives of art education students' experiences in transdisciplinary spaces. *International Journal of Education & the Arts*, *16*(15), 1-38. http://www.ijea.org/v16n15/

Guzdial, M., & Morrison, B. (2016). Growing computer science education into a STEM education discipline. *Communication of the ACM*, *59*(11), 31-33. https://m-cacm.acm.org/magazines/2016/11/209119-growing-computer-science-education-into-a-stem-education-discipline/fulltext?mobile=true

Habermas, J. (1971). *Knowledge and human interests*. Beacon.

Halliday, A. J., Kern, M. L., Garrett, D. K., & Turnbull, D. A. (2018). The student voice in well-being: a case study of participatory action research in positive education. *Educational Action Research, 27*(2), 173–196. https://doi.org/10.1080/09650792.2018.1436079

Heafner, T. (2004). Using technology to motivate students to learn social studies. *Contemporary Issues in Technology and Teacher Education*, *4*(1), 42-53.

Healy, S. (2009). Toward an epistemology of public participation. *Journal of Environmental Management*, *90*(4), 1644-1654. https://doi.org/10.1016/j.jenvman.2008.05.020

Hellerich, K. (2024). Leading Participatory Action Research for Teacher Agency. *Journal of Educational Leadership in Action, 9*(2), 8-20.

Herrington, J., & Kervin, L. (2007). Authentic learning supported by technology: 10 suggestions and cases of integration in classrooms. *Educational Media International, 44*(3), 219-236. http://dx.doi.org/10.1080/09523980701491666

Hoeg, D. G., & Bencze, J. L. (2017). Values underpinning STEM education in the USA: An analysis of the next generation science standards. *Science Education, 101*(2), 278-301.

Hoffert, S. B. (2009). Mathematics: The universal language? *Mathematics Teacher*, *103*(2), 130-139. https://doi.org/10.5951/MTLT.2023.0194

Hoggan, C. (2023). The 7 cardinal sins of transformative learning scholarship. *Journal of Transformative Education*, *21*(4), 447-453.

Holley, K. A. (2017). *Interdisciplinary curriculum and learning in higher education*. Oxford University Press.

Hunter-Doniger, T. (2018). Art infusion: Ideal conditions for steam. *Art Education*, *71*(2), 22-27. https://doi.org/10.1080/00043125.2018.1414534

Isozaki, T. (Ed.). (2024). *Theory and practice of STEAM education in Japan*. Taylor & Francis.

Jang, H. (2016). Identifying 21st century STEM competencies using workplace data. *Journal of Science Education and Technology*, *25*(2), 284-301. https://doi.org/10.1007/s10956-015-9593-1

Jha, G. (1942). *The chandogyopanishad: A treatise on Vedanta philosophy.* Oriental Book Agency.

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory into Practice, 38*(2), 67-73. http://dx.doi.org/10.1080/00405849909543834

Jørgensen, A. M. (2020). Communitification and emotional capital: Producing, shaping and re-shaping communities before and after mining in Norbotten and Disko Bay. *Polar Record*, *56*, e7. https://doi.org/10.1017/S0032247419000548

Justice, C., Rice, J., Warry, W., Inglis, S., Miller, S., & Sammon, S. (2007). Inquiry in higher education: Reflections and directions on course design and teaching methods. *Innovative Higher Education*, *31*, 201-214. http://dx.doi.org/10.1007/s10755-006-9021-9

Kang, N. H. (2019). A review of the effect of integrated STEM or STEAM (science, technology, engineering, arts, and mathematics) education in South Korea. *Asia-Pacific Science Education*, *5*(1), 1-22. https://doi.org/10.1186/s41029-019-0034-y

Kaplan, A. (2017). *The conduct of inquiry: Methodology for behavioural science*. Routledge.

Kaplan, H. (2019). Border materials, early childhood art education, and the ontological persistence of American flexibility. *Studies in Art Education*, *60*(2), 120-131. https://doi.org/10.1080/00393541.2019.1600220

Kathmandu Post. (2018, Feb 15). Nepal's first school-level STEAM challenge. *Kathmandu Post.* https://kathmandupost.ekantipur.com/news/2018-02-15/nepals-first-school-level-steam[1]challenge.html

Kathmandu University School of Education (KUSOED). (2018). *Curriculum for MPhil in education: Specialization in STEAM education*. http://soe.kusoed.edu.np/wp[1]content/uploads/2019/01/MPhil-STEAM.pdf

Kathmandu University School of Education (KUSOED). (2019). *STEAM education. Program brochure*. https://soe.kusoed.edu.np/steam-education/

Kemmis, S., & McTaggart, R. (2005). Participatory action research: Communicative action and the public sphere. In N. K. Denzin & Y. S. Lincoln (Eds.), *The sage handbook of qualitative research* (pp. 559-603). Sage.

Khalid, I. L., Abdullah, M. N. S., & Fadzil, H. M. (2024). A systematic review: Digital learning in STEM education. *Journal of Advanced Research in Applied Sciences and Engineering Technology, 51*(1), 98-115.

Kim, H., Kim, E., Lee, S., Ham, G., & Sung, J. (2024). A case study on the application of a STEAM education program for children in a community child center: Focusing on creative problem-solving and interpersonal skills. *Korean Journal of Child Studies, 45*(3), 203-222.

Kincheloe, J. L. (2008). *Critical pedagogy primer*. Peter Lang Publishing

Klaassen, R. G. (2018). Interdisciplinary education: A case study. *European Journal of Engineering Education, 43*(6), 842-859. https://doi.org/10.1080/03043797.2018.1442417

Kleinsmann, M., Deken, F., Dong, A., & Lauche, K. (2012). Development of design collaboration skills. *Journal of Engineering Design, 23*(7), 485e506. https://doi.org/10.1080/09544828.2011.619499.

Kline, S. J. (1995). *Conceptual foundations for multidisciplinary thinking*. Stanford University Press.

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *The Journal of Education, 193*(3), 13-19. https://files.eric.ed.gov/fulltext/ED467192.pdf

Kolb, A. Y., & Kolb, D. A. (2009). Experiential learning theory: A dynamic, holistic approach to management learning, education and development. In *The SAGE handbook of management learning, education and development* (pp. 42-68). Sage.

Kolb, D. (1984). *Experiential Learning: Experience as the source of learning and development.* Prentice Hall.

Krueger-Henney, P., & Ruglis, J. (2020). PAR is a way of life: Participatory action research as core re-training for fugitive research praxis. *Educational Philosophy and Theory*, *52*(9), 961-972. https://doi.org/10.1080/00131857.2020.1762569

Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2015). *Guided inquiry: Learning in the 21st century*. Bloomsbury Publishing USA.

Kuhn, D., Black, J., Keselman, A., & Kaplan, D. (2000). The development of cognitive skills to support inquiry learning. *Cognition and Instruction*, *18*(4), 495-523. https://www.jstor.org/stable/3233891?origin=JSTOR-pdf

Lai, M. Y., & Murray, S. (2012). Teaching with procedural variation: A Chinese way of promoting deep understanding of mathematics. *International Journal for Mathematics Teaching and Learning*, 1-25. https://researchoutput.csu.edu.au/en/publications/teaching-with-procedural-variation-a-chinese-way-of-promoting-dee

Lajoie, S., & Poitras, E. (2017). Crossing disciplinary boundaries to improve technology-rich learning environments. *Teachers College Record*, *119*(3), 1-30. https://doi.org/10.1177/016146811711900301

Lambert, J., Cioc, C., Cioc, S., & Sandt, D. (2018). Making connections: Evaluation of a professional development program for teachers focused on STEM integration. *Journal of STEM Teacher Education*, *53*(1), 3-25.

Lamichhane, B. R., & Luitel, B. C. (2022). A critical rendition to the development of mathematics education in Nepal: an anticolonial proposal. *British Journal for the History of Mathematics*, *38*(1), 3–23. https://doi.org/10.1080/26375451.2022.2109832

Lansdown, G., Jimerson, S. R., & Shahroozi, R. (2014). Children's rights and school psychology: Children's right to participation. *Journal of School Psychology*, *52*(1), 3-12. https://doi.org/10.1016/j.jsp.2013.12.006

Larrea, M. (2021). We are not third parties: Exploring conflict between action researchers and stakeholders as the engine of transformation. *Action Research*, *19*(1), 110-125. https://doi.org/10.1177/1476750319865015

Larrivee, B. (2000). Transforming teaching practice: Becoming the critically reflective teacher. *Reflective Practice*, *1*(3), 293-307. https://doi.org/10.1080/14623940020025561

Lather, P. (1986). Research as praxis. *Harvard Educational Review*, *56*(3), 257-278. https://doi.org/10.17763/haer.56.3.bj2h231877069482

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues*, *2*(4), 34-46. https://doi.org/10.1111/j.1540-4560.1946.tb02295.x

Luitel, B. C. & Taylor, P. C. (2019). Introduction: Research as transformative learning for sustainable futures. In *Research as transformative learning for sustainable futures* (pp. 1-16). Brill Sense

Luitel, B. C. (2009). *Culture, worldview and transformative philosophy of mathematics education in Nepal: A cultural-philosophical inquiry* [Unpublished PhD thesis]. Science and Mathematics Education Centre, Curtin University.

Luitel, B. C. (2013). Mathematics as an im/pure knowledge system: Symbiosis, (w)holism and synergy in mathematics education. *International Journal of Science and Mathematics Education*, *11*(1), 65-87. https://doi.org/10.1007/s10763-012-9366-8

Luitel, B. C. (2019). Journeying towards a multi-paradigmatic transformative research program: An East-West symbiosis. In P. C. Taylor & B. C. Luitel (Eds.), *Research as transformative learning for sustainable futures* (pp. 19-37). Brill Sense.

Luitel, B. C., & Pant, B. P. (2019). Integrated curriculum and transversal skills. *Education Journal of Curriculum Development Centre,* 32-46. Curriculum Development Centre.

Luitel, B. C., & Taylor, P. C. (2007). The Shanai, the pseudosphere and other imaginings: Envisioning culturally contextualised mathematics education. *Cultural Studies of Science Education*, *2*(3), 621-655. https://doi.org/10.1007/s11422-007-9068-7

Luitel, B.C., & Pant, B. P. (2021). Integrated curriculum and transversal skills. *Education Journal of Curriculum Development Centre, v*(i), 32-46.

MacDonald, C. (2012). Understanding participatory action research: A qualitative research methodology option. *The Canadian Journal of Action Research*, *13*(2), 34-50. http://dx.doi.org/10.33524/cjar.v13i2.37

Maguire, P. (1987). Doing participatory research: A feminist approach. *Participatory Research & Practice, Paper 1*. http://scholarworks.umass.edu/cie_participatoryresearchpractice/1

Maharjan, M., Dahal, N., & Pant, B. P. (2022). ICTs into mathematical instructions for meaningful teaching and learning. *Advances in Mobile Learning Educational Research*, *2*(2), 341-350. http://dx.doi.org/10.25082/AMLER.2022.02.004

Mahmoudi, S., Jafari, E., Nasrabadi, H. A., & Liaghatdar, M. J. (2012). Holistic education: An approach for 21 century. *International Education Studies*, *5*(2), 178-186. https://doi.org/10.5539/IES.V5N3P178

Manandhar, N. (2018). *Conceptual and procedural knowledge of students in mathematics: A mixed method study* [Unpublished MEd dissertation]. Kathmandu University School of Education, Nepal.

Mård, N. (2020). History in multidisciplinary education: A case study in a Finnish primary school. *Education 3-13, 49*(5), 513–528. https://doi.org/10.1080/03004279.2020.1737172

Marquardt, M., & Waddill, D. (2004). The power of learning in action learning: a conceptual analysis of how the five schools of adult learning theories are incorporated within the practice of action learning. *Action Learning: Research and Practice, 1*(2), 185–202. https://doi.org/10.1080/1476733042000264146

Martinez, J. E. (2017). *The search for method in STEAM education*. Springer International Publishing.

Matz, R., Rothman, E., Krajcik, J., & Banaszak Holl, M. (2012). Concurrent enrollment in lecture and laboratory enhances student performance and retention. *Journal of Research in Science Teaching, 49*(5), 659-682. https://psycnet.apa.org/doi/10.1002/tea.21016

Mayo, P. (2015). Antonio Gramsci's impact on critical pedagogy. *Critical Sociology, 41*(7-8), 1121-1136. htpps://doi.org/10.1177/0896920513512694

McCarney, J. (2004). Effective models of staff development in ICT. *European Journal of Teacher Education*, *27*(1), 61-72. https://doi.org/10.1080/0261976042000211801

McGinn, C. (2015). The science of philosophy. *Metaphilosophy*, *46*(1), 84-103. https://doi.org/10.1111/meta.12116

Mchombo, S. (2019). Verbal arts as culturally relevant pedagogical tools in math/science education. In Z. Babaci-Wilhite (Eds.), *Promoting language and STEAM as human rights in education* (pp. 17-38). Springer.

McLaren, P. (2023). Critical pedagogy: A look at the major concepts. In A. Darder, K. Hernandez, K. D. Lam & M. Baltodano (Eds.), *The critical pedagogy reader* (4th ed., pp. 75-97). Routledge.

McLean, S., & Attardi, S. M. (2023). Sage or guide? Student perceptions of the role of the instructor in a flipped classroom. *Active Learning in Higher Education, 24*(1), 49-61. https://doi.org/10.1177/1469787418793725

McNiff, J. (2010). *Action research for professional development: Concise advice for new and experienced action researchers*. September Books.

McWhinney, W., & Markos, L. (2003). Transformative education: Across the threshold. *Journal* of *Transformative Education*, *1*(1), 16-37. https://doi.org/10.1177/1541344603252098

Mead, G. H. (2023). Self. In *Social theory re-wired* (pp. 425-437). Routledge.

Meesuk, P., Sramoon, B., & Wongrugsa, A. (2020). Classroom action research-based instruction: The sustainable teacher professional development strategy. *Journal of Teacher Education for Sustainability*, *22*(1), 98-110. http://dx.doi.org/10.2478/jtes-2020-0008

Meinel,C., Leifer, L.,& Plattner, H. (2011). *Design thinking: Understand improve apply*. Springer.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. Jossey-Bass.

Mezirow, J. (1997). Transformative learning: Theory to practice. In P. Cranton (Ed.), *Transformative learning in action: Insights from practice* (New directions for adult and continuing education), (No. 74, pp. 5–12). Jossey-Bass

Milner-Bolotin, M. (2015). Technology-Enhanced Teacher Education for 21st Century: Challenges and possibilities. In X. Ge., D. Ifenthaler, & J. M. Spector, (Eds.). *Emerging technologies for STEAM education: Full STEAM ahead*. Springer.

Ministry of Education (MoE). (2007). *National education framework for school education in Nepal*.

Ministry of Education (MoE). (2009). *School sector reform plan 2009-2015*.

Ministry of Education (MoE). (2013). *Information & communication technology (ICT) in education master plan 2013-2017*.

Ministry of Education (MoE). (2016a). *Teacher Competency Framework. National Center for educational development.*

Ministry of Education (MoE). (2016b). *School sector development plan 2016-2013*.

Ministry of Education, Science and Technology (MoEST). (2024). *Flash I report* 2080.

Mirra, N., Garcia, A., & Morrell, E. (2016). *Doing youth participatory action research: Transforming* inquiry *with researchers, educators, and students*. Routledge.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054. https://psycnet.apa.org/doi/10.1111/j.1467-9620.2006.00684.x

Morales, M. P. E. (2016). Participatory action research (PAR) cum action research (AR) in teacher professional development: A literature review. *International Journal of Research in Education and Science*, *2*(1), 156-165. http://files.eric.ed.gov/fulltext/EJ1105165.pdf

Mughal, F. (2021). When global meets local: Action learning, positionality and postcolonialism. *Management Learning*, *52*(1), 65-85. https://doi.org/10.1177/1350507620936237

Nasheeda, A., Abdullah, H. B., Krauss, S. E., & Ahmed, N. B. (2019). Transforming transcripts into stories: A multimethod approach to narrative analysis. *International Journal of Qualitative Methods*, *18*, 1-9.

National Planning Commission (NPC). (2007). *Three year interim plan*.

National Research Council (NRC). (2013). *Next Generation Science Standards (NGSS): For states, by states.* The National Academies Press. https://doi.org/10.17226/18290

Nevala, M., & Palander-Collin, M. (2005). Letters and letter writing: Introduction. *European Journal of English Studies*, *9*(1), 1-7. https://doi.org/10.1080/13825570500067903

Nguyen, M., & Mougenot, C. (2022). A systematic review of empirical studies on multidisciplinary design collaboration: Findings, methods, and challenges. *Design Studies*, *81*, 101-120. https://doi.org/10.1016/j.destud.2022.101120

Orey, D. C., & Rosa, M. (2020). Positionality and creating dialogue in Nepal: Connecting ethnomathematics and modelling - the importance of place through ethnomodelling. *Social Inquiry: Journal of Social Science Research*, *2*(1), 82-103. https://doi.org/10.3126/sijssr.v2i1.28909

Orosz, G., Németh, V., Kovács, L., Somogyi, Z., & Korom, E. (2023). Guided inquiry-based learning in secondary-school chemistry classes: A case study. *Chemistry Education Research and Practice, 24*(1), 50-70. https://doi.org/10.1039/D2RP00110A

Owen, C. (2007). Design thinking: Notes on its nature and use. *Design Research Quarterly, 2*(1), 16-27.

Padilla, L. (2014). *"My gut has to feel it": A participatory action research study of community college educators navigating the emotional terrain of human rights*

education [Unpublished PhD thesis]. University of San Francisco, California, CA.

Palmer, P. J. (2017). *The courage to teach: Exploring the inner landscape of a teacher's life*. John Wiley & Sons.

Pant, B. P. (2015). *Pondering on my beliefs and practices on mathematics, pedagogy, curriculum and assessment* [Unpublished MPhil dissertation]. Kathmandu University, Nepal.

Pant, B. P. (2017). Doing, teaching, learning and thinking about mathematics on becoming a transformative teacher. *Journal of Education and Research, 7*(1), 11-24. http://dx.doi.org/10.3126/jer.v7i1.21237

Pant, B. P. (2019). An integral perspective on research: Methodological and theoretical journey of a teacher educator. In P. C. Taylor, & B. C. Luitel (Eds.). *Research as transformative learning for sustainable futures: Global voices and visions* (pp.75-87). Brill Sense.

Pant, B. P., & Luitel, B. C. (2016). Beliefs about the nature of mathematics and its pedagogical influences. *Proceeding at the International Congress of Mathematics Education* (ICME-13, 2016) in Hamburg, Germany.

Pant, B. P., Luitel, B. C., Bjønness, B., & Gjøtterud, S. (2023a). "Science" and "art" as ways of knowing in school education in Nepal for an inclusive learning environment. *Discover Education, 2*(16). https://doi.org/10.1007/s44217-023-00039-w

Pant, B. P., Luitel, B. C., Gjøtterud, S., & Bjønness, B. (2023b). “Ignoring” to “Autonomous” participation: Narratives of a participatory action researcher. *The Canadian Journal of Action Research, 24*(1), 38-55. https://doi.org/10.33524/cjar.v24i1.661

Pant, S. K. (2023). *Use of school gardening as STEAM pedagogy: A study through participatory action research* [Unpublished MPhil dissertation]. Kathmandu University.

Pant, S. K., Luitel, B. C., Pandey, M. K., & Pant, B. P. (2023). Reviving a Forsaken Entrepot using integrated school gardening: An approach to curriculum contextualization. In B.C. Luitel, B. Devkota, S. Bastien, & B.K. Sitaula (Eds.), *Implementing transformative education with participatory action research* (pp. 98-109). IGI Global. https://doi.org/10.4018/979-8-3693-0607-9.ch007

Park, P. (2001). Knowledge and participatory research. In H. Bradbury & P. Reason (Eds.), *Handbook of action research: Participative inquiry and practice* (pp. 83-93). Sage.

Parkhouse, H., Gorlewski, J., Senechal, J., & Lu, C. Y. (2021). Ripple effects: How teacher action research on culturally relevant education can promote systemic change. *Action in Teacher Education*, *43*(4), 411-429. https://doi.org/10.1080/01626620.2021.1896395

Parnell, D. (1985). *The neglected majority*. Community College Press.

Patnaik, P. (2004). Translation, transmutation, transformation: A short reflection on the Indian Kala Tradition. *Translation Today*, *2*(2), 178-191.

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47-61. https://doi.org/10.1016/j.edurev.2015.02.003

Peters, C. (2016). Critical pedagogy and art. *Encyclopedia of Educational Philosophy and Theory*, 1-6. http://dx.doi.org/10.1007/978-981-287-532-7_238-2

Pinar, W. F. (1978). The reconceptualisation of curriculum studies. *Journal of Curriculum Studies*, *10*(3), 205-214.

Pinar, W. F. (2023). *A praxis of presence in curriculum theory: Advancing currere against cultural crises in education*. Routledge.

Píša, J., & Hruška, V. (2023). Disentangling the ‘capacity to act': Variegated resources of individuals exerting change agency. *European Planning Studies*. https://doi.org/10.1080/09654313.2023.2258165

Pradhan, L. (2011). Teacher education in Nepal. *Journal of Educational and Social Research*, *1*(5), 75-80.

Prasad, R. (2016). Panchtatva, agriculture, and sustainability of life on earth. *Asian Agri-History*, *20*(3), 141-54. https://api.semanticscholar.org/CorpusID:134061548

Pretty, J. (1995). Participatory learning for sustainable agriculture. *World Development*, *23*(8), 1247– 1263. http://dx.doi.org/10.1016/0305-750X(95)00046-F

Prince, M., & Felder, R. (2007). The many faces of inductive teaching and learning. *Journal of College Science Teaching*, *36*(5), 14-20.

Quigley, C. F., Herro, D., & Jamil, F. M. (2017). Developing a conceptual model of STEAM teaching practices. *School Science and Mathematics, 117*(1-2), 1-12. https://doi.org/10.1111/ssm.12201

Quinnell, R. (2019). Shifting from STEM to STEAM-reflecting on academic identity and scholarship. *International Journal of Innovation in Science and Mathematics Education,* 27(7), 1-9. http://dx.doi.org/10.30722/IJISME.27.07.001

Rajbanshi, R., Dhungana, P., & Luitel, B. C. (2021). Identification of needs of community schools of Kavre, Nepal for educational improvement. *The Qualitative Report, 26*(11), 3551-3562. http://dx.doi.org/10.46743/2160-3715/2021.4975

Ratnam, T. (2023). *STEAM education to unleash students' creativity and knowledge-building capacity: An Indian perspective.* In K. Plakitsi & S. Barma (Eds.), *Sociocultural approaches to STEM education*. *Sociocultural explorations of science education* (Vol. 21). Springer, Cham. https://doi.org/10.1007/978-3-031-44377-0_2

Richard, V., & Bélanger, M. (2018). Accepting research: teachers' representations of participation in educational research projects. *International Journal of Educational Methodology, 4*(2), 61-73. https://doi.org/10.12973/ijem.4.2.61

Richter, D. M., Paretti, M. C., & McNair, L. D. (2009). Work in progress-disciplinary egocentrism as a barrier to interdisciplinary design. In *2009 39th IEEE Frontiers in Education Conference* (pp. 1-2). IEEE.

Rittle-Johnson, B., & Schneider, M. (2015). Developing conceptual and procedural knowledge of mathematics. In R. C. Kadosh & A. Dowker (Eds.), *The Oxford handbook of numerical cognition* (pp. 1118–1134). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199642342.013.014

Rosa, M., & Orey, D. (2010). Ethnomodeling as a pedagogical tool for the ethnomathematics program. *Revista Latinoamericana de Etnomatemática, 3*(2),14- 23

Ross, V. (2003). The Socratic method: What it is and how to use it in the classroom. *Standford University Newsletter on Teaching, 13*(1), 1-4.

Salagame, K. K. K. (2017). Meaning and well-being: Indian perspectives. *Journal of Constructivist Psychology*, *30*(1), 63-68. http://dx.doi.org/10.1080/10720537.2015.1119087

Sangwaranatee, N., Sangwaranatee, N., & Saisin, K. (2024). Teaching STEAM and engineering education through project-based learning: Fostering creativity and innovation in students. *9th International STEM Education Conference (iSTEM-Ed)* (pp. 1–7). IEEE. https://doi.org/10.1109/iSTEM-Ed62750.2024.10663128

Satchwell, C., Larkins, C., Davidge, G., & Carter, B. (2020). Stories as findings in collaborative research: making meaning through fictional writing with disadvantaged young people. *Qualitative Research*, *20*(6), 874-891. https://doi.org/10.1177/1468794120904892

Schaffner, J., Glewwe, P., & Sharma, U. (2021). Why programs fail: Lessons for improving public service quality from a mixed-methods evaluation of an unsuccessful teacher training program in Nepal. *The World Bank Economic Review*, lhae028. https://doi.org/10.1093/wber/lhae028

Scheerens, J., van der Werf, G., & de Boer, H. (2020). *Soft skills in education*. Springer International Publishing.

Schubert, W. H. (1986). *Curriculum: Perspective, paradigm and possibility*. Macmillan.

Schuermans, N., Loopmans, M. P., & Vandenabeele, J. (2012). Public space, public art and public pedagogy. *Social & Cultural Geography*, *13*(7), 675-682. http://dx.doi.org/10.1080/14649365.2012.728007

Schulz-Forberg, H. (2013). The spatial and temporal layers of global history: A reflection on global conceptual history through expanding reinhart Koselleck's" Zeitschichten" into global spaces. *Historical Social Research*, *38*(3), 40-58. https://www.jstor.org/stable/i23644129

Schwab, J. J. (1973). The practical 3: Translation into curriculum. *The School Review*, *81*(4), 501-522. https://www.jstor.org/stable/1084423

Sharan, S., & Pathak, V. (2017). Concepts of Panchamahabhut at elemental level. *World Journal of Pharmaceutical and Medical Research, 3*(7), 80-89.

Shrestha, I. M. (2018). *My pedagogical sensitisation towards holistic mathematics education: A practitioner's inquiry* [Unpublished MPhil dissertation]. Kathmandu University School of Education, Nepal.

Sinclair, N. (2001). The aesthetic is relevant. *For the Learning of Mathematics*, *22*(1), 25-32. https://www.jstor.org/stable/40248343

Singh, D. P. (2016). Five classical elements (panch tattva) of creation-a perspective from Sri Guru Granth Sahib. *Sikh Research Journal, 1*(1), 1-7.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics Teaching, 77*(1), 20-26. http://www.jstor.org/stable/41187667?origin=JSTOR-pdf

Smallhorn, M., Young, J., Hunter, N., & Burke da Silva, K. (2015). Inquiry-based learning to improve student engagement in a large first year topic. *Student Success, 6*(2), 65-71. https://doi.org/10.5204/ssj.v6i2.292

Smith, K. A. (2000). Inquiry-based cooperative learning. *Journal of Education, 20*(2), 213-219.

Smith, L., Bratini, L., Chambers, D. A., Jensen, R. V., & Romero, L. (2010). Between idealism and reality: Meeting the challenges of participatory action research. *Action Research, 8*(4), 407-425. https://doi.org/10.1177/1476750310366043

Somekh, B. (2006), *Action research: A methodology for change and development*. Open University Press.

Spivak, G. C. (2003). *Death of a discipline*. Columbia University Press.

Stephan, P. (2012). How economics shapes science. Harvard University Press.

Stetsenko, A. (2017). *The transformative mind: Expanding Vygotsky's approach to development and education*. Cambridge University Press.

Stinson, D. W., & Bullock, E. C. (2015). Critical postmodern methodology in mathematics education research: Promoting another way of thinking and looking. *Philosophy of Mathematics Education Journal, 29,* 1-18.

Stripling, B. (2009). Teaching inquiry with primary sources. *Teaching with Primary Sources Quarterly*, *2*(3), 2-4.

Stroud, A., & Baines, L. (2019). Inquiry, investigative processes, art, and writing in STEAM. In M. S. Khine & S. Areepattamannil (Eds.), *STEAM education: Theory and practice,* (pp. 1-18). Springer.

Sutiani, A. (2021). Implementation of an inquiry learning model with science literacy to improve student critical thinking skills. *International Journal of Instruction, 14*(2), 117-138. https://doi.org/10.29333/iji.2021.1428a

Taylor, E. (Lily), & Taylor, P. C. (Eds.) (2022). Introduction – Transformative STEAM education for sustainable development. In *Transformative STEAM Education for Sustainable Development* (pp. 1-19). Sense- Brill.

Taylor, P. C. (2013). Research as transformative learning for meaning-centred professional development. In O. Kovbasyuk & P. Blessinger (Eds.), *Meaning-centred education: International perspectives and explorations in higher education* (pp. 168–185). Routledge.

Taylor, P. C. (2015). Transformative science education. In R. Gunstone (Ed.), *Encyclopedia of science education* (pp. 1079-1082). Springer.

Taylor, P. C. (2016). Why is a STEAM curriculum perspective crucial to the 21st century? *Proceeding of Australian Council for Educational Research Conference*, 89–93.

Taylor, P. C., Taylor, E., & Luitel, B. C. (2012). Multi-paradigmatic transformative research as/for teacher education: An integral perspective. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education* (Vol. 24, pp. 373–387). Springer. https://doi.org/10.1007/978-1-4020-9041-7_26

Taylor, P.C. (2018). Enriching STEM with the arts to better prepare 21st century citizens. AIP *Conference Proceedings*, *1923*(1), 89-93. https://doi.org/10.1063/1.5019491

Taylor, P.C., & Medina, M. (2011). Educational research paradigms: From positivism to pluralism. *College Research Journal, 1*(1), 1-16.

Thambinathan, V., & Kinsella, E. A. (2021). Decolonizing methodologies in qualitative research: Creating spaces for transformative praxis. *International Journal of Qualitative Methods*, *20*. https://doi.org/10.1177/16094069211014766

Timsina, C. P. (2022). *Information and communication technology (ICT) for contextualized learning environment in school education* [Unpublished master's dissertation]. Kathmandu University.

Tobin, K. (2009). Tuning into others' voices: Radical listening, learning from difference, and escaping oppression. *Cultural Studies of Science Education, 4,* 505-511. https://doi.org/10.1007/s11422-009-9218-1

Tripp, D. (2005). Action research: A methodological introduction. *Educação e Pesquisa*, *31*(3), 444–467.

Tyack, D., & Tobin, W. (1994). The "grammar" of schooling: Why has it been so hard to change? *American Educational Research Journal*, *31*(3), 453-479. https://doi.org/10.2307/1163222

United Nations (UN). (2015). Transforming our world: The 2030 agenda for sustainable development. *Resolution Adopted by the UN General Assembly*, *25*.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2018). *UNESCO ICT competency framework for teachers*.

Upaddhyaya, M. P. & Timilsina R. R., (2024) (Eds.). *Rig-Vedadi Bhashya Bhumika Mahrishi Swami Dyananada Saraswati*. Ishwar Ashram Trust, Srinagar. https://archive.org/details/Rig-edadiBhashyaBhumikaMahrishiSwamiDyanandSraswati

Utami, B., Indriyanti, N. Y., Probosari, R. M., Supurwoko, S., Fakhrudin, I. A., Khasanah, A. N., & Hudha, M. N. (2024). Empowering teachers in implementing the project to strengthen students' Pancasila profile using STEAM-based learning for optimizing sustainable development goals (SDGs) in Junior High School. *Masyarakat Berdaya Dan Inovasi*, *5*(2), 1–7. https://doi.org/10.33292/mayadani.v5i2.190

Van Manen, M. (1991). *The tact of teaching: The meaning of pedagogical thoughtfulness*. State University of New York Press.

Vargas, N. V., Ortiz, J. L. A., & Ceballo, V. M. A. (2018). Project based learning in technical and vocational education and training. *International Journal of Environmental & Science Education*, *13*(9), 767-776.

Visvanathan, S. (1997). *A carnival for science: Essays on science, technology, and development*. Oxford University Press.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes.* Harvard University Press.

Wagle, S. K. (2021). *Place pedagogies, eco-spiritual cosmologies, and cultural stories: Wisdom from Dharmashala* [Unpublished PhD thesis]. Kathmandu University.

Wagle, S. K., Luitel, B. C., & Krogh, E. (2019). Irrelevance of basic school education in Nepal: An anti-colonial critique on problems and prospects. *Dhaulagiri Journal of Sociology and Anthropology*, *13*, 31-39. https://doi.org/10.3126/dsaj.v13i0.24032

Wals, A. E., Bjønness, B., Sinnes, A., & Eikeland, I. (2024). *Whole school approaches to sustainability: Education renewal in times of distress*. Springer

Walter, M. L. (1993). Participatory action research. *Rehabilitation Counseling Bulletin, 37,* 2–5.

Wamsler, C. (2020). Education for sustainability: Fostering a more conscious society and transformation towards sustainability. *International Journal of Sustainability in Higher Education, 21*(1), 112-130. https://doi.org/10.1108/IJSHE-04-2019-0152

Warren, A., & Ott, M. G. (2016). *Project-based learning across the disciplines: Plan, manage, and assess through +1 pedagogy.* Corwin.

Webster, L., & Mertova, P. (2007). *Using narrative inquiry as a research method: An introduction to using critical event narrative analysis in research on learning and teaching*. Routledge.

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and instruction, 16*(1), 3-118. https://www.jstor.org/stable/3233668

White, S. C. (1996). Depoliticizing development: The uses and abuses of participation. *Development in Practice, 6*(1), 6– 15. https://www.jstor.org/stable/4029350

Whitehead, J. (2008). Using a living theory methodology in improving practice and generating educational knowledge in living theories. *Educational Journal of Living Theories, 1*(1), 103-126. http://ejolts.net/node/80

Whitehead, J. (2018). *Living theory research as a way of life*. Brown Dog Books.

Whitehead, J., & McNiff, J. (2006). *Action research: Living theory.* Sage.

Wright, D. E. (2015). *Active learning: Social justice education and participatory action research*. Routledge.

Wright, L. H., Tisdall, K., & Moore, N. (2021). Taking emotions seriously: Fun and pride in participatory research. *Emotion, Space and Society, 41*, 10-83. https://doi.org/10.1016/j.emospa.2021.100836

Yonfa-Medranda, M., Sabando-Vera, D., Parrales-Guerrero, K., Cueva-Tumbaco, J., & Ramírez-Prado, M. (2024). University-community partnership contribution towards rural sustainability: Participatory action research in the rice farming community of Paipayales, Ecuador. *Rural Sustainability Research, 51*(346), 66-80. http://dx.doi.org/10.2478/plua-2024-0007

Zeni, M., Schnellert, L., & Brussoni, M. (2024). Outdoor play and learning in elementary schools: A critical participatory action research project. *The*

Canadian Journal of Action Research, 24(3), 105-126. https://doi.org/10.33524/cjar.v24i3.675

Zigler, E. F., & Bishop-Josef, S. J. (2006). The cognitive child versus the whole child: Lessons from 40 years of head start. In D. G. Singer, R. M. Golinkoff, & K. Hirsh-Pasek (Eds.), Play = learning: How play motivates and enhances children's cognitive and social-emotional growth (pp. 15-35). Oxford University Press.