USE OF SCHOOL GARDENING AS STEAM PEDAGOGY: A STUDY THROUGH PARTICIPATORY ACTION RESEARCH

Sanjaya Kumar Pant

A Dissertation

Submitted to
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AN ABSTRACT

of the dissertation of *Sanjaya Kumar Pant* for the degree of *Master of Philosophy in STEAM Education* was presented on 15 May 2023, entitled *Use of School Gardening as STEAM Pedagogy: A Study through Participatory Action Research*

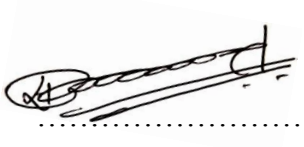
Approved by

……..	……..
Prof. Bal Chandra Luitel, PhD	Asst. Prof. Manoj Kumar Pandey, PhD
Dissertation Supervisor	Dissertation Supervisor

Before the beginning of school gardening activities at Shree Janahit Secondary School, Dharmashala, Namobuddha Municipality-7, Kavre, I visited school and community, and interacted with schoolteacher, students, and parents a couple of times. It was considered a leader school where university researchers used to undertake initial interventions, and I being a continuum in the process discovered their needs and interests where school teacher, students, and school management committee (SMC) were motivated to onset place-based learning in our attempt of contextualizing curricula. With the purpose to explore and use school gardening as STEAM pedagogy, we began to collaborate with school teacher, students, parents, and community members, and formed a school gardening club (SGC). It consisted of a team of participatory action researchers who considered positivism, criticalism, interpretivism and post-modernism as major philosophical dimension under multi paradigmatic PAR. And, informed with several aspects of socio-scientific issues (SSI) while designing eco-san based school garden, we involved in mutual dialogue, argumentation, informal reasoning and discussion with stakeholders.

In a set of two PAR cycles (i.e. plan, act, observe, and reflect), researcher and co-researchers sowed the seed of gardening activities in twelve different plots (triplicates of four groups) designed under four polyhouse. Compared with control (C) group (20kg), the yield of vegetable was highest in human urine and biochar (UB) treated group (84 kg), followed by urine (U) treated group (63 kg) and chemical fertilizer (CF) treated group (58kg). With this experimental design, we had to learn to appreciate local resources and knowledge as they might be the most undervalued resources in our context. School gardens would empower us not only in building local economies but also strengthen us to stand on our own feet. From pedagogical vantage,

the school gardening could be an immediate and effective means and ways to contextualize our curricula by rationalizing disempowering forces prevalent in our practices. While we involved in designing STEAM projects in context of school gardening, it not only harnessed soft skills in learners, rather provided opportunity of self-transformation. Beside this, integration of artificial intelligence (AI) in the second cycle of PAR enabled us to realise how far/ near we are from Industry 4.0., and it in turn accelerated our pace of glocalization.



…… 15 May 2023

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The dissertation entitled *Use of School Gardening as Steam Pedagogy: A Study through Participatory Action Research* presented by *Sanjaya Kumar Pant* on 15 May 2023.

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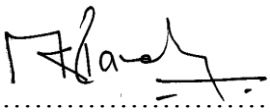

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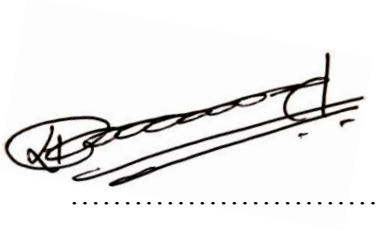
I understand and agree that my thesis will become a part of the permanent collection of the Kathmandu University Library. My signature below approves the release of my thesis to any reader upon request for scholarly purposes.



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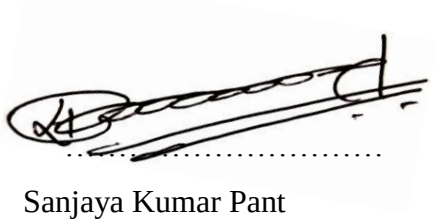
DECLARATION

This thesis contains an account of my research and no material submitted or published for a degree at any university.



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DEDICATION

To my Late grandparents Jagat Prasad Pant and Shivamaya Pant, father Devi Prasad Pant, mother Mithudevi Pant, wife Durga Pathak Pant, sibling Anjaya Kumar Pant, daughter Divyanshi Pant, and to all teachers and students.

ACKNOWLEDGEMENTS

Dapcha, and the School Garden (at Janahit Ma. Vi) had always been a great learning place throughout my research journey, and I cannot begin to express my love for the place and organization where thesis has been grown and harvested. I would like to express my deepest appreciation to my thesis supervisor, the Dean of Kathmandu University School of Education, Prof. Bal Chandra Luitel who played a decisive role in undertaking eco-san based school gardening activities as my research-work, and believing me for the profound challenge, and in my abilities. I am deeply indebted to Asst. Prof. Manoj Kumar Pandey for continuous guidance and encouragement throughout the duration of this research project. This thesis would not have been possible without the support and constant nurturing of Asst. Prof. Binod Prasad Pant, the head of department of STEAM education, my childhood friend and co-researcher in this journey. I would like to extend my gratitude to Prof. Hridaya Ratna Bajracharya, an external examiner, Prof. Bhimsen Devkota and Prof. Sheri Lee Bastien from Tribhuvan University (TU) and Norwegian University of Life Sciences (NMBU) respectively for insightful suggestion and care. I gratefully acknowledge the assistance that I received from NORHED 'Rupantaran' Project and special thanks to Asst. Prof. Roshani Rajbanshi. Many thanks to Linda Jolly from NMBU for material support and, Niroj Dahal, Netra Kumar Manandhar for the APA check. I appreciate the support received from two young and inquisitive brothers, Rohan Bhattarai and Swoyam Chaulagain in convoying artificial intelligence in school garden. I cannot leave Kathmandu University School of Education (KUSOED) for research opportune. Special thanks to school administration, teachers and students of Dapcha for being helpful during the hard time of pandemic and onwards. I also had a great pleasure working with various committees, clubs, and the community members in Dapcha. I would like to recognize the warmth and support received from Mohan Sir, Surya Sir, Prashant Sir, Mangal Sir, Ramchandra Sir, Hem *daju,* just to name a few during my stay at Dapcha. Many thanks to dear wife Durga for moral and emotional support in pursuing this research endeavor. Thanks also to all those people whose direct and indirect help had greatly contributed in the research journey.

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ABBREVIATIONS

ABET	Accreditation Board for Engineering and Technology
AI	Artificial Intelligence
ANNs	Artificial Neural Networks
CBS	Central Bureau of Statistics
CCTs	Continuous Contour Trenches
CDC	Curriculum Development Center
CMR	Crop Monitoring Robot
CNN	Convolutional Neural Network
DAO	District Agriculture Office
DAP	Diammonium phosphate
DC	Direct Current
FAO	Food and Agricultural Organization
FFS	Farmer's Field School
ERO	Education Review Office
FSM	Feces Standard Money
GDP	Gross Domestic Product
GoN	Government of Nepal
HOTS	Higher Order Thinking Skills
IBL	Inquiry Based Learning
IC	Integrated Curriculum
ICT	Information and Communications Technology
IPM	Integrated Pest Management
KU	Kathmandu University
KUSOED	Kathmandu University, School of Education
LDC	Least developed country
LOTS	Lower Order Thinking Skills
MoAD	Ministry of Agriculture and Development
MOE	Ministry of Education
MoEST	Ministry of Education, Science, and Technology
MPhil	Master in Philosophy
NASA	National Assessment of Students Achievement

nCOV-19	novel Coronavirus
NMBU	Norwegian University of Life Sciences
NORHED	Norwegian Programme for Capacity Development in Higher Education and Research for Development.
OECD	Organisation for Economic Co-operation and Development
PAR	Participatory Action Research
PBL	Problem Based Learning
PBL	Project Based Learning
Ph.D.	Doctor in Philosophy
PGR	Project Green Reach
PH	Percentage of Hydrogen ion
PTA	Parents Teacher Association
SDGs	Sustainable Development Goals
SGC	School Gardening Club
SLC	School Leaving Certificate
SMC	School Management Committee
SMS	Short Message Service
STEAM	Science, Technology, Engineering, Arts, and Mathematics
TLT	Transformative learning theory
TPD	Teacher Professional Development
TU	Tribhuvan University
UNESCO	United Nations Educational Scientific and Cultural Organisation
USSGA	United States School Garden Army

CHAPTER I
SETTING THE CONTEXT

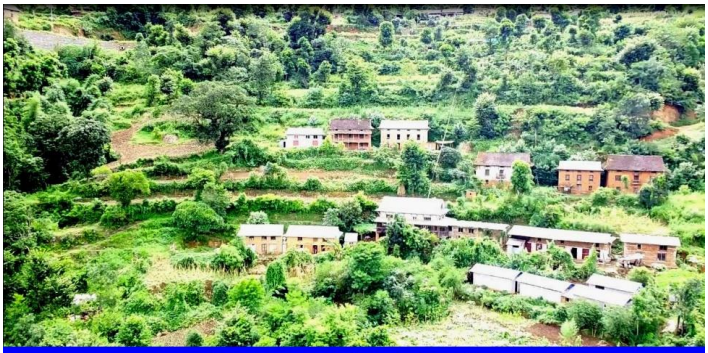
In this chapter, I discuss my home and surroundings, my early school, my experiences as a teacher and school gardening as STEAM pedagogy for setting the context of my study. With these backgrounds, I make my personal and professional stand points to delve into my research space by bringing school garden as a desirable source of STEAM pedagogy. Then, I mention the statement of problem, research purpose, research question and significance of the study to enlighten my readers on my work.

My Grandfather: A 'Real' Teacher

I spent my early childhood in a remote village of Kavre district called Birta-Deurali, roughly 70 KM east from the capital city of Nepal. Our family economy was largely sustained by traditional art of agriculture and animal husbandry. Most of his time, father spent serving in public sphere as agricultural technician through government organizations thereby leaving me mostly in a company of mother, grandparents, uncle and aunts in a joint family. During my early childhood, I used to play a role of caring and counting cattle in order to assist my grandfather's schedule. There was a separate habitat for large flink and flock of cattle and birds that were more than hundred in number and grandfather was in-charge of them. I being the youngest member of family was willing to join his company as grandfather was caring me all the time. My duty was to release goats from goat pens in morning and enclose them back in late-afternoon after they return home from open grazing in Jungle. In the meantime, I had to give considerable attention to counting goats, verify their exact numbers and report back to grandfather with precision. I had seen many times grandfather speaking aloud in a rhyme (eg. *Rama, duna, traya, chatwar, pancha, shat, sapta astha etc.)* while counting cattle and

Figure 1

The Landscape of Birta-Deurali



My home and surrounding

birds. It was a sheer joy and fun to be able to retrieve and count dozens of goats at the age of four. It was for our (me and my grandfather) symbiotic benefits that learning to count digits and writing letters began before the onset of my formal schooling. Early childhood attention was captured by gardens and agricultural farms surrounding my house. I loved playing with muds and vegetation. I liked counting flowers and leaves. Though my mother was not always happy to see me engaged in the fields for a reason that I come home with dirty hands and cloths, but I was intrigued and challenged by seemingly nonacademic task like this.

Classroom Devoid of 'Cattle'

While reflecting upon my basic schooling, learning science and mathematics in my early years was summoned up with complex experience of emotions. Grown-up in the Brahmin culture, the pursuit of knowledge became a fundamental and primary requisite of my upbringings. At the age of three, I was admitted in a primary school which was around 10 minutes of walk from home. I was happy to learn counting digits with grandfather rather than from school teacher since it was amusing to learn numbers while rearing and counting cattle and birds in field. Contrary to it, my primary mathematics classes were devoid of goats and hens. All I did was read digits aloud with teacher and wrote them several times in blackboard and paper. Every time I learnt memorizing digits forcefully from school teacher it released stress hormone which was later compensated being in a company of grandfather and cattle. The company of grandfather and cattle was accompanied with freedom to learn as I could roam freely in my own world of imagination. Most of the time, my childhood memoirs were filled with question such as why my grandfather don't come in the classroom and teach me to count digits but only teachers who didn't care me at all. However, there was no any place for imagination and sharing my social and cultural experiences while making meaning of digits inside the classroom. Research demonstrates that more than at any other point in infancy and adulthood, the early years are crucial for the development of healthy brains and well-rounded personalities (Goouch, et al, 2003). Building contexts, making meaning and deepening my understanding of digits were a far cry in my primary schooling. Gradually I began to sense that from its early days the world of digits was detached from my cultural reality. I realised that subject such as science and mathematics was not contextual rather it was made a foreign subject (Luitel, 2009).

Upon the completion of grade three, mathematics took a more strange turn from 'Grandfather's *Mathematics*' to '*Teacher's Mathematics.*' To my surprise, the start-up culture of mathematics teacher in the new class of the new academic year revealed three different and new courses of mathematics, viz. arithmetic, algebra and geometry. I was afraid with the depiction of these dominant images of mathematics curricula that perpetuate a mono-cultural worldview in Nepali classrooms—curriculum as subject matter, discrete tasks and concepts (Schubert, 1988). Now, I was not in a state of thinking, imagining, talking and sharing ideas of mathematics with friends and family as the curricula was departing away from my realities. Once and for all, this notion of mathematics hijacked the emotional bonding and harmonious mathematical communication with my beloved grandfather. As teacher demonstrated the rule using an example, I had to work through 5 to10 questions of a similar type and then he introduces the next rule and then repetition. I could not find any passion in learning mathematics; it was a 'death' to my passion. Teacher's ultimate focus on procedural knowledge rather than conceptual knowledge (Rittle-Johnson et al., 2015) was absurdly proving absolutist solution of a problem. The situation of science was also not much different from mathematics. Many times I felt why Teachers' cattle were very different from cattle at my home. They were boring as they don't play with me. But, my cattle were very loving and kind alike grandfather. The most disgusting episodes in my learning was that rather than raising curiosity via experimentation and project works, teachers were more guided from lectures in classroom.

In secondary level, I was introduced with optional mathematics, a subject made for so called 'sharp minded student'. Teacher introduced the subject with trigonometric ratios along with dozens of formula. And soon I was assigned to memorize them in the very next day. Being unable to recall so called 'assignment' (list of formula) simply means that the learner is incapable to make knowledge or is intellectually dull. In such situation, the immediate response of teacher would be to make me fell less worthy than chicken by enforcing to act in a posture apparently like chicken, which is also a kind of severe physical punishment. My classrooms were devoid of any variations in practices while teaching and learning disciplines like Mathematics, Science, Nepali, English, and Social Studies – solely making them decontextualized and non-viable. A beautiful quotation reflects beauty and meaning of the present moment as 'Today is the tomorrow you thought on yesterday' (Dale Carnegie, 1936), but hardly had it been internalized in my classrooms.

Education, according to Gigliotti (1998), is “a means of providing an environment in which students feel absolutely compelled to become involved in the creation of their future by understanding how important they are to the present." Rather than becoming involved in architecting my future, I was afraid to try anything new in my classroom because of pedophobia. Thus, I was not able to create anything original; literally I was in a kind of cognitive paralysis. At this stage, a question recurrently haunting my mind was: *why I am learning all these diverse forms of disciplines that have seeming no relationship with life I am living?*

What If I Use Acid Other Than Hydrochloric?

With burning desire to provide ‘better’ school experience, my parents with their utmost available resources admitted me in a community school at district headquarter. It was a canicular day of summer in the year 1997. Science teacher enters inside our classroom with a book, few chalks and a duster. With a scanty background of hydrogen gas (H_2) he wrote down formula for laboratory method of preparation of the gas. It was:

$$\mathbf{Zn + 2HCl \rightarrow ZnCl_2 + H_2}$$

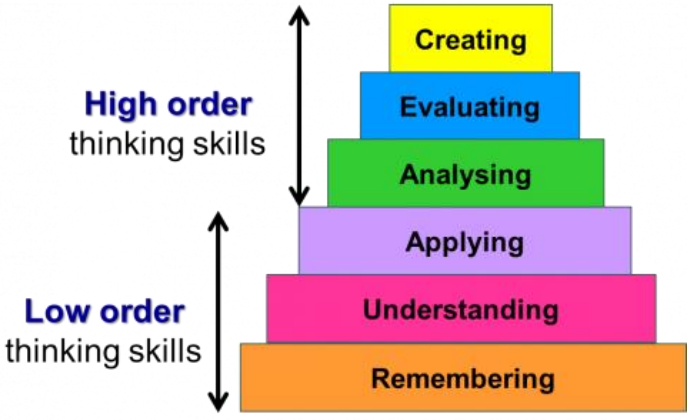
Teacher made no mistake in writing the chemical equation as it was one and same in my textbook. Then, he began to explain why and how reactants (zinc and dilute hydrochloric acid) were use during the process of preparation. At the meantime, my cognition was simplifying by generalising the undergoing chemical process as: “acid reacts with metal to give hydrogen gas.” I contented for able to generalise reaction in easier way. Then, I dared to ask with science teacher, what if acid other than hydrochloric was used in the process of preparation? With deafening voice, he said, “come out from bench”. I felt that I might have done something wrong by asking question with teacher. I felt alarmed. While I approached near to the teacher, he went ballistic and slapped me for raising a question, most probably-“an ugly question” for my teacher. I was scared and confused in handling the situation as it was completely out of the blue. I noticed that my peers seemed sad to witness such a terror-stricken classroom environment. This is one among many episodes I had witnessed while going through school education. Reflecting over my high school and college science education, I felt leadership as dictating, curriculum as textbooks, teaching as transmitting, assessment as upgrading, and research as proving (Qutoshi, 2016). Research says teaching strategies using social constructivism as a referent include

teaching in contexts that might be personally meaningful to students, negotiating taken-as-shared meanings with students, class discussion, small-group collaboration, and valuing meaningful activity over correct answers (Wood et al, 1995). I think, this is the time to make a paradigm shift from the conventional behavioristic teaching to an optimistic approach, and that teachers need to work collegially towards reconstructing education culture together rather than heroically on their own (Taylor, 1996). At the same time, we need to acknowledge that leadership is more relational in nature, meaning that they work together, dependent upon various factors, and are more interconnected as well (Pant, 2022). With such an encouraging and empowering view of teaching (teaching as liberating), our narratives of teaching and learning would carry insights that could raise pedagogical thoughtfulness (van Manen, 1991) in our readers-teachers and teacher educators and researchers.

Only LOTS Has Damaged a Lot!

As I moved to intermediate of science the situation was more pathetic than high school. Teachers were competent to reproduce their knowledge in front of students but without any flavor of curiosity and excitements in it. The teachers in their poorly ever-longing faces were dominantly rehearsing verbal-linguistic approach as the only way teaching in the classroom. Rather than seeing intelligence as dominated by a single general ability, human intelligence has specific '*modalities*' (Gardner, 1983). And this distinction of variations in intelligence hadn't been yet conceived in my intermediate level. The notes and exercises of lecture failed to germinate a curiosity and hope for the future. I felt that memorizing text and later recalling and retrieving them were killing my innate abilities of creativity and innovation. I was forced to exhibit only lower order thinking skills (LOTS) i.e., '*remembering and reciting*' only as suggested in Bloom's revised Taxonomy of education (Anderson & Krathwohl, 2001).

Figure 2
Bloom's Taxonomy: LOTs and HOTs



(Source: **https://mayoazamacona.wordpress.com/2014/11/02/blooms-taxonomy/**

Lately, I came to realize that this chalk and talk approach of teaching science and math was not only paralyzing my cognitive skills but suicidal for teacher and nation in a greater sense.

While reviewing human civilization from its pre-historic era to modern age, I found education playing a major role. What led hunting-gathering human to reach today's techno-innovator *Homo sapiens* is markedly because of the gradual innovation and development in the education system.

Education has fostered veracities of extraordinary abilities such as critical thinking, effective problem solving skills and many more.

Life Is Like a Boomerang!

A famous story-teller Paulo Coelho said elsewhere that "life is like a garden, you reap what you sow." My early teaching experiences were alike to the approaches used by my school and college teachers. They were more concerned at LOTS. I started teaching with the same chalk and talk approach as predecessors. Reflecting over the back, I felt sorry with my learners as classrooms possess rarely any space for creativity and innovation during my teaching. I was more alike sage on stage or seemingly like a commander in a battalion who knows how to go ahead but doesn't care what others are going through. My classroom had limited or almost no space for sharing others' experiences or learning by doing. Learning by designing projects and reflecting over the problems or any issues were barely incorporated in my lesson plan. I used to believe that memorization and revelation of facts and figures was an only way out for learners. I felt that life is just a boomerang; whatever was thrown out eventually came back to me. While I became habitual in more than a decade long teaching practices, slowly I started to question myself on: *rather than teaching did I ignite higher order thinking skills (HOTS) in learners? Am I preparing students to think, analyse and discover any potential solution for contemporary challenges of their time? Did my teaching enrich their heart with love and compassion the world needs for its sustainability?*

Gradually, I started to ponder and reflect on contemporary local and global issues related with developments, our role in national and global economies, impacts of cultural variations on education, environmental crisis and sustainable developments etc. Later, I realised that solution for solving these contemporary global issues lies in educating young people with inter-disciplinary and trans-disciplinary abilities for

reconciling these global conflicts. And it entails immersing them in transformative learning experiences that teach them how to reflect critically on their valued beliefs and mental habits. Also, it helps to engage empathically in realistic ethical decision-making situations, reflect on their spiritual connection to nature, and develop their moral agency for making the world a happier and healthier place to thrive (Taylor & Taylor, 2019). And, as we emphasize on learner rather than the subject or teacher, learners needs to be involved in the curriculum process and the curriculum needs to be developed in a culturally inclusive and participatory way (Luitel & Taylor, 2006). Therefore, Learning as a cultural meaning making requires us to preview the landscape of '*transformative pedagogy'* (Freire, 1993; Taylor, 2004). With these frame of references, a question inquiring my mind is: *how can the mindset of our educators who are undergoing through decontextualized and culturally non-inclusive curricula be transformed?*

STEAM Education: Exploring a New Dimension

In this section, I discuss about STEAM education and school gardening as one of the dimension of STEAM education. During two phases of my learning experiences, i.e. first as a school and college student and second as a teacher, I shared many problems of our education. Major among them are the decontextualized and culturally non-inclusive curricula (Luitel 2009, 2013, 2019), subject-centric pedagogy and behavioristic approach of teaching (Lawrence, 2007). To solve these problems, efforts have been made worldwide in connecting various disciplines and develop Science, Technology, Engineering, Arts and Mathematics (STEAM) based approach in teaching and learning. While announcing "The second basic plan to foster and support human resources in science and technology (2011-2015)," the Korean government has continually emphasized STEAM

Figure 3

STEAM Education

Source: **https://www.steamtruck.org/blog/steam-education-history-importance**

education policy (Hong, 2017). Students are encouraged to work on challenges from the actual world as part of this integrated, interdisciplinary learning method. And the issues are resolved by applying the knowledge of science, math, engineering, and technology in a unique (i.e. artistic) approach. This STEAM based approach of learning is being used inside the classroom but what if we use the same approach in different settings – In School Garden? This research is an approach to bring STEAM education outside classroom where learners are prepared as per the necessity of Nepalese society considering broader democratic values.

School Gardening as STEAM Pedagogy

Numerous research have undertaken on the relationship between school gardens and academic performance in learners. Research showed that garden component measured academic outcomes; showed improvements in science achievement and in math scores as well (Berezowitz, Bontrager & Schoeller, 2015). Skelly & Bradley (2007) have found that learner's involvement in school garden have enhanced sense of responsibility and also positively affected their attitudes towards learning science and various environmental aspects. A number of academic studies support the idea that garden-based learning gives participants a sense of belonging and improves educators' cultural sensitivity. Gardening has been considered as a seed of learning various skills and disciplines. Supported by various empirical evidences school gardening has been in focus of numerous schools from early education.

School gardening has explored veracities of intelligences in pupils. According to Miller (2007) "gardening has enabled students to communicate about their world, through verbalization, showing, drawing, and/or writing. Besides this, students exhibited various emotions related to garden experiences, including feeling more connected, taking risks, developing self-confidence, and mastering their fears. Also, many important skills were developed, such as visual-spatial, language, science, math, body awareness, interpersonal, and intrapersonal skills."

In a research work undertaken at central part of Nepal, researchers (Acharya et al., 2022) said that, "……. students learned real-world science applications by measuring plots and recording the growth of plants. As they worked with the collaborative inquiry, they learned to care for living things; developed necessary discipline and collaborative life skills such as patience, responsibility, cooperation and understanding. Science teachers believe that the gardening program helps to learn

science through the meaningful engagement of students in activities…science teachers linked the curriculum in an integrated approach with gardening activities."

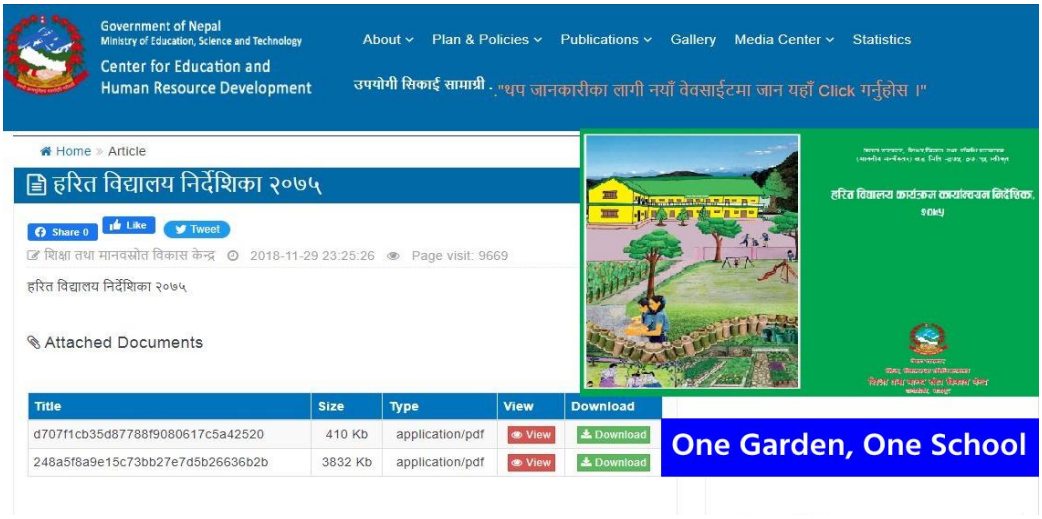
Also, if we could utilize school gardening to include scientific, mathematical, engineering, and technical information in a creative (i.e. artistic) approach, it may bring fresh light to teaching and learning and inspire students to work on challenges from the real world. Therefore, in an attempt to understand real-world problem of our curricula being decontextualized and culturally non-inclusive, my research work on "Use of school gardening as STEAM pedagogy" might add some elements to it.

Green School Guideline – "One Garden, One School"

With the notion of *One Garden, One School*, the eight-part guidelines onset new discourse in our education system which remarkably broadened our purview of classroom. And, later in the year 2020, Curriculum Development Center (CDC) under GoN introduced Integrated Curriculum (IC) in school education and started implementing integrated teaching and learning in all grade levels. An important aspect of green school guideline is that with collaborative functioning of students, teachers, parents and community members, it envisions transforming community schools into a "living laboratories".

Figure 4

Displaying Green School Guidelines in Government's website



(Source: www.doe.gov.np)

In the year 2018, the Ministry of Education, Science, and Technology has unveiled the first Green School Guidelines in the nation in an effort to make schools eco-friendly places (MoEST, 2018).

Though, teacher educators and policy experts viewed the Green School Guidelines and *One Garden One School* implementation strategies positively (Acharya et al., 2019), the successful execution of such policies require strong collaboration within stakeholders.

With the support from NORHED 'Rupantaran' project run under Kathmandu University School of Education (KUSOED), this research aims to bring all stakeholders (students, teachers, parents and community members) at a common place (school garden) for a period of one academic year and facilitates in transforming policies into practice. With experiential learning as a basic principle, a new dimension of STEAM education is explored considering school garden as a pedagogical resource.

Problem Statement

National Assessment for Student Achievement (NASA, 2013) stated that the national average score for science and mathematics in class eight is 31 and 35 respectively, and this is comparatively lesser than that of 2011. A recent study on national assessment result showed that more than 70% students in Mathematics in grade 5 have achieved only below 28%, and 55% of the students do not have adequate knowledge and skills in Nepali subject (ERO, 2019). Furthermore, the students' ability to solve complex problem is low, only 21% of the maximum scores were reached. Students are much better in the recalling type of questions (68%). Also, majority of failing students in School Leaving Certificate (SLC) examination belong to science and mathematics. Different results and researches have shown that number of students taking science and mathematics major (both in education and science faculty) in higher level is in decreasing tendency, not only in Nepal but throughout the world (Wilson & Mack, 2014). All these signify that government's plans and policies mainly for science and mathematics education are either insufficient or going in a wrong direction. At this crucial moment, there exist questions that need to be reflected upon, such as: does our pedagogical compass aligned in right direction? Do our policies reflected well into practice? Indeed, this is urgent for transformative practioner in the domain of science, technology and mathematics education to reflect and review policies and practices.

Our pedagogy is guided by chalk and talk approach dominantly using text-books. In such, it may be inappropriate to talk about the material equipped science and mathematics classroom, and activities enriched teaching methodologies in the class. In a situation where subject teachers are profoundly lacking in both public and private

schools, it is inappropriate to expect well-trained teachers and well-equipped classrooms. As long as classrooms uses didactic approaches focused towards reproduction of knowledge, it is unlikely to expect pedagogical improvements. Thus, at present, it seems more relevant to think of integrated pedagogy where disciplinary borders are blurred with tremendous abilities to connect concepts to the real-world problems with STEAM-based approach. And, following the literatures on school gardening, it can be said that school gardening would be a more relevant pedagogical approach/ tool to make learners more engaged while valuing their own context and values.

Purpose of the Study

The major purpose of this research is to explore school gardening as STEAM pedagogy in a context of a public school situated in a semi-rural setting.

Research Questions

As this study is focused on exploring STEAM pedagogy at the basic level, the purpose of the study guides me to address the following research questions:

1. In what ways does teachers and students work towards contextualizing curricula through school gardening?
2. How does school gardening evolve as a pedagogical model in STEAM-based learning?
3. What are the prospects and challenges to implement school gardening as STEAM Pedagogy?

Significance of the Study

This research work is an attempt to ‘rescue’ learners from the traditional notion of classroom where they construct their own realities by confronting with real-world challenges. They will not only focus looking in ‘front’ of the classroom but look in ‘every direction’ of the garden and more importantly look ‘beneath’ their own feet for their independence and interdependence with nature. And, in doing so learners discover their own ‘music’ that bestows the melody of their own culture and context. Therefore, this research could be significant to teacher and teacher educators who takes similar pathways in finding their limitless joys of ‘karmas’ in teaching. For the researchers, policy makers and even for educational resource developers this research work on school gardening could add an excitement by cautiously helping them to unravel the ‘missing link’ in their discourses. Also, for all those who are involved in teaching STEAM disciplines by integrating creative ways (arts) in STEM subjects, it

helps to explore new vistas by synchronising affective and cognitive domain. This research can be useful for students who are collaboratively learning science, mathematics and other activities which integrate various disciplines. The stories we uncover herein might help curriculum developers, text-book and reference-book writers ranging from the federal to the local level to design their activities. It certainly helps them to employ and support interdisciplinary and inquiry based educational practices. Likewise, for the participatory action researchers and others who work in area of professional development of teacher, it can be important eye-opener. As researcher undertake challenges of farming in a sloppy terrain (24%) developing autochthonous way of fertilizer and watershed management, thus this research might prove helpful in the areas of natural resource management, environment conservation and agriculture. The journey we made during absolute darkness of pandemic can release adrenaline into the blood vessels of learners which might strengthen their excitements. Lastly, our stories about integration of artificial intelligence in school gardening can be helpful for those who realise its potential in transforming today's society by harnessing 21st century skills in our learners.

Organization of the Chapters

This section gives an overview of the dissertation chapters. While arriving at the end of the first chapter, "setting the context" we come upon introduction, problem statement, purpose of the study, research question, significance of the study, and delimitation of this research work. In chapter two, we have re(viewed) literatures on curriculum integration in the light of STEAM education. Research regarding school gardening along with theoretical literature is presented followed by research gap. These literatures give an insight about genuine attempts and activities ongoing in the areas related with research question. Chapter three is the backbone of this research project, and shares research legitimacy incorporating philosophy, design, paradigm, and process of the research along with ethical considerations.

The chapter four displays all the preparations and arrangements we made before the beginning of gardening phase. They include narrations related with our team's effort in finding suitable land, land preparations, construction of eco-san, and water management system (pond and CCTs). Gardening activities regarding construction of polyhouse or grow tunnel, designing research plots, seed sowing, plantation, fertigation along with pest management are organized in chapter five. The narration portrays our working with teacher, students, and community people. Moving

further, chapter six explores on how we connected school gardens with the local markets. Integration of artificial intelligence (AI) in the school garden along with STEAM projects designed by teachers is also included in the chapter. In chapter seven, we present results of this research endeavor and discus school garden as a pedagogical model. And, finally the eighth chapter consists of my reflection of being a participatory action researcher. To this, readers can also find conclusion along with various implications of this research.

CHAPTER II
LITERATURE REVIEW AND THEORETICAL DISCUSSION

In this chapter, readers can delve deeper into how various disciplinary worlds align together to solve the real-world problems in the school education. For this, I have proceeded through series of literatures that might enable readers to dissolve their mind-set accompanied with 'disciplinary egocentric classroom' and prepare them to land in unchartered territory of school garden. Dear reader, for this journey, a real start would be to recognize and ponder upon following two basic questions: Who am I? And, why am I reading this paper? As you are going through this research work, I suppose, you may be a teacher, teacher educator, researcher, policy maker, reformer etc. And, you have desperate desire to bring reform in school education or may at least know illnesses in our ongoing educational practices. Thus, I am unfolding research journey further with an assumption that you are clear in your purpose of reading it. Similarly, shall we look consciously into why our curriculum is not sufficient to address contemporary issues and challenges? Or, is integrated curriculum well enough to address our challenges?

In coming sections, I discuss why we require integrated approach of teaching and learning, then mention various literatures on STEAM-based approach and, finally take my readers into the world of school garden that are designed collaboratively by stakeholders with an aim to understand and solve real-world problems.

Integrated curriculum (IC) may mean different for different scholars. Simply speaking, it is about linking one feature of a topic to another discipline so as to address a real-world challenge. According to Jacob (1997) an integrated curriculum is a form of curriculum mapping that allows horizontal and vertical integration of concepts. By cutting across the subject matter and unifying the concept, IC works. When an integrated curriculum is employed, the study reveals that learners become more engaged and involved in the learning process. According to Beane (1997), an integrated curriculum is an approach that uses student's questions to generate curriculum. It is often associated with finding real solution for real problems. Integrated curriculum is a much discussed issue among educators in Nepal and has been considered as common method of curriculum development in basic education. With a motive of making learners more engaged and involved in the learning process

(CDC, 2020), using the Integrated Curriculum (IC), CDC under GoN began implementing integrated teaching and learning across all grade levels. The way curriculum has been integrated is based upon the theme or topic. Our curriculum integration is much guided by the four characteristics of integration as suggested by Beane (1996):

1. The curriculum needs to be structured around issues that are significant to individuals and society as a whole.
2. Without taking subject lines into account, it should employ appropriate information in the context of the issue.
3. Instead of for a test or grade, it should employ a current situation, and
4. The emphasis should be on tasks and activities that apply knowledge and analysis to real-world situations.

Now, I discuss how integrated teaching and learning can be developed using a multidisciplinary approach of Science, Technology, Engineering, Arts and Mathematics (STEAM) education and how it aligns within Green School guideline (MoEST, 2018).

STEAM: An Approach to Curriculum Integration

As we know that STEAM is the acronym for integrated approach of learning Science, Technology, Engineering, Arts and Mathematics. In order to better understand STEAM, let us delve into each subject domain.

Science deals with and seeks the understanding of the natural world (NRC, 1996), and is the underpinnings of technology. Science is very concerned with what is (exists) in the natural world. Science seeks out meaning of the natural world by "inquiry," "discovering what is," "exploring," and using "the scientific method."

Technology, on the other hand, is the modification of the natural world to meet human wants and needs (ITEA, 2000). "The goal of technology is to make modifications in the world to meet human needs" (NRC, 1996). It is very concerned with what can and should be (designed, made, and developed) from natural world materials and substances to satisfy human needs and wants. Some processes used in technology to alter and change the natural world are: invention, innovation, practical problem solving and design. UNESCO (2018) has argued that the 2030 Agenda for Sustainable Development recognizes that the prevalence of Information and Communication Technologies (ICTs) has a significant potential to accelerate progress,

to bridge the digital divide and support the development of inclusive knowledge societies.

“Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind” (Accreditation Board for Engineering and Technology [ABET], 2002).

“Mathematics is the science of patterns and relationships” (AAAS, 1993). It provides an exact language for technology, science, and engineering. Developments in technology, such as the computer, stimulate mathematics, just as developments in mathematics often enhance innovation in technology.

Now, the pivotal question that arises before us is what is Arts? Why and how is it used? Actually, an art is a way of expressing STEM discipline. In general, it is commonly understood that the contributions of the arts (such as employing poetry, tales, and artwork in teaching and learning) are not well acknowledged in the fields of math and science. (Pant, 2015). It cannot be under looked because it might be a reason for ongoing crisis in our school education system.

As a way of exploring curriculum links between Science, Technology, Engineering, Arts and Math, an integrated STEAM curriculum collaborating with the STEAM subject teachers and focusing on solving real-world problem in a social context is required. A more engaging curriculum would thus be driven by the experience of the students and the teachers' implementation in the classrooms as a result of this integrated approach.

Learning through STEAM

With STEAM pedagogy learning will predominantly focuses on major survival skills for the twenty-first century such as critical thinking and problem solving, collaboration across networks, communications, curiosity and imagination. The project will be focused on a real-world issue and involve genuine practice, putting students in circumstances that are real to them, their lives, and also presenting them with challenges they may meet in the workplace. It is intended that this research project will foster some "authenticity". In the process of developing useful learning outcomes, the project-based and problem-based learning will enable students to integrate skills and knowledge from a variety of sources. Additionally, it makes learners more autonomous through taking heightened responsibility towards their work.

Frankly speaking, as we make students to become autonomous, i.e. learn to plan, investigate and engage in their own learning, then the objective of STEAM education shall remain almost fulfilled. Nevertheless, STEAM-based approach of teaching and learning should enhance day-to-day activities of teachers which will help develop better STEAM curriculum by enhancing teacher performance in the project-based and problem-based activities. Therefore, our involvement in STEAM-based learning should certainly encourage learners to 'create and do' rather than just 'know and understand'.

School Gardening as STEAM Pedagogy

School garden, in my research is taken as an approach of teaching curriculum through which learners at a young age learn to inquire various subject disciplines. If we trace the history of School gardening, many literatures suggest it from the time of World War I where in order to change the American food system, the United States School Garden Army (USSGA) and National War Garden Commission promoted both school and home gardens. (Hayden-Smith, 2007). During this era, gardening was celebrated as a national priority. These projects were so successful that they actually caused local agricultural markets to decline in several regions of the nation. But, once a part of the nature study movement was no longer a national priority, the USSGA dismantled shortly after armistice.

In various contexts, school gardens were utilized for various objectives. There is no unanimous view about 'garden' as it is perceived differently in different context and culture. Gardens in Asian schools were used to provide food and "build character" rather than as a nature study educational tool whereas African-American students were more likely to grow up in rural areas, hence agricultural methods were predominantly taught in African-American school gardens (Kohlstedt 2008). Many attempts have been made on integrating school garden in the curriculum. It is obvious that gardening provides students with opportunities to interact with nature on a personal level that promotes positive behavior changes (DeMarco & et al, 1999). Also, When used as a teaching strategy for interactive, hands-on lessons, school gardening may be a great tool, and can be the key components of experiential education for lifelong learning skills, such as problem solving and critical thinking. Through the school gardening, teachers can rationalize what the STEAM subjects contribute separately to the curriculum and how they relate to each other at the basic level. Also, our engagement in this relatively newer discipline helps us to describe and

evaluate different curriculum models for STEAM which in turn enables us to develop an assessment strategy as well as a critical approach to the pedagogy of the classroom, laboratory, workshop and training.

This widening approach of School gardening as STEAM pedagogy might prove as an essential feature at school education. It might realign the compass of our educational discourses in the right direction by contextualising our curricula. In addition, teachers need to demonstrate how arts education serves as a nucleus for creativity and innovation, which in turn fosters new enterprise that will form the foundation of our country's economic prosperity in the future.

Place-Based Pedagogy

Being inside a classroom or in school garden is a completely different experience for me. It does not take long time to realise the power of place in our life. Some places make us feel more vibrant and meaningful by (re)collecting positive experiences of self and the world and vice-versa. There have been numerous discourses and literatures regarding significance of 'place' in developing learning attitude. A pioneer researcher and environmentalist, David Sobel (2004) defined place-based pedagogy (placed-based education) as, "…..the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science and other subjects across the curriculum. Emphasizing hands-on, real-world learning experiences, this approach to education increases academic achievement, helps students develop stronger ties to their community, enhances students' appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens. Community vitality and environmental quality are improved through the active engagement of local citizens, community organizations, and environmental resources in the life of the school."

School boundaries as a place remained largely time disciplined, where students were controlled by the daily rhythm of school routine, clock needles and bells (Holloway & Valentine 2003). Thus, school placed itself as a 'closed place' to live and learn. And, this notion of 'closed place' finally transformed into place-based pedagogy that seeks to connect local ecological, cultural and historical contexts in which schooling itself takes place (Elfer, 2011). In the perspective of contemporary place-based educational thought, Dewey's impact is especially relevant since he frequently stressed localized instruction as well as the requirements and characteristics of the

learner. Moving back to the time, one can discover *Gurukul* educational practices arising from the teachings of Vedas and Buddhist teachings where learning would take place in an open space, where everyday life skills were the curricular domains (Wagle, 2021). Either ancient or the contemporary form of place-based learning might promote learners agency by tailoring learning in accordance to their needs and capabilities. Also, place-based pedagogy could offer veracities of elections in determining where and what learners mastery about.

Sustainability and Gardening

The idea of sustainability is becoming relevant in the era where world need genuine initiations to mitigate both local and global challenges. We are aware that larger issues of sustainable development includes loss of biodiversity, climate change, over-exploitation of natural resources, unemployment etc. Therefore, sustainable development urgently requires transformative shift in our perspectives to look at these burning issues, and for this an education guided by comprehensive understanding of these issues is essential. Education plays a crucial role in sustainability processes (de Haan, 2004, as cited in Michelsen & Fischer, 2017), and without altering the way we learn, sustainable progress will not be feasible (Vare & Scott 2007). Now, a fundamental question is, do school gardening addresses the issues of sustainability or do gardening facilities learning process?

Though research linking on garden and sustainability is scarce, but we agree that education should foster deeper understanding of concerns pertaining to society's sustainable development and the development of skills that enable people to take part in developing novel solutions to the economic, social, technical, and cultural difficulties endangering the planet's ecology. (Michelsen & Fischer, 2017). In this regards, School gardening being an aspect of place-based pedagogy shall remain significant in recognizing and addressing local and global challenges. Experiential, place-based learning, according to research on environmental education, raises test scores across the subjects. (State Education and Environment Roundtable, 2000; Bartosh, 2003). Moreover, environment-based education has been linked to increases in math proficiency, standardized test scores, and school attendance while lowering the amount of student expulsions, referrals, and suspensions (Louv, 2005). Besides this, a study of seven researches on specific school gardens by Blair (2009) reveals that all of them found that students who gardened had better attitudes toward learning and took greater satisfaction in their work. According to a research on Los Angeles school

gardens, out of 84 schools examined, 52% presently have gardens, 33% have never had gardens, and 15% formerly had but later abandoned them. Teachers being overworked, a lack of funds, and a loss of space were the three most often cited reasons for discontinuing the garden programs (Azuma et al., 2001).

Connecting gardening with multiple facets of sustainability (such as social, ecological, economical etc.), use of ecological sanitation (eco-san) can be a new approach. In our context, Devkota, Pandey & Maharjan provided interesting insights in use of eco-san toilets where they presented human urine as a source of fertilizer (Devkota et. al, 2020). Moving further, this perspective of looking at gardening in school environment would unlock many viewpoints and curiosities in understanding what sustainability is and should be. Urine being an animate by-product is a rarely used local resource. Practice of putting human waste such as urine as a source of fertilizer might onset a new journey of educational discourse where local and more convenient way of looking at sustainability would invent solutions to our many contemporary issues. Primarily, eco-san mediated school garden could be a wonderful initiation to produce food from organic fertilizers thereby contributing to sustainability. Thus, if we could work in the sustainability of school gardens, they would in turn harbor to solve many of the social, ecological, and economical problems.

Digitalizing Human Waste: feces Standard Money (fSM)

Rather than contaminating the nature, human waste, which many people considered useless, has been taken as a basis of new currency system in one of a South Korean university. In an attempt to convert feces into compost or energy, Professor Jaeweon Cho came up with an idea of feces Standard Money (fSM) where feces produced by one person in a day is considered as 10 “Ggool” (Science Walden, 2023), . And, “Ggool” as a unit of fSM is used to determine the value of other essential goods such as a meal, vegetable, a book, and a coffee or even public transportation system within university ecosystem. Working under a notion of Science Walden with active educationist, scientist and artist, Prof. Cho has hoped that this new approach of sustainability will help to overcome many our social, ecological, and economical issues. Thus, human waste could be considered as a potent resource and medium to connect schools garden with our communities in a more sustainable way.

Experiential Learning: John Dewey

As a novel participatory action researcher, I take some theories as a referent to guide my entire research journey. Among many, I find that experiential learning theory is more significant to unlock the secrets of adult learning. An American Philosopher and Psychologist, John Dewey (1859-1952) in his book Experience and Education (1938) expressed his ideas that curriculum theory need to have experience as central in the educational process. Dewey left behind a legacy that is important for contemporary place-based educational thought since he frequently stressed localized instruction and the requirements and characteristics of the learner.

Dewey believed that the learner should be seen as an active participant rather than as a passive recipient of information and that they should really serve as the foundation for the curriculum-setting process and the process of education itself.

In his famous book, 'School and Society', Dewey wrote "……..a revolution, not unlike that introduced by Copernicus when the astronomical center shifted from the earth to the sun ...in this case, the child becomes the sun about which the appliances of education revolve; he is the center about which they are organized." Dewey argued, in conclusion, that educational programs must be created with a significant consideration for the learners they serve. Dewey was not just a supporter of child studies, and his justification for putting the young learner close to the heart of the educational process stemmed from his theory on the nature of learning.

In How We Think (Dewey, 1933), he said "Thinking begins in what may fairly enough be called a forked-road situation, a situation that is ambiguous, that presents a dilemma, that proposes alternatives….In the suspense of uncertainty, we metaphorically climb a tree; we try to find some standpoint from which we may survey additional facts and, getting a more commanding view of the situation, decide how the facts stand related to one another." He essentially emphasized that there must be a problem present for learning to take place, for the student's experience to be expanded, or for thinking to be sparked. Literatures have suggested that School gardening provides many "forked-road situation" and creates dilemma, confuses learners but this is the place where learners enables and positioned themselves as bigger than their problems.

In his book The School and Society, Dewey says "…we cannot overlook the importance for educational purposes of the close and intimate acquaintances got with nature at first-hand, with real things and materials, with the actual processes of their

manipulation, and the knowledge of their social necessities and uses." Dewey used the ordinary activities of life as a foundation for setting up the meaningful, experiential classroom. Dewey discovered the essence of far larger chances for ongoing learning, learning much beyond the activities themselves, inside the occupations (such as sewing, weaving, woodworking, etc.). Dewey discovered the essence of far larger chances for ongoing learning, learning much beyond the activities themselves, inside the occupations (such as sewing, weaving, woodworking, etc.). Even today, Dewey's vision of looking at occupations and learning activities are beyond the purview of many schools. When we say that students should be engaged in activities such as gardening, there were many people who just gave a 'suspicious' look at the things we were doing. They might have thought that engagement in school gardening is just an extra burden for learners and is a waste of resources. But, for them Dewey may sound much unpleasant. Dewey came to a fairly sharp conclusion that, "When occupations in the school are conceived in this broad and general way, I can only stand lost in wonder at the objections often heard, that such occupations are out of place in the school because they are materialistic, utilitarian, or even menial in their tendency…The world in which most of us live is a world in which everyone has a calling and occupation, something to do." With Dewey's perspective mind, it is certain that school gardening can be excellent tools to learn and relearn basic education in Nepal.

Finally, regarding the place-based pedagogy what Dewey said is eye-opening to all. He remarked that, "The lack of any organic connection with what the child has already seen and felt and loved makes the material purely formal and symbolic…The genuine form, the real symbol, serve as methods in the holding and discovery of truth. They are tools by which the individual pushes out most surely and widely into unexplored areas. They are the means by which he brings to bear whatever of reality he has succeeded in gaining in past searchings. (Dewey, 1938) " Dewey appeared to comprehend that the learner's prior experiences were frequently influenced in those environments near to the school. Place-based educational philosophy was greatly influenced by Dewey's analysis of the interrelationships between the learner, the experience, and the local.

In the book Experiential Learning (1984), David Kolb mentioned four-stage model of learning which is regarded as a foundation for experiential learning. The stage begins with the concrete experience, followed by reflective observation which leads to abstract conceptualization, and finally to the application stage. These four

stages are the different forms of adaptations to reality and I also consider this theory to unlock how I and my co-researcher make learning during school gardening.

Transformative Learning Theory: Research as Envisioning

Transformative learning theory (TLT) engages learners in reflecting critically on the presuppositions underpinning their values and beliefs (Mezirow, 1997, Luitel & Taylor, 2019), whereas undertaking research as/for envisioning and culturally contextualized educational practices help explore researcher and co-researcher's educational practices so as to generate transformative STEAM education (Luitel & Taylor, 2019). With these theoretical referents, I involve myself and call upon co-researchers (teachers, students, parents as well as community members) in research site to make a reflection on the deep-seated and long-rooted underlying beliefs, values, intentions, and attributes (Mezirow, 1997 regarding the school gardening.

A question before us is: How TLT helps in the process of transformation? Primarily, with this theory, we transform our 'taken-for-granted frames of reference to make them more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove more true or justified to guide action' (Mezirow, 1991). Also, transformative researchers 'draw on constructivist, critical, social and arts-based epistemologies to examine reflectively, critically and imaginatively their lived experiences revealing the historical and sociocultural framing of their personal lives and professional practices' (Taylor, 2013).

In this context of school gardening, the four processes of learning, as discussed by Mezirow (1997), are very engaging. The first way, elaborating an existing point of view, allows me to reflect on the assumptions and values inherent/laden in school gardening. The second way, establishing new point of view, creates spaces to critically reflect on the assumptions for better alternatives of school gardening as STEAM pedagogy. The third way, learning to transform the point of view, encourages me and, also motivates co-researchers to amend their beliefs and practices while being engaged in gardening. And, the fourth way, transforming our ethnocentric habit of mind by becoming aware and critically reflective of our activities on school gardening helps both researcher and co-researchers to welcome new insights and thoughts for reshaping our actions and cognition. And, in this regards, transformative learning theory proves to be signficant to reveal why have been promoting culturally decontextualised curricula as well as disempowering practices by questing researcher and co-researchers world views (beliefs, values, assumptions and traditions).

Review of Empirical Literature

Regarding STEAM pedagogy and the possibility of school gardening being one among many dimension of it requires review of numerous research works. Thus, in this section, I thoroughly go through various literatures and their findings to strengthen my research work. Though each of the STEAM subjects (i.e. Science, Technology, Engineering, Arts and Mathematics) have clear differences, but also have a number of common threads, such as communication, problem solving, discovery approaches, direct applicability to everyday life etc. In our context, these giant five ships are passing silently in the night without speaking to each other about their relationships they share in common. People are practicing only to build enough schools but if we look into the curriculum they have already proved to be irrelevant as the school attendance are going patchy and the drop-out rates are huge. A research conducted by ILO (Sarkar, 2004) also highlighted on the relevance of curriculum, needs and values as a major responsible factor for the dropouts in school.

While reviewing researches of our context, science and mathematics curriculum are not only decontextualized, but also disengaging (Luitel, 2009, 2013, & 2019), there is rarely any place for imagination and sharing social and cultural experiences while making meaning of science and mathematics. Research demonstrates that (Goouch, Powel & Abbott, 2003) more than any other period during infancy and adulthood, the early years are crucial for the development of healthy brains and well-rounded personalities. But, one could rarely discover such developments in his/her early education. Here, I am afraid with the depiction of the dominant images of science and mathematics curricula that perpetuate a mono-cultural worldview in Nepali classrooms—curriculum as subject matter, discrete tasks and concepts (Schubert, 1988).

Many researchers (Luitel, 2009; Pant, 2015; Shrestha, 2017) in the areas of school education discussed the various ways for making mathematics and science curriculum more contextual by wisely incorporating cultural heritages of different communities. And, with this being done we can make our teachers and students realise that knowledge we are discussing are from our own communities, and for our communities. Therefore, in order to medicate severely ill educational processes we have to consider learning as a meaning making process as well. Only then, it overcomes culturally dislocated curricula by the enactment of culturally contextualized curricula (Luitel & Taylor, 2005).

While fixing the problem resulted from the decontextualized curricula, attention is given to the competing interest of globalizing economies, diverse cultures and natural environment. These issues can be solved by engaging co-researchers in the transformative learning experiences where they learn to reflect critically on valued beliefs and habits of mind, engage empathically in real-world ethical decision-making scenarios, contemplate their spiritual connection with the natural world, and develop their moral agency for making the world a healthier and happier place to thrive (Taylor & Taylor, 2018). In order to design transformative learning pedagogies researcher (Taylor & Taylor, 2018) suggest that, science education needs to foster interdisciplinary collaboration between STEM and the Arts to create interdisciplinary STEAM curriculum spaces. Furthermore, STEAM approach brings transformative learning by bringing cultural-self knowing (self-realization), relational knowing (opening to difference), critical knowing (political astuteness), visionary and ethical knowing (over the horizon thinking), and , knowing in action (making a difference) (Taylor & Taylor, 2018).

Now, one of the major entry points could be exploring mathematics and science from students' localities, culture and their livings. And, it is obvious that school gardening can be one among many ways since it is locally available and can connect learners with their localities as well. Literatures suggest that the concept of school gardening and its evolution began from the time of World War I. Review of studies, both published and unpublished, from 1990-2010, reported that academic outcomes of garden-based learning is well connected with schools. Of the academic outcomes addressed, science was most common, followed closely by language arts and math (Williams & Dixon, 2013). Moreover, science had the highest proportion (93%) of positive effects, followed by math (80%) and language arts (72%). These researches strongly suggest that garden-based learning has positive impact on academic outcomes of learners (Williams & Dixon, 2013).

While exploring Brooklyn Botanic Garden’s Project Green Reach (PGR) which is an after-school and summer program for students in K-8, researchers (Morgan et al., 2009) came up with following seven themes while observing the participants. Themes include:

1. Learners challenging home and school environments,
2. Increase in academic and interdisciplinary skills,
3. Understanding of science concepts and gardening skills,

1. Environmental awareness and appreciation,
2. Social development and growth,
3. Positive life experience and culturally significant to the participants' community.

> (…….*one mother said about the program that "it turned around her daughter's life; she now loves science; whereas she had been doing very poorly in science she now is top in her class, takes care of the principal's plants and helps the teacher with plant information; she love science." (pg. 47)*

Above themes are clear indications that school gardening (or garden-based learning) can bring more engagement as well as transformation in the learners. Some of the major skills of STEAM approach which are highly sought in our education activities are increase in interdisciplinary skills, social development and growths and these are also manifested through school gardening projects. These researches suggest that school gardening can be one of approach of STEAM pedagogy.

Further reviewing literature on impacts of school gardening in Nepal, researchers (Bhattarai, et al., 2015- 2017) have highlighted that school vegetable gardening is an effective concept to increase knowledge, awareness and preference towards nutrient dense vegetables and their importance in human health. After one year of intervention, researchers observed a substantial ($p < 0.01$) improvement in children's knowledge of fruit and vegetable awareness, as well as their knowledge of sustainable agriculture, food, nutrition, and health, as well as their stated preferences for eating fruit and vegetables. The study involved a total sample of 2060 students randomly chosen from thirty schools in the hills (Dolakha and Ramechhap districts). If we look at the current status of gardens in community schools in other parts of the world, the result is quite progressive. The number of school gardens in California has increased from 13% in 1996 to at least 24% in 2005, and were most common at the elementary level (Graham et al., 2005). The reason or purpose for using school gardening in schools of California included academic instruction (89%), extracurricular activities (60%), and edible produce (39%). They used gardens to teach many subjects, most frequently science (95%), environmental studies (70%), and nutrition (66%). The garden has provided a valuable context to tie in nutrition, math, science, and language arts skills.

In one of participatory action research carried in central Nepal, researcher (Acharya, 2019) found that "the science teachers' positivist congestions were rooted in

the dogmatic approach in chemistry teaching and hinders the eloquent engagement of students in the school gardening activities. Science teachers' belief system enabled researcher to understand the positivist epistemology mindset and transform into play way chemistry learning in the school garden." The PAR undertaken in one of a community school of Nepal showed that "teachers and students enthusiastically appreciated the concept of integrating the school garden for teaching and learning purposes, and to some extent, the lack of guidelines to integrate the courses with the school garden hindered the connection (Baral, 2021)." Now, we require more empirical evidences to undertake school gardening as an approach of STEAM pedagogy and generalize findings in our context. Thus, this research work is intended to work out on several aspects of gardening.

Research Gap

STEAM approach of teaching and learning is on the latent phase of development in Nepal. While reviewing government plan and policies, the integrated curriculum with inter-disciplinary approach of teaching and learning is still in infant stage. At this situation, STEAM education and the probability that school gardening can be one of a dimension of STEAM pedagogy requires more research works. At this moment, few research on school gardening has guided us to move on this unchartered territory. Now, this research work not only bridges the gap regarding school gardening but also explores possible opportunities and challenges on implementing School gardening as STEAM pedagogy at basic level. This research journey enables me to be a transformative researcher and a teacher educator who could realise the opportunities and challenges of school gardening.

Chapter Summary

This chapter began with a discussion on integrated curriculum and organizes literatures regarding various ways of curriculum integration. Curriculum integration has been effective tool where I analyzed how Science, Technology, Engineering, Arts, and Mathematics (STEAM) education has been used to solve the real-world problems. This multidisciplinary approach of learning has been used for different purpose in different settings. Therefore, I discussed various research work carried in context of school garden, and understood that garden-based learning could be a promising pedagogy for harnessing more engagement in learners when incorporated into subject matter.

Research regarding school gardening along with theoretical literature has been presented followed by research gap. These literatures gave insights about genuine attempts and activities ongoing in the areas related with research questions. Furthermore, I learnt that some places could make positive impact in learning by making us feel more vibrant and meaningful. The role of place-based pedagogy in (re)collecting positive experiences of self and the world has undoubtedly embellished importance of school garden. While reviewing literature, I found that garden-based learning has been pivotal in understanding a number of social issues in a more sustainable way. Consideration of human waste as a source of fertilizer shall be a convenient way to begin contextualizing our learning. Some of the theories such as Dewey's experiential learning and transformative learning theory (TLT) of Mezirow has been considered as a lamppost for theoretical orientation to school garden in the light of STEAM education.

CHAPTER III
RESEARCH METHODOLOGY

This chapter consists of philosophical dimension and methodological journey we choose in this study. I discussed about information collection tools, analysis of information/ data and interpretation of information. Our strategies of engagements in field, making meaning of our observations along with quality standards and ethical consideration of this research has been unpacked herein.

Epistemological Assumptions: 'We' Create Knowledge

"Epistemology is about the nature of knowledge about the reality or society and is concerned with knowing this world and the relationship between the knower and the known" (Guba & Lincoln, 1998). Being an action researcher, I believe that knowledge is constructed by real world phenomena, i.e. constructed through the interaction between the consciousness and worldly phenomenon, and the consciousness may differ depending on the people.

Knowledge is constructed and those who participate in its investigation can transform reality (Maguire, 1987). The focus is made on producing knowledge through prolonged participation, engagement and interactions with co-researchers i.e. teachers, students and above all the school management committee in school gardening program. As I believe upon multiple realities for construction of STEAM knowledge, we tried to explore such realities through individual experiences and mutual activities related to gardening. During the process, I considered the participants' stories as well as my critical observation in the gardening activities as the sources of knowledge. Thus, 'we' is considered as a source of knowledge.

Ontological Assumptions: Being Critical

"Ontology is about the form and nature of reality or society is concerned with questions like how they are and what they do" (Guba & Lincoln, 1998). According to Stetsenko, the ontological perspective in this study is transformational and being activist (2017). And, the idea that human progress in its interconnected aspects of being, knowing, and doing is inherent in his/her agency. By making both individual and group contributions to this process, individuals may work together to collectively transcend the status quo. In this regard, I and my community (students, teacher, parents and community members nearby school) interact in an ecosystem of

school gardening so as to contribute in knowledge production via critical self-reflection. Hence, while being in a community of school garden, the critical being (or awareness) that evolves as we make prolonged action and interaction is our ontology or a way to understand reality.

Axiological Consideration: Valuing Co-Researchers

The value of anything, either that is value free or value laden, all this belong to the axiological consideration. "Axiology concerns with human nature and, in particular, the relationship between human beings and their environment (Cohen, Manion and et al, 2007)." The value here refers either value-free or value-laden. As me and co-researchers (students, teachers, parents and community members) have their own value system, the educational practices are dependent to the respective value systems. This research study believes that attributes perceptions and practices of the participants and also their experiences and stories are closely related to the value system they have been working with. Through the construction of inter-subjective knowledge, I evaluated their value system using my own personal values.

Multi Paradigmatic PAR

Multi paradigmatic participatory action research (PAR) has been used as my philosophical dimension. For the first time, in the year 1946 Kurt Lewin used the terminology action research. During that time, his purpose of using action research was to transform the societies by embedding the social interaction in the work of science. According to McNiff & Whitehead (2006) action research is for professional development, and their work seemed committed in developing living educational theories by the use of action research studies. In total, sole purpose of action research was to bring improvement in researchers' practice in the work environment.

I used positivism, criticalism, interpretivism and post-modernism as my research paradigms. It is the nature of the research task which determines the right selection of my research paradigm. Positivism allowed me to use all the socio-scientific principles required during the experimentation phase of gardening by operationalizing the variables and measures. Positivism guided to select right experimental group among many by carefully comparing and contrasting with control group where different kinds of fertilizers were experimented on the basis of scientific principles. During the preparation of raised bed, selection of seeds, irrigation and fertilization, as well in the analysis of the growth of vegetable, objective nature of positivistic paradigm guided me.

Another paradigm I considered herein is critical research paradigm. Through this, I looked at the social inequalities and power differences to empower the learners. According to Taylor (2014) "Central to the critical research paradigm is a transformative intent to promote social justice, with practitioners acting on the world to make it more democratic, fairer, more equitable, more inclusive" (p. 15). Also, I required it for critical outlook to investigate my field, to invite co-researchers to reflect on their own beliefs and practices about the knowing, and ways of knowing (Stinson & Bullock, 2015).

Interpretivism as my research paradigm enabled me in the interpretations of multiple realities, phenomena and social context/setting which were being observed. In this paradigm, reality was constructed through the meaning constructed by individuals, socially constructed meanings, multiple and relative meaning become the foundation of reality. Interpretivism believes in the subjective reality where our action is the result of our own meaning not external forces. The nature of the research attempts to understand how the individual makes meaning of certain practices and theories. I believed in the process of knowledge construction through multiple ways of interpretations, interactions and sharing in social context in which the process depended on how co-researchers constructed their meaning during the school gardening and implementation of it as STEAM pedagogy.

The postmodernism paradigm allowed me to use multiple genres of arts for cultivating different aspects of actions occurred in the field (Taylor & Medina, 2011). This art-based approach treated learners as artistic being in which they storied their life, sang songs, and communicated through various means other than standard academic texts during their vivid involvement in school gardening.

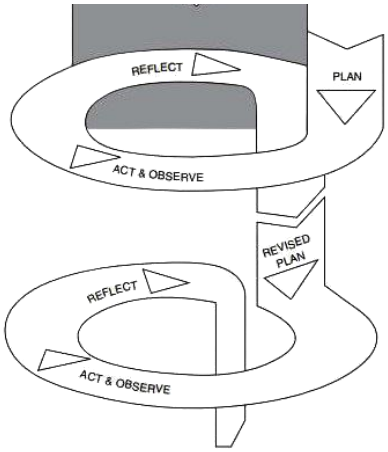
Research Methodology

My research work was concerned with the school students, teachers and the stakeholders. And, with co-researchers, I participated via interaction, discussion, interview and other means of active engagement. So, I sought PAR as my research methodology. The beauty of PAR was that all three elements which appear as its acronym, Participation (life in society), Action (experiences) and Research (knowledge making) (Chevalier & Buckles, 2019) are well integrated.

Rather than the objective interpretation of an outsider, PAR demanded a type of insider participation that illuminated the problem under study (Padilla, 2014). PAR used a collaborative research team that utilized dialogue and reflection during all phases of the research process. Park (2001) called PAR the research of the people, by the people, and for the people. Bringing this analogy in my research work, I found school students, teachers, parent, community members and teacher educators as people. Chevalier and Buckles (2019), the pioneers in the field of PAR, mentioned that participatory action inquiry is a methodological investigation where the parties engaged in concrete actions and investigations towards collaborative problem solving and goal attainment. It set itself apart from other qualitative approaches with the guiding ideals of democratic, egalitarian, liberating, and life-enhancing qualitative inquiry (MacDonald, 2012), I used various steps of PAR in an experimental research design.

Figure 5

PAR in spiral self-reflection form



(Source: Kemmis and McTaggart (2005)

The ideas of Kemmis and McTaggart (2005) which said PAR as a social, a practical and collaborative process and a reflective process to transform both theory and practice for the emancipation of the members of the society was guiding mantras of my research work. A spiral of cycles was usually believed to be involved in the participatory action research method. First of all, the spiral reflective form of PAR required setting a plan for a change which was followed by the acts (or execution of plan). Then, we observed the consequences resulting from the action we made earlier. The consequences of change was reflected (using various forms of arts as we work on STEAM pedagogy) and the spiral continued further in the second cycle with re-planning, acting, observing and again reflecting and so on and so forth.

Actions and Activities as Data

Now, let us examine what are data, and nature of the data? Generally, data is collected as an evidence to claim/ support any theory/ knowledge. When a participatory action researcher gathers/ records actions and activities that take place

during the phenomenon, it chronicles what we refer as data (Habermas, 1972; Kemmis & McTaggart, 2005). All of participatory actions/ activities which occurred during preparatory, gardening, and harvesting phase in school gardening are within the scope of our study, and are the source of data. One of a unique feature of PAR is researcher and participants (called as co-researchers) collaborate to establish the appropriate methods of data collection (McNiff & Whitehead, 2006). Effective data generation techniques used in PAR include focus groups, participant observation and field notes, interviews, diaries and personal logs, questionnaires, and surveys (Gillis & Jackson, 2002; Greenwood & Levin, 1998; McNiff & Whitehead, 2006; Stringer, 1999; Stringer & Genat, 2004), whereas we employed some of these methods such as participant observation and field notes, interview, and personal logs/ memos.

Narrative Writing as Analysis

There were innumerable observations and experiences which were made during yearlong engagement in Namobuddha community stockpiled in my mind. From the myriads of data generated I screened only those set of experiences which would best guide to understand my research questions. Narrative inquiry being first and foremost a way of understanding experience (Clandinin & Caine 2008) has been used for data analysis. While writing narratives I tried being critically reflective so as to understand me and my co-researchers storied life experience in research site. D. Jean Clandinin and Vera Caine (2008) mentioned that, "narrative inquiry, across various disciplines and multiple professional fields, aims at understanding and making meaning of experience through conversations, dialogue, and participation in the ongoing lives of research participants (p. 542)." Our narratives help us to comprehend the educational along with the socio-economic status of Namobuddha, in which we actively opposed unfair and poorly contextualized practices and heightened our awareness to support more empowering ones.

Research Site and Co-Researchers

My research site was located at one of a school in Namobuddha Municipality of Kavre district. Traditionally, present-day Namobuddha is popularly known as Dapcha (a place where school gardening was carried), and I interchanged (used) these words as a synonymous to represent the place of research involvements. It was an ancient city of Nepal located at an elevation of 1600m, and around 60 KM north-east from the Capital. There was a high school where numerous research works regarding baseline survey along with school improvement activities were carried out by my

predecessors. Thus, it made me a bit easier to initiate my research activities as I as introduced as a continuum of researcher, yet with entirely new agenda of discovery by my supervisor. With the school management committee (SMC), teaching faculties and students, I no more remained unknown for all. During school gardening, students were involved with parents' permission. And, from the time being, they became co-researchers in the gardener's team. To this, a group of parents and the community members residing nearby school area remained an integral part of gardening.

Need Assessment

Moving through the baseline survey undertaken by predecessors as well as my interaction with the SMCs and teachers, I discovered that all of we were eager to bring change in school. The change which I perceived was both subjective as well as objective in nature. Few changes in the physical infrastructures such as well furnish and spacious classrooms, availability and access to more teaching and learning materials and required resources, and quest of pedagogical innovation were noticed as major needs of the school. Besides that, teacher's desire to empower learners in/with their own local context unlocked an illuminating idea of using school garden as new pedagogy. We agreed to stand together for school gardening as our new pedagogical practice. Also, the work of my predecessors had previously highlighted STEAM approach of teaching and learning as a new approach to contextualize and engage learners. Thus, I and my co-researchers planned to undertake school gardening as a new pedagogical intervention (or innovation) in STEAM pedagogy.

Action

It was a sunny day. I sat together with co-researchers to design action-plan on school gardening. There were few teachers and members of SMC in meeting. The Chair of the SMC began the discussion process with a brief historical context and present circumstances of Namobuddha (. Co-researchers shared their experiences on prior involvements in similar activities where they had practiced gardening hiring around 200 sq. m (nearly half a ropany) of land in southern part of school. They shared that, the land was meager to start gardening and they faced challenges in irrigation since moisture retention was very low in soil. In the meeting, co-researchers opined for a larger land mass that would be more suitable for sustainable gardening. Participants in meeting decided to form a club for efficient functioning. Then, the Chair of the SMC led seven-membered "School Gardening Club" (SGC) including headteacher, ex-headteacher, accounts, and one teacher as school garden coordinator, researcher,

and other two from SMC. In a participatory discussion, all of us agreed to search a wider gardening space and began setting a timeline for action-plan.

It was a participatory action research, so unfolding a concrete and detailed action-plan was beyond the scope of our methodological choice. Gradually, we began discussing about appropriate land mass for undertaking gardening activities in the community. Within a period of two weeks, SGC explored land mass roughly 150 meters away from the resource point, i.e. school toilet. The land was 24% sloppy with numerous terrains.

Cycle 1

Landscape having a slope of 24% is rarely suitable for drip irrigation as it requires uniform gravity to flow fertigation. So, we began bulldozing the sloppy terrain into a more planar orientation. Then, locally available organic manures (fowl and cattle's waste) were distributed uniformly throughout the newly-made land surface. In the beginning, few teachers (of Science, Mathematics, Nepali, Computer etc.) along with their students (from grade six to eight) participated in gardening activities. Gradually, we engaged in empowering dialogue and critical feedback from and within co-researchers (Freire, 1970) which subsequently outreached gardening activities in larger communities of local people. Before the onset of gardening phase, our discourses were more focused to determine various aspects of gardening such as size of plot, selection of seeds, fertilizer, and type of irrigation to be deployed. And, it required understanding from socio-scientific perspective as well.

Informed With Socio-Scientific Issues (SSI)

Let us focus on why we had to be informed with socio-scientific issue (SSI) in undertaking this research endeavor. Majority of scientific innovations were made to ease human life. In either way, these innovations could never remain absolute as every good innovation in itself is a double-edged sword which possesses adverse effects besides its utility. The social dilemmas related to the conceptual and technological aspects of science are covered in SSI, which is concerned with scientific innovations that have an impact on human society. It is about these social dilemmas that learners would engage in a mutual dialogue, argumentation, informal reasoning, and discussion (Sadler, 2003; Zeidler & Nichols, 2009). While this research aims to use human urine and biochar as fertilizer in experimental plots, it could have multiple impacts in society. A part of society could find this approach beneficial and organic while others might think of as impractical. Therefore, socio-scientific issues address controversial,

decision-making process for creating solutions to these issues, also covers moral reasoning by the individual and evaluation of ethical concerns (Zeidler & Nichols, 2009).

A major question before us is, how can we associate SSI in our education? Or how did we incorporate these issues in research process? Based on a thorough understanding of the characteristics of these organic fertilizers, we gave students the opportunity to reflect on the ethical and moral dilemmas that arose when using urine and biochar as fertilizers. We also gave them the opportunity to participate in decision-making on these dilemmas. As a result, the educational value of SSI went beyond simply developing learners' basic scientific literacy and helped them become more aware of ethical and moral issues, as well as improving their ability to reason and make decisions while engaging in school gardening activities. Besides this, we encountered many specific issues such as relevance of organic way of pest management, designing ground water recharge system and ponds, use of ICT during pandemic of COVID-19 etc. While we recognize these issues as a part of SSI, we enabled learners and approached in a better way. We came to the conclusion that socio-scientific challenges are directly tied to the character of science, particularly as these issues call for interactions between science and society. Moreover, we could better educate our students for the issues they will face in the real world if we adopt a multidisciplinary approach to understand and solve SSI.

Experimental and Control Groups

We agreed to design four groups: Urine and biochar (UB), Urine (U), Chemical fertilizer (CF), and Control (C). We sowed four different types of seeds (i.e. tomato, capsicum, cabbage and Brinjal) for which four different rows of raised-bed were designed in each unit plot.

We prepared biochar (source of fertilizer) by cutting the locally available foliage, and incompletely burning them in a small earthen burrow. Then it was homogenously used in one of urine & biochar treated plots (UB-polyhouse). Whereas, urine (source of fertigation) obtained from the eco-san unit of the school was diluted with water in a ratio of 1:3, and passed through the drip-lines in urine treated plots (U-polyhouse). In the other plots mentioned as CF-polyhouse, we used chemical fertilizer. And, the plots under Control (C- polyhouse) were treated with water only. During the whole process, members from SGC made significant contribution in entire gardening activities. The duration of first cycle was 6 months.

Cycle 2

The second cycle began with reflection (arts-based) of the first cycle. Many teachers shared their experience (ideas and feeling) through power point presentation, digital medium (videos-making), whereas some use songs and poem to evince them. The reflections were immensely powerful. Prevention of crops (vegetables) from pest was considered as a major challenge in many of the reflection sessions. In order to prevent vegetables from the pest attack, there was an addition of artificial intelligence in school gardening. And, together with co-researchers, we formulated a revised action plan for the second cycle of school gardening. The activities were designed with a hope that school garden gives better yield as well as ensure increased students' participation. Finally, we observed and monitored the results as per the limitation of our time. The second cycle took six months.

PAR Matrix

Table 1

PAR Cycle

PAR Cycles	Objectives	Time
First Cycle: First Phase	Exploring obstacles in school gardening, Unfolding challenges during pandemic	24th September 2019 to March 2021
First Cycle: Second Phase	Involvement & interactions with Co-researchers	26th April, 2021 to 26th May, 2021
First Cycle: Third Phase	Collaboration among teachers, parents and community members	May 2021 to November 2021
Second Cycle	Enhanced interaction with learners	December 2021 to May 2022

In the table below, I've outlined the research activities for each phase of the PAR cycle.

Table 2

Summary of PAR Cycle

PAR Cycle	PAR Activities

Observation	Reviewing earlier activities, observing the schools' resources, and reviewing existing situation
Planning	Periodic meetings with co-researchers and other stakeholders, planning and sharing an action plan
Action/Intervention	Formation of School gardening club, hiring and leveling of land, construction of eco-san unit, temporary urinary, making CCTs and ponds, designing polyhouse, germination, plantation and harvesting of crops and sharing among co-researchers.
Reflection	Critically evaluating actions and making revised action-plan for the second cycle.

The beauty of PAR is that theory, action, and reflection work together bringing researchers and co-researchers at a place while identifying and solving the issues (Reason and Bradbury (2008). During my year-long engagement in the research site and around a year working through online medium, I realised that PAR is really efficient igniting and broadening "engagement, collaboration, partnership, and sustainability" (Torree et al., 2018, p. 855). During these periods, there were considerable interactions, collaborations and partnerships within school communities, and outside. This collective engagement enhanced the sustainability of our actions because PAR always respects community knowledge and their desires (Torree et al., 2018). With the help of participatory action research, we were able to produce fresh knowledge by way of active participation, emphasizing a feeling of shared accountability, hence this research is a research is a shift from the "I ask, you answer" to the "we explore" (Wadsworth, 2001, p. 78) approach..

Actions and Reflections

The most important part of my research work was the meaning making through action and reflection. It began from the very first day of my field work till the end of the report finalization. And, action and reflection took place continuously with the co-researcher (students and teachers, community members, parents, members of SMC) and in the activities that took place in the school gardening site, discussion forums and workshops.

"Distilling a lot of information to find important details and embedded components is what is meant by meaning making" (Stringer, 2007, p. 95). To "transform the raw data into a new and coherent depiction" (Throne, 2000, p. 68), inductive meaning making process and constant comparison (Lincoln & Guba, 1985) was used. In order to do this, I started the meaning-making process by organizing, transcribing, classifying, categorizing, creating themes from the data that had previously been gathered from the co-researchers. I used categorization and coding as the initial meaning-making approach after examining the data gathered, distinguishing different concepts, and seeking the stakeholders' opinions to compare their interpretations (Stringer, 2007).The analysis of the events (Webster & Mertova, 2007) helped me develop the meanings of the action and reflections. Also, during the process of data extraction and documentation, I engage in collaborative and active observation, action, and reflection. Also, I critically discussed the events by illuminating the values, assumptions and deep-seated beliefs and practices of the co-researchers and other stakeholders with the ideas of critical reflection (Mezirow, 1991). Finally, passing through these rigorous steps, I analysed data and constructed meaning with help of co-researchers.

Ethical Considerations

"Ethics involves the study of right and wrong conduct" (Dooley, 2007). Ethical issues in a research are equally important to the findings of the research, the lack of which may challenge the authenticity of the research and the conclusions derived. Without the readers are assured with ethical issues, the data/information collected during the research cannot be regarded reliable. As "ethics is concerned with the attempt to formulate codes and principles of moral behavior" (May, 2001), therefore a researcher needs to show such behaviors while accomplishing a research.

For maintaining the ethical issues in the process I was conscious in each steps of the research. The co-researchers were approached along with the official letter from the university administration and also with the full consent from the school authorities. The participants were briefly explained about the objectives of the research study and motivated for voluntary participation, assuring them for their rights to quit their participation at any stage of the research activity (Udo-Akang, 2013). They were assured to maintain the confidentiality for the information they provided and the research activities on their ease of time, place and other aspects. They were also assured for taking their consent before the data / information was employed for

analysis and conclusion derivation. The research participants were not segregated on basis of gender, sexual orientation, assumed abilities and disabilities, economic status, linguistic proficiencies and any other criterions. During the period of research, I undertook my other ethical considerations as following.

Quality Standards

The quality standards make a research reliable and findings valid. The quality of the research depends upon how the methodologies, techniques and processes employed for data collection were used. I maintained following quality standards for my research study:

Authenticity

The authenticity is the quality standard of the research referring the relationship that the researcher has maintained with the co-researchers. The authenticity of a research concerns with fairness, beneficence and non-munificence. It enabled me to explain and provide proofs that the data are authentic. The authentic criteria includes fairness (the fairness in representation of information), educative (if the participants are benefited by learning their social world), catalytic (if the participants are benefited by knowing about the problems in their social world) and tactical (if the participants are empowered by the researcher to improve their social situation) (Taylor & Medina, 2011). The researcher, by establishing authenticity, assures the reader that the research is genuinely evaluated and implacable to social, political and educational contexts.

For maintaining fairness of the research I remained careful in selecting the participants so as to provide proper information for me. Furthermore the interviews and discussions were conducted in natural setting as possible and valuing their self-esteem so that they get empowered for giving fair answers. Whenever necessary, I made cross queries during the interviews and discussions. I have not evaluated their beliefs as right or wrong and also not referred them to follow mine or any others' beliefs and practices. I represented all their voices and beliefs; they were not marginalized so as to avoid misrepresentation. Also I kept the verbal and textual data until the research publication is published. For maintaining educative catalytic and tactical criterions, I made proper discourses with them and enabled them to go for deeper understanding of the practices in their context. I informed them the research findings that they got benefited through the study made on their local-social contexts.

The study and discourses on their own practices and the alternative beliefs empowered them for further enhancing their pedagogical skills.

Trustworthiness

Trustworthiness of a research is related to the quality maintained by the researcher while describing the collection and generation of textual data, categorizing them and making meaning throughout so that the research findings are worthy. Guba and Lincoln (1989) referred trustworthiness in a qualitative research is parallel to the reliability of quantitative research, reflecting the overall process, contexts and findings of the research. Trustworthiness has further criterions like credibility, dependability, transferability and confirmability, which is discussed as following

Credibility

Credibility is the criteria of isomorphism between the constructed realities of participants and the realities represented by the researcher. There are several methods of establishing credibility in a qualitative research, some of which are prolonged immersion in the field, checking interpretation with the participants, engaging in open ended or emergent inquiry (Taylor & Medina, 2011).

For maintaining the credibility in my research study, I made proper contact with the participants, frequently visited them, and conducted discussions so as to generate necessary information. I continued the engagement until the saturation of the information. I remained concerned on maintaining natural setting and motivating them to share their real experiences and stories. During focus group discussion, my role was to facilitate the participants to express their views and control the extraneous variables as possible.

Transferability

Transferability of a research refers how the research findings are useful and similar to others across educational settings. It is even the degree of similarities between researcher and the observers, who later read the research paper. The research paper consisted of thick description of the context that the reader might compare with his or her own social and educational context (Taylor & Medina, 2011).

To establish transferability in my research I made maximum description of the research site and the description of environment where the PAR took place. As a researcher I engaged and interacted with co-researchers more so as to bring out re-read experiences and stories from them. While writing the research paper, I directly quoted them wherever possible. I honestly represented their perceptions and practices and I

tried to minimize the distortion of their actual feelings. I remained conscious that the readers have to be able to compare and contrast their social/educational context with the ones in research process.

Dependability

Dependability in research refers the assurance of finding similar results for conducting other research on similar contexts, comparable to reliability of positivistic researchers (Shenton, 2004). It helps my readers know the extent to which proper research practices have been made so that they make understandings of the methods followed and their effectiveness. “In order to address the dependability issue directly, the process within the study is reported in detail, thereby enabling a future researcher to repeat the work, if not necessarily to gain the same results” (Shenton, 2004).

In my research study I adopted the emergent participatory technique for collecting the participants’ experiences and stories related to their academic and professional journey through their narratives. For maintaining dependability I had not participated in interviews and 3discussions with pre-assumptions and beliefs about the problem issue. I focused on exploring their real experiences and stories. Also during the processing and analyzing the textual data, special considerations were made so that my personal beliefs and attributes do not affect the meaning making and conclusion deriving process. I immersed into the research process deeply.

Confirmability

The confirmability of a qualitative study assures that the conclusions are based on the opinions and experiences of the participants rather than the researcher's own traits and preferences. It is related to the transparency of the data/information. It is even the extent to which researcher admits own predisposition (Shenton, 2004, p.72). For maintaining confirmability of my research, I tried to maintain the participants’ views in their own perspectives as possible. I did not let my individual beliefs and assumptions to distort the ideas and experiences shared by the participants. I conducted member checking the textual data before employing them for analysis and conclusion deriving.

Pedagogical Thoughtfulness

Pedagogical thoughtfulness is the process of applying the research findings in pedagogical activities. The research process had encompassed almost all the experiences and ideas shared by the participants and from the literatures reviewed and derived some conclusions that the readers and the stakeholders could use in further

STEAM practices. Hence the findings from this research might be helpful for further STEAM-based pedagogical practices and might be established as a noble pedagogical innovation.

Chapter Summary

Participatory action research (PAR) as our methodological choice consisted of three basic elements, i.e. Participation (life in society), Action (experiences) and Research (knowledge making). Participation of researcher and co-researchers in school gardening activities had constructed knowledge. Therefore, 'we' as knowledge creator had been considered as our epistemological assumption (or source of knowledge). By 'being critical' and 'valuing co-researchers' as the ontological and axiological assumption respectively, the research uses multi paradigmatic PAR where positivism, criticalism, interpretivism and post-modernism are considered as major philosophical basis (or research paradigm).

Action and activities which were performed during gardening had been considered as data, and they were generated using various methods such as focus groups, participant observation and field notes, interviews etc. Narrative writing was used to analyze our experiences. There were two cycles in which gardening activities were carried: namely, cycle 1, and cycle 2. Researcher and co-researchers made collaborative actions from the preparation of polyhouse and seed sowing to the harvesting of vegetables. There were several research plots where comparative study of local bio-fertilizer (human urine, biochar), and chemical fertilizer over the growth and yield of plants were experimented. PAR cycles were run for more than a year. Finally, reflections were made by critically evaluating the actions we performed considering quality standards such as authenticity, trustworthiness, credibility, transferability, dependability, confirmability, and pedagogical thoughtfulness during the process. Thus, in this way, the research methodology which has been considered as backbone of any research project shared research legitimacy by incorporating philosophy, design, paradigm, and process of the research along with ethical considerations

CHAPTER IV
PREPARATORY PHASE: BEING WITH TEACHER AND STUDENTS

The preparatory phase consists of activities that come before the onset of gardening such as formation of school gardening clubs, management of land mass, construction of ecological sanitation (eco-san) unit, and exploration of water management system. As we worked with teachers and students in pre-gardening phase there were number of actions, observations, and reflections made. Field data were analyzed and themes were generated based on initial codes. Now, we delve into all major themes as a response to the first research question, i.e. *"In what ways does teachers and students work towards contextualizing curricula through school gardening?"* These five themes have guided us to discover ways to contextualize curricula through school gardening. I have suggested five different ways of curricular contextualization we made while working with teachers and students in school garden.

In first part; I have reflected upon initial days of my field visits whose context was rooted in the understanding of culture and context of the research site. While being in a team of university researchers, school teachers, and students I found research site culturally diversified as it consist of different ethnic groups with various needs and skills. Having conversations with teachers and students in school I explored that with regards to the cultural features/ diversity of students we could onset journey towards contextualization of school curricula.

Part One: Being In a Team: Contextualization Based On Cultural Diversity

Few rounds of initial visits to the research site helped me gain richer understanding of cultural diversity of Dapcha and its importance in contextualization of the curricula. These visits were meant for need assessment of school gardening project.

The Heart in a Sprint

The human soul expresses its want of salvation from the entropy created by the laws of nature. The want is manifested through the defiance of usual chores, and for a researcher I found engagement in research as one of them. Going through university classes till the cows come home, I had in my mind to go out for the research, as praxis, to release all the traces of lassitude. It was 24th September, 2019. The journey started in the gentle rain at 8 am. There were 9 of us including researchers, facilitators and a

driver of our vehicle. The movement of the entire group of researchers due in course marked a big roar of our team collaboration and communication as are the essential aspects of 21st century skills. Our vehicle gained its momentum and with it the dormant desire to be participatory action researcher of mine came into being. The journey left numerous indelible marks in my memory associated with various emotions such as aplomb, confusion, certitude, excitement etc. For sometimes, I examined why I am going through such complex variations of emotions and thoughts.

The jeep speeded past the narrow bends of the roads; and most of the times I was jerked by the emotion of how I am going to connect with the teaching faculties and learners of my target school? How should I be introduced in school- Is it me as an expert among the pool of university researchers visiting school for mining data or a student who is in it a subject as well as an object of research? How could be ways to understand and appreciate cultural differences in students? The majority of the time, I enter this endeavor with a nave and unreasonable set of expectations for teachers, students, and myself because to my lack of expertise facilitating PAR as well as my intake of radical, innovative, and powerful PAR research (Fine et al., 2004; Fine et al., 2007; Poon & Cohen, 2012; Torre, 2005; Tuck, 2012). I recognised tension surfaced because of my earlier involvements in various roles such as a teacher trainer or due to my previous exercises in expecting and setting higher goal for my students or may be over confidence raised from peer circle whose artistic praise of mine could hardly be unnoticed. During the jaunt, sometime I shouted in excitement- dashing against the seats, while sharing many of our untold stories regarding the quest of research. As though in a sprint, the heart was beating fiercely. It never slowed down- I gave up on it!

Surrounded By Temples and Monasteries

About an hour's drive took us to *Kavrebhanjyang* where we lunched. Mind experienced a huge relief in that many fruitful sharing happened till then. Once lunch was over, we kicked off again. The journey continued on a high tide. I lowered glass pane by a quarter, then mustered up a long breath with a feeling of courage. I was persistently looking through window, trying to figure out silence embedded in the realms of nature and diversified culture of the region and cognizing what it meant for us. It was already 10 am. The Jeep passed through *Paatle-khet*, a down-hill formed from numerous small terraces of paddy fields. We had glanced couple of temples as well as stupas and monasteries on either side of the road which gave a clue of multi-

cultural context prevalent in the research site. Religious temples, stupas, and monasteries located all across the way to school made me conscious about cultural richness our ancestors have gifted us. We learnt from locals that Namobuddha is a location of profound compassion. They said that a famished tigress and her three cubs were discovered by the Buddha when, in a past life, he was a prince who had strayed from a royal gathering and wandered into the forest. The famished tigress couldn't feed her kids, and the prince was so moved with sympathy for her that he offered her his corpse to eat. Since then, Namobuddha has been remembered as the place of great compassion.

The way was narrow, worsened by the mild continuous rain. The rain was committed to making our journey difficult and we as its antagonist continued despite challenges. Most of the time, I used to realise life as a long pilgrimage where any moment could bring transformation within us. The serpentine twists and turns of the road reminded me of Greenhalgh and Taylor (1997) as researchers who pursue qualitative research should seek deeper truths while aiming "to study things in their natural setting, attempting to make sense of, or interpret phenomena in terms of the meanings that people bring to them" (p.740). My decade long habits or assumptions of viewing things with more positivistic paradigm has to be either transformed or blended with interpretivist or constructivist paradigm since they help viewing the reality from multiple perspectives.

Ultimately, we reached a small bazar, turned to small elevation of the hill on the south side, where we have had the project' other working schools. With mild ascent of few kilometers, we reached School at the hilltop of Namobuddha (previously called, Dapcha). The landscape and topography of Dapcha was very much appealing as one could view the long range of Himalaya at the northern flank during clear weather.

Among the pool of researchers, I as a new member was introduced with the head teacher and teaching faculties' of the school and received a warm welcome from the entire school team. However, I was strengthening my morale as the one who would catch fish must not mind getting wet as it was all about building rapport with the head teacher along with other teaching and non-teaching faculties of that school. I cracked the so called hard nut by shifting my sail with the wind. With the feeling of being a helpful member of school, my week long engagement at school was a little fun with the entire team of teachers and students.

Figure 6

School at the hilltop of Dapcha

During my stay, discussion focused primarily towards understanding of real-life situation of learners, their culture, achievements and challenges along with future vision of the students and school. While we engage in need assessment I was attentive towards understanding history, wants and needs of various population groups and the indigenous population as well. While interacting with teachers, I found Dapcha consisted largely of Newar, Brahmin, and Tamang communities; whereas *Dalits*, a minority group having significant population size was discriminated in a caste-based system. I was more excited to uncover what exist in the communities yet were excluded from knowing as the classrooms and school environment poorly reflected the cultural richness and diversities inherent in communities. Because of these cultural mismatches, teachers may use pedagogical strategies that ignore the depth of the cultural variety that students bring to the classroom (Stemn, 2010). Our journey of need assessment continued while I interacted with teachers, students and visited communities exploring culture in an attempt to contextualize school curricula.

Heightened Cultural Consciousness via PAR

In a discussion with school teachers and students (co-researchers) in a participatory approach, we not only uncovered cultural aspects of the communities but also sorted out few immediate actions to be undertaken viz. construction of eco-san and school gardening activities, thereby connecting it with previously constructed urinary toilets at the southern part of the school. With co-researchers (school teachers and students) we made several rounds of interaction and discussions while planning near future activities and actions. Common in every plan and action was designing a culturally relevant pedagogy which would empower students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills and attitudes (Ladson-Billing, 1994). The school community consisted of marginalized

communities and they were equally valued and well considered in our participatory meetings. Also, we figured out handful of challenges in school whatsoever, central one was discovering land mass suitable for school garden as school possesses limited land resources to carryout pre-figured activities.

Finally, after the completion of need assessments we sat for informal discussion within small group of researchers from the university as this sort of discussion was apparently a tradition set in practice by earlier researchers. I realised that even a discussion among participatory action researchers in leisure time fosters sharing, reflection, guidance and collaboration along with cultural sensibilities in the project enabling researchers to generate better alternatives. It was my turn to share my week-long experiences at school. Before sharing about gardening activities and its next level of planning, I happened to share few 'silence' in a group of researchers. It was, an amazing 'silence' pre-occupied in between me and the co-researchers as we were about to begin our first PAR meeting. Firstly, I had a belief that it is the school teachers who would be presenting their needs in the form of agendas in meeting which will be followed by discussion. Whatsoever, I waited desperately for someone from the teachers' group would break the 'silence'. But, to my surprise things didn't happened the way I thought. Frankly speaking, firstly, I was more influenced by the 'silence' of my co-researchers and their expectation of me as an expert on school garden. That dilemma in perceiving the overall situation has been beautifully said in a phrase by famous American Sociologist Charles Horton Cooley, "I am not who you think I am, I am not who I think I am, I am who I think you think I am? (Cooley, 1902)" And, perception my co-researchers have of them forced me to play a proactive role of an initiator in the PAR meeting. Hence, I found that this distinction in role has categorized us into two groups, i.e. PAR researcher and PAR co-researchers. Secondly, I came to realise stereotypes or beliefs I hold about my co-researchers while on setting PAR meetings. I came to see that occasionally we adopt something as we grow up and just accept it as truth. So, contextualization of our curricula based on prevalent culture should also imply that how may someone whose attitudes are impeding students' learning be persuaded to change? What kind of response would you have if a teacher had preconceived notions about your or your child's capacity for learning? (Stritchens, 2000).

Sharing with colleagues of mine continued while I thanked co-researchers for joining the participatory meeting, then introduced myself and continued interactions so

as to build rapport. We discovered more about heterogeneous culture Dapcha have had manifested since time immemorial. Furthermore, we couldn't overlook inequalities and scarcities students were facing. Beside this, I learnt that one could develop significant insights or ideologies about PAR by conducting research in collaboration with the participants, gaining personal experience, changing one's viewpoint through interaction with the participants and the environment through social constructive learning, and critically reflecting on one's own action, experience, and learning (Rajbanshi & Luitel, 2020).

Further unravelling my initial meetings in a group of university researchers, I shared how co-researchers shared their expectations and needs regarding the construction of eco-san unit in school gardening plot and onset gardening. Though we resolved numerous issues into two clear agendas, one was finding a suitable piece of land and other was developing infra structure along with gardening activities. In real, it took week-long discussion in a group of co-researchers to reach a common consensus. And, during participatory meetings with teachers and students following reflections or realizations has been made:

1) Contextualization of curriculum begins with understanding, appreciating, and integrating cultural diversity inherent in groups or communities.
2) Primarily, researcher is responsible or should be prepared to onset the discussion process with complete honesty and sincerity.
3) Participatory action research strictly demands the dynamic interaction and requirement of both researcher and co-researchers, and
4) Rapport building with co-researchers is a slow and steady process and may even take an hour to days, and both should be equally credited for the construction of knowledge.

In the second part I present efforts we made while foraging a suitable land for undertaking school gardening activities. During need analysis, discovering appropriate gardening space was listed as major action; thus in an attempt to contextualize school curricula, school teachers as well as students residing nearby school premises began exploring alternative possibilities. However, suitability of land was determined based on the needs and usefulness of learners/ students.

Part Two: Foraging School Garden: Contextualization Based on Learners

It makes sense that students themselves should have a key role in the formulation of curriculum contents if we assume that an acceptable curriculum should

be near to and familiar to students. Thus, we formed various clubs to enhance the student's participation and facilitate the process of curricula contextualization.

Learning from Locals

In the day of 2nd March, I got a phone call from university. It was a gentle remainder of field visit for the next day; however I had marked it before. For me, it was a remarkable and exciting day since a multipartite participatory meeting was scheduled with all stakeholders regarding the exploration of land and reaching a common agreement between all stakeholders followed by resource mapping for eco-san based school garden.

By 8 am, I reached nearby bus stand carrying a measuring tape, pen and notebook as a necessary material inside my bag. We headed towards Dapcha along with supervisors and other researchers from KUSOED. Sharing about school garden and eco-san continued during the journey. While being in the Jeep with supervisors, I realised that a supervisor has to fulfill versatility of roles while facilitating researcher. Besides providing few major forms of instructions such as giving feedback in shaping initial draft of thesis, supervisor's role of facilitation in the research field further strengthened our framework of the participatory research design. These higher forms of learning and cognitive developments are more social in nature (Lantolf 2000; Vygotsky 1978). And, we were more focused and determined in fulfilling actions that were set in the earlier PAR meeting.

On the half-way to Dapcha, we received the chair of the School Management Committee (SMC). Team decided to explore an alternative route, and leaving the highway took a small road right to Kavrebhanjyang, and then rested a while for a short breakfast in a small, road-side cafe. We sat on small chairs surrounding a round plastic-made table, then ordered Chapati, Curry and Tea. While waiting for the breakfast on our table, one of my supervisors introduced me briefly with the Chairman and said, "He is Sanjaya, and will focus on eco-san and school gardening activities in your school." In his response, with feeling of gratitude, Chairman said that school is really lucky to have continuation of researchers from university. Then, with curiosity, the SMC's Chair asked us about how eco-san works and how do we ensures participation of learners during the process? "It should be done in a participatory approach by school teachers, students, and researcher and this uses waste materials from the toilet or reuses them for the purpose of agriculture" answered Professor. I provided paper and pen where he drew a rough sketch depicting the component of eco-

san. Professor shared the multiple significance of human waste generated from school, as they could be used as organic manure.

In a moment, I requested SMC's Chair to share about socio-economic condition of learners and region as a whole. Inside the Jeep, the Chairman drew all of us attention as he briefed about the socio-cultural aspect of the Namobuddha Municipality (Dapcha region) where majority of the inhabitants had to depend on small scale farming and animal husbandry. But, in the present, more than half of the population have padlocked their homes and left village. Many of them have migrated to capital and nearby cities for better living and few have gone abroad in search of job. After few moments, professor said, "Chairman, isn't it a high time to understand why and how our socio-cultural aspect seemed to be fizzled out?" With intent of critical analysis professor indicated us to dig deeper into the root cause of the present status of Namobuddha. For few minutes noise of engine dominated us as the Jeep drove away. I broke the silence with a question, "you mean we need to delve deeper into the cause rather than effect, isn't it Professor?" Highlighting on the importance of students' participation during curriculum contextualization, we realised the significance of various clubs (Eco Club, STEAM Club, Gardening Club, Robotics Club etc.) and students' portals (Magazine, Wall-Magazine, Students' Corner etc.) to ensure learners' engagement. "If then, tailoring the gardening activities based on the needs and interest of learners would help us overcome our contemporary issues", said the SMC's Chair. There is also the importance of engaging students (Lawrence, 2007; Hancock & Mansfield, 2002) in the development and definition of subject content and in the framework of pedagogical processes (Author, 2010; Bernhardt, 2009). As Souto-Manning (2008, p. 97) states "…school, being a social space, should open its doors to the discussion of the reality of their students, starting with the experiences students bring with them into the classroom". In few rounds of discussion with stakeholders all of us agreed to involve students in the learning process.

Being With Learners

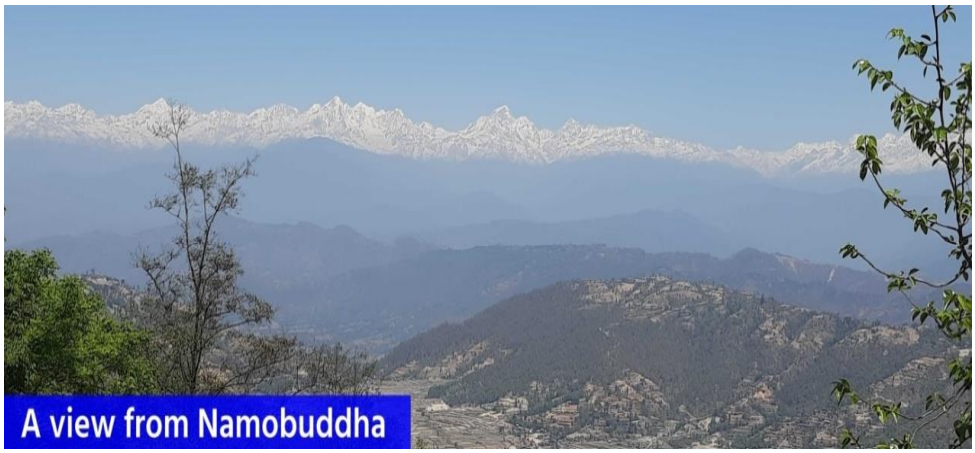
It is commonly accepted that students adopt learning practices that help them comprehend the subject matter better if they believe their learning environment will allow them to have a thorough comprehension of it. So, we shared our mind with learners. In discussion session with learners, they shared their perspectives on foraging school garden and many were pleased to have one in their school as it align better so

as to suit with their homely context. Also, we shared why we eco-san mediated gardening would be our future choice.

Furthermore, a student put her query, "is it safe to use human waste from the perspective of health and hygiene?" How do we proceed together to design eco-san based school gardening? Researchers have shown that this approach would avoid disease and promotes health, preserves the environment and conserves water, and recovers and recycles nutrients and organic matter back into the soil (Esrey, 2001). "Regarding the human waste, either one or both the solid and liquid waste could be used as they are safer source of fertilizer" answered science teacher. Then, teacher clarified further on why we should connect them in school education. It was a more thought provoking discussion in the team of teachers and students. The learners seemed more satisfied with the multiple benefits of using eco-san in the community, and appreciated the teachers and researcher for noble cause.

Figure 7

Himalayan range viewed from School



Guided by Western Modern Worldview, the existing pedagogical approaches have been flourishing disengaged nature of teaching and learning (Luitel & Taylor, 2013). Thus, we moved further to explore in our own context and culture tailoring the needs and interest of students and teachers so as to bring real engagement in our learners.

Exploring a Dapcha-Model

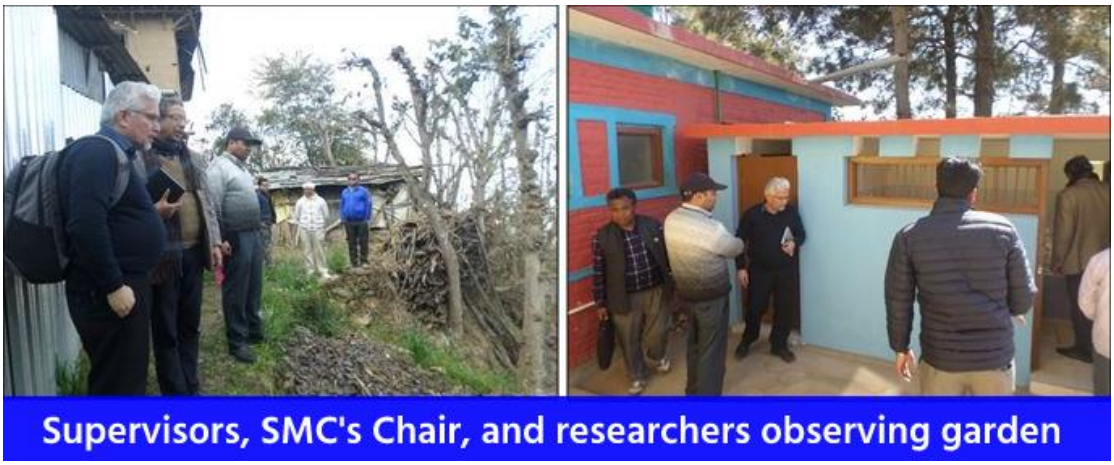
With co-involvements of learners in the process of contextualization of curricula, focus was entirely shifted to discovery of right land mass to design right model of learning. Through students and teacher we succeeded in conveying right information onto communities. In many public spheres such as health office, ward

office, tea shop etc. I witnessed community members' discussions intended towards finding right model or approach of education. They were deeply portraying the depth and breadth of socio-educational aspect of Dapcha community, and primarily about finding suitable land mass nearby the school. Though, this was not a dime a dozen but certainly, these discussion made our journey saccharine and apparently shorter.

School administration planned a meeting with stakeholders, and at half past eleven we reached the high school. Clear blue sky and gentle breeze of wind at the hill top inspired carried on working. Without any delay, we joined the multipartite meeting organized to settle down issues of land mass and construction of various components of school gardening along with eco-san unit. Elected bodies from the municipality, Chair of SMC, Principal and administrators, Coordinator of the project, my research Supervisors and other researchers participated in an hour-long discussion on various aspects of school garden.

Figure 8

Being with Supervisors at research site



Lucky were we because just below school ten ropanies of land facing on the northern side was identified and an immediate agreement was made for a period of ten years. We shared happiness in meeting as we succeeded in selecting right land mass for discovery of student-centered model of teaching and learning. Then, standing at upper-most terrace of the newly hired land, we discussed on few possible routes by which urine from the urinary (constructed earlier) could be brought in the field (or at the site of school gardening). Soil sample was collected for laboratory investigation of various parameters. Making a "V" shaped cut, it was collected in a polythene bag and sealed it. Since organic matter and/ or pH measurements were of importance (particularly when evaluating potential herbicide residue carryover) so we preferred

collecting 0 to 15 cm sample (Pennock & et al., 2008). On the same day, carrying soil sample for laboratory investigation, we returned back to Kathmandu. On our way back to home, I further discussed on various issues regarding the sustainability of the project so as to enhance students' participation with my supervisors.

In the third part, I share how we contextualize curricula based on our pedagogical practices, particularly in the light of tough days of pandemic. Teachers' approaches in online and physical mode of class and their contribution in students' learning would help better understand our pedagogical practices.

Part Three: Pandemic of COVID-19: Contextualization Based On Pedagogical Practice

For more than month researcher and co-researchers remained indecisive about what would be our next move amid the pandemic of COVID-19. We were actively observing the new situation which was far beyond our purview. Following actions we made herein would assist in understanding of pedagogical practices for contextualization of our curriculum.

Learning As Our Being and Becoming

Upon returning from the initial field visit, we sent soil sample collected from the research sites to the government owned soil testing laboratory at Pulchok. There was a queue of soil samples at the laboratory and I had to wait for few weeks for the result. We were at the second week of March and the news channels were repeatedly broadcasting the alerts issued from World Health Organization (WHO) regarding the outbreak of COVID-19, a public health emergency of global concern.

On 11th March, 2020, WHO declared it a pandemic and at this stage, I had no idea about my next move rather than wait for how government take care of the situation. State of confusion and fear prevailed for few weeks and, then on 24th March, 2020, government declared a nation-wide lock-down. For first few weeks, we could not even think of breaking globally spread chain of confusion and uncertainty. However, I was in constant communication with supervisors, and one day, supervisor wrote an email dissecting the chaos in a group of researchers as he put his perspective. Professor had planned for some informal discussion with researchers in his email. He mentioned:

"Based on the discussions with colleagues, we shall start the informal discussion today at 5.30 pm. We might discuss for 1.5 hour. Yes, the government has announced a holiday. The online discussion and classes are voluntary. We try to make

this free time useful. Let's put this into perspective: Human civilisations have always faced problems throughout history. They survived or became extinct based on their use of knowledge and wisdom. We may extinct or survive. I think this is not a problem. This situation comes and goes. We also leave this planet. Learning has been our being and becoming! This is the purpose of this class, or rather discussion session."

Best wishes from

Bal Chandra

Inspired by reflective synthesis of past and the present context, we began continuing various activities that were possible at those space and time. Professor's perspective also emphasized that the (local) context in learning can be meaningfully used only within a pedagogic practice that uses a framework of reflection (Paliwal & Subramaniam, 2006). By the time, I was not just fond of reflecting on why we need to reflect in order to contextualize our curricula but also where we failed in our journey of educating the self.

We joined in online mode, and discussed on several possibilities of pursuing research activities in Namobuddha. During these hardships, I engaged myself in writing few papers and attended webinars. But, central to it was, we as a researcher began communicating with the teachers of the community school despite the terror of pandemic. This was a journey made in our attempt to contextualize curricula based on pedagogical practices via online mode. While moving on, we discovered that very few school teachers (almost less than 20%) were available online in the initial days, and were interested to share their perception about existing situation in their localities, as well as impact of pandemic on teaching and learning. Teachers agreed continuing the online discussion with researchers and also explore effective pedagogies utilizing window of opportunity hidden in the tough time of pandemic. We agreed carrying on sharing sessions in weekly basis, however there were ample challenges yet to be resolved. It was a 'real-big' challenge for all of us to explore the alternate possibilities of face-to-face school (F2f). Believing that online learning cannot take the place of all the roles that schools perform in our society, but it is much more than just a less effective alternative to traditional face-to-face instruction (Zhao, 2020).

Gradually we started connecting school teachers in online mode. Teachers with smartphones and basic literacy of internet on email and internet got connected in virtual group but they were very few in numbers, whereas others remained far from the access of online sharing. We communicated remaining teachers who were beyond the

reach of internet via GSM network. Many asked us, “is it effective?” or “does online education works?” Though the question was apparently meaningless at that time, but to their response we said, if we could make best out of the new situation then it might. Research shows that learning transfers from one context to another more effectively when the learner understands not only the facts but also the "big picture" the underlying principles, patterns, and relationships that is acquired through the application of knowledge (Glaser, 1992; Bransford, Brown, & Cocking, 1999; Greeno, Resnick, &Collins, 1997). Our focus was more towards bringing perspectival shift or understanding the significance of shifting our pedagogical practices in a composite.

During our phone calls, we asked teachers without smartphone to pair up with nearby teacher having smartphone considering health protocols. By this way we brought up more than half of school teachers into the pipeline of online education, but few remained still beyond the reach from technology. Slowly, we were internalizing a fact that place, the teacher, the culture of the school, and the broader community influence how people construct their definition of education and what it can do for them (Street, 1999). Together with learning new information and abilities, co-researchers learn how to establish a sense of self even in hardship. None the less, we were realizing what professor opined earlier on learning as it is in our being and becoming.

Contextualizing New Pedagogical Practice

During the period of a month, the lockdown had not only affected schools and education rather poignantly damaged almost many social activities. Ministry of education was badly condemned for their poor focus and inability to restore the rhythm of basic education in a minimal level. One of a state-owned Internet service provider (Nepal Telecom) soon released a subsidized offer of data which they called ‘*e-Shikshya Package*’ for students and teachers of institutional belongings. We facilitated teachers to fill up the form in

Figure 9

Project work designed by teacher

order to subscribe subsidized data package. The subsidized cost of internet motivated few more teachers to buy (or burrow) smartphone, and along with it we shared our understandings about organizing virtual meeting sites such as Google Meet and Zoom for teachers. During weekly meeting, teachers were a bit hesitant about asking questions with us, but while we simplified the matter they showed more interest in learning to use Microsoft Word, Power Point slides, editing Google Docs and Forms and even open account in YouTube, and upload videos. Some teachers designed creative project work in their subject while others used various forms of arts (poem, story, and video as a means of expression) project work.

Day by day, schools teachers were expanding their knowledge of ICT with the support from university researchers; whatsoever they couldn't transfer these newly acquired skills to teach students as there was no any technological means to reach learners. Poor receptivity of internet in majority of hilly landscape of Namobuddha and lack of smartphones among majority of parents made online classes insurmountable. Despite such challenges, school administration exercised carrying online class (based on Zoom and google meet App) for students of secondary level. One of a teacher shared his understanding after month-long experience of handling online class, and said:

"Teaching through online is a terrible challenge in these days. Even for grade ten, we have not succeeded connecting all of our students. We have discovered three major challenges at this point: lack of smartphone, poor economic condition to afford data package and absence of online culture in learners."

At this moment, the government offered few classes on radio and television, but significant number of pupils remained out of reach because, 20% of Nepalese do not have access to these media (Poudel, 2020). Later on, government distributed CUG (closed user group) SIM to teachers and parents of the community school in free of cost. It was only Mobile Phone (GSM Network) that stood out as a means of communication with students as well as parents amid the pandemic. Though, it was not free from challenges. School administration had to face bunch of issues regarding Phone-based class, however they settled major issues, viz. frequency of class and periodicity of subject in a week, time and duration of phone-based classes etc.

Being a participatory action researcher, I had observed several phone-classes while being physically present with teachers. A math teacher who started dialing CUG

numbers from 10:28 in the morning shared his experience of teaching via phone-class as follow:

"I began calling from half past ten, and now two hours has gone. During this, I couldn't connect with only three students out of twelve as they were away from the reach of network. Comparing phone-class with regular physical class, I found students more curious to talk with me and learn from me as they exhibited higher span of attention during phone call. It might be because of some sort of 'proud' feeling they might have felt while communicating through mobile phone or due to latent desire to play with modern gadget. To this, one more may be added and this is about parental concern which I found relatively higher as students are with their parent during phone call."

Besides being engaged with school teachers, I started sharing my observations regarding online-based pedagogical activities with supervisors. Soon, professor added a new session with MPhil and PhD scholars, providing weekly guidance related with ongoing research work. Besides this, I kept on sharing insights in a larger group of 'Rupanaran' project members at Tribhuvan University (TU), Kathmandu University (KU) and Norwegian University of Life Sciences (NMBU) in weekly basis. In an attempt to contextualize curricula while reflecting upon hard days of pandemic, the greatest achievement so far was exploration of numerous approaches in online (alternative) pedagogical practices. We discovered how educators and students create contextualized learning opportunities by drawing on real-world examples from their immediate surroundings (Gillespie & Marilyn, 2002). These chances emphasize the practice and development of the abilities students will need to carry out tasks and achieve goals in their daily lives. These newer skills such as communication, creativity, critical thinking and team-work (between teacher, students, and parents) while maintaining social distance explored virtual platforms that were never explored in such high quantities in semi-urban settings in Dapcha. This made us feel high though the pandemic kept on reemerging in various forms.

Journey we made while constructing and connecting eco-san unit with school garden was unique and innovative, and discovered that the place where education happens is central when organizing pedagogical intervention. In part four, I shared on how we used socio-scientific issue (SSI) as an approach to discover eco-san based model of sustainability in Dapcha community, technical aspects of its design, along with significance of place in curriculum contextualization.

Part Four: Standing On Eco-San: Contextualization Based On Place

Transforming to reform-oriented mindset of a researcher and co-researchers being part of life habits was not a usual phenomenon, but a good starting point in contextualizing curricula. Gradually we connected eco-san considering it as a pivotal unit in school gardening while caring and considering local knowledge and economy of Dapcha. Our realizations in recognizing and exploring local resources and knowledge of the place was an illuminating experience for us as it unfolded a new dimension in curriculum contextualization based on place.

Life Habits as a Starting Point

As we knew that COVID-19 pandemic was highly recurrent in nature, we thought of resuming our field work after a year-long closure. It was 26th April, 2021 that government decided to impose lockdown for the second time to restrict the spread of corona virus. I thought of leaving my comfort zone (my home) before the authorities impose lockdown in the Capital and major cities. A day before its promulgation, I joined school in Dapcha so as to inquire about school gardening activities with co-researchers. At the same time, being a participatory action researcher and the one who is in an attempt to contextualize curricula based on the place, I had to be with my co-researchers, align with research site and community; students' lived and experienced reality, and connect subject matter with the reality (Kemp 2006, Kitchens, 2009).

I knew that headteacher was preparing for uncertain closure of school from the next day, and at the meantime, researcher and few co-researchers thought of making an alternative plan during the duration of closure where teachers and students of STEAM club (a newly formed 20 membered group of teachers and student) and others residing nearby school planned a short gathering. The next day, we sat for participatory meeting with members of the club and requested stakeholders to join gardening activities, following the standard health protocols. Following this, we made another round of meeting with teachers and planed a tentative timeline to construct ecological sanitation (eco-san).

During initial days of second wave of pandemic, the high school and nearby communities of Dapcha were not reported with active cases of COVID-19. An action plan was drawn to construct eco-san considering the existing situations; however the unpredictable yet terrific situation of pandemic had limited our activities within a group of local teachers and students (largely of STEAM Club) because of restriction of

people's movement from one administrative region to another. Just below the high school runs a rural road and the gardening plot was on the other side of the road. The plot was 24% sloppy in orientation. Thus, all of the stakeholders agreed on bulldozing the sloppy terrain into a plain plot in order to fix various units of eco-san and allow nutrition and water flow uniformly through drip lines in research plot. Hence, keeping aside the top soil, the plot was labelled into a flat piece of land which was later covered with the top soil. At the heart of school gardening was eco-san, thus for its fixation in the school garden we planned series of meetings with SMC, administrators, headteacher, teachers and community members. The project *Rupantaran* had previously built urinary for teachers as well as students. The urine collected thereafter had to be taken to gardening site which was situated 200 meter below the school. By emphasizing the place, we were creating curriculum that is near to students' lived and experienced reality, in which the subject matter can readily be applied to real-life circumstances, enhancing students' knowledge of such subjects (Shriner et al. 2010; Kitchens 2009; Im and Pak 2012).

In the meeting, stakeholders raised issues regarding safe and sustainable way of handling human urine and we discussed on its various dimension. The first concern was from the perspective of safety. A septuagenarian, Bir Bahadur Tamang was one of the eldest members in SMC, and said:

"sir, yo pisab bhaneko ta phohar ho, gaai-wastu ko bhaya ta thikai hunchha, manchhe ko ta k kaam hola ra?"

English translation:

"If it is of cattle it might make sense, but I wonder if human urine is of any use?"

I found that co-researchers were more open in discussion on any issue which they found relevant in their context, life habits, and experiences as it is often considered as a beauty of PAR. In response to Bir Bahadur's query, another representative from the community said:

"Sir haru le filter garera prayog garne hola ni, teso vayo vane ta ramrai hola ki!"

English translation:

"When filtered, it may not harm us as they (researcher and teacher) might be thinking so!"

Second was on the issue of effectiveness of human urine as a fertilizer and few school teachers along with community members doubted whether it could be of real

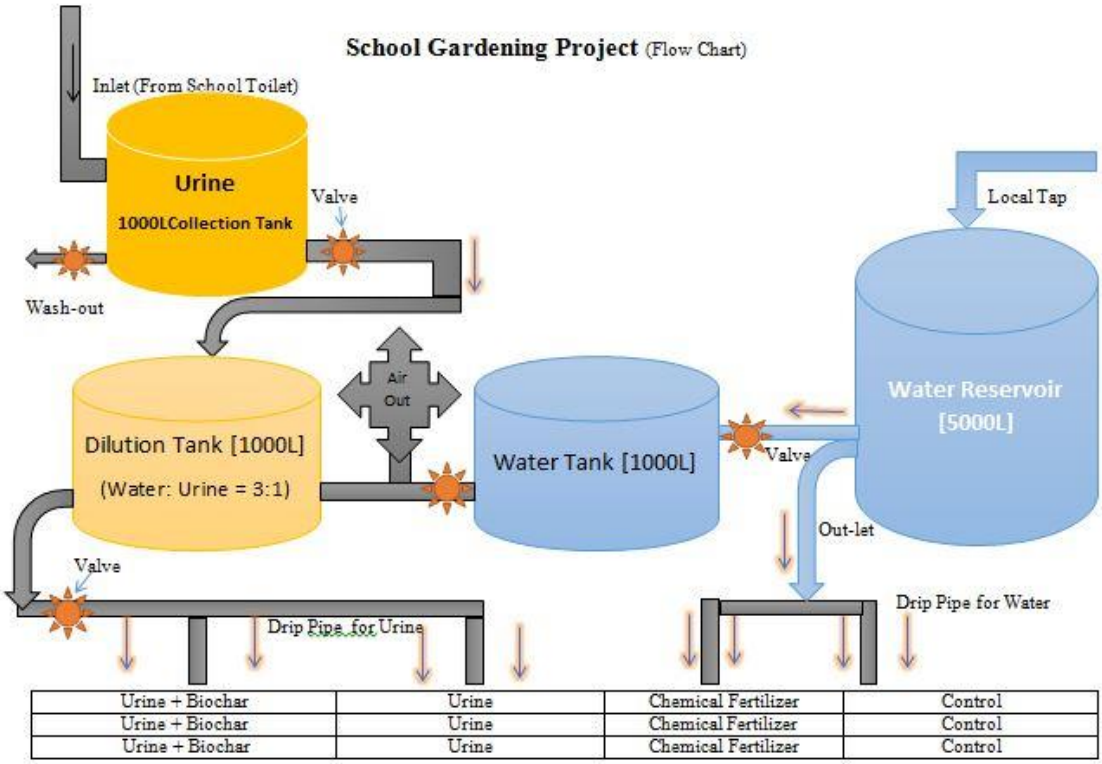
use. Whereas few said that it might be lethal to herbs and shrubs (small plant) as well. To this, one more was the issue of its odor and few local people were alarmed as it could spread foul air in nearby communities as well. Though, many of the concerns of stakeholders were best answered later from our field involvement and experiments; however we use socio-scientific issue as an approach to address disputable subjects, the decision-making process for find solutions to these challenges, as well as moral reasoning by individuals and the appraisal of ethical concerns (Zeidler & Nichols, 2009). We shared our understanding about ecological sanitation (eco-san) with co-researchers it is an approach of sanitation where the latrine's contents i.e. manure or urine are diverted for use as fertilizer for plants. It is crucial to remember that eco-san is a method that promotes innovative sanitation ideas and concepts while taking socioeconomic and ecological considerations into account. Additionally, it is described as a system that safeguards the environment, conserves water, recovers and recycles nutrients, and adds organic matter back to the soil in order to avoid disease and promote health (Esrey, 2001). In the context where majority of community people depend on agriculture and animal husbandry as their primary source of livelihood, eco-san based school garden had presented a unique perspective on place-based pedagogy; and this in the word of Smith (2005, p.8), teaching in this way does not require the elimination of non-local knowledge so much as the simple inclusion of the local. Thus, eco-san was an exciting starting point in the long pilgrimage of curricular contextualization by being with the life habits of community and their place.

Who Needs Chemical Fertilizer's Plant?

Amid lockdown, members of both the clubs (School Gardening Club and STEAM Club) visited school garden and explored possible routes to carry urine from the urinary block at school to the school garden. With experiential learning as a base of our understanding, we fixed a route to transport urine. A flow chart diagram for school gardening project was designed as following:

Figure 10

Schematic diagram of eco-san in the school garden



By the process of filtration from the blood called urination, human urine which is a liquid waste product of our body gets excreted through urethra. The remaining components of urine, which is an aqueous solution made up of more than 95% water, include urea, creatinine, dissolved ions (such as chloride, sodium, and potassium), as well as inorganic and organic compounds or salts. Usually, urine is a completely sterile product unless collected from patients consuming pharmaceutical drugs, and is quick acting fertilizer high in nitrogen and phosphorous; it may be applied directly to the soil with no danger to human health (Hoglund & et al., 2000). In contrast, fecal matter contains organic matter but has low nutrients for plant growth. According to Jonsson (2004), each adult excretes an average of 500 L of urine annually. Each person excretes 1-1.5 L of urine every day, on average, in 4-5 occasions. Children urinate roughly half as much as adults do. According to estimates, 550 L of urine includes 4 kg of nitrogen, 365 g of phosphorus, and 1 kg of potash (Jonsson, 2004). Alongside these benefits, I recalled my childhood memoirs where my grandparents had considered human and animal waste under integral farming system. But, today

they are the most underrated, poorly understood and poorly utilized resources for plant fertilization. This was more evident from the discussion with the stakeholders in the school since many young generations had impression of human urine as *'Phohar'* or waste. Our soil has very low levels of nitrogen, low to medium levels of phosphorus, and medium to high levels of potassium (Joshi, 2002).

The majority of the chemical fertilizer used in Nepal for the cultivation of crops and vegetables is being imported from neighboring country and ministry of agriculture and livestock development (MOALD, 2020/21) had reported their annual sales of Urea, Diammonium phosphate (DAP) and Potash was 225,180 metric ton (mt), 140,982 mt, and 12,990 mt respectively. And, in total it is 379,152 mt of chemical fertilizer. According to the report by Central Bureau of Statistics (CBS, 2021), Nepal's population has reached 29,192,480 in 2021. If we could dream of collecting urine from the entire population then it would generate approximately 249,888 mt of Urea that would outreach the current demand of chemical fertilizer. This figure implies that, we should neither depend on foreign countries for chemical fertilizer nor establish chemical fertilizer plant; we would be fairly independent in agricultural production, in terms of fertilizers.

For collection of urine from the urinary toilets, a small pit of 2 ft. × 1.5 ft. × 1.5 ft. was made underside toilets to outlets urine out of it. With school teachers, administrators, local bodies, SMCs and university researcher we unified to construct eco-san unit in a participatory approach. Stakeholders in meeting decided to segregate the construction process into four major phases:

1) Collection of urine from the urinary
2) Transportation of urine to school garden
3) Management of diluent or water in garden, and
4) Dilution and distribution of urine

Among the organic and inorganic salts present in urine, the majority of these remain in solution. Although phosphorus-rich materials have a propensity to settle out in storage containers, the consistency of this fluid being similar to syrup, and when urine passed through piping system, "urine syrup" may sediment in pipes if the inclination is insufficient (Stockholm Environment Institute, 2010). Therefore, pipe fixed at the base of the pit takes urine 200 meter away into a 1000 liter tank in the garden through transversely placed PVC pipes of 2 inch diameter.

Figure 11

Various stages during construction of eco-san

Entire structure of School garden locates at the hill-top (1600 meter above the sea-level) of Namobuddha Municipality. There used to have natural water reservoirs such a *kuwa* (stone-covered under-ground water reservoir), *pokhari* (big-sized water lake) etc. in the region. However, mega earthquake in 2015 badly damaged underground water channels of the region. Already water-scarce region was severely suffering from drinking water. Then, the demand was partially fulfilled by lifting water through a distance of roughly 7.5 KM from downhill of River Roshi. And, we used same water source for the dilution of urine in the eco-san unit as well for irrigation to horticulture, fish, pig, and mushroom farming school gardening, connecting pipes of 300 meter length from the uppermost tank of the region. Teachers, community people along with representatives from local government contributed while fixing water carrying pipes with the best of their knowledge.

During this process, we maximised involvement of local people, used local knowledge and locally available technologies, fitted pipes with sockets and other essentials while making eco-san unit. With a week-long hard work we succeeded in bringing water to the school garden plot and a 5000 liter tank (Tank- 3) was placed on a small foundation raised at 3 feet height from the ground) for storage. At the side, another tank (Tank- 4) of 1000 liter volume was placed for storing water (as a diluent) for diluting urine collected in the primary tank (tank- 1).

Figure 12

Connecting water source in school garden

As suggested by various literatures, a three-fold dilution of urine was made where three part of water was mixed with one part of urine. Teachers made bamboo scale using local materials and knowledge; and used for measuring volume of urine and water during dilution. Working closely with stakeholders I learnt that the relevance of the school garden depends on how well it solves or addresses local problems or issues, and reflects daily lives of people and the community with utmost utilization and exploration of local resources and knowledge system inherent in the region or place.

In part five, I discuss how school garden and its component helped to contextualize curriculum based on disciplinary contents. Among numerous activities we made, construction of pond and CCTs are considered as context to explore and reflect in multi-disciplinary way.

Part Five: Ponds and CCTs: Contextualization Based On Disciplinary Contents

As we completed construction of eco-san unit, focus was shifted towards inclusion of other essential infrastructures such as water reservoir system, ground water recharge system etc. in school gardening plot. Working on these structures that support sustainability of the school garden, our focus was primarily on curriculum contextualization. Gazing at pond and CCTs, we observed teacher and students' reflection on school garden as it facilitated teaching and learning process while contextualizing various disciplinary contents.

Pond That Refracts Disciplines

Upon the fixation of eco-san unit at the topmost part of school garden, we proceeded on accomplishing activities planned in the earlier meeting (of STEAM club) where construction of rainwater harvesting pond along with poly-tunnels was on immediate work-list. It was any day in the last of May 2021. Few school teachers and students came into the school garden carrying measuring tape, wooden sticks, rope, paper and pencil in their hands. We sat at the side of eco-san unit and discussed about half an hour regarding the tentative requirement of water for gardening. Previously, we had connected tap and managed to store water into a tank (of 5,000 liters capacity) in garden; however community leaders suggested that it is wise to manage alternative source in case of interruption and scarcity in regular source. Thus, teachers participated in a discussion with stakeholders to find alternative possibilities. Finally, we planned to explore appropriate site for rain water harvesting pond and came up with an idea to construct one at the top of field. On the other hand, a mechanism of checking the top soil to be eroded away in sloppy terrain was sought out as we planned to build ground water recharge system as its remedy.

We measured available space, calculated the dimension of rain water harvesting pond along with its orientation. Soon, in a team of stakeholders, we reached at a common consensus of building a pond of significant capacity (of volume 15 feet by 12 feet by 7 feet) at the side of eco-san unit since requirement of water reservoir for gardening (for olericulture, horticulture and others) was estimated to be higher than 35,000 liters. Construction of pond was initiated with the help of bulldozer which was later smoothed by people.

Figure 13

Working on a rain water harvesting pond

It was mid-day of June. As pond was getting closer to its final form, a group of teacher approached very near to the pond in leisure time. They gave curious look into the pond (in 360°), whatsoever one of a teacher whispered in my ear, "Sir, do you think this as a real-pond only?" I said explicitly while wanting to explore more from them, "Of course, but it is yet to be completed, perhaps take few more days!" He was Ram Prasad (a pseudonym), familiar and an experienced teacher to me since we met few years before while he was a headteacher in the downtown. Then, he requested fellow teachers to speak their mind about pond. Bhim sir said:

"Maile ta prachur sambhawana dekhdai chhu yo pokharima, wastabmai bhannu parda yo pokhari le yahaka wanaspati ra jiwjantu lai jiwan dine chha, jiwan ko Kendra hune chha. Ra, bigyan matrai kaha hora katha, kabita pani yasai bata sikna sikauna sakina ni"

English translation:

"I could see immense possibilities in it. Truly speaking, being a center of life (biological sciences), pond will support all living beings inhabiting nearby this area. And, besides science one can learn to recite poem or write story being with pond."

It was an amazing observation from Bhim sir who has been teaching Nepali to his students. As Ziyana, a young teacher of mathematics looked on/ through the pond makes following reflection:

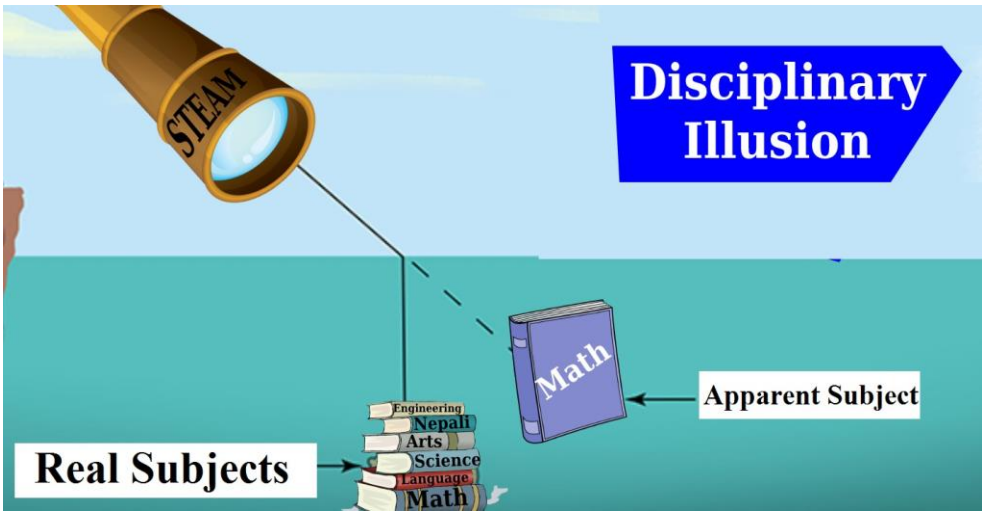
"yo pokhari lai ganit shikshyan ko samagri banauna sakinna ra, sir? Jastai widhyarthi lai chhetrafal, aayatan, jyamiti lagayat kaa wishaya laai practically sikaauna sakinchha ki!"

English translation:

"If pond can be used as a pedagogical tool for mathematics, it might help students to learn various concepts such as area, volume, and geometry present in the subject in real way!"

Figure 14

Refracting disciplinary illusion



I was in a thunderstruck as co-researchers appeared to have richer understanding of curricula. They have started looking at things with clear perspective, in a multidisciplinary approach (of STEAM education). They discovered not only math (single subject) while they gaze into pond, rather discovered a new perspective of pond which refracts not just a discipline but various disciplines and disciplinary contents. "Sir, we are considering school garden in multi-disciplinary approach, and thanks to university researchers; however we are desperately waiting to design school garden as a classroom as well as curriculum with endless possibilities of contextualization of our disciplinary contents," said Ram Prasad.

Teachers were expatiating their understanding through various training and workshops we have presented them. In case of any difficulties, they barely felt hesitancy in presenting their needs and curiosities. "Sir, I know what to teach but I'm not aware enough on how to teach, especially from multidisciplinary perspective", said Priya (a pseudonym), a recently enrolled grade teacher. I said to her that we can learn to design and implement STEAM lesson plan as well, and requested her to find a right time with head teacher for next workshop on designing STEAM lessons in the light of school garden. The encouragement and curiosity of co-researchers fueled journey towards curriculum contextualization based on their disciplinary contents since they

visited school garden during their available time with continuous enthusiasm in garden-based learning.

In Defense of Sustainable School Garden

Recognizing education's ability to accelerate change, the United Nations developed the Decade of Education for Sustainable Development (ESD), which ran from 2005 to 2014 (UNESCO, 2014). By both integrating sustainable development into education, and integrating education into sustainable development, the overall goal of UNESCO's Global Action Program (GAP) on ESD is to create empathetic citizens willing and able to address the complex challenges of today (UNESCO, 2015). In line with this, School gardening activities aims to link our action (local) with global understandings. And, in its defense we used the term "sustainable" which is to rests on the principles of social justice, economic growth, and environmental health (Ralston, 2011). During gardening, I realised that curriculum contextualization remains incomplete unless we impart sufficient effort in understanding local problems and issues, and address them. Numerous problems were encountered as we worked towards the notion of sustainable school garden. Primarily, we shifted our focus to explore a mechanism that could check top soil likely to be eroded away from sloppy terrain, one of a major problem in hilly terrain.

Initially, I requested teachers to share their plan if any, regarding sustainability of the sloppy terrain. However, all of us agreed to sit for a meeting and discover a way out. Many of the teachers were local inhabitant of Dapcha region and they have had witnessed a continuum of changes in geo-climate over long period of time. And, for me that was a great opportunity to learn more about soil, water resources and other biodiversity of hilly region. As meeting initiated with brief introduction of the region, we discussed on geo-climatic situation and its sustainability. Co-researchers briefed more about how small hilly region went on losing its wetlands, ponds and fertile top-soil over a period of time. Sexagenarian ex-principal, Santaman recalled how they established school and worked towards construction of buildings in the year 1960 A.D. by encroaching and exploiting public spaces, old community pond, and pond eco-system at the hill-top of Dapcha. His reflections were as alarming as we face worse environmental health of these days:

> *"The pond was habitat for not only wild animals but also source of life for community and their cattle. Besides this, there were a couple of Pokhari (Ponds), Dhunge Dhara (a stone-crafted local tap), Kuwa (a stone-covered*

ground-water reservoir) and wet lands of similar types at few other places. As time passed, agendas of socio-political transformation gained its momentum in rural regions. More schools and other community centers such as health post, post office, buildings for elected bodies were made at the cost of ancient water reservoirs and public places. Later, giant machines such as bulldozer were introduced and deployed to build rural roadways across the Chutara (a resting place for travelers made by surrounding banyan or poplar tree using stone wall) and water sources ignoring the sensitivity of underground water channels flowing beneath them. Frankly speaking, I am not against these infrastructures and developments but they had to be made considering alternatives ways and targeting sustainability at the core. And, I don't hesitate to take the share of my responsibility for all these wrong we did in the past."

As Santaman sir shared his mind, I felt mesmerized with his simplicity while he placed himself far from the 'blame-game' and didn't hesitate to take the share of his responsibility. During discussion, some teachers inquired what if they start building more ponds and begin conserving biodiversity in the region. Few shared their opinion on reversing the human encroachment in public places. Others opined about constructing check-dams to prevent sweeping away the top soil in terrain. I put forward few concepts on how construction of Continuous Contour Trenches (CCTs) reduce flood and help store water in hilly terrain.

During my year-long involvement of field work, I witnessed the major problems of Dapcha. The loss of soil posed the same concern as a lack of water. For both of these problems in low-rainfall, hilly, and undulating terrain locations, CCT is the most appropriate approach (Borse, 2016), like Dapcha region of Namobuddha Municipality. Since 1993, the forest areas have been the subject of a continuous contour trenching experiment (Technical manual, 1998). In the meeting with stakeholders, we shared the success story of '*Paani* Foundation' where actor Aamir Khan and his team worked in drought-affected areas of Maharastra as they came up with idea of CCTs, a scientific method of water shed management. In fact, their work is still remembered as a movement for water revolution where 550 billion liters of water storage capacity were added over the course of four years.

We made discussion on undertaking watershed development work in school garden. Before carrying any activity there were few things we considered. First was determining the slope of the ground and second was marking contour lines. Building

watershed structure on the contour lines is not only efficient, if farming is done along the contour lines the resulting produce is higher too. CCT is excavating continuous trenches that are 60 cm wide and 30 cm deep along continuous contour lines that have been marked with a contour marker (Borse, 2016). In an experimental study conducted by Dr. Panjabrao Deshmukh Agriculture University in Akole, it was found that CCTs contribute to improved soil moisture conditions, which in turn affect plant growth and, ultimately, result in better leaf area index (LAI) of the plantation in CCT treated catchments compared to non-treated catchments (Patode & et. al., 2015). It is a well-known fact that the most crucial element of sustainable development is the involvement of people in development processes. And, in our case, it was school teachers who planned to build CCTs with active participation of students in the terrain of 24% slopes. Teachers planed two days for its construction, thus set routine so as to involve students from class six onwards. We then bought digging tools along with lime or chalk powder for marking the contour from nearby market at Bhakundebesi. CCTs were constructed on contour lines that lie at the same level on the ground. Such a contour line always runs crosswise to the slope. Thus, to obtain such exact contour lines, we required to measure the slope of ground at various point. And, an instrument that made it possible was the hydro-marker.

Figure 15

Co-researchers measuring slope of school garden

Hydro-Marker Saved Thousands Of Rupees!

I shared basic principle behind hydro-marker and materials required for its construction. Science and Mathematics teachers showed relatively more interest in making hydro-marker using locally available materials. Our understanding of sustainable school garden has to focus not only on environmental health and social justice but also with economic growth of the region. Designing hydro-marker was an eye-opening activity we involved in as it is easy to understand for co-researchers.

Hydro-marker is also available in the market, but can also be made locally and quickly. We found that making of hydro-marker locally cost nearly one thousand rupees whereas market price for this instrument was ten times higher than this. Commercially available hydro-markers were made up of aluminum arms but we used bamboo sticks (2-3 inch wide and 1 inch thick) as its substituents since are local product and inexpensive as well. Another was 8-10 meter long transparent pipe of 1cm diameter (Level pipe). Measuring scale, pencil and marker were used for calibration and if available, plastic cock can be used to seal the level pipes at both ends. Following few simple procedural steps with mild conceptual understandings we made hydro-marker in far inexpensive way. Then, it was calibrated using transparent scale and, finally tested its accuracy in sloppy terrain of school garden.

While making hydro-marker, teachers shared their observations and reflections. Chandraman sir (a pseudonym), math teacher said:

> *"Hajaar rupaiya ko lagani le jhandai das hajar bazar mulyako samagri nirman garna safal vayaeu. Hamile sthaniya srot sadhan lai bibek puryayara upayog garna sake udhyamilata ko bikas ni hune raichha ta!"*

English translation:

"We succeeded in making a product worth ten thousands using one thousand rupee only. And, one can develop this into entrepreneurship if our local resources are wisely utilized!"

In series of interaction with co-researchers we knew that economic growth is central in continuation of gardening activities in school. The lesson learnt while making hydro-markers positively contributed in shaping the future of school gardening activities. And, our focus was more towards generating entrepreneurial skills in learners so that it strengthens school gardening in a more sustainable way. Relating entrepreneurial learning to the field of STEAM education, I realised that entrepreneurs translate innovative ideas and develop them into products and services. And, the process requires creative and critical thinking, problem solving, communication skills along with a growth mindset and the ability to manage risk and uncertainty whose attributes are integral to STEAM learners.

Guided By Local Problems and Issues

We started constructing CCTs with active involvement of teachers and students. I noticed that it is not only students who were excited to study and work in school garden but also the teachers.

Figure 16

Co-researchers constructing CCTs

In the meantime, few local parents came in the garden and asked us about the ongoing activities. They seemed surprised to see teachers and student working hard throughout the day. When parents talked with teachers and got informed about what we were constructing at, they shared gratitude for incorporating local issues and context in education. One of an old-aged parent, Harekrishna *baa* (respect for old-aged male) living next to the school garden plot used to make frequent visit to school garden. In one of the sunny day of summer, he stepped in the garden as usual, observed ongoing works (construction of CCTs) for half an hour, and then shared his insights:

"Sir, what are you digging in this dry and sloppy terrain?" I greeted him with gentle smile. "We are constructing scientific trenches so as to check the flow of top soil and water during rainfall", I said to him. Pointing at the trench, he exclaimed, "Do you mean that these longitudinal ponds will store (or help store) water underground, and prevent erosion!" I said, "Yes, this the main purpose of pond and actually it may not store water for a longer period of time as the reservoir tanks do rather it works as ground water recharge system."

Then, I stepped into the terrain and explained him further on how the entire CCTs in terrain (nearly four ropanies) work as recharge system. During his hour long stay in the field, curiosity about the ongoing work on watershed management system in sloppy terrain enforced him to visit the length and breadth of the land several times. While leaving off the garden, Harekrishna *baa* said us:

"Baajo baari khanne, amulya seep sikaaune shiksha lyaunu vakochha, aba padhe pachhi iniharu le Nepal mai rojagaari paaya dekhi kati raamro hunthyo sir! Paani ko samasya ni samadhan vaya ta dapchali le tapaiharu lai kahile birsidainathe, sir!"

English translation:

"May such practice of working in school garden infused with valuable skills for our learners help explore better employment in Nepal and if you succeeded overcoming scarcity of water with these activities then you will be remembered by people of Dapcha!"

Our two-day involvement in CCTs with students and teachers ended with a ray of hope and possibilities to explore solutions for most of the problems we have created. We learnt that water and its management is pivotal to the sustenance of school gardening project. Thus, rain water harvesting pond and CCTs remained first and most important measure for the sustainability of school gardening in a place where water scarcity is a major challenge. More importantly, I realised that contextualization requires understanding local problems and local issues while working together and addressing them in the pedagogy.

Chapter Summary

The chapter portrays all preparatory activities performed ahead of gardening phase. There were teachers and students who were vividly involved in process. We formed School Gardening Club (SGC) and STEAM Club (SC) with involvement of SMC, PTA, teachers, students, parents, community members and researcher. SGC was formed for connecting school with the community, whereas SC was made for interaction among students, teachers, and researcher. It was a community school situated at the semi-urban settings, and had limited land resources for carrying garden related activities. Thus, SGC in coordination with community members finalized almost ten ropanies of land for undertaking gardening activities. While we reached an agreement with landlord and planned ahead for the laboratory investigation of soil sample, COVID-19 emerged as pandemic. Then, the journey of exploration of alternative learning began. There were many observations we made while school operated its activities in online learning mode. It was real challenges to communicate with learners as almost majority of them were without facilities of internet and smartphone.

As situation improved we began constructing eco-san unit in the school garden. But, reemergence of pandemic at frequent interval limited our interaction with co-researchers, especially students. However, eco-san remained center of attraction among large number of co-researchers. Importantly, while engaged in the preparatory phase of school gardening with teachers and students, we learned various ways by which curricula could be contextualized. Contextualization requires understanding of cultural diversities, the learners, pedagogical practices, place, and the disciplinary contents. For a reason that we learned to stand on our own feet utilizing local resources, eco-san inspired us to redefine sustainability in our own context. Furthermore, we worked on constructing continuous contour trenches (CCTs) and ponds for the sustainability of school garden. They helped us not only in recharging and harvesting of ground water and rain water respectively, but equally facilitated contextualization of curricula from the disciplinary context. Hence, involvements of stakeholders during the preparatory phase enabled us to explore own pedagogical practices enabling us at recognizing sustainable ways of curricular contextualization.

CHAPTER V
GARDENING PHASE: WORKING WITH TEACHER, STUDENTS AND COMMUNITY PEOPLE

Activities regarding construction of polyhouse (or grow tunnel), designing research plots, seed sowing, plantation, fertigation along with pest management were organized under gardening phase. The chapter answers second and the third research question, i.e. *"How does school gardening evolve as a new pedagogical model in STEAM-based learning?"* and *"what are the prospects and challenges to implement school gardening as STEAM Pedagogy?"* as I share both the process and findings of gardening phase of the project.

Pedagogical models are theoretical constructs derived from learning theories (such as constructivist approach, collaborative approach, reflective approach, integrative approach, inquiry-based approach, transformative approach etc.) that strengthen the implementation of specific learning strategies such as design thinking, problem-based learning, place-based (or situated) learning, project-based learning, garden-based (or nature-based) learning, entrepreneurial learning etc. While researcher and co-researchers engage in all three phases of school gardening, we came across various learning strategies accompanying diverse theoretical constructs. We noted that school garden was evolving into a comprehensive pedagogical model (or total pedagogical model) for school education since educational activities in school garden was wholly or partially framed within either one or many of learning theories. Let us delve into each theme we have generated from the gardening phase and the specific learning strategies that forms an integral part of this evolving pedagogical model.

Part One: Polyhouse: Design Thinking as a Pedagogical Model

In accordance to our plan, we, the member of STEM Club made a brief meeting where all of us agreed to move further ahead and design a polyhouse in the plot that has recently been engineered. There were two distinct primary purposes of making polyhouse. First was to evaluate and compare the effects of human urine, biochar and chemical fertilizer with respect to control (water-treated) group on growth of vegetables whereas second was exploring a 'living classroom' in the light of gardening activities guided with various learning theories in local context. Guided by

these purposes we began exploring best alternative possibilities in making polyhouse at school gardening site.

Five Phases of Design Thinking

A group of passionate teachers and students were regularly observing field activities and few began participating in ongoing construction works at various levels. Whether it be cutting of bamboo from nearby jungle and digging holes for its fixation or designing plots for the experimental design, teachers were concomitantly sharing their ideas. The whole process of designing polyhouse could be better understood from the perspective of design thinking as Lor (2017) defines it as a unique, creative, and human-centered approach and mentality that involves multidisciplinary collaboration to produce user-focused products, services, and experiences.

Though various models of design thinking are in practice but the one we followed used Kelley's Stanford model of Design Thinking that consists of following five phases:

1) Empathise
2) Define
3) Ideate
4) Prototype and
5) Test (Kelley, 2001).

The first stage is concerned about analysis of needs and challenges of school. Many of the members of STEAM club attended a participatory meeting for which stakeholders were consulted for their views and ideas in designing poly-house. In the meetings, representatives from the parent teacher association (PTA), school management committee (SMC), local parents and teachers made a day-long discussion and agreed on the need to construct polyhouse in school garden. We were seeking plentiful of information on the design of polyhouse from the school family in order to onset its construction. I was aware that we should be empathise problem at local level (school and community), otherwise designing polyhouse might appear insignificant and unrelated for school and community therein. Thus, as a part of design thinking process, stakeholder mapping was undertaken to empathise them.

Stakeholders' Mapping Explored New Way of Farming

A five-membered school management committee was formed out of full-fledged SMC for efficient decision making on the current affair related with school gardening in no time. During mapping of stakeholders a group of SMC (n=5), school

teachers (n=10), community leaders (n=3) and *Rupantaran* team with researcher (n=2) were considered. The purpose behind focus group discussion and interview with the key informants were clearly explained and consent was sought for record keeping. Stakeholders were asked to explore their understanding about new way of farming using eco-san on issues such as

i) Is it necessary to construct a polyhouse for eco-san based gardening;
ii) If required, what is the optimum dimension of it and how could it be better designed; and
iii) What would be your contribution in its sustainability or what kind of role you could play in the days to come?

Informal interviews and focus group discussion took place during end of May, 2021. Focus group talks followed a semi-structured interview schedule. Beginning with an introduction question that encouraged open and free discussion among co-researchers, the questioning sequence guided by Krueger and Casey's (2014) guidelines were continued. A variety of opening, crucial and concluding questions were posed to the co-researchers when they had become acquainted with the subject matter and had settled into the discussion. Finally, summaries of the group discussions were written as soon as each focus group was finished while getting a quick overview of what was discussed. The data collected in the first phase led to the development of a total of following four themes.

1) Necessity of polyhouse for garden-based learning environment.
2) Promoting local materials and local knowledge while working.
3) Polyhouse as a means of connecting school with community, and
4) Sustainability through unleashing entrepreneurial activities in community.

'Defining' of challenges was a focus of second step in the design thinking process. The ‘define’ phase enabled co-researchers sought solutions and ideas for the next phase, i.e. ideation phase. Reflecting over the earlier findings and making use of the gathered information was critical to encourage problem solving as co-researchers shared a number of ideas, influences, requirements, and feelings with regard to the necessity of the polyhouse, and they were examined and defined. The size of polyhouse and availability of 3M (i.e. manpower, money and locally available materials) as well as knowledge for its construction was defined at this stage. While working with co-researchers in participatory way, we co-defined several elements

those were empathized. Indeed, a major shift in our perspective was evident while being in a team and co-designing as an integral part of design thinking process. I felt like I am working 'with school' not 'for school' when stakeholders (co-researchers) reflects great responsibility in process of designing. At any day during the process, the chair of SMC said:

> *"Bishwobidhyalaya ka sir haru le yasari hami sanga dinvari sakriya vayara kaam gareko dekhda ma lagaayat haamro sampurna school ko team atyantai khusi chhau. Tapai le hamro saathi haru ko baliyo sahabhagita dekharai thaha paisaknu vayo hola, haami rokidainau Sir, polyhouse banayarai chhadau."*

English translation:

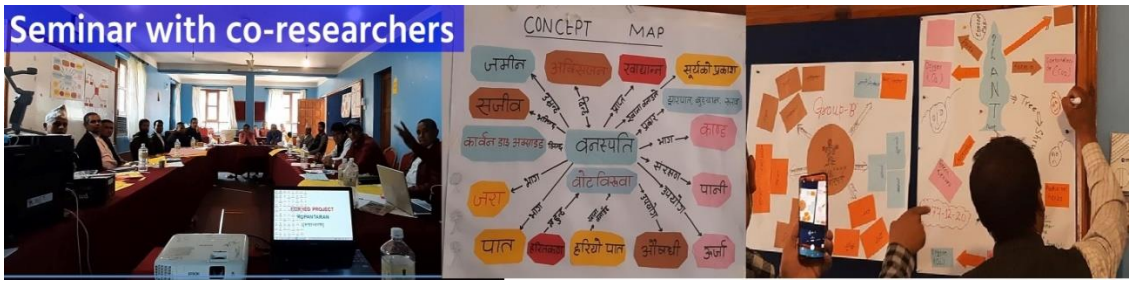
"I and my team are immensely happy to behold how university researchers are working with us throughout the day. You might notice the way our friends are strongly participating in the process. Indeed, we won't leave any stone unturned, Sir."

Concept Map and Vision Board Shaped Our Ideas

The third phase of design thinking known as ideation centers on the creation of ideas. Ideation served as both the catalyst as well as resources to create polyhouse (or prototype). In order to facilitate this process, a seminar was scheduled with co-researchers in Bhaktapur where we co-created and refined the ideas on designing polyhouse. Concept map and vision board are some of the method we used while generating and shaping our ideas. These practices helped a lot in prioritizing the ideas on various issues defined in earlier stage.

Figure 17

Workshop on ideation



The fourth stage, prototype consists of designing at least one solution for problems defined before. At the heart of 'prototype' lies presentation of the visual solution for users which is then followed by fast feedback for its smooth operation. Both co-researchers and researcher agreed on designing all of the polyhouse required for the purpose and observe it till a period of one complete cycle of harvesting of

vegetables. It was not just about the shape and size of polyhouse required to be tested rather its strength and durability in defense of harsh weather (like rainfall, wind and heat). All of the stakeholders participated throughout the construction phase of polyhouse, and during this, local knowledge and resources were wisely used. The reason for using bamboo was because of it being a local product which is economic and was plentiful inside the premise of school garden.

The construction of whole structure of polyhouse required technical skills and we replenished the desired skills seeking help from local parents who possess an amalgamation of local knowledge and technical skills.

Figure 18

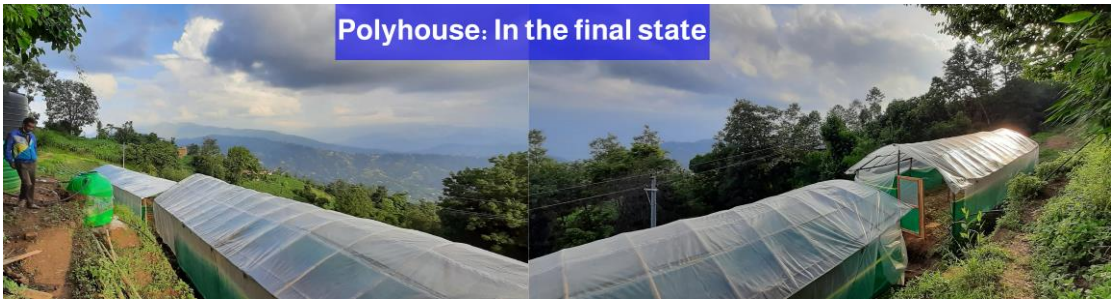
Researcher and co-researchers working on polyhouse

Test is the last stage in the design thinking process where prototype is presented as solution to the stakeholders. Thus, polyhouse built so far was introduced for gardening where they were tested in real environment. All of the parameters which are inevitable for gardening were thoroughly analyzed. At first, level of all plots was examined with hydrometer made using local materials by co-researchers. It was for drip system of irrigation that the surface of every gardening plot was uniformly levelled by gently rearranging top soil. Secondly, uniform flow of fertigation through the drip lines and emitters were adjusted so as to ensure equivalent distribution of urine in the irrigation system. Thirdly, environment inside the polyhouse such as soil moisture, humidity and temperature were examined regularly. And, the value of polyhouse designed by design thinking approach was gauzed from overall productivity or growth and insusceptibility to diseases in vegetables.

During this, stakeholders exhibited skills such as creativity, collaborations, communication, and critical thinking that are integral part or competencies of 21st century.

Figure 19

Four polyhouse at the final stage



Evident from our involvements while designing poly-house, these principles (or stages) of design thinking approach implies in solving most of our real-world problems related with pedagogy. Numerous educators and academics have studied the possibility of design thinking improving curriculum and teaching practices (Balakrishnan et al., 2021; Noh & Karim, 2021). This approach proved significant in bringing stakeholders at a common place and transform institution by nurturing and transforming their ideas so as to transform the players itself. It can be said that design thinking has the power to transform the way we work by transforming the way we think, approach problems, and develop products and services (Plattner et. al., 2015). Design and effectiveness of polyhouse was studied from the perspective of Kelley's Standford model of design thinking, and this approach can be used as an important pedagogical means in generating solution to existing issues.

In the second part, I elaborate on how we make preparations to run an experimental design. Effects of various treatments groups (urine, biochar, and chemical fertilizer) over four different genera of crops were discussed in detail so that other can replicate it in their context.

Part Two: Effects of Eco-San: An Experimental Design

Though we have come through a long way of preparations to carry an experimental design inside polyhouse but recurring nature of COVID-19 pandemic was still preventing us from collecting urine from the eco-san unit as school was failing to resume its regular business. Thus, collection of urine which is an essence of eco-san was still a major challenge for us. It was any day in first week of June, 2021. With local teachers we sat for informal discussion to seek any alternative plan we could execute so as to meet current crisis of urine. After a long discussion, we agreed to approach in the community and seek support and guidance from them. Though, we were clear on what we should do but not on how should do. However, amid pandemic

and in a state of lockdown, it was a huge challenge to pay home visit in community and convince them. Certainly, we required to make a detailed planning and long preparation on safety and hygiene as well. But before ensuring availability of urine for fertigation from community, we were left to prepare few raised beds and sow seeds on them for germination.

Figure 20

Division of plots for experimental and control unit

We started designing plots inside polyhouse whereas on the other hand also continued making preparations for urine collection. A randomized block experimental design was used to examine the effects of eco-san (human urine) and biochar on crop yield and soil chemical characteristics in the school gardens of Namobuddha Municipality.

Working On Real-World Problem

In order to solve real-world problem we designed four polyhouse, and under each polyhouse three identical plots (triplicates) were constructed. The total plot size was 126 m2, and each plot was 3.5 × 3 m, consisting of four rows of 20 plants (five plants in one drip line). Drip irrigation was fitted with active participation of local leaders, parents, school teachers and students. Among four polyhouse, one was considered as ‘control’ and remaining three as ‘experimental’. Thus, there were three different experimental polyhouse and were labelled as ‘UB’ (for Urine & Biochar treated), ‘U’ (for Urine treated) and ‘CF’ (for Chemical Fertilizer treated). Only water was used in a triplicate of ‘control’ plots, whereas triplicates of experimental plots were treated with ‘urine and biochar’, urine, and chemical fertilizer.

Three replications of each treatment were performed. Considering market value, and as well as ability to grow in N rich environment, stakeholders agreed on testing following four crops:

1) Tomato (*Solanum lycopersicum*) variety “Srijana’

2) Cabbage (*Brassica oleracea*) variety “Green Coronet F1”
3) Capsicum (*Capsicum annuum*) variety “California wonder”, and
4) Brinjal (*Solanum melongena*) variety “Runako F1”.

Now, both the researchers and co-researchers focused in preparing raised beds at one corner of polyhouse. The whole process of seedlings preparation was guided by experienced teacher Dhurba sir, who has nearly three decades of experience of farming vegetables inside polyhouse. Following his leadership, we collected nearly twenty kilogram of humus (consisting of dead and decayed leaves and bark of tress) from nearby jungle and brought inside polyhouse.

Figure 21

Co-researchers collecting humus from the School's Jungle

We sowed seeds sparsely covering the raised bed. While covering seeds gently with the humus, Dhurba sir asked us:

“Sathiharu lai jungle bata malilo mato lyayara beeu kina purya hola jasto lagchha?

English translation:

“Friends, what do you think why we used humus to cover seed?”

One of teacher said, may be because it is more fertile. Others also speak their mind. Finally, the questioner answered:

“Beeu umrina lai jhandai dainik jasto paani halnu parchha. Tesaile chisyan banairakhna jungle ko mato haleko kinaki yasle dherai paani sosna sakchha.”

English translation:

“Germination requires water at regular interval. Whereas humus possess high water holding ability so to maintain moisture humus are used.”

Figure 22

Co-researchers monitoring germination

While we were preparing four raised beds some teachers were busy connecting water from the tank to the polyhouse. Raised beds were mulched after sowing so as to maintain temperature and moisture. It took two weeks for tomato and cabbage to germinate whereas three weeks for Brinjal and a month for capsicum. Finally, seedlings were prepared and ready to be transported into the experimental plots prepared after deep plowing and harrowing 2 times with tractor. But, before plantation of seedlings in experimental plots, soil sample was collected from four different sites to make it composite. Soil sample was sealed and labelled. The next day, I took sample to the government run Central agriculture laboratory in Hariharbhawan, Lalitpur. Then, it was tested for basic physiochemical properties. Following was the report of soil sample:

Table 3

Pre-farming Soil Sample Report

P^H	Organic matter %	Nitrogen %	Phosphorous %	Potash Kg/ha
5.8	Very Low	Very Low	High	Average

(Source: Soil Test Report, 2021)

The report showed that nutrient availability in research plots were very low for organic matter and nitrogen (but, urine possess high nitrogen if used) whereas average for potash and high for phosphorous. With report of soil sample, we called a meeting with stakeholders and discussed for possible solution. Agriculture department under government of Nepal has their own standard guideline for soil improvements and it was clearly mentioned in test report we received from laboratory. And, we agreed to follow recommendation where 40 *doko* (‘V’ shaped hand woven bamboo basket) of well decomposed organic manure equivalent to 1000 Kg was administered uniformly

in all plots. Then plots were ploughed and levelled again. In all twelve experimental plots four raised bed of equal size were prepared where each crop was given a row.

Figure 23

Co-researchers preparing raised beds

Drip lines were spread across each row. Emitters were placed at an interval of two feet so that each row bears six plants and accommodate twenty-four plants of four varieties within a plot. Finally, drip systems were checked for uniform discharge of fertigation. All of the plots were ready for plantation. Then, next day stakeholders united again and the task of plantation of crops was completed in all four polyhouse.

Table 4

Experimental Setup

Experimental Setup				
Crop	Total plot size	No. of replication	Plant per treatment	Total plant
Tomato	10.5 m^2	3	5	15
Cabbage	10.5 m^2	3	5	15
Capsicum	10.5 m^2	3	5	15
Brinjal	10.5 m^2	3	5	15

At this point of time, we have not only planted all four types of crops inside polyhouse but also succeeded at collecting urine from community. No matter how much difficult it seemed but the dedication of school team made it possible even in tough period of pandemic. These efforts made by researcher and co-researchers as part of university-community collaboration further strengthened bond between school and parents which was evident in the increase in parental participation in school gardening. In this way, school garden could be used to solve real-world problem.

Figure 24

Involvement of stakeholders during plantation

Dapcha Needs Urine, Biochar, and Drip Irrigation

Dapcha was fighting for lack of drinking water, and running a farm house in such situation was a real challenge. With more participatory meetings with stakeholders, we learnt about the multiple benefits of drip irrigation. The whole process of urine collection and fertigation through drip system was coordinated by a teacher who had deployed three local inhabitants to facilitate him in the process. Application rate of drip line is specific to any irrigation system. It can be used to find out the rate of water application in drip irrigation line, given the flow rate (in liter per hour), constant space between the emitters (in cm) and a constant space between drip lines (in cm). In our case, the values were given below:

Flow rate (Q_e): 2 l/h

It was observed that, 240 liter of diluted urine (60 l urine mixed with 180 l water) was emptied by 120 drippers placed inside UB & U polyhouse.

Distance between emitters ($Emit_{y)}$): 60 cm

Distance between drip lines ($Row_{x)}$): 60 cm

When used following equation to calculate the application rate (AR) (or Precipitation Rate) of drip line irrigation system:

$$AR = 231(Q_e \times Eff) / (Row_x \times Emit_{y)}$$

Where, Irrigation efficiency (Eff) is 0.95 for drip.

(Source: Washington State University, 2022)

Hence, Application Rate (AR) of our drip irrigation system becomes 0.56 cm/hr. This means, each emitter fertilized 0.56 cm below the plant surface while

running irrigation system for an hour. The duration of daily application of fertigation (or irrigation) was important and was recorded as following:

Table 5

Duration of Fertigation

	Duration of fertigation (in minutes)				
Treatment	Tomato	Cabbage	Capsicum	Brinjal	Remarks
C	0	0	0	0	Only water, no fertilizer is added.
CF	0	0	0	0	Solid form of CF was used as Basal dressing.
U	60 min	60 min	60 min	60 min	Top dressing.
UB	60 min	60 min	60 min	60 min	Top dressing.

C: Control, CF: Chemical Fertilizer, U: Urine, UB: Urine and Biochar

Figure 25

Working in the Control plot (C)

In the plot where CF treatment was performed, Diammonium phosphate (DAP) and Urea were administered at a rate in accordance with the farmer's traditional practice (180 kg ha-1 N).

Figure 26

Using chemical fertilizers in chemical fertilizer treated plot (CF)

In the plot where Urine (U) was treated as source of fertilizer, the urine collected from the community was diluted three fold times before applying it as fertigation.

Figure 27

Co-researcher observing plant growth at urine treated plot (U)

In the UB treatment plot, besides diluted urine we prepared biochar by incomplete combustion of plant biomass. And, the UB plots were inoculated biweekly with biochar as basal dressing. Two kilograms of biochar was used for biweekly inoculation in all sixty crops in UB polyhouse.

Figure 28

Crops inside urine and biochar treated plot (UB)

In the first week of September, as we began harvesting tomatoes we were amazed. They were turgid and dark reddish which were accompanied by natural aroma spread in polyhouse. Their beauty was overwhelming. Soon, we brought a spring balance from nearby Bazar, Bhakundebesi. Ripening of tomatoes in UB-plot was followed by U-plot. It was the C-plot where tomatoes ripened at the last. We collected first batch of few ripened tomatoes from UB plot and took measurement. It was around two kilograms. Stakeholders made a collective decision of preparing snack from these tomatoes and share them in a team. One of a teacher who was steaming tomatoes in the school kitchen commented that, "tomatoes were cooked in less time compared with tomatoes available in the market." Others reported unique fragrance and palatable. The harvesting period lasted till the end of November.

Different crops differ in their harvesting period. Upon complete harvesting of all four crops we analyzed their gross yield or production. Mean value of all triplicate plots at various treatments were calculated and analysed below:

Table 6

Mean value of crop yield

Mean values of crop yield as affected by different treatment.					
Treatment	Yield in Kilogram (Kg)				
	Crop				
	Tomato	Cabbage	Capsicum	Brinjal	Total
C	7	8	2	3	20

CF	25	20	6	7	58
U	24	24	5	10	63
UB	35	31	9	9	84
Total	91	83	22	29	225

Finally, after complete harvesting of crops from experimental plots the soil sample was collected from four different sites to make it composite. Soil sample was sealed and labelled. The next day sample was taken to a soil testing laboratory (ATC) in Lalitpur. Then, it was tested for basic physiochemical properties. Following was the report of soil sample:

Table 7

Post-farming soil sample report

Table: Soil Sample Analysis Report

Soil Treatment	P^H	N%	P2O5 Kg/ha	K2O Kg/ha	O.M. %	Sand %	Silt %	Clay %	Texture	
C	5.33	0.08	13.53	455.60	0.69	41.06	41.76	17.18	L	
CF	6.02	0.12	54.11	643.20	0.53	47.06	37.76	15.18	L	
U	4.02	0.15	21.26	871.00	0.47	45.06	37.76	17.18	L	
UB	5.52	0.15	25.12	683.40	0.53	45.06	39.76	15.18	L	

(Source: Soil Sample Analysis Report, 2021)

Thus, effects of eco-san, biochar, and chemical fertilizers on the overall productivity or yield of crops were studied. At the end, we are left with a question, why is urine considered as a waste product?

Is Urine A Waste Product?

Generally, waste product is considered as useless materials produced while making something (Merriam-Webster, 2023), or anything which is either hazardous or of useless. If we peep into how urine is produced by our body, then it is simply a by-product produced by the kidneys in their process of cleaning our blood. Excreting urine from body simply mean body does not need it in the meanwhile. Medically, it is considered as waste as our body simply excrete it during its physiological functioning. Actually, urine is not a waste product rather is a waste-like product because of it being little irritant to our olfactory senses. Chemically, large bulk (more than 90%) of urine consists of water, whereas remaining portion consists of Nitrogen, Phosphorous, and

Potassium etc. Many of us who believe urine is a waste product, it shouldn't be overlooked that urine remains completely sterile (free from pathogens or germ-free) until it reaches urethra, with medically ill patient being an exception. Besides this, around 11 g of nitrogen are typically expelled daily, with the majority of nitrogen in urine being eliminated as urea (Thomas, 2023). When we experimented with human urine to cultivate various types of crops inside polyhouse the results were inspiring. In the control polyhouse (C), we harvested 20 kg of vegetables in total, i.e. 7 kg, 8 kg, 2 kg, and 3 kg of tomatoes, cabbage, capsicum, and Brinjal respectively whereas polyhouse which used urine (U), and urine and biochar (UB) as fertilizer yielded 63 kg and 84 kg respectively. When compared with the control, net production increased by 300- 400% in urine and biochar treated plots. The total production in the chemical fertilizer (CF) treated plots was 58 kg, and it is little less than urine treated plots. In all of the four polyhouse, the highest amount of harvest was observed in urine and biochar treated plots.

To this, data shows that use of biochar flourished crop production to a significant level. The chemical nature of the substrate used in the preparation of biochar also determines biochar production; however they contain stable organic carbon, aromatic compounds, aliphatic compounds and ash (Lehmann & et al., 2011). Chemical composition, stability, specific surface, and porosity are among the most crucial characteristics of biochar (Saletnik & et al., 2019) which contributed in better yields of crop in the biochar treated plots. Biochar has number of benefits in sustainable food production as it reduces nutrient leaching, greenhouse gas emissions, increases agricultural productivity, and reduces bioavailability of environmental contaminants (Oni & et al., 2019). Finally, after complete harvest of the crops we analysed soil samples from all four different polyhouse. Compared with control, urine treated plots showed high availability of various essential nutrients such as nitrogen, phosphorous, and potassium. Thus, this experiment informs us that urine being a rich source of nitrogen along other nutrients is inextricably important for sustainable food production, whereas addition of biochar amplifies the food production.

In part three, we share our understanding about exploration of our own (local) resources and knowledge system while carrying school gardening activities. Use of tobacco powder and bio-pesticide in the school garden helped us not only in fighting against pathogens but in recognizing local resources and knowledge.

Part Three: Appreciating local resources and knowledge

While working with stakeholders- primarily with teachers and community members in school garden, co-researchers shared their knowledge about local resources available therein. It was sunny day in the mid of August, 2021. There used to have regular meeting with co-researchers regarding the challenges and progress regarding school gardening.

Figure 29

Community Participation

It was a time when school had resumed its all-academic activities. Unlike before, we were collecting urine not only from community but at the same time school had started contributing a major amount of urine from eco-san unit. I reached school fifteen minutes before the morning assembly. On the ground I saw two teachers apparently worried but having conversation in quite serious outlook. I approached near to Dhurba and Mangal sir and inquired about the reason to be unhappy in the very beginning of the day. Indeed, from the very beginning the school gardening project was a center of attraction both in community and school and this was evident in innumerable yet consecutive participation of co-researchers. Both teachers said, "Tomatoes planted in adjacent neighbors' field began to wilt. So, we are discussing about the possible solution to prevent vegetable inside polyhouse from probable infection."

I asked, "Did you came up with any ideas or plan to prevent or resurrect such situation, if happened?"

"No, but we need to sit together and discuss" they replied. I shared the situation with headteacher and asked to plan for an urgent meeting with other co-researchers. While preparing for meeting, I saw few teachers coming to the school garden during their leisure time and observed the situation in the neighbors' garden as well. Headteacher briefed the general purpose of the meeting and encouraged teachers

to share their ideas on pest management. Dhurba sir alarmed us by saying that our crops are relatively safer than that of neighbors just because they are inside polyhouse but it may not take long time for disease to infect. Then, Ramchandra sir added further to it:

> *"Yadi tyo agaute daduwa dhusi ko sangkraman rahechha vane hapta-dus din pani lagdaina rog phailina. Hamile rasayanik wishadhi ko shighra prawandha garnu parchha."*

English translation:

"If the infection was by *early blight fungus* than a week or 10 days could be long time to destroy our crops. Sooner is better to get prepared with chemical fertilizers."

Figure 30

Participation of stakeholders in a meeting

A typical fungus that causes leaf spoting in tomatoes is called early blight. *Alternaria* leaf spot or target spot are other names for it. Early blight is caused by *Alternaria solani (*Baysal-Gurel et al., 2009). The early blight fungus can originate from a variety of places such as from soil or purchased seeds. Teachers continued adding facts about various diseases that infects tomatoes.

Sunbathing Sterilizes Soil

Headteacher adds as the discussion was more focussed in finding solutions in our own context.

"Yadi yo maato batai aayoko ho vane ta hami aattinu pardaina ki? Kina ki, haamile hamro sabai plot harulai suryako prakashle nirmalikaran gareko thieu ni ta. K hamile bastabik srot ko pahichana garna sakchhau ta?"

English translation:

"If the fungus originates from soil, we should hardly worry on. Because, we had sterilized soil by Sunbathing. Can we identify the real source of disease?" After land leveling we had left entire field barren for a month so as to reduce or minimize the load of pathegenic microoranisms from further growth and multiplication in soil. Sunbathing is a traditional practise adopted by many farmers where the ultraviolet radiation of the Sun inhibits or kills the harmful pathogens. Sunbathing is said to have numerous benefits. Sunbathing is used to swiftly get rid of nematodes, mold, and other undesirable organisms from the growth media. This aids in creating the ideal growth environments for seed germination. Improved crop output because of greater nutrient availability might be another benefits of soil sterilization. Additionally, it is believed that such method of soil sterilization enhances helpful soil bacteria and other microbes. But, a scientific study is essential to back up such practices. Whatsoever, these beneficial practices and knowledge that has been inherited from our ancestors must be appreciated and valued. Also, tracing the real source of fungal infection in our neighbour's garden was a farcry for us. The fungal spores are microscopic and dormant in nature, thus they can came in contact with crops in many other ways. Wind, water or even the farming utensils could be a potent carrier. And, I requested co-researchers to find better soultion of prevention.

As discussion was going on, suddenly math teacher draw all of our attention. He said:

"Hamile yaha purnataya jaiwik tarikale kheti gariraheka chhau. Tesaile rasayanik wishadhi ko bikalpa kina nasochne ta?

English translation:

"We are practising organic farming here. So, why don't we think organic ways of pest management?"

Tobacoo Against Shoot Boorer

One of a co-researcher shared his ideas and experiences on pest management. A decade ago, he had taken training at District Agriculture Office (DAO) in Dhulikhel. And, had learnt to recognize categorize pest into friendly and harmful. The goal of

"integrated pest management" or IPM is to create a healthy crop with the least amount of interruption to agro-ecosystems while promoting organic pest control methods.

Figure 31

Numerous pests infecting crops inside polyhouse

Nepal government in support of FAO, Norway and other agencies lunched from IPM program from 1998 to 2014, where over one hundred thousands of farmers have been graduated from Farmer's Field School (FFS) and 2700 trainers are actively facilitating IPM process across the nation (Kafle and et., al, 2014).

Figure 32

Co-researcher treating infected Brinjal plant with local method

There were few Brinjal plant in experimental plots wilted by attack of fruit and shoot borer. Now, rather than chemical pesticides co-researchers began searching biopesticide as its remedy. Then, we carried its treatment by circumventing the plant with fine tobacco in the soil and observed the effects for few days. Also, we pruned

the infected and wilted steam and leaf immediately. We saw larvae hiding inside these wilted stem and slowly hijacking the nutrients from the vascular bundles (phloem) of plant body. To these worms we put the tobacco powder as stimulus and observed its response. To our surprise, the worm wriggled for a while and died within a minute. This serious issue of infant Brinjal plant was solved using biopesticide.

Formulation of Biopesticide

Besides this, we still had a major challenge of probable fungal infection in tomatoes or cross infection from neighbors' farm into polyhouse. And, to this problem we came up with two clear options as its solution. First was to prepare bio pesticides using the local resources and local knowledge and test for its effectiveness. In case of its failure, we determined to make a quick shift onto chemical pesticides since fungal infection spread abruptly. With this broad understanding all of us agreed to collect local herbs that could cause unusual sensation and irritation in pest such as bitter, foul odor, spicy etc. We collected *Titepati* (*Artemisia vulgaris*), *Asuro* (*Justicia adhatoda*), *Banamara* (*Ageratina adenophora*), *Neem* (*Azadirachta indica*) and *Sishnu* (*Urtica dioica*). It was altogether ten kilogram in weight.

Figure 33

Preparing biopesticide using local knowledge and resources

These herbs were cut into small pieces and put inside a container which was finally immersed in cow's urine. The container with its cap closed was placed in sunlight. The mixture was stirred every day for ten days. Finally, we got dense solution with strongly pungent odour.

Figure 34

Biopesticide in the final stage of preparation

The prepared solution was diluted in the ratio of 1:4 and applied in the stem, leaf, flowers and fruits as top and basal dressings. Treatment was applied every week.

Figure 35

Using locally prepared biopesticide in infected tomato plants

During first three weeks, there was no any fungal infection in tomatoes. The local resources and knowledge worked very efficiently and succeeded keeping away infestation for nearly a month. Thermodynamically speaking, the nature of our polyhouse was more open system where energy and matter exchange conveniently thus the biopesticide and other ways of IPM alone remained insufficient to combat pathogens. In today's world growing organic and healthy crops have been big challenges for a developing nation. It is because a number of extraneous and

microscopic factors from seeds to ongoing practices in society play a detrimental role in their healthy growth. It is a high time to raise awareness in local as well as global arena by appreciating and valuing local knowledge and resources into practice.

In part four, I share narratives about a long and challenging journey we made amid the pandemic with community members while we seek more urine to run experiments.

Part Four: Community- University Partnership: An Opportunity For All

During community-university partnership in ecological sanitation (eco-san) based school gardening work, I encountered many opportunities to reflect and review own practices. I, being a representative of university worked together with a group of community members for a period of more than a year. Active participation of major stakeholders were observed during land labelling, construction of poly-tunnels, fixing of eco-san unit from urinary of community school to the garden, plantation, fertigation and harvesting. Among them, a remarkable interaction with community took place at a time when we had to depend entirely upon local community for urine in order to run our experimental plots. Though earlier researchers from university had substantial engagement with the parents but we had some other challenges at that moment. Firstly, the situation was very inconvenient as nation-wide lockdown was in execution. Second was related with our work itself. We were seeking urine from community despite knowing what and how they might respond to us. Anyway, organized and motivated group of co-researchers decided to set a new experiment in the community.

Donate Urine, Save Life!

We calculated the volume of urine for daily requirement in experimental plots and it was 60 liters per day. Humans regularly generate urine, which includes certain nutrients necessary for plants growth (Adeoluwa and Cofie, 2012). In average a healthy person produces 500 kg of urine in a year, and 1 to 1.5 liters per day (K.C. and Shinjo, 2020). To collect the required amount we required more than forty people who could donate urine in regular basis for more than three months. We planned three ways to fulfill our targets.

Figure 36

Community members taking urine collection vessels from school

Firstly, we distributed a gallon (10 liter volume), a funnel and bedpan for twenty houses in community. We explained every community members the reason for their contribution of urine and asked for their interest to sustain the research work. Almost all of them were happy to be a part of this campaign.

Second was collection of urine from the public space. We had to build temporary urinary center in public place. And, while we were collecting raw materials for making urinary we were facilitated many people from the community.

Figure 37

Constructing urinary at public space for urine collection

They helped us throughout the day by building walls, rooftops and even fixed the pan. Even furthermore, one of community member convinced why we urine is important in irrigation. Publicly he was raising his voice for building trust and support with his slogan, "*Pisab dan garau, wanaspati ko jiwan bachau*!" This means, "Donate urine, save plant life!" Entire co-researchers were motivated to partner with community members. This was just a beginning. We had to go a long way in building trust and continuous support from the community. Going back to everyone's house regularly and collecting urine in a safe way requires some intelligent execution. Thus, under the supervision of teacher process of collection of urine was coordinated.

Besides this, some co-researchers also made personal effort to collected their own urine and contribute in the process of experimentation.

Figure 38

Centrally collecting urine into Eco-San tank

School Garden as a Community Learning Center

For a number of times local bodies (or *Janapratinidhi*) of Namobuddha Municipality visited the school garden. They inquired about how we used eco-san to grow vegetables and appreciated the experiential way of learning STEAM disciplines. They reflected loyalty and appreciated the undergoing work inside polyhouse. During my year-long engagement in school gardening, it can be said that building relationship from both community partners and university is a time-consuming process and demands genuine reflection of loyalty from both (Pant, 2021). Recognizing and appreciating the skills and effort provided by community partners is equally vital.

To advance its strategic aim of ending hunger by 2025, Nepal has encouraged all stakeholders to take a concerted effort (MoAD, 2016). However, if we examine the present rate of vegetable intake per person annually, it has increased feverishly from 60 kg to 105 kg of vegetables since two decades ago (CBS, 2009/10). Thus, to create equitable food system in the community, universities should take opportunity to review public policies in order to build the capacity of their community.

Participatory action research (PAR) had explored the opportunities as well as challenges encountered by stakeholders such as community practitioners, faculty and researchers / students in the "real world" settings. Additionally, community partners and practitioners ought to communicate to their university partners both their strengths and their weaknesses.

Figure 39

Members of local government learning from School garden

In addition to community practitioners, academic members should be clear about their roles and objectives throughout the relationship by developing standardized rules or procedures for collaboration and communication between communities and universities.

The relevance or value faculty assigns to the farm visit to their students or the integration of field-based activities in curriculum might be indicators of the quality of the university-community collaboration. To this aim, I would advise the faculty to provide the researchers and students plenty of opportunities to express their results or reflections in the journal. During my fieldwork, I came to the realization that future community-university cooperation will be greatly influenced by the promises and commitments made to farmers or community partners. Also, every researcher and student should understand that we represent the ideals of the university in the community, thus we must practice and exhibit participatory techniques and attitudes at the greatest level.

In part five, I discuss on how could revive a place which has been neglected since so long for being inefficient to fetch daily requirement. While working in the revival of such place, we learnt to value the significance of context, tradition and wisdom by which we are bound with.

Part Five: Reviving forsaken Entrepot: Context, tradition and wisdom

Old Newari settlement- Dapcha, now confined under Namobuddha Municipality, once served as a bustling commercial hub. To me, this community

resembled a museum of history, a piece of the past we neglected while we created more efficient trade routes and transportation systems.

Figure 40:

Eco-San unit in the final stage

Dapcha, a forsaken entrepot on a historic trade route from Kathmandu to Eastern Nepal, is located high in the hillsides. I noticed that majority of the youth are gone in Dapcha, since many have relocated to the city in search of "warmer climes," like other hillside settlements. Dapcha, according to what I've been informed, formerly had a thriving market, but in the present it has been reduced to a hushed up, expiring bazaar that has only reminisces of the past. Many homes in Dapcha still adhere to the Newari architectural style of the Middle Ages and have remained untainted by contemporary styles. I witnessed that this region has suffered as a result of the present times because of how quickly circumstances are evolving.

Recognizing Our Wisdom Tradition

The ethnic communities of the Tamang, Newar, and Khas (including the Brahmins, Chhetri, and Dalit) make up the municipality's population, which provides the municipality a diverse cultural fabric. The Namobuddha shrine, which is connected to Sakyamuni Siddhartha Gautam, the historical Buddha who was born in Lumbini, Nepal, is the municipality's most important cultural asset. While we consider on wisdom tradition or focus on Nepal’s history of enlightenment it reflects three traditions—Vedic, Videha Janak and Buddhist (Dahal, 2014). Each of these traditions explores the purpose of existence, the reality of human nature, connections to the natural world, and means of emancipation. Primarily, in Dapcha, the Vedic and Buddhist philosophies hold the path to enlightenment (Namobuddha Municipality, 2022) and the reconciliation of *atman* and *permatma*, human mind and heart, as well as nature and culture, is the disintegration of the personal ego for larger public benefit

(Dahal, 2014). The foundational tenets of its authentic civil society are niskam karma (selfless service to others), enlightened thought and behavior. Since ancient times, the seers, sages, leaders, and masters have believed in the rational, irrefutable possibility of achieving peace via social equality. According to the Hindu-Buddhist worldview, individual freedom is only permitted to the degree that it does not jeopardize nature's ability to survive, and this is what sustainability should be concerned with.

Etymologically, Oxford learner dictionary has defined sustainability as involving the use of natural products and energy in a way that does not harm the environment (Oxford University Press, 2022) whereas Cambridge dictionary defined it as causing, or made in a way that causes, little or no damage to the environment and therefore able to continue for a long time (Cambridge University Press, 2022). Central to these definitions is focus over the environmental issue. In exploring what sustainability meant for 'Namobuddha' we worked collaboratively with all the stakeholders from the very beginning of our discussion. Actually, in the rural setting of Namobuddha Municipality where modern and ready-made resources and materials were scarcely available, we had a challenge to explore and develop 'Namobuddha model of sustainability' using more and more locally available resources. On the other hand, despite the dominating atmosphere of western modern worldviews on education and sustainability we reached a common understanding with teachers and community leaders to explore from our own wisdom tradition and local context.

Redefining Sustainability

Reviving the forsaken Entrepot was what most stakeholders dreamt of. The abundant natural resources, cultural diversity, and strategic location on the Sindhuli Highway, which is expected to stimulate commercial activity, Namobuddha Municipality has excellent economic potential. The municipality in its official web portal had announced that the Kathmandu Valley's "farmers markets" mostly feature goods obtained from the Namobuddha mountain flank's northern villages of Phulbari and Patlekhet, which is the nation's hub for organic farming (Namobuddha Municipality, 2022). Indeed, the success stories some agro-preneur encouraged school team to onset school gardening projects in sustainable way. Food production in a sustainable society must be based on the return of plant nutrients to the soil (Winblad & Simpson-Hébert, 2004). The problem of discovering innovative ways to boost soil fertility for sustainable agricultural production has resulted in the option of recycling

waste materials such as human urine and excreta. Ecological sanitation is a different strategy to get over the drawbacks of traditional wastewater systems (Werner et al., 2004a). The closure of material flow cycles and ecological techniques are the foundations of the eco-san sanitation paradigm.

Open defecation has traditionally been a practice among the majority of Nepalese people (Water Aid Nepal, 2006). One of Nepal's Sustainable Development Goals (SDGs) aims for 2030 is to achieve universal and equitable access to clean, affordable drinking water, sanitation and hygiene for everyone, and the elimination of open defecation (NPC, 2017). In the past, farmers in Nepal would discharge pit latrines onto the farmland while they were growing vegetables and using urine and excreta as fertilizer. The farmers eventually started building septic tanks for their toilets and stopped utilizing the sewage on their farmland, instead disposing of it in local rivers or drainage systems. For this reason, to maintain the rural environment's cleanliness and boost rural agriculture output, it is crucial to look into the potential uses of eco-san urine.

Thus, in order to lead to enduring peace, modern civil society, which is disturbed by the instability of postmodernity, has to grasp this old knowledge that sees human existence as connected to other beings rather than as separate shards. In order to alleviate from the current situation, the balancing of differing ideologies and affiliations calls for more honesty, meaningful discussion, and collaboration. The eternal essence of our ancient wisdom shall be revived through a web of public sphere anchored in the open discourse of the historical past. And, for which, schools or the educational institution could be a center of that sphere as they possess numerous interconnections in any society. Such intricate relationship of school with society could build long-lasting harmony, a common understanding of democratic nation, and a collective sense of equity for all people. Thus, this is a high time to redefine sustainability from our own context and using our own wisdom traditions.

Chapter Summary

It is a compilation of narrations related with gardening phase while we worked with teacher, students, and community people. We designed four polyhouse using a design thinking approach thereby generating partially controlled environment inside it. Local resources and local knowledge were of utmost utilized from the construction of polyhouse to the harvesting of vegetables. Polyhouse were divided into experimental and control unit where efficacy of urine, biochar, and chemical fertilizers were tested.

There were triplicate of plots, and drip system of irrigation was uniformly incorporated. The harvest was highest in urine and biochar (UB) treated experimental plots, proving both the urine and biochar as an efficient fertilizer.

During the research journey, we observed a strong partnership between community and university as well. Whether it is in the collection of urine from the community or in construction of polyhouse, community members had provided significant contribution. Together with school teacher, students, and community member, we hope that Dapcha, once a forsaken Entrepot shall be revived. And, this is how we could contextualize our curricula valuing cultural diversity, available (local) resources aligned with learners, (wisdom inherent in the) place, and the disciplinary contents. Moreover, this experiment poised certainly a number of questions before us as a challenge to implement eco-san based school gardening: why have we been considering urine as a waste product? What prevents us to consider urine as a potent source of local fertilizer? How could we re/design our pedagogies so as to appreciate local resources and knowledge? Certainly, these challenges demand a critical perspective to reflect (and rethink) on what sustainability was/ is/ should be for us.

CHAPTER VI
HARVESTING PHASE: BEING IN/WITH THE SCHOOL GARDEN

Harvesting phase brings stories about entrepreneurial learning concerned with how the products of school gardens were connected with local markets. While harvesting good health from the school garden, I reflect critically on our journey so as to improvise action in the second cycle of gardening. There were stories of excitements and imperturbation as we initiate integrating few aspects of artificial intelligence in the school garden, and these stories have distinguished our ultimate journey of exploration of STEAM pedagogy from very beginning to the execution of intelligent design in a newer vista. However, this chapter is a continuum of preceding one (chapter V) as it carry on exploring second and the third research question, i.e. *"How does school gardening evolve as a new pedagogical model in STEAM-based learning?"* and *"what are the prospects and challenges to implement school gardening as STEAM Pedagogy?"* Let us delve into each theme we have prepared regarding the harvesting phase.

Part one concentrates over journey towards entrepreneurial learning when garden products (Tomatoes, Capsicum, Cabbage, and Brinjal) reach local markets. How entrepreneur learn, especially in small scale organization have been narrated herein.

Part One: Building Local Economies: Entrepreneurial Learning

We intent to explore various forms of learning while journeying through school garden. As stakeholders stepped into harvesting phase, it helped us in understanding of how entrepreneur learns. It was early morning of 27th November, 2021. Thundering with flashes of light and rainfall was implanting thought about impermanence of nature. Peeping into magnificent mountains of Namobuddha through humid glass pane, I was cognising on if anything lasts forever. Actions we made beginning the school garden was reeling in my mind. We came so far. The hilly land with 24% sloppy orientation was plane-labelled, the dry barren lands were irrigated, and successfully harvested crops. This was the day to quantify immense love and gratitude bestowed upon us. We began sum total our harvest. Indeed, we harvested 270 kilo Tomatoes, 249 kilo Cabbage, 66 kilo Capsicum and 77 kilo of Brinjal from the twelve plots. In total, it was approximately 675 kilograms of vegetables.

Early Experience as a Base in Entrepreneurial Learning

Long before tomatoes begin to ripen inside polyhouse, we thought of its possible market. School had no clear idea or any experience of selling vegetables in school since had never practiced growing. I put curiosity on possible market for garden products in teacher's meeting, also strategies if any we could think of. With a surprise few teacher stared at me. I made a quick react, "why we surprise? Isn't it a high time to think about exploring possible market for our products?"

Immediately, Ramchandra sir who had a small tailoring shop nearby school speaks his mind, "though Dapcha bazar looks small, the *Newari* people (indigenous community who practice buying and selling goods as traditional occupation) of this place have skills of business all in their gene." I had heard many stories about Dapcha as it is an old and forgotten Entrepot of trade. However, nowadays there are few local shops in bazar. One cannot find more than beverage (home-made alcohol) as local product in these shops. We, in Namobuddha were accustomed to buy food products grown somewhere else. So, I asked again, "what's preventing us to express those unexpressed gene, Sir?" This time, he smiled and said, "Sir, this could be a right time to practice entrepreneurial skills we learnt from forefathers." Together, we burst into laughter as teacher reflects over issues.

Finally, stakeholders agreed to sell the harvest in nearby shops. We approached local Shopkeeper, Narayankrishna and Bijuli *dai*. Initially, they looked hesitant to sell our harvest. Prashant sir, a local teacher and accountant of school was the first to read micro-expression in the face of local shopkeepers. He published their mind:

> *"Dai haru school ko tarakari bechna lajaunu vayako chai pisab le umareko vayara hola, haina? Ek patak rakhnos, bikri vayana vane hami antai lagchhau!"*

English translation:

"You looked a bit hesitant to sell vegetables we harvested in school garden because we grow out of urine? Brothers, try selling once. If it is not sellable we will take elsewhere."

In order to motivate these shopkeepers, initially we had reduced the cost of vegetables by 20% as compared with market price. Finally, both Shopkeepers agreed in our proposal.

Tomatoes were the first to harvest in garden. In a period of five days we harvested ten kilograms tomatoes and gave five kilos to each Shopkeeper. All of us

were much excited to know initial feedback from customers. Although, before selling vegetable products in the nearby market, teachers have tested them. Unique and pleasant taste of these organic vegetables had heightened their self-confidence to a newer level. After three days, we planned to collect feedback from Shopkeepers but to our surprise, they reached school garden with baskets asking more tomatoes.

Figure 41

School garden developing as source of vegetable

It was completely beyond our expectation. Bijuli, a Shopkeeper said:

"Pisab bata school ma falayako golibheda k bikri hola ra socheko thiya, tara ekdam swadilo rahecha bhandai haadaalus nai po vayo ta sir."

English translation:

"I was thinking who would buy urine-based product of school but people immensely liked it because of its superior taste."

I realised early experience as a base for entrepreneurial learning. Entrepreneurial learning reflects the importance of experience as a central consideration of all learning (Boud et al., 1993). Local teachers and community members exhibited good sense of entrepreneurship as many generations the *Newari* community had practiced it, and it inspired all of us. Choueke and Armstrong (1992) have discovered on which type of learning influences in personal development. In their findings, 95% said past experiences, 61% said learning from colleagues whereas 54% said self-learning has significantly impacted in personal development. And, conceiving school garden as a pedagogical tool exposes learners with entrepreneurial skills that

are inevitable for survival in global age since it offers unique experiences to learn from colleagues and self-learning.

School Garden as a Locus of Local Economy

Success story of school garden spread as forest fire. In a week, few group local businessperson visited school garden. They observed how stakeholders worked in school garden. And, ordered vegetables for their hotels. I inquired with one who travelled five kilometer distance for buying the school garden-grown tomatoes. He said to me that he was ex-student of school and was running a hotel for his livelihood. In order to prepare snacks such as noodles and *mo:mo:* (a steamed food usually taken for snack) and its soup, he came to school garden seeking Tomatoes and Cabbage as they are grown organically and relatively less cheap. We were simply overwhelmed with joy for growing love for the garden-based products. Many inspired us to increase and enhance volume of school garden by incorporating more varieties of organic products in future. During harvesting, garden products were booked by many shopkeepers, local people, firms and institutions. Because of our limited production, we couldn't fulfill all of their demands but promised to fulfill later with more addition in our varieties as well. While witnessing erosion of demand of vegetables from the local vendors I felt many times that we could enhance and strengthened local capabilities for more innovations.

And, at this moment a question hunting my mind is, can school be an engine of innovation, a center for local economy? Though, we are very far away from answering this question. However, most of our schools are financially stressed but for the purpose of imparting good education if they could accommodate field-based engagement in students and teachers' schedule they could certainly drive school into an engine of innovation. By this, there remains a high possibility that school themselves can derive a lot of financial benefits that could in turn enhance the educational qualities. In addition, place where parents have very poor income, garden-based leaning could deploy a large number of parents with skills which will not only enhance parental engagement in school rather contributes in boosting local economy. Gibb (1987) says "the predominant contextual learning mode in small business environment is that of . . . learning from peers; learning by doing; learning from feedback from customers and suppliers; learning by copying; learning by experiment; learning by problem solving and opportunity taking; and learning from making mistakes." Thus, if we establish school as a small business environment, as a center of knowledge production and

innovation, a place for research and development (R&D), then it will soon revolutionise local forms and organizations to cooperate with schools. In this way, we could revive our schools in a new role and goal, and as a locus of local economy.

Part Two: PAR: An Opportunity for Self-Transformation

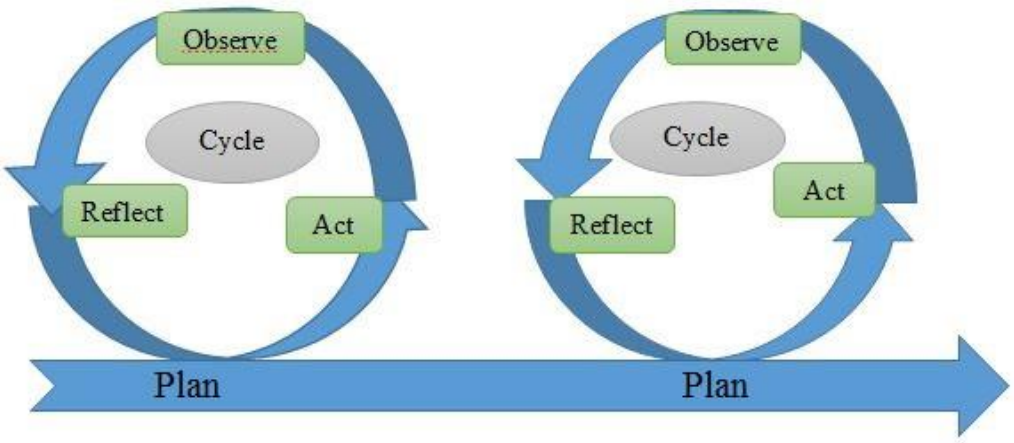
While journeying participatory action research (PAR) as my methodological choice, many times I disobeyed the mechanistic descriptions of PAR offered in literatures. While working in a real-world setting with number of co-researchers, we had to come up with unique perspective and solution to many of the challenges we encountered.

What Did and Didn't Work Well?

Stakeholder visited PAR cycle (observe-act-plan-reflect) often periodically reflecting over what did and didn't work well. Pandemic and the state of lockdown enforced us to face several challenges among which one was limited participation of students in the first cycle. Nearly six months later, situation progressed in all of us favor. School resumed their schedules and we were connected again with students in larger circle. As we introduced eco-san embedded school garden as a new factor of change in the school garden and acted upon, we observed the whole process, our involvement and its consequences. We spent countless time in reflecting on the process. In the PAR, reflections are important because they inform about re-planning.

Figure 42

PAR cycle



Many scholars such as Jean Piaget, John Dewey, Lev Vigotsky, Jeromy Bruner, Jeorge A. Kelly and Ernst Von Glasserfield enriched Constructivism with

multitude of approaches. The fundamental lamppost of cognitivism, Twomey Fosnot (1989) brightened up cognitive corner with his four principles;

1) Learning is an important way, depends on what we already know.
2) New ideas occur as we adopt/ change our old ideas.
3) Learning involves inventing ideas rather than mechanically accumulating facts, and
4) Meaningful learning occurs through rethinking old ideas and coming to new ideas which conflict with our old ideas.

These aforementioned principles began igniting the mindset of co-researchers with notion of 'self being the designer of own fate.' Weekly discussion sessions with co-researchers during PAR might have helped them realise that we should be responsible in constructing more productive and constructivist classroom that consists of learner's centered active instruction.

Now, a question arises before us: how do teachers keep on preparing learners in constructivist classroom? 'Rupantaran' project planned of continuing field visit for stakeholders to powerful learning sites such as agro farm, model schools etc. And, we organized sharing session to reflect on their belief and values. Discussion sessions were accompanied by sharing the prospects as well as challenges of place-based pedagogy at the center. SMC, PTA and teachers shared their experiences and practices. While important discussions and sharing were undergoing we reminded how important the culture of reflection is. It was not an easy task. Sometimes things do not work as our plan, and the same plan may not work for all kinds of learners. However, we began constructing a new notion of school where we could 'enjoy' in our professional practices This was something special to all of us involved as prepared ourselves to learn, unlearn and relearn. Upon being critical self-reflective we felt strong desire to construct school garden, first in our mind and then out of it. Dougiamas (1998) in his paper 'A journey to constructivism' unfold some pedagogical insights:

"……students come to class with an established world-view, formed by years of prior experience and learning. Even as it evolves, a student's world-view filters all experiences and affects their interpretation of observations. For students to change their world-view requires work. Students learn from each other as well as the teacher. Students learn better by doing. Allowing and creating opportunities for all to have a voice promotes the construction of new ideas."

In a series of meeting that took place for a week, we reflected on our actions and observation from the preparatory phase to the harvesting phase. We found that the yields were better and higher in the plots where urine along with biochar was used as fertilizer. Also, the status of proportion of micronutrients was higher and P^H optimum among all. Hence, stakeholders agreed to uses urine and biochar in all twelve plots of four polyhouse. We had observed that Brinjal were highly infected among all crop types and it was the urine treated plots where rate of infestation was highest. All of the stakeholders who were directly or indirectly involved in school gardening rarely had efficient technical knowledge. These facts were more evident when we faced very cruel moment of pest attacks primarily in the Tomatoes and Brinjal.

Figure 43

Crops infected by pests

Agro technicians were uncommon in the rural Namobuddha. The only option we have was consult with technician from government offices (such as *Krishi Gyan Kendra* or district and regional agricultural offices). Again, addressing our issues from these resource center was still beyond our reach as they don't have provisions of visiting farmer's farm rather farmer had to visit their office.

Solutions as Integral Part of Transformative Learning

Beautiful part of journeying through PAR is that not only problems but solutions became integral part of transformative learning. We go beyond our issues, placing ourselves at the center of accountability for most of our challenges, and discovering solutions. For time being, we had to depend on internet as an available source of knowledge on pest control and management since technical services offered by government and public organizations were beyond our reach. Pondering over innumerable diseases and discovering the proper remedy in the right time was not only troublesome but tedious. Thus, while reflecting over plant pathology with the knowledge and resources poorly available at school garden, we thought of bringing few modifications in second cycle of PAR by incorporating artificial intelligence in

pest management and disease control. To this, we agreed practice crop rotation as another modification or approach in pest management and nutrient recycling for second cycle.

Because of sharp reduction in spread of n-COV-19 virus we were planning to reconnect student from grade six to nine as prominent actors. Teachers seemed excited to share their experience of gardening learnt so far in the previous cycle with their students. About involvement of students for coming cycle of school gardening, headteacher planned an immediate meeting with teachers and said:

> *"Shikshyak sathiharu, hamile hapta ko dui din afno bidhyarthi haru lai bagaicha sanga jodnu parne huncha, ra tesko lagi hamro pratakshya anubhav ra bigat ma bhag linu bhayako rupantaran ko gosti ra talim lai liyara* STEAM *pariyojana haru banauna dui hapta ko tayari-samaya chhuttayako chhu. Ahile kamtima ek chauthahi path lai pariyojanama adharit banaune prayas garnuhos."*

English translation:

"Dear teachers, as we planned to connect our students with school garden twice in a week, I have allocated time period of two weeks to prepare STEAM projects based on our direct field experience, workshop and trainings we have attended through *Rupantaran*. For now, try preparing projects for one-fourth of lessons."

This was milestone decision from the school administration to incorporate STEAM approach of teaching and learning. Very soon, teachers began to prepare STEAM projects by connecting their curriculum with the school garden. Hence, transformative learning as an important theoretical construct could be used to strengthen implementation of garden-based learning.

On the other hand, we had to begin a new journey of incorporating few aspects of artificial intelligence (AI) in the second cycle of gardening. So, with active involvement of Science, Technology and Math (STM) teachers we dare to move ahead towards the land of unchartered territory.

Part Three: Integrating AI in School Garden: Prospects and Challenges

It was 5th December, 2021, a special day for school gardener at Namobuddha. We spent almost all of 2021 working in soil, manipulating and nourishing them with various arrays of fertilizers and water. And, this very special day of 5th of December unified in saving soil as we were celebrating World Soil Day-2021 with a new perspective to integrate some intelligent design in school garden. We had divided

students from grade six to nine into two groups and with both groups along with STM teachers we gathered in ICT lab for raising awareness on what artificial intelligence is.

Figure 44

Workshop on Artificial Intelligence

After-School Class Bridges Gap on AI

Giving some historical background along with brief introduction we showed learners videos about how IBM robot participated in debate with human, Google's driverless car, the humanoid robot 'Sophia', and Honda Asimo and Boston dynamics AI Robot. As we observed the students' curiosity during the workshop, we became confident that they would empower themselves in the future and comprehend the fundamental ideas underlying this novel technology, AI. In a separate interaction with participants, they agreed to acquire knowledge about electronics and electricity as a prerequisite to understand the world of automation and robotics. Thus, immediately after workshop, we made a rough schedule for 'basic electronics and electricity' as after-school class for students and teachers, where we agreed to focus largely with sixth to ninth graders and STM teachers for nearly a month.

During these periods I interacted with twenty-two participant including three teachers and was amazed by their unbelievable dedication towards learning how Artificial Intelligence works. During these periods, I realised that that schools should play a significant and responsible role in giving students opportunities to learn and directing them toward success. Learning must be directed toward developing cutting-edge abilities and applications that will support a strong future in a sustainable environment.

In the workshop, together with students we understood fundamental knowledge on AI such as definitions and its type, reasoning, problem solving and about machine

learning and its applications. We learned about common AI technology in terms of applications, such as how Facebook identifies our friends in images we upload and YouTube recommendations. Besides sharing knowledge about AI, we had allotted times in enhancing AI skills such as programming skills and computational thinking skills. Computational Thinking refers to "a student's ability to solve problems, design systems, and understand human behavior based on computer science (Wing, 2006)." While carrying hands-on activities in the after-class, we concomitantly shared advantages and disadvantages of artificial intelligence and allow learners to reflect on what is morally correct and appropriate and what is not. In order to bridge the existing gap, the after-school class proved significant since learners acquire basic skills of electronics and electricity which enhance their computational thinking.

Where Do We Stand In AI Education?

In China, MOE drafted the Artificial Intelligence Action Plan for Institutions of Higher Education in April 2018, listing the "construction of a multi-layer AI education program including that at the primary and secondary school levels" (Liu, 2022). Whereas in India, the IBM AI Curriculum was launched in collaboration with CBSE in September 2019, and as part of this curriculum, AI skill training was provided to 5,000 Grade XI students and 1,000 teachers across India (Sheth, 2020). In the near future, it is expected that AI technology will advance at a rapid rate and become a general-purpose technology similar to networking and electricity. While our northern and southern neighbors China and India moved way ahead in crafting and implementing school curriculum in artificial intelligence, the Curriculum Development Center (CDC) in Nepal looks far behind to realise the significance of Artificial Intelligence in the age of digital economy. Whereas, if we peep into the higher education in Nepal, there are plentiful of programs such as Bachelor of Computer Engineering (BE computer), Master of Computer Science (MCS), Bachelor of Science in Computer Science and Information Technology (BSc. CSIT), Master of Science in Computer Science and Information and Technology (MSc. CSIT), Bachelor of Technical Education (B Tech Ed), Bachelor of Technology in Artificial Intelligence (B Tech in AI) and Master of Technology in Artificial Intelligence (M Tech in AI) to name a few programs run by various universities which significantly broadens our knowledge about Artificial Intelligence. In order to educate students on AI, Ministry of Education, Science and Technology (MoEST) along with other stakeholders should reflect serious interest and concern in designing policy framework and procedures.

The purpose of education has to be changed to reflect how our society is developing and how AI will be integrated into human labor systems in the future (Parliament 2018).

A school is renowned for its teachers' ability to bring out the best in the learners. The future of the nation will be shaped by students; it is up to them to clear the way for sustainable growth and the preservation of the environment. And, learner who understands AI should be able to use it to advance mankind. I call it presence of AI attitudes in learners. Till this date, our school education has been seriously missing AI attitudes in our learners as CDC failed to recognize its worth in digital era. Needless to say, in both our personal and professional life, artificial intelligence is gaining popularity in a variety of applications and has embedded almost in every of our life. This was more evident in the reflective note of a teacher during after-school class. He recalled his daily routine as following:

> *18th December, 2021*
>
> *"As I participated in various sessions on AI, very soon I realised that we have been surrounded by AI all around. Though, it might seem funny for a while but its truth. I wake up in the morning with my alarm downloaded in my mobile app, and then look for todays' weather forecast. As I checked Facebook as morning routine and surprisingly I got new friends suggested by Facebook. As I upload a picture in Facebook, it suggested me to tag my friends. Then, I checked videos for todays' presentation in class. I got surprised when You Tube recommended videos that I wished to view. Then, I took my lunch and opened Pathao (an ride-sharing app) and a two-wheeler came to me. I rode bike and reached school. There, I checked my email, but already the Artificial Intelligence within the system has removed emails containing malicious codes of virus in the Spam.*
>
> *It really surprises me when I reflected upon my daily schedule. From every knock and corner we are surrounded by Artificial Intelligent. So, I was grateful to learn all of these wonderful prospects along with the challenges of Artificial Intelligence in the days to come."*

Therefore, it's a high time that we must act responsibly for putting ourselves and our students in the best possible position for the future. And, being a responsible citizen of digital era should empower learners emphasizing upon AI literacy based on knowledge, skill, and attitude. With this, we can overcome challenges of integrating

Artificial Intelligence in our education and transform young learners into a successful innovator of digital era.

Part Four: Crop Monitoring Robot: An Explosion of Soft Skills

After acquiring general knowledge of Artificial Intelligence, we made action plan on designing Crop Monitoring Robot (CMR) to facilitate disease detection process in the school garden. In the first cycle of gardening we had manually inspected all four polyhouse of school garden and marked diseases using traditional techniques but such traditional approaches demanded a lot of time, effort, and manpower. Empathized from our involvements in first cycle of PAR, we defined several problems associated with traditional approach of crop monitoring. In a group of stakeholders we made plentiful discussions that led ideation by prioritizing the ideas and prototype an autonomous vehicle that will inspect school garden autonomously by checking any degradation in soil or threat for any potential diseases that could spread within the plants.

We planned to prototype an intelligent machine that would identify the diseases using its Artificial Intelligence and send us proper ways of pest management in our mobile phone. The problem of diseases on plants is that when they are detected it's already too late. Plant diseases would have been spread all over the field before the symptoms could be seen. Understanding such delicate nature of plant disease, we collected thousands of images of infected plants from the open source, processed them, and analyzed their distinct attributes with the input data thereby predicting the potential diseases that our plant could be infected with. However simple it may sound but we had invested nearly two weeks working on the prototype.

Before collecting vast number of images of plant diseases we learnt that plant could be infected by number of pathogens such as bacteria, virus, fungi, arthropods, nematodes etc.

Among these causative agents first three are microscopic thus we had to depend upon the symptoms they manifest on the plant leaves. In our case, rather than collecting the infected leaves and analyzing them in laboratory we were using digital knowledge available to us. This less time consuming method required sound knowledge about the texture of diseased leaves.

Symptoms of Diseased Leaves and Methods of Detection

The bacterial disease is characterized by microscopic, water-soaked patches that are a pale green color and quickly become visible. The lesions get larger before

becoming dry, dead spots. Viruses are frequently mistaken for nutritional deficits and herbicide damage. This disease is frequently spread by aphids, leafhoppers, whiteflies, and cucumber beetles insects; examples include the mosaic virus; for easy identification we should look for yellow or green stripes or dots on the infected leaves. In overall, the growth may be hindered, and leaves may be wrinkly or curled. When discussing fungus disease, we often refer to Late blight (*Phytophthora infesters*), which manifests as water-soaked, gray-green patches on older, lower leaves. These dots deepen as the fungal condition progresses, and on the undersides, white fungal growth appears. The fungus (*Alternaria solani*) that causes early blight causes little brown spots with concentric rings that resemble a bull's-eye pattern on the lower, older leaves. When a disease reaches maturity, it spreads outward across the surface of a leaf, turning it yellow.

Figure 45

Infected Tomato leaves inside polyhouse

The identification of plant leaf diseases involves five key procedures.

Image Acquisition

First, the photographs of diverse leaves were gathered from two sources: mostly the web and a small number from our camera, taking into account the needed resolution for higher quality.

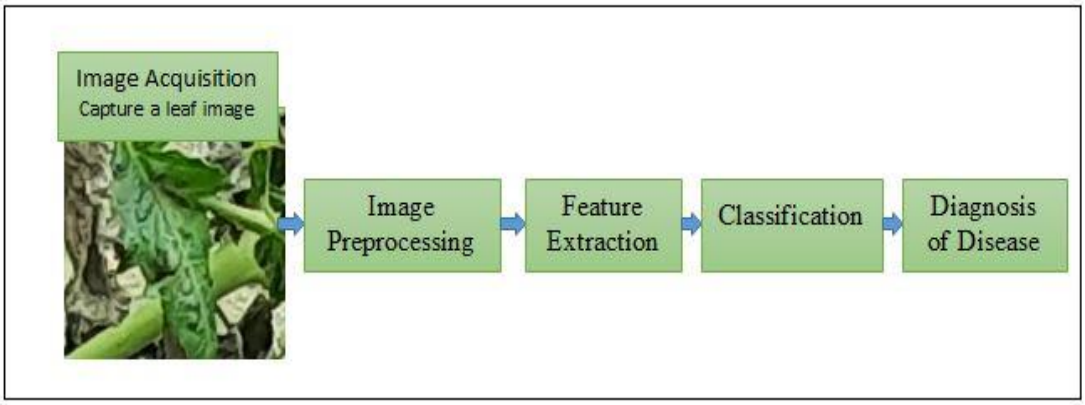
Image Pre-Processing

The second phase involves improving the picture data by suppressing unwanted distortions and enhancing specific visual attributes crucial for further processing and analysis tasks. Basically, there major steps for image pre-processing, i.e. image enhancement, color-space conversion and image segmentation. Image segmentation is a technique used to break up an image's representation into smaller,

more digestible chunks. Though there various techniques used for image segmentation, but we used Chan-Vese segmentation because it easily partitions a digital image into multiple segments or sets of pixels (Chan-Vese Segmentation, 2012).

Figure 46

The general methodology for detection of plant diseases



Feature Extraction

Following segmentation, the diseased portions of plant leaves were excised. Color, shape, and texture qualities were frequently observed in image features. Though there are various methods for feature extraction, we used texture feature extraction method for extracting interesting and relevant features from the image being input.

Classifier

After the extraction of features they were classified. Artificial Neural Networks (ANNs), a popular machine learning method have been widespread in their application (Kulkarni & Patil R. K, 2012). We used Convolutional Neural Network (CNN) for classification. It is a neural network with convolution input layers that functions as a self-learning feature extractor from input images. As a result, it can carry out feature extraction and classification using the same architecture.

While training dataset with over 60,000 images, students and teachers were preparing mechanical part of the robot. We went to nearby market (*Bhakunde Bazar*) to get metal parts for the Robot Chassis.

Figure 47

Designing mechanical parts of CMR

With active participation of co-researchers we started designing the mechanical part of the Robot. In a period of two days we completed with a finished chassis, and started working on power supply system from the batteries. Four DC motors were then connected in the Frame in chassis. We connected motor driver circuit to test these motors. Whereas some co-researchers started working on the logical components of the robot such as fixing motor driver so as to control the current signal and started connecting motor with Arduino. Finally, prototype of CMR was completed.

Figure 48

Co-researchers learning to use electronic devices

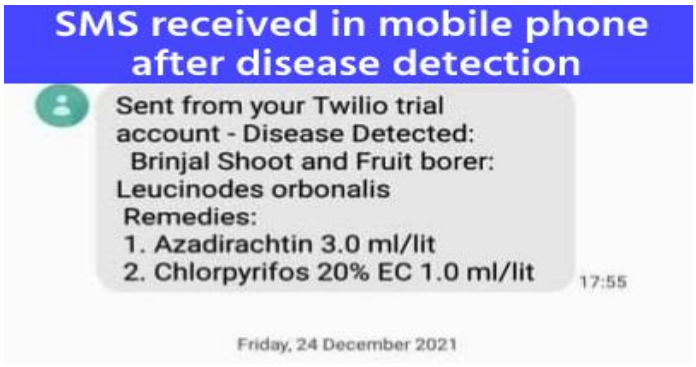
Working of Robot in Polyhouse

Crop Monitoring Robot (CMR) was connected via Wi-Fi to communicate with a mobile phone to send the data. The robot uses a webcam to capture the image of a leaf in real-field setting. Following that, the trained dataset of leaves was used to

process the image. To extract the information from the leaves, the deep learning system employs image segmentation techniques.

Figure 49

SMS sent by CMR to mobile phone



The best-fit label for each attribute was chosen after comparison with hundreds of data sets. Finally, algorithm output the appropriate predicted plant disease. To make it more convenient, output was sent using SMS to mobile phone using Twilio library of python.

Since, the detection of diseases was done by using data of the shapes, sizes, textures, and other attributes of the leaves, it is never 100% accurate. Also, results may differ with different temperatures, saturation, and color. For maximum accuracy the robot an environment where the external conditions like humidity, temperature are much under controlled, like the polyhouse in school garden is preferred.

Figure 50

CMR working inside School garden

The rapidly accelerating pace of technology along with new economic order in the world have demanded learners equip with a certain set of soft skills such as critical thinking and problem solving, creativity and innovation, communication and collaboration, etc. With experiential learning as a basic principle, the learners harness numerous soft skills which are evident in the qualitative data collected through participants' observation and their reflections in discussions. Minga, a ninth grader student attended all classed we offered after-school said:

> *"Sir, malai school garden ma lagda kahile kahi chai sikne kura katti dherai baki xa jasto lagthyo, timi haru ko school ma pisab bata tarakari umarna matrai ta sikauchha vanthe bahira ka sathi haru le, tara robot ko kaam ma samabesh vayapachi chai naya generation le jaanu parne gyan sike jasto vayo. Dherai sathi haru pani hamlai sikaideu na vandai aauchan!"*

English Translation:

"While working in school garden I used to think that are more to learn. Friends from neighboring school said me that I am only good at harvesting vegetables in urine, but while being engaged in AI integration I am feeling that I learnt something valuable to new generation. Many friends come to learn about Artificial Intelligence with me."

To this, headteacher who was involved in the process of designing CMR added further:

> *"Hamro school le rog patta lagaune robot nirman ko kaam garirahada tala bazar (Bhakundebesi) ko school harule pani hami bata sikne chahana garya chhan re! Sabai tira nikai chaso badya chha."*

English translation:

"As we begin designing a robot for disease detection, many schools in the downtown (Bhakundebesi) are willing to learn this tech-education from us. This project is drawing a lot of attention."

During this, I observed participants exercising more collaborations and communications with their peers and mentors. Few students began sharing knowledge and skills of AI with students from neighbor schools as well. Some community leader and parents visited school garden to observe CMR and appreciated for bringing innovations and good practices in school and community. There was remarkable shift in the group dynamics of participants during and after the project. And, one with the explosion of such skills could adapt to the complex nature of the work environment and thus demanded a subsequent shift in our education. These observations made

during the integration of Artificial Intelligence (AI) in school gardening projects reflected on an explosion of soft skills in high school students and teachers. Hence, using algorithms from deep learning, students and teachers designed robot that inspect farm autonomously and check for any soil degradation or any potential threat for diseases that could spread within the crops.

Part Five: Exploring STEAM projects

Where ever we go, in the library, computer lab or in staff room there were dozens of teaching materials piled up in every knock and corner of these rooms. Teachers who once used to spend most of their leisure time in non-educational discourses were unbelievably busy in designing projects relating STEAM disciplines.

Figure 51

STEAM Projects designed by school teachers

Multi-color chart papers, Scissors, Glue-sticks and color markers were rampant. It was a complete U-turn in teachers' involvement and activities after headteachers' big announcement to go through STEAM. Indeed, entire work engine of school were trying to meet the deadlines and plan STEAM projects for 25% of their lessons. There were inquiries, collaborations and communication going on all around. Head teacher was facilitating teachers in every possible way so as to design innovative STEAM projects for their students. In addition, a two-day workshop was scheduled to facilitate teachers from teacher educators. And, teachers were eagerly waiting to share finished projects in the workshop with teacher educators and delve deeper into any issue unresolved. Ongoing circumstances were enabling me to believe that school is in a state of transformation. A transformation we all have dreamt together. To this hustle and bustle, headteacher was consulting with subject teachers to re-arrange their routine for garden-based learning.

Since one year we worked closely with teachers and community members in school gardening. They were resourceful and have collected experiences since the

inception of gardening activities. Whatsoever, pandemic (COVID-19) caused limited participation of students in the first cycle of gardening. I was uncertain on how school was planning to connect learners with School Garden. But, as I knew from the headteacher that teachers were planning to take two classes a week in the School Garden and accordingly they were designing their projects, I was literally blown away. It was not just the contribution of researcher and co-researchers that matter but how school management conceives overall phenomenon and develop a new perspective on that issue.

Sample Project and Assessment Plan

It was a public holiday on 4th December, 2021. School had organised a workshop for teacher where they planned to share projects with each other and learn from each other. Every teacher had prepared at least ten projects for each subject. While teachers were curiously waiting to share their project, headteacher came in front of hall and welcomed participant. Then, headteacher initiated the session by sharing own project work which was then followed by other teachers. There was a common format or template of project they shared. Regarding plantation in urine fertilized plots, Science teacher had prepared series of project from preparation of gardening plots to the harvesting of crops, for grade eight. They were appreciating each other for their effort in designing STEAM projects and one has been referred below as sample project work prepared by teacher:

A Sample Project on School Gardening

Name of Teacher:

Project Work-1: Farming with urine: is this possible?

Class: Eight

Objectives of Project Work:

1) To explain the importance of urine as a fertilizer.
2) Discuss on the nutrients required for growth of plant.

Area Covered:

Biology, Chemistry, Geology, Thinking Skills, Communication Skills

Step-wise Activities for Students:

1) Ask following questions with students and discuss.

1) Have you ever worked before in the farm?
2) What type of crops does your farm have?
3) What are the materials necessary for farming vegetables?
4) Why is fertilizer important for growth of vegetables?
5) Do you think we can use other than Chemical (Urea and DAP) as fertilizer?

(**Note**: In the present scenario where availability of chemical fertilizers is scare, highlight on significance of local resources as an alternative to save soil and cost).

In the project work teacher have prepared their own method of assessment where rubrics was designed as following:

Table 8

Assessment plan

Criteria	Poor	Average	Good	Very Good	Excellent
Time	12-15 days	10-11	9 days	8 days	7 days submission
Knowledge on content	Definition Of Fertilizer	Definition + Types	Definition +Types + Uses+ Advantage & Disadvantage	Definition + Types + Uses + Advantage & Disadvantage + PPt. Slides	Definition + Types + Uses + Advantage & Disadvantage + PPt. Slides + Greetings
Skills					
Presentation					

Multiple Lenses of STEAM Education

While a teacher share projects work, remaining teachers were actively discussing from multiple perspectives. They were using multiple lenses of STEAM education during discussion. Some were looking from the perspective of Integrated Learning, meaning that activities should have inclusion of two or more subjects. In the earlier cycle, researchers have set discourses from a perspective of technology integrated learning as well. This approach was reflected while designing STEAM projects such as using sensors to know the various parameters like soil moisture, P^H in Soil, nutrients in soil, humidity of air, use of crop detection robot, opportunities and challenges in automation of farmhouse, etc. Some were analyzing from a perspectives of Arts integration where they suggested use of various forms of arts such as drawing, dancing, singing, writing poem/story etc. in peer's projects. Ramprasad sir, while sharing his project on basic operations in mathematics sang a song to inspire students in class. He said:

A Poem prepared by a Math Teacher

"Kaile Tunnel kaile ko pokhari,

Yaslai hamle sikane kasari?

Jodi Malewa

Mai padhne thiyani timi padhe vaya!

Bhanta, Banda, Tamatar falya chhan,

Tribhuj, warga, aayat ni yatai chhan,

Jodi Malewa

Mai padhne thiyani timi padhe vaya!

Mai padhne thiyani timi padhe vaya!!

Source: https://www.youtube.com/watch?v=MmL5dMoz87c)

Explaining further, he said, "Students have mindset that mathematics is a difficult subject. And, I have used different forms of arts in teaching mathematics. These methods proved effective even in online classes during pandemic".

There were many STEAM projects designed from the perspective of transformative learning where teachers were aspired to transform their educational practices for sustainable future of Namobuddha. They have designed projects giving more values and efforts to issues such as selection of urine as fertilizer, Integrated Pest

Management (IPM) for disease control, Continuous Contour Trenches (CCTs) as ground water recharge system, Rain-water harvesting pond for sustainable development etc.

The projects discussed during two-day workshop had used various forms of teaching where teachers integrated two or more discipline of Science, Technology, Engineering, Arts and Mathematics (STEAM). While acknowledging interdisciplinary and multidisciplinary teaching approach they had answered why for the 'STEAM-based education'. There projects emphasized vast arrays of methods from inquiry-based learning and observational method to the exploration of mathematical relationship among subjects. Besides use of technology, they had equally explored design thinking approach in designing their projects on school gardening.

Figure 52

Periodic visit of teacher and students in the school garden

Either it is in designing gardening plots or pattern of plantation, teacher were conscious about systematic approach of design thinking. Integration of arts was ubiquitous in most of STEAM projects that was designed considering school garden as learning tool. Herein, the urgent need to integrate arts and technology in subject disciplines and design STEAM projects and training module as a neo-approach for Teacher Professional Development (TPD) has been highly sought (Pant et al., 2020). As two-day workshop was at the verge of completion, headteacher shared few additional programs in School Garden for year 2022. Besides running second cycle of gardening from second week of January, 2022, school had

Figure 53

Students sowing seeds for second cycle of PAR

planned mushroom farming, scaffolding and fertigation of horticulture zone (where Kiwi was planted), pig farming and fishery. Teachers along with other stakeholders looked more excited to continue the school gardening while it finally evolved into "Integrated School Gardening" incorporating various areas of agriculture and animal husbandry. As slogan goes, "success breeds success", a strong university-community partnership from the beginning of 'rupantaran'/ NORHED project inspired and moved all of us towards discovering this promising pedagogical model.

Headteacher appreciated participants for active participation in planning STEAM projects. After a week, teachers appeared (or better to say transformed) in a new role and goal in School Garden. Not only for teaching standard curriculum designed by Curriculum Development Centre (CDC), teachers were there for facilitating students in the inquiry and experimentation of project. Every student has their own action plan and own group. They were given certain project previously designed by teachers and accordingly headteacher has allotted schedule for periodic farm visit. While going through second cycle of gardening I figured out pedagogy of hope and innovation in school. Most of time students were available in the garden, doing experiment and observation of living world of plant, insects and worms. Teachers had formed small groups of 4-5 students who were undertaking different activities in the garden. I observed that School Garden was emerging as a new pedagogy for students. From designing of raised beds to the harvesting they were collaborating and communicating with peers of their group. There was an exceptional interaction full of joy and happiness between teacher and students. I noticed that there was fundamental shift in the perception (or mindset) of learners. In focus group discussion with 7th graders most of them said that project based learning (PBL) was a fun for them but at the same time, they didn't deny that it has increased sense of responsibility in them. Teachers have clear framework for assignment and assessment for students and were diligently working with every student by periodically reviewing their observation and allowing them to reflect critically.

When asked about ongoing practices teacher said it was more like 'smart teaching' than they did before. I noticed that teacher weren't controlling and commanding their learners at any time rather they were controlling the micro-climate in which learners thrive. Also, gradually teachers were shifting their belief system about their role as a gardener. I learnt that process of transformation might take long time but not transformation itself. With right approach and effort it can happen to

anybody at any time as this was more evident teacher's ongoing practices. They made critical reflection of new roles. Teachers placed themselves in a new role of gardeners and students as plant and if provided the right condition they grow and discover themselves.

Figure 54

Students working on new gardening project

Lastly, it was well noted that STEAM approach of teaching and learning has been proven effective in cognitive and affective learning as well. And, while learner joins school garden, the STEAM based course work designed therein enabled their learning skills. In particular, the effect was higher in affective domains (Kang, et al., 2018) as STEAM used arts and allowed students to choose and design their activities, and is directly linked with the emotional function of our brain. Thus, STEAM experience in school garden better prepared learners for higher education, and improved competencies such as communication and teamwork skills.

To this date, School is continuously moving ahead by exploring new projects, new possibilities and renewing itself by inventing new wheels. This was more evident in their involvement in Mushroom farming. Thus, transformation has no destiny but it is a destiny in itself.

Chapter Summary

The dedication and hard work we exhibited in school garden had been harvested in this chapter. You discover stories of researcher and co-researchers while being in and with the school garden. We had planted four different varieties of plant: tomato, cabbage, capsicum, and Brinjal, and they differ in their harvesting time. In all three phase of gardening, i.e. from the preparatory stage to the harvesting, we worked closely with all stakeholders. And, observed significant participation in the school

garden. It wouldn't be an exaggeration if we conclude that school garden could coordinate and create conducive environment in building local economies, or it can be considered as initiation to correct our course on local entrepreneurship. Being involved in the school garden, the participatory approach we used provided opportunity of self-transformation.

As we critically evaluate our involvements in terms of harvest we made, we lost remarkable portion of yields due to pest infection. We realised that our journey shall be more productive if we incorporate artificial intelligence (AI) in early detection of pests that could infect our plant. We learnt numerous prospects and challenges of AI while we worked towards its integration in the second PAR cycle. While we work in crop monitoring robot (CMR), learners were more engaged in the process which in turn enhanced various soft skills such as collaboration, communication, critical thinking etc. Besides this, teachers started exploring several STEAM-based projects for their students, planned activities, and involved learners integrating curriculum with gardening. Followed by this project, school started few more exciting additions in the school garden such as mushroom culture, pig farming etc. Hence, the journey of transformation gained momentum unifying with its own context.

CHAPTER VII
SCHOOL GARDEN: TOWARDS A COMPREHENSIVE PEDAGOGICAL MODEL

It was 24th September 2019 that I joined research site (community high school) at the hilltop of Namobuddha and kept renewing my identity as a researcher till end of May 2022. During these thirty-two months, I worked as a university researcher with co-researchers (students, teachers, parents and community members) in school garden. Though we were disturbed by pandemic (COVID-19) for a period of thirteen months (from 24th March 2020 to 25th April, 2021), but kept exploring alternative possibilities to connect with co-researchers even during harsh days. After going through first and second cycle of participatory action research on school gardening, and at the same time, being a critical observer of whole phenomenon, herein, I share results and our learnings in school garden. Field involvement has been presented in three distinct phases (i.e. preparatory phase, gardening phase, and harvesting phase) where several themes and sub-themes were generated. This chapter sums up research findings in the form of themes and upon its foundation outlines all three research questions.

Part One: Curricular Contextualization: A Reflection

This pedagogical journey that onset from the foothill of behavioristic tradition, drifts along with experience of mosaic of realizations via the cycle of actions and reflections, finally reached at the highland of transformative practice while passing through various forms of constructivist outlook. In the initial days, our pedagogical approaches were largely guided by the behavioristic tradition. The century old fashion of teaching and learning was enforcing ‘chalk and talk approach’ in teachers where learners were considered as a passive receiver of knowledge with sole emphasis in and around cognitive domain. Curricula were decontextualized. The way our curriculum has been developed and implemented presents a hurdle to many of the efforts made to make it more engaging and immediately applicable to one’s culture and context. Thus, in order to contextualize our curricula, we planned to intervened using school garden. Our engagement with stakeholders at Namobuddha remained an eye-opener as we uncovered several deep-rooted issues of our education system. Being in local community and with the local community we learned to address them and contextualize our education.

Reflecting over early days, a perspectival shift for curricular contextualization was merely a day-dream for stakeholders. Largely, teachers were assuming that their minds contain images that somehow represent reality as if they were copies, or pictures (Gill-Perez, 2002). Traditional theories have heavily shaped their cognition in the way classrooms were built, courses were taught, and the way the students' knowledge was assessed. Frankly speaking, classrooms were devoid of any variations in practices while teaching and learning mathematics and science – solely making them decontextualized and non-viable (Luitel, 2006).

Here, I am not arguing that behaviorism is entirely irrelevant in education. If we make a cumulative review of developments made in areas of behaviorism, not all but some concepts of behaviorism are still widely accepted and are being practiced. Major concepts of behaviorism such as stimulus-response chain, task analysis, behavior analysis, educational training and instruction etc. are still in practice in several areas. The principle underlying such areas assumes a learner is essentially passive, responding to environmental stimuli. The learner starts off as a clean slate (i.e. tabula rasa) and behavior is shaped through positive reinforcement or negative reinforcement (Watson, 2013).

While I along with other university researchers stepped in the school, gradually ideas contrasting with the behavioristic approach of the world came on the scene. The earlier notion of learner as a passive being was now questionable with the idea of learner as an active cognizing being. Day by day, we set various issues on discussion such as structure of classroom, approach of teaching and learning, nature of knowledge, etc. Often times I found education system driven by text-bookish and teacher centered approach, where learners are supposed as a passive receiver or collector of information. By a metaphor "sage on stage" those earlier days shall be better represented.

But, at such situation there was no other way than being reflective of ourselves. Very little at a time, we encouraged co-researchers reflect and critical evaluate on every component relating school such as students, classroom, curriculum etc. (Thorpe, 2000). And, I found that the most arduous task for all of us was to be self-reflective because we have developed a culture where one could discover innumerable faults in others but not at self. This defaulted approach to peep into other person slowly progressed as we practiced in being more introverts. During interaction, I realised that it is not only about what we reflected upon but also how we reflect. Brown et al.

(1999) argued that to prevent reflection from becoming 'navel-gazing' it should involve engagement and proactivity. We designed various sharing sessions with teachers so as to ease them to recognise every fiber which constructs our values and belief. Also, as practitioners, we gradually built this into practice of teaching but it was hard to apply the same lesson to ourselves. Boud et al. (1993), who considered reflection to be a generic term that describes the processes involved in exploring experience as a means of enhancing understanding. With more practice at analyzing our experiences, we found better understanding of self and our activities. Rethinking upon the old ideas and practices we arrived at a point in time where co-researchers began implanting new ideas, listen to new, contrasting opinions and analyse them. Co-researchers allowed themselves to move ahead and construct what was not with them. In one of a reflection session, Science teacher said:

"I have been teaching Science since seven years, but after attending series of reflection sessions I am realising that reflecting upon oneself is more difficult that teaching my subject. Reflection answers even deeper questions that were never inquired, such as, why am I teaching Science? Who is this teaching Science? And, how am I teaching Science?"

Indeed, we were more interested in building our own community of practice, share and reflect over the issues that were hindering us in achieving our goal. Most of the time, I saw stakeholders were putting their viewpoint on diverse issues of school and arguing on its defense only. Generally, the culture of reflection was not easy and ongoing for SMC and PTA, whereas teachers were quite ahead of them. Revisiting and reflecting over the entire journey of school gardening, we discovered five different ways teachers and students worked towards contextualization of school curricula. They are:

1) Contextualization based on cultural diversity
2) Contextualization based on learners
3) Contextualization based on pedagogical practice
4) Contextualization based on place, and
5) Contextualization based on disciplinary contents

I observed that teachers enriched their classroom allowing students to imagine, hypothesize, pose questions and investigate new ideas/concept. Learners began constructing their own realities, understanding and developing knowledge through experiencing things of their social surrounding and reflecting on those experiences as

well, as a result curricular contextualization based on learners appear on the scene. This approach gradually reshaped the minds of learners and allowed to fit within his/her new frame of reference. But, we need to incorporate not only the belief but of teachers' pedagogical practices, address cultural diversity of stakeholders, place, and disciplinary contents. Thus, we invested significant time and efforts in facilitating every stakeholder act towards contextualization of their curriculum by reflecting on their perspectives and rigid dogmas.

Actually, learning is an organic things and it grows only with the right condition, which means constructivist guided classrooms, relevant pedagogical practices related to encouraging critical discussion, problem solving, and emancipation of a person, and holistic development of learner introducing transversal skills are to be cared (Care & Luo, 2016). And, the process of contextualization continued reflecting upon these values. At first, it was not easy to realise that garden which once was neglected could be a potential tools for teaching and learning. Day by day, the school was embracing itself in a bigger form by liberating itself from cozy and narrow four-walls of physical boundary and appreciating the power of place in learning. Initial journey of school garden was alike bird beginning its first, nascent flight into infinite sky. There were excitements, hope and courage built upon observations and realizations of learners. Sooner, 'blackboard' once was believed as a reflection of knowledge was waiting for its own 'death'. As learners, we seek color, more colors and living colors guided by dynamic learning medium and approach. Co-researchers were reinventing themselves in both multidisciplinary and integrated ways, i.e. in the air, water, sunlight and in vastness of biotic environment of garden. This is how journey towards the contextualization of curriculum proceeded.

Part Two: School Gardening: Towards a Comprehensive Pedagogical Model

For more than a year, we (researcher and co-researchers) were involved in number of local activities in basic education. Under school gardening project, we identified several local problems and sought solution being mostly within the periphery of local context. In preparation to onset school gardening activities, my interaction with students, teachers and parents of a community school along with community members was meaningful. Learning multiple perspectives in viewing several aspects (i.e. culture, pedagogy, learners, environment, socio-economy, etc.) of Dharmashala (a place where school is situated), we were involved in framing culturally sensitive pedagogy on school gardening. In this section, I summarize my

engagement in school garden where we worked collaboratively to contextualize curricula in order to develop a comprehensive pedagogical model. We used STEAM-based multi-disciplinary approach of teaching and learning in the semi-urban context of Namobuddha which explored school garden as a comprehensive pedagogical model in school education.

Bajracharya & Brouwer (1997) said that, "most of the problems in Nepal are very basic in nature, such as poor sanitary conditions, the lack of healthy drinking water, acute shortages of energy, a lack of transportation, and a lack of adequate healthy food. However, education in general, and science education in particular, seem to have remained indifferent to these problems; they neither reflected these problems in their curriculum content nor provided a way to address them in other forms (pg. 430)." While being in one of a community school (in the year 2019), I witnessed observations made by Bajracharya & Brouwer still relevant some twenty years later. School was fighting for healthy drinking water, poor sanitary condition were all around with inadequate healthy foods for learners. Science materials, if there were any in school, were found in unopened packages in dusty cupboards in an unused dark, damp and cramped room usually designated as the 'science room' (Young et al. 1982). I witnessed that school canteen was cozy and with poor sanitary conditions. I was mystified not because school trying hard to change these situations but we didn't learn and improve even a little since 1997A.D (when Bajracharya & Brouwer published above paper), rather might remain in low status than twenty years before in many aspects. It was really terrific for any educational institutions failing to educate itself in such a long run of time. Researchers have discovered several pedagogical challenges to overcome such situation.

Inspired from the work of local entrepreneurs (see appendix 3), we planned to proceed with designed activities in school garden. While we were undergoing first cycle of PAR, there was limited participation of students because of the pandemic and enforcement of lock-down in that region. Voluntarily, students residing nearby school community joined the project. Community members and teachers were active throughout the process of planning, acting and reflecting, even during pandemic. We agreed to construct ecological sanitation (eco-san) as a source of fertilizer so that it could be a strong alternative to mitigate present day crisis. But, in a group of co-researchers there were multiple opinions regarding its significance in crop production. Thus, in first cycle of PAR, we planned to examine the effectiveness of human urine

as a source of fertilizer. During this, we built rain water harvesting system and CCTS as ground water recharge system. It took few weeks to design polyhouse using local resources, local materials and local knowledge. The polyhouse presented considerable learning opportunities for every co-researcher. Community members along with representative from the local government contributed throughout the process of construction of urine transportation system. They shared local knowledge and resources (e.g. bamboo, woods, stone and sand etc.). Finally, we designed raised beds and sowed seed. The plantlets were planted in various experimental and control plots. Urine, biochar, and chemical fertilizers were used as per our research design. And, after a period of three months, they were harvested gradually.

In each phase of school gardening, every activity was carefully undertaken, whether be it in choosing of bio-pesticides or chemical fertilizer to combat pathogens. Researcher and co-researchers have gone through innumerable series of inquiries and dialogue to challenge the unnoticed hegemonies prevalent in one's belief during periodic meetings and workshops. Engagement in school gardening project generated dialectical logic to illuminate a Third Space wherein learners may be empowered to challenge hegemonies of cultural reproduction and examine reflexively their own identities, coming to recognize and reconcile their core cultural beliefs with those of Western modern science; thereby dissipating otherwise strongly delineated cultural borders (Adams et. al., 2008). It can be said that design thinking approach, inquiry-based approach, project-based and problem-based approaches, place-based learning etc. could be a wonderful start up approaches for strengthening our pedagogical needs and innovation. During this, we questioned on why we were unnoticed about our own context in designing our curricula? What forced us to separate out from our rich knowledge tradition and adopt western views in architecting school education? When and how do we get empowered or realise that school garden could be powerful learning tool for school education? How close or far we are from generating our own version of multidisciplinary approach of pedagogy? Could we consider School garden as a birth of 'Nepali STEAM' situating in our context, cultural diversity, and wisdom tradition?

Reflecting over the journey (from preparatory to harvesting phase), our practices from collection of urine to integration of artificial intelligence was informed by theories we have chosen (such as experiential learning theory, transformative learning theory). However, while school gardening was evolving as a comprehensive

pedagogical model, theoretical constructs from various learning theories (such as constructivist approach, collaborative approach, reflective approach, integrative approach, inquiry-based approach, transformative approach etc.) strengthened the implementation of specific learning strategies used in school gardening, such as design thinking, problem-based learning, place-based (or situated) learning, project-based learning, garden-based (or nature-based) learning etc. By this, school gardening evolved into a total or a comprehensive pedagogical model for school education.

Part Three: The Neolithic Revolution To Industry 4.0: Where We Stand?

This section overviews human civilization from the Neolithic revolution, first revolution made by agricultural technologies to the fourth industrial revolution, also called Industry 4.0 and reflects on where we stand while considering School garden as a new pedagogical model. Simply put, it summarizes prospects and challenges while we implement school gardening as STEAM Pedagogy. First, let us discuss briefly on these four waves of revolution.

The most recent data shows that Homo sapiens first appeared in Africa some 300,000 years ago (Hubline et al., 2017). For long period of time, humans remained as hunting-gatherers. Then, somewhere before 10,000 years ago humans witnessed the first revolution called as the Neolithic revolution. The nature of production underwent arguably the most glaring alteration as a result of the Neolithic Revolution. It landed humans from nomadic hunter-gatherers to the first farmer. Humans started living in a sedentary life making permanent village and communities. This was the time when human transformed into farmer and sought new ways of agriculture, partly to survive and partly to gather for future. Mostly, humans used river banks to settle because of fertile land and source of water. So, every sustainable river in itself is an observer of human civilization. When their production over crossed their requirement for survival then humans began manufacturing goods. This transition from agriculture to manufacturing of goods was the second revolution in the history of mankind. The second wave of revolution is called the Industrial revolution and it took place around 300 years before from Britain and gradually moved to other parts of Europe and United states (Madsen & Murtin, 2017). At the heart of second wave lies steam engine which changed the source of power from cattle to machine ("*Industry 4.0* Platform", 2017). The way that industry brought significant transformation should be credited for mass manufacturing systems like conveyor belts. In one sense, the second wave was fulfilling deep seated desire for material prosperity. It was not more than thirty-five

years that Internet was invented and this led humans into the third wave called the revolution of Information or digital revolution. In this duration, humans' desire for information remained fever high. Now, we have limitless access to every kinds of information. Following the Neolithic, Industrial and Digital revolution, humans are preparing to step into a fourth revolution called the fourth industrial revolution (or Industry 4.0). The beauty of *Industry 4.0* is that it is not going to transform human society but will transform each individual as already evident in our lifestyle. Overviewing all three revolutions we passed through, it appears to me that these revolutions were more sporadic in nature, i.e. scattered or occurred in irregular intervals in some places.

Standing at the edge of third wave, a question haunting my mind is, where do we stand? Or, what are our prospects and challenges to implement school gardening as STEAM Pedagogy? Being involved in school gardening activities with co-researchers for more than a year, I present answer in two parts: one is our position in terms of physical prosperity, and the other is our pedagogical positioning.

In Terms Of Physical Prosperity

As we discover real situations analyzing facts and figures regarding physical progress and prosperity, our journey could be better prepared. In a report published by National Planning Commission, under Government of Nepal, it is said that, according to the government's long-term plan, Prosperous Nepal and Happy Nepali, the nation would become developed in 25 years. It has been incorporated into the 15th Five-Year Plan, which also includes the Sustainable Development Goals (SDGs) and pledges to Nepal leaving the least developed nation (LDC) category by 2024 (Nepal Human Development Report, 2020).

Our agricultural industry which employs over 66% of the entire population contributes to the national economy by one-third of the country's GDP. It has been generating a wide variety of employment opportunities, from farming to small-scale businesses. But, we are struggling frequently with issues such as unavailability of fertilizers and improper irrigation, natural catastrophes such floods, droughts, landslides, earthquakes, illnesses, and insect outbreaks. Farmers are growing food crops to meet the needs of themselves and their families on smallholdings. This kind of subsistence farming is still dominating the nation's agriculture sector, which has led to low agricultural commodity production and productivity. In the light of these situations, we are struggling hard to rationalise and transform our lifestyle and

economy into the second wave (i.e. the industrial revolution) which many developed countries experienced some 300 years before. And, while being involved in school garden, I realised that by integrating school gardens in our schools we could initiate contextualization of our curricula by all five distinct ways (discussed in chapter IV) which in turn enable us to harvest more products in sustainable way, thereby leading us into the world of manufacturing goods (a representation of second wave).

In Terms of Pedagogical Awareness

Every kind of revolution humans witnessed in the past became possible when they questioned themselves on why they are doing what they are doing. But, being with co-researchers, I felt as if we have forgotten to question. Regarding pedagogical awareness, there are still plentiful of preparations yet to be made. In order to align our pedagogy in the right order, we must question ourselves about our ongoing pedagogical practices and belief. Being engaged in school gardening, gradually we learnt to question with each other. Questioning our beliefs and values helped us to recognize our malpractices. In the initial days, our pedagogies were influenced by behavioristic approaches, but slowly things transformed.

Even today, Dewey encourages us to actively challenge practices and traditions that limit and devalue learning and life experiences, and he challenges us to reveal out why we still have trouble solving these fundamental problems. He writes: "there is, I think, no point in the philosophy of progressive education which is sounder than its emphasis upon the importance of the participation of the learner in the formation of the purposes which direct his activities in the learning process, just as there is no defect in traditional education greater than its failure to secure the active cooperation of the pupil in construction of the purposes involved in his studying" (Dewey 1938). It is an undeniable fact that our pedagogical approaches have been emphasizing rote learning, memorization or more emphasis on the procedural knowledge rather than conceptual one isn't advancing learners' critical thinking (Luitel, 2013; Manandhar et al., 2022).

During my school days I was forced to exhibit mostly lower order thinking skills (LOTS) i.e., 'remembering and reciting' only as suggested in Bloom's Taxonomy of Education. To develop the higher-order skills which our learners require to prepare themselves for the *Industry 4.0*, individuals must engage in meaningful inquiry-based learning. From our own engagement in school garden, it can be inferred that learners have the chance to integrate their knowledge, do in-depth research, write

about it, and analyze it, as well as communicate effectively with audiences, thanks to real-world experiences combined with ongoing involvement and cooperation (Barron and Darling-Hammond, 2008).

At the time when the world is preparing to leap into *Industry 4.0*, we have to gear up in reviewing our pedagogical assumption and speed up to contextualize curricula. For this, school garden (or place-based pedagogy) is a right pedagogical tool to initiate journey. With co-researcher, we made an effort to integrate artificial intelligence in school garden (mentioned in part three & four of chapter VI) which is considered as one of five technologies (3D Printing, Artificial Intelligence, Big Data, Cloud Computing, and Internet of Things) of *Industry 4.0* (Chun et al., 2019). School garden offered us lot possibilities to bridge our pedagogical gap. Being in our culture, context, and the place, garden-based learning has strengthened us to connect us with *Industry 4.0*. Hence, pedagogical awareness is inevitable to realise our true potential and transform Nepal into an era of *Industry 4.0*.

Chapter Summary

This chapter summed up answer to all three research questions explicitly, and helped us to outline a model for school garden. There were three parts in the chapter. First one is related to perspectival shift (via reflection) as a requirement for curricular contextualization. It mean, with habit of analyzing our experiences (thoughts and feelings), one could better understand self and activities we were bound to carry regularly. Reflecting upon self, one renews continuously thus allowing shift in their perspectives. Construction of new mindset prepared us to learn, unlearn and relearn the context and culture of Namobuddha. Upon being critical self-reflective of these awareness, we succeeded in our plan of contextualizing curricula. Since, school garden was built with school and community (not for school and community), thus evolved as a comprehensive pedagogical model for school education.

Reviewing our journey of the school garden, we came to compare and contrast with various time zones ranging from the Neolithic revolution to Industrial 4.0. As the world is preparing to step into the fourth revolution, we discovered ourselves far behind. Indeed, we are in a struggle of basic needs to survival. It is not only in terms of physical prosperity that we are lacking behind but pedagogical awareness. Thus, an immediate course correction is required. And, for this, we have to relocate our journey, wisely understanding and integrating school garden as a pedagogical tool.

CHAPTER VIII
REFLECTION, CONCLUSION, AND IMPLICATION

In the final chapter, readers can find synthesized reflection along with brief conclusions of year-long journey of being participatory action researcher, and implications of this research in school education.

My Reflective Learnings

During the journey, reflection has become a part of my being. I loved being introvert so that I could better critically reflect upon my experiences. In the words of Brookfield (2017), "for a good or ill, world is never the same after teaching". But, we must be critical about these statements because it is not the other who brings change in us; it is by the self with more critical reflection. My reflective learnings have been summed up in six different categories: thematic reflections, professional reflections, theoretical reflections, methodological reflections, reflection on research questions, and reflection from co-researchers at the final. Along with these reflective learnings, master plan of regarding school gardening prepared by school team would reflect strength of overt and covert transformations school team has undergone.

Being a teacher educator and a participatory action researcher I had tried to examine my field engagement critically. Critical self-reflection for teacher educators is considered in terms of preparing teachers: teachers' personal and professional development and the improvement of the whole educational system (Jacobs, Assaf, & Lee, 2011). During the course of becoming teacher educator, almost all use to experience the profession of teacher. Thus, in the preparatory stage of professional development we should recall our earlier days and reflect over experiences we have collected. Besides being a teacher educator, the reflections I put herein have been synthesized interweaving the field engagement of both researcher and co-researchers of the participatory action research.

Thematic Reflection and Learning

Revisiting gardening activities for a while, we designed several raised beds in all twelve different plots, placed drip lines across them. In experimental plots we used urine, biochar, and chemical fertilizers. Seemingly it was an experiment with various variables but there was lot going on. Indeed, we were exploring a lot of pedagogical perspectives such as inquiry-based, project-based, problem-based and garden-based

approaches in the School garden. In real-life situation, we learn to assimilate process and synthesize ideas and engage one other by supplementing and revising existing knowledge. Reflecting over those actions, I noticed that our undergoing mal practices where learners were caught up in a fiercely competitive struggle for knowledge, wealth or power could be best managed by adopting and encouraging more collaboration and communications between the learners.

While reflecting over themes, I begin with recalling initial team work we made with stakeholders. From the very beginning of searching suitable piece of land-mass for school gardening to harvesting, we were guided and inspired by inquires and collaborations with teacher, students, SMC, PTA and community members. Though learning through inquiry comes in various guises (Prince and Felder 2007), but we had used inquiry-based learning (IBL) as an umbrella term that covered addressing our research questions and generating insights in the form of theme. Levy et al. (2010) defined IBL as 'a cluster of strongly student-centered approaches to learning and teaching that are driven by inquiry or research'. According to Prince and Felder (2007), it is described as teaching that starts by providing students with a specific task, such as interpretation of experimental results in gardening, a case study to examine, or a complex real-world problem like issue of fertilizers to address. Besides this, field involvement had made me reflect considerably upon teacher educators. They should be aware of producing academically sound teachers who could improve current practice of teaching and learning. Once we manage a pool of academically sound teachers, and then only we can move further through innovative practices of school gardening and design a creative style of pedagogy. Certainly, teachers can have strength to enhance own personal and students' holistic development, and work to change the current practices for the better (Brookfield, 2017). For whatever we do or teach other to do well, we must exhibit critical reflective practice on our own practices and carry on the series of works for its improvement (Sullivan et al., 2016).

Sustainability is another important issue. Being a teacher educator, I like to reflect upon a question, how school garden contribute towards sustainable development? The modern world is in a race to win everything. But, its side effects have/would be detrimental in coming days. We have exploited almost all of our natural resources, polluted water, air and earth. Therefore, our educational practices must address these burning questions and define and re-define sustainability as 'being friend of nature'. Thus, during our journey of school gardening, we have given

considerable attention in it by designing CCTs which worked water recharge system and pond for rain water harvesting. Besides this, the use of eco-san had refined our perspective of sustainability, focusing on eco-friendly way of developments.

And, finally the themes associated with local economy and entrepreneurial learning has beautified school gardening to the next level so that our learners could harness enough entrepreneurial skills required for 21st century. Relating entrepreneurial learning to the field of STEAM education, I realised that entrepreneurs translate innovative ideas and develop them into products and services. And, the process requires creative and critical thinking, problem solving, communication skills along with a growth mindset, and an ability to manage risk and uncertainty whose attributes are integral to STEAM learners. Similarly, the use of multi-disciplinary approach in designing products is also an indispensable attribute of garden-based education. For students facing an uncertain future where the nature of employment is expected to alter radically, these transferable skill sets are becoming increasingly important. Thus, entrepreneurship nurtured with the principle of STEAM approach of learning could stimulate economic and social growth and leads to more job opportunities. And, in this sense, school garden could be an important pedagogical tool for learners.

Professional Reflection and Learning

Being a learner in the multidisciplinary area of science, the school gardening has provided rich pedagogical awareness. Mainly, my realization of Inquiry-based approach in learning science is likely to contribute in my professional life. The categories of problem-based, project-based, and garden-based (nature-based) teaching have been proposed by certain authors as a way to categorize various kinds of inquiry-based learning (IBL) (Mills and Treagust 2003; Prince and Felder 2007). And, now reflecting on several approaches herein, it has strengthened further in my professional practices.

On one hand, along with the advent of science and technology, world is becoming better but we are confronting with complex problems as well. The emergence of new viruses, depletion of natural resources, and global warming are some of them. In order to understand and solve these complex problems, we must require more communication and collaboration in local and global level. And, my engagement in research work has enhanced these skills in me, and this will certainly help to mitigate our contemporary challenges. Besides this, during my professional

practice, I used to have so many shortcomings such as imposing my ideas to learners, perceiving them as passive receiver of knowledge, poorly-cognizing selves, and focusing more on LOTs etc. At one period of my life, I was perceived as a 'popular' Psychologist and efficient memory trainer, teacher and parent's trainer. But, my involvement in research work made me reflect upon my profession in a very different way. Now, I started focusing more on creativity and critical thinking in myself and in learners rather than popular stuffs like memory power and memorization of facts and figures. Along with this, I promote collaboration and team works in place of compete and win in my professional discourses. At the end, this research endeavor enabled me to realise learners as active cognizing being capable of solving their life-world problems.

Theoretical Reflections and Learnings

Besides experiential learning theory and transformative learning theory as our major theoretical orientation, school gardening is informed by other theoretical constructs derived from learning theories (such as constructivist approach, collaborative approach, reflective approach, integrative approach, inquiry-based approach etc.) which strengthened the implementation of specific learning strategies such as design thinking, problem-based learning, place-based (or situated) learning, project-based learning, garden-based (or nature-based) learning etc. My engagement in research work has enabled me further in understanding and critically analyzing on these theories.

The pioneer philosopher of 20th century, John Dewey, in his provocative book "Experience and Education" stated that, "…….the belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative. Experience and education cannot be directly equated to each other" (Dewey 1938). During the process, stakeholders allowed themselves to deconstruct many of their fundamental beliefs about school, education, teaching and learning and many more. I was excited to undertake research activities with joy for a reason that very soon we will redefine a number of variables with our own experience on gardening.

Also, while working in social context of Dapcha, and being with community members for more than a year, I generated entirely new meaning for some 'big' terms such as, pedagogy, sustainability etc. Social constructionist perspective stresses that through discourse, we generate meaning from our experiences and perceptions as they

learn implicitly and emergently (Bruner, 1990). And, it was evident during this research journey as well. According to Mumford (1995), learning occurs "when people can demonstrate that they know something that they didn't know before (insights and realisations as well as facts) and/or when they can accomplish something they couldn't do previously (skills)." So, the three aspects of knowing, acting, and understanding may be thought of as the power to behave in a different way. I along with my co-researchers moved through these three aspects of learning.

Another theory implied herein is Transformative Learning Theory (TLT). According to Mezirow (1991), transformational learning involves deep changes in self, changes in cognitive, emotional, physical, and unconscious aspects and involves an expanded level of awareness of the context of one's views and feelings. As stated by Mezirow (2009), change and transformation are not possible without understanding the existing frame of reference. I knew that transformation can be achieved if we change our assumptions and ideas while appreciating the context in which we learn. Comprehending the context and identifying needs has awakened me to the requirement for critical reflection in order to transform my own frame of reference (Mezirow (2009).

Methodological Reflections and Learning

Participatory Action Research (PAR) being my methodological choice, the collective engagement of researchers and co-researchers enhanced during school gardening. If we review upon our methodological awareness, it can be said that participatory action research enabled me to produce fresh knowledge by way of active participation, emphasizing a feeling of shared accountability, hence this research is a shift from “I ask, you answer” to the “we explore” (Wadsworth, 2001).

The ideas of Kemmis and McTaggart (2005) which said PAR as a social, a practical and collaborative process and a reflective process to transform both theory and practice for the emancipation of the members of the society was guiding mantras of me. PAR prepared me to begin discussion process with all the stakeholders. I engaged in more collaboration and interaction with students, teachers, parents, and community members. And, the interactions were result oriented but time consuming which may even took an hour to days. PAR helped a lot, such as in reaching an agreement between land-owner and stakeholders, promoted more dialogue, cooperation, and collaborations with stakeholders. During gardening, I learnt to set a distinct community of practice by architecting club with engagement from SMT, PTA,

teachers and few students. In all these activities, democratic and discursive process of participatory action research became a guiding philosophy to carry on school gardening.

Reflection on Research Questions

There were three questions which guided the whole research process. In chapter IV (preparatory phase), I have organised preparations made in order to onset school gardening. There were five themes generated from the preparatory phase on school gardening. It was an answer to the first research question, i.e., *In what ways does school work towards contextualizing curricula through school gardening?* I learnt that contextualization of curriculum could be undertaken in five different ways, i.e. based on learners, place, pedagogical practices, disciplinary contents, and cultural diversity. The basic elements such as formation of workaholic team, discovery of suitable land mass, management of resources such as water and fertilizers should be well considered to smoothly run school garden. I organized intervention we made during first and second cycle of gardening which helped to uncover second and third research questions, i.e., *How does school gardening evolve as a pedagogical model in STEAM-based learning?, and "What are the prospects and challenges to implement school gardening as STEAM Pedagogy?*" I found that while the world transformed from the Neolithic revolution to the digital revolution and now preparing for giant leap into Industry 4.0, yet we are struggling for basic needs (or survivals). Thus, in order to transform ourselves there were a number hurdles but more prominent one is the limiting belief about self.

In all three phases of school gardening (i.e. preparatory, gardening, and harvesting), I observed active participation of co-researchers (students, teachers, parents and community members) in all four steps (plan, act, observe, and reflect) of PAR cycle. However, I encountered several challenges as we engaged in the process. Primarily, transforming a school largely guided with behavioristic tradition into a more constructivist-guided approach with experiential and transformative learning being its integral component of pedagogy was quite arduous. While we began reflecting critically over our beliefs, values, and traditions, I and my co-researcher learned to realise our old habits of mind. It was truly a great endeavor to question- "why we are doing what we are doing?" As we began unfolding new ideas and realizations they were soon merged into actions in the school garden. And, with the continuous involvement (actions and reflections) of researchers and co-researchers in

the eco-san mediated school gardening, we overcome some of major challenges thereby letting school garden evolve as an "emerging comprehensive pedagogical model" in STEAM-based education.

Reflection and Learning from the Co-researchers

Communication, interactions and discussion being an important aspect of PAR, there were innumerable sharing between researcher and co-researchers. Altogether, there were four distinct groups of co-researchers, i.e. student, teacher, parent, and community member. I had collected insight from co-researchers representing all four groups. The reflective insights are presented below:

Co-researcher from Students' Group

I am a member of School Gardening Club (SGC) and my home is very near to the school. As much as possible, I joined many activities in school garden. In the initial days of gardening, I was not much interested because there was similar program in the last year also. But, when I saw you and school teachers coming regularly, even during Saturday in the garden then I was a bit curious about it. One day, I saw bulldozer at the field and it was flattening the slope field. I was really surprised and later realised that it might be a long-term project for school as things were going steadily and smoothly. Teachers and other parents (living nearby school) who come in the garden were happily working in the farm (school garden). Then, I said to my friends that we should join when the seed sowing begins. From then, with my friends I am regularly participating in the field work. Also, I have collected urine from my family during pandemic. I learnt many things such as growing vegetables from urine and biochar.

But, friends who study in other school used to tease me when I shared about urine-based (eco-san) vegetable farming with them. They laughed and said, "Who will eat those dirty tomatoes grown from your urine?" But, with urine, vegetables grow very well. I took few pictures of tomatoes in my mobile and showed to them. They were really surprised to see big and healthy vegetable. One day, I brought them in my school garden. They visited all four polyhouse and were very happy. Few months later, we had extra class about learning to make Robot. That was very interesting to me. I learnt how to fit motors in chassis, and also knew about programming. I want to know more

about AI and design new things. The school gardening is interesting because later I planted cucumber and we made good harvest from urine and biochar.

Co-researcher from Teachers' Group

This was an amazing experience for me to be a part of school gardening. My role was to supply urine in three sets of experimental units and water in one set of control unit. Gardening was new discipline for me. I entered in teaching profession immediately after my SLC, so I had to remain away from these (gardening) skills. This time, when I heard that our urine would be taken as fertilizer for growing vegetables, then I became interested to join. During school gardening, I remained always at the frontline. Whether it is in designing the gardening plots or polyhouse, I was there. I learnt about many plant diseases, and the local ways to prevent from pathogens. That was good experience in my life.

Frankly speaking, I am interested in school garden because I believe that we should prioritize organic fertilizer rather than chemical fertilizer. Also, I wanted to know the effects of urine in the growth of vegetables. The results were amazing. We planted sixty Kiwi fruit in between CCTs and they are growing well. Besides this, I am also coordinating pig farming project in school garden. Also, in school garden, we are planning to start mushroom culture and fish farming. In my opinion, in a period of four to five years, my school will succeed imparting skill-based education to almost all kind of learners. So, I am happy to be its integral part.

Co-researcher from Parents' Group

There were many researchers from Kathmandu University who worked in different subject. Being a parent, I joined the club (School gardening club) and learnt many things. Though I could not come here regularly, but I have participated in many activities. My house is more than five minutes of walk from here. I have three children, one passed SLC recently from here, and two are studying in grade nine and six. My role was to collect the urine from parents' house from two different villages. I did it to the best of my ability. And, I had taken care of spraying both the locally prepared and chemical pesticides, and then I focused more on controlling vegetables from steam borers. Before a decade, I had worked in agro-farm, and while being here, I learnt many techniques of farming inside the polyhouse.

Now, from the second cycle, I have been helping (facilitating) our students learn agriculture and other important life skills from this garden. I found students very curious and interested to learn here. They came here with happy face. In our time, there was no such field-based education. School's students and parents are lucky to have diverse opportunities to learn new techniques in our own village. Students are also harvesting different types of vegetables such as tomato, cabbage, capsicum, Brinjal, cucumber, bitter gourd etc. I am happy to help students and teacher in school garden with my skills and also eager to learn new things from them.

Co-researcher from the Community

Before the school garden, there were no such programs that connect school with the community. Last year, few teachers have visited my home. I was happy to have them. This year, Nepali teacher made a phone call, and said me to pay a visit to the school if I am interested to learn new technique about farming. I am a farmer. I do farming in small area. Besides this, I built local houses. I found eco-san completely new. I have heard in radio that we can use urine as fertilizer. But, here I learnt things very well. I also helped this project by donating our family's urine.

Interesting to me is the beginning of technical education in school. This is village and such kinds of skills are necessary to raise economy and share knowledge with one other. My children are also learning from here. They said to me that they come to garden and learn, and have two classes in each week. My children really enjoy learning from the school garden. I am also interested to use similar techniques (eco-san) to produce vegetables for our family. I tasted tomatoes grown here and was very delicious.

These above are just a few co-researchers who shared their experience about school gardening. During harvesting phase, I saw a handful of parents and community members visiting school garden, almost every day.

Figure 55

Visitors learning from the school garden

As we completed the first cycle of gardening, number of people and people in group visited school garden regularly. Initially, there were local people but later on, government officials, representatives from various I/NGOS, school teachers from various schools, private agriculture farm and self-employed youth started connecting with the school garden. Most of visitors said that they are eager to learn and onset similar project in their school/area, and drive school as a center of knowledge and innovation.

School's Master Plan

Figure 56

Team 'Rupantaran' welcomed by stakeholders

After the completion of both cycle of PAR, School administration in consultation with SMC and PTA came up with School's Master Plan. With a slogan *"एक व्यवसायिक सिप सिक्दै र कमाउदै "* (earning and learning a skill), school was planning to include more entrepreneurial skills so as to attract more students. We knew from headteacher that among numerous impacts of school gardening, one was increase in students' enrollment by more than 20%. School was planning to connect with

students' alumni and host a grand meeting so as to collect targeted funds required to sustain the master plan. They said that, as soon as school collects seed money (2.5 million rupees), the program sets in action. Beside this, school planned to gather funds by performing various charity programs in communities. With main objectives of developing skill-based student, school plans to invest certain amount as seed money as per students' proposal. Then, teacher guide learners incubate their ideas into an entrepreneurship. During these process students learn required life-skills so as to sustain their business. After certain cycle of work, students will return their seed money to school (or financial institution), and share remaining profit in their own personal requirement or invest in expansion of their business. Such kinds of educational programs prepare learners for their future world by harnessing required hard and soft skills. Students have infinite appetite to learn and innovate. But, the challenge of such innovative programs lies in how well they get implemented in real-world situation.

Conclusions

This section concludes research questions with observations and reflections I made during a year-long involvement in school gardening. Primarily, I was trying to figure out how teachers and students worked towards Curricular Contextualization (CC) through school gardening, and came up with five different approaches. First observation was the contextualization based on cultural diversity of the place. During my interaction with teachers, I found that Dapcha consisted largely of diverse cultural groups of Newar, Brahmin, and Tamang communities having distinct and unique cultural identities such as language, costume, lifestyle etc. Besides this, *Dalits*, a minority group having significant population size was discriminated in a caste-based system. I found that school environment poorly reflected the cultural richness and diversities inherent in each community. Because of these cultural mismatches, teachers may use pedagogical strategies that ignore the depth of the cultural variety that students bring to the classroom (Stemn, 2010). We learnt that contextualization of curriculum begins with understanding, appreciating, and integrating cultural diversity inherent in the groups or communities. This observation and reflections we made while being in a group of co-researchers (school teachers, students and community members) helped us to plan and (co-)design a culturally relevant pedagogy which would empower students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills and attitudes (Ladson-Billing, 1994).

Also, marginalized communities if present should be equally valued and well considered during the process of curriculum contextualization.

Contextualization based on learners is another approach we learnt during curriculum contextualization. Being with learners, we explored newer vistas in 'reading' a student rather than 'teaching' them. Highlighting on the importance of students' participation, we realised the necessity of various clubs (eco club, STEAM club, gardening club, robotics club etc.) as well as students' portals (magazine, wall-magazine, students' corner etc.) to ensure and enhance learners' engagement. Tailoring the gardening activities based on the needs and interest of learners help us overcome our contemporary issues. There is also the importance of engaging students (Lawrence, 2007; Hancock & Mansfield, 2002) in the development and definition of subject content and in the framework of pedagogical processes (Author, 2010; Bernhardt, 2009). Students' club enriched our journey of pedagogical innovation while learners shared their experiences of school, home and community where they situate.

Truth of our time is that difficulties, uncertainties, and the complex nature of job-world (future) is what todays' learners would encounter. Our education system is poorly working towards equipping learners with the skills they require in this complex and challenging job-world. The entry point to such a future world could be by giving learners' control and responsibility for own learning. It is central idea behind school gardening project as observed in various stages of gardening where learners are given autonomous along with responsibility. They are free to determine various aspects of gardening such as size and location of plot, seed selection, periodicity of fertigation etc., and this has in turn made them more responsible to grow and harvest so as to implant entrepreneurial mindset. Students learn via the design and construction of actual solutions to issues through project and problem-based learning (Cornell University, 2014). While teacher were designing garden-based STEAM projects in the second cycle, few things were better considered. They had not just connected STEAM projects with the intended goals of curriculum rather included socio-cultural issues of Namobuddha which made learners more responsible in the activities undertook.

Trilling and Fadel (2009) has mentioned about the beauty of involvement of learners in effective project-based learning (PBL), which guided our work towards contextualization of curriculum since very beginning, and is summarized in five key characteristics: First is the connection between outputs of school gardening project (learners' engagement) and the learning objectives (life skills). Second, the main ideas

or tenets of the school garden (or place-based learning) are introduced to learners through regular field engagement, questions and puzzles (in regular classes) making them feel/ internalize as they being an integral part of the project. Third, study and investigation conducted by students in all three phases of gardening entails questioning and knowledge development. Fourth, much of the garden-based learning is designed and managed by the students whereas teachers provide 'gentle' scaffolding. Fifth, gardening projects are focused on genuine issues such as management of resources (land-mass, water, fertilizer, seeds, bio-pesticides etc.), exploring alternative solutions to contemporary issues, and others that students care about in the real-world. All these characteristics of PBL were reflected in different cycles of school gardening activities. Although, our curriculum has tried linking subject matter with the learning goals but our traditional worldviews of education has sharply minimized the role of learners in terms of participation and co-creation of knowledge. Therefore, our involvements in school garden in solving the real-world problems and authentically caring our learners highlighted its significance in a clear way. Also, Souto-Manning (2008, p. 97) states "…school, being a social space, should open its doors to the discussion of the reality of their students, starting with the experiences students bring with them into the classroom". Thus, success of curriculum contextualization largely depends on how well we understand learners' world views by allowing them to share experiences and enhance their engagement in school garden.

Thirdly, amid pandemic we learned to contextualize curricula based on our pedagogical practices. Reflecting upon how hard days passed through, the greatest achievement so far was exploration of numerous approaches in online (alternative) pedagogical practices. We discovered how educators and students create contextualized learning opportunities by drawing on real-world examples from their immediate surroundings (Gillespie & Marilyn, 2002). These online pedagogical practices emphasized the development of abilities students need to carry out tasks and achieve goals in their daily lives. Co-researchers exhibited various skills such as communication, creativity, critical thinking and team-work (between teacher, students, and parents) while maintaining social distance, and this in turn explored virtual platforms that were never explored in such high quantities during pandemic in the semi-urban settings of Dapcha. While we examine and utilize the prevailing situation, it strengthened us to consider pedagogical practices as another essential approach towards curriculum contextualization.

Working closely with stakeholders, I learnt that the relevance of the school garden is solely determined by its ability to address local problems or issues, and how well it reflects daily lives of people and the community with utmost utilization and exploration of local resources and knowledge system inherent in the region or place. While working through all three phases of school gardening, co-researchers were driven by the place, with the place, and for the place. Being a participatory action researcher with an attempt to contextualize curricula based on the place, I had to be with my co-researchers, align with research site and community; students' lived and experienced reality, and connect subject matter with the reality (Kemp 2006, Kitchens, 2009). By emphasizing the place, we made an effort to create curriculum that is near and dear to students' lived and experienced reality, in which the subject matter can readily be applied to real-life circumstances, enhancing students' knowledge of such subjects (Shriner et al. 2010; Kitchens 2009; Im and Pak 2012). Thus, place was considered as fourth important dimension while contextualizing curriculum.

School gardening possesses certain purpose to nurture ongoing pedagogical practices. Participation of learners and stakeholders in the process had given purpose to gardening. It was noted from the garden-based discourses among teachers that school gardening made significant imprints in the mind and behavior of stakeholders as they engage in gardening. Co--researchers appeared to have richer understanding of curricula. They have started looking at things with clear perspective, in a multidisciplinary approach (of STEAM education). They discovered not only Science or Math or Nepali (as single subject) while they gaze into pond, or polyhouse of gardening plots rather discovered a new perspective on the subject matter which refracts not just a discipline but various disciplines and disciplinary contents. With multi-disciplinary approach, we not only designed school garden as a learning space rather as a curriculum with endless possibilities to contextualize disciplinary contents. The encouragement and curiosity of co-researchers fueled journey towards curriculum contextualization based on disciplinary contents since many of them visited school garden periodically depicting continuous enthusiasm in garden-based learning, and prepared garden-based STEAM projects for students.

While teachers and students worked towards curriculum contextualization, school gardening was evolving as a pedagogical model in STEAM-based learning. Derived from learning theories (such as constructivist approach, collaborative approach, reflective approach, integrative approach, inquiry-based approach,

transformative approach etc.), the pedagogical model (or theoretical construct) strengthened the implementation of specific learning strategies such as entrepreneurial learning, design thinking, problem-based learning, place-based (or situated) learning, project-based learning, and garden-based (or nature-based) learning. During my engagement in all three phases of school gardening, I came across various learning strategies accompanying diverse theoretical constructs. I observed school garden was evolving into a comprehensive pedagogical model (or total pedagogical model) for school education since educational activities in school garden was wholly or partially framed within either one or many of learning theories.

If a student enters school in 2020, then s/he will be prepared for job market not earlier than 2040. Student have to enter an environment of jobs yet to be created, technologies yet to be invented and challenges yet to be predicted. Going through all three phase of school gardening, it was disclosed it deeply concerns with entrepreneurial learning as well. The development of entrepreneurial skill was clearly evident when more students participated in the second cycle of gardening so as to harvest more vegetables. It is the major reason that school recently included mushroom farming, pig farming and fisheries in school garden making it more integrated with one another. Researcher suggest that by thinking critically and creatively and being innovative in problem solving, everyone can be an entrepreneur (OECD, 2018); and it further said `many of the behaviours associated with entrepreneurship can be taught.' Therefore, it is the responsibility of school to include local entrepreneurship and develop a curriculum that could prepare skilled citizen for the future world. While learners engage in the school garden, some of them started replicating gardening activities in their home garden as well. They started sharing newer perspectives of gardening in class for which their parents facilitated in understanding agriculture-based knowledge.

Besides this, school boundaries as a place remained largely time disciplined, where students were controlled by the daily rhythm of school routine, clock needles and bells (Holloway & Valentine 2003). Thus, school placed itself as a 'closed place' to live and learn. And, this notion of 'closed place' finally transformed into place-based pedagogy that seeks to connect local, ecological, cultural and historical contexts in which schooling itself takes place (Elfer, 2011). Also, evident from our involvements while designing poly-house, principles of design thinking approach was implied in solving most of our real-world problems related with pedagogy. We found

that this along with other several approaches proved significant in bringing stakeholders at a common place and transform institution by nurturing and transforming their ideas so as to transform the players itself. It can be said that design thinking has the power to transform the way we work by transforming the way we think, approach problems, and develop products and services (Plattner et. al., 2015). With this and several other learning strategies (problem-based learning, place-based (or situated) learning, project-based learning, and garden-based learning), school gardening was observed as an "evolving comprehensive pedagogical model" for school education.

Regarding my third research question, I observed several prospects and challenges to use school gardening as STEAM pedagogy. Being with stakeholders, I came to experience school garden and STEAM lessons designed at its base bestow various benefits for the holistic development of learners, and enables learners to grow and harvest transformative learning experience. Research by Cox and Jennings (1995) suggested that the ability to learn from mistakes makes successful entrepreneurs, and many successful and large entrepreneurs were found to learn from the critical incidents. Whereas, we found school garden as right place to make mistakes so that learners develop enhanced level of awareness as a part of transformative learning experience. It is not only students but many teachers and community members had gone radical shift in their learning. Inspired by eco-san based school garden, Chair of SMC designed a separate eco-san unit for his community (of around 20 families) located at a distance of 4 KM from school. With critical self-reflection, I found stakeholders questioned their own assumption, presuppositions, and meaning perspectives (Mezirow, 2006). Transformative learning, according to Mezirow (1991), "involves radical shift in self, changes in cognitive, emotional, physical, and unconscious aspects" and "an expanded level of awareness of the context of one's views and feelings."

To tot up the prospects of school gardening, this approach of teaching and learning has been proven effective in cognitive and affective learning as well. And, as a learner joins school garden, the STEAM based course work designed therein enables their learning skills. In particular, the effect was higher in affective domains (Kang, et al., 2018) as STEAM uses arts and is directly linked with the emotional function of our brain. It can be said that, STEAM experience in school garden prepared learners for higher education, and improved competencies such as communication and teamwork

skills. These highly desirable skills of 21st century in our learners make them competent for the new technology, opportunities and challenges which has not perceived yet.

On the other hand, I witnessed several challenges during experimentation of school gardening project in school. In the initial days, it was a real-challenge for me to work with teachers and other co-researchers who were solely guided with behaviouristic rituals. Teachers asked me to impart expert solutions for existing pedagogical problems for a long time rather than co-working to discover solutions. In a team of stakeholders, we worked in several rounds of participatory meetings, field visits, and workshops to enhance pedagogical awareness in teachers. Gradually, we overcome many of their issues that concerned mainly with 'why and how' about school gardening. With the financial support from NORHED 'Rupantaran' Project run under Kathmandu University, we initiated (planned, designed and acted) on various components of school gardening. But in a long run, such kind of university-community collaboration may not prevail. Therefore, regarding the continuation of financial and other technical support (teacher training, workshop, field visits etc.) for the sustainability of school gardening, the garden itself has to evolve into an eco-entrepreneur (a center of local production).

Implication of the Research

Followings are the implication of this research endeavor made after critically examining the findings:

For Government

Government formed a policy where they conceptualized one garden in one school under green school guidelines. One significant feature of the green school guidelines is that they envisage turning community schools into "living laboratories" with the help of collaborative efforts from students, teachers, parents, and community members. But, it has not yet set in action (or apparently ineffective). As a developing nation, certainly there could be many reasons behind ineffective promulgation of the government policies, or how policy fails. However, wisely reflecting on poor academic achievements over the past, stakeholders might realise on how and where they could make necessary course corrections. While we observed meaningful engagement of students, the active participation of teachers in designing and implementing STEAM projects and above all, the unparalleled support and coordination from the parents clearly assured that the integrated learning with STEAM

based pedagogical approaches can be best practiced within the Green School Guideline or school gardening and could be a potent recourse in contextualizing our curricula (Pant & Luitel, 2021). Thus, this research would be a lamppost to transform or revive merely a 'dead' policy (Green School Guidelines) into action by guiding stakeholders from federal to the local government, and tailor and implement school gardening in the best interest of the community and nation.

For Schools and Universities

Generally, the land space present in community schools is either remained unused or poorly used for creative activities. Schools can generate ideas as well as action plan regarding construction of school garden in the light of this research work, in those unused or ignored space. Even in the case, schools lack their physical resources, they could start hiring a piece of land near from the school and start constructing school garden as we did. Since, we have experimented in community school with participatory approach of action so our work can be easily understood and applied in any situations. Every school have their own context and distinct culture, so I don't recommend to reproduce our work rather take it as learning experience since contextualization of curriculum requires unique eyes (or perspective) to observe, plan, act, and reflect on issues. Hence, this research work might be helpful to teacher and teacher educators to contextualize their curricula.

For Community

An important aspect of this research was ceaseless engagement of parents and community members from the inception of school gardening project. After going through series of actions and reflections these co-researchers might have acquired certain set of skills which can be useful for rest of community. As these representatives share this valuable knowledge in the community, it might bring a multiplier effect in understanding and exploring our resources and abilities. Thus, this research implies well with Dapcha community for sustainable way of food production and in sharpening entrepreneurial skills.

For Researchers and Policy-makers

For researchers, policy makers and even for educational resource developers, this research work might add excitement in their discourses. The findings of school gardening project could be useful for all the learners who are collaboratively learning STEM discipline. Also, those who are involved in teaching STEAM disciplines by integrating creative ways (arts) in STEM subjects, it helps to explore new insights. The

journey we made during absolute darkness of pandemic might release adrenaline into the blood vessels of learners thereby strengthening their excitements.

For Curriculum Developers and Textbook Writers

The stories we presented in this research work might help curriculum developers, text-book and reference-book writers. It might be helpful ranging from the federal to the local level to design their activities. This dissertation has presented numerous local issues and provided rich insights as its way out.

For Environmental Engineer and Agro-Scientist

As researchers took challenge of farming in a sloppy terrain (24%) developing sustainable ways of farming, fertilizer production and its application along with watershed management, thus this research might prove helpful in the areas of natural resource management, environment engineering, sustainable development and agriculture. Basically, the idea originated herein such as CCTs, organic farming using eco-san, waste management, preparation of biopesticide etc. might appear significant for agriculture and environmental scientist to delve deeper into; and could be an emerging area for further research and exploration.

For Computer Scientist and AI Experts

Integration of artificial intelligence (AI) in school garden situated in the semi-urban region is a sheer challenge. Our stories of AI integration in school garden might be insightful for those who realise its potential in transforming today's society by harnessing 21st century skills in our learners. Thus, Computer Scientist and AI experts might find this research useful in terms of smart farming.

Hence, the opportunity or challenge presented here as a real-life problem stimulates purposive learning in learners. Learning is a social as well as individual process. New learning generates ideas, possibilities and theories from existing knowledge. Now, a fundamental question is, are we ready to take the risk of learning? The risk of learning is never a loss, it's a profit. Yes, profit to solve practical problems for which there were no `textbook' answers.

Limitations of the Study

In our quest to revive Dapcha using school garden, we came across several limitations. This research as a part of partial fulfillment of University requirements placed time as one of a major constraint. In limited time-frame, we had to run experiments and observed its effectiveness for two cycles (PAR cycle) only. If we had observed gardening in a more integrated way (mentioned in school's master-plan)

undertaking more cycles, the result would have been more impactful. The second one is our inability in considering human waste from a broader perspective (feces or solid waste as fertilizer and energy source) and move further towards its digitalization (see chapter II). Third one is, PAR as our methodological choice is more context-dependent, so the result would have been different if we had more/ less resources available (in terms of technology and skills) and increased/ decreased participation of diverse stakeholders of the region. And, lastly the emergence of pandemic (COVID-19) during initial phases of field engagement limited our engagement into partial group of learners and community members, otherwise could have more meaningful participation and generate better outcomes of this research.

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APPENDIX 1

नेपाल सरकार
कृषि तथा पशुपन्छी विकास मन्त्रालय
कृषि बिभाग
केन्द्रीय कृषि प्रयोगशाला
(माटो, बीउ, बालि संरक्षण)
हरिहरभवन, ललितपुर

फोन: ५५२०३१४
फ्याक्स: ५५५३७६१
ईमेल : centralaglab.sspp@gmail.com

प्र. दर्ता नं. :- ८४ मिति :2066-05-25

माटो स्वस्थता प्रमाणपत्र तथा मलखाद सिफारिस प्रतिवेदन ।

श्री संजय कुमा पन्त ठेगाना (गा.पा./न.पा./म.न.पा.) दाप्चा - ९ काभ्रे

वडा नं. ..... जिल्ला .....प्रदेश नं. 3 खेत/बारी .....

माटो स्वस्थताको अवस्था: माटोको बनोट : .....

पि.एच.		प्राङ्गारिक पदार्थ %		नाइट्रोजन %		फास्फोरस कि.ग्रा./हे.		पोटास कि.ग्रा./हे.	
5.8	अम्लीय ✓	VL ✓	कम	VL ✓	कम		कम		कम
	तटस्थ		मध्यम		मध्यम		मध्यम ✓		मध्यम ✓
	क्षारिय		अधिक		अधिक		अधिक ✓		अधिक

सुक्ष्मखाद्यतत्वको अवस्था

Zn (जिंक) ..... पि.पि.एम Cu (कपर) ..... पि.पि.एम., Fe (आइरन) ..... पि.पि.एम. Mn (म्यागनिज)..... पि.पि.एम. B (बोरोन) .....पि.पि.एम. अन्य .....

सिफारिस प्रतिवेदन

(१) कृषि चुन 925 कि.ग्रा. प्रति रोपनी ।

(२) रासायनिक मलको साथमा गुणस्तरीय प्राङ्गरीक मल तल दिइएको मात्रामा अनिवार्य प्रयोग गर्नुहोस ।

• १५०० कि.ग्रा. वा ६० डोको प्रति रोपनी	• १००० कि.ग्रा. वा ४० डोको प्रति रोपनी	• ५०० कि.ग्रा. वा २० डोको प्रति रोपनी

(३) खाद्यतत्व सिफारिस मात्रा

बालिको नाम	नाइट्रोजन	कि.ग्रा./रोपनी		फास्फोरस कि.ग्रा./रोपनी			पोटास कि.ग्रा./रोपनी		
धान सिंचित	५.००	२.५०	१.२५	१.५०	०.७५	०.३८	१.५०	०.७५	०.३८
धान असिंचित	३.००	१.५०	०.७५	१.००	०.५०	०.२५	१.००	०.५०	०.२५
मकै वर्षे	३.००	१.५०	०.७५	१.५०	०.७५	०.३८	१.५०	०.७५	०.३८
मकै हिउदे	४.५०	२.२५	१.१३	२.२५	१.१३	०.५६	२.२५	१.१३	०.५६
गहुँ सिंचित	५.००	२.५०	१.२५	२.५०	१.२५	०.६३	१.३०	०.६५	०.३३
गहुँ असिंचित	२.५०	१.२५	०.६३	२.५०	१.२५	०.६३	१.००	०.५०	०.२५
कोदो उन्नत	३.००	१.५०	०.७५	२.००	१.००	०.५०	१.५०	०.७५	०.३८
उखु (मोरहन वाली)	६.००	३.००	१.५०	३.००	१.५०	०.७५	२.००	१.००	०.५०
उखु (खुटीबाली)	७.५०	३.७५	१.८८	३.००	१.५०	०.७५	२.००	१.००	०.५०
तोरी रायो	३.००	१.५०	०.७५	२.००	१.००	०.५०	१.००	०.५०	०.२५
जौ, उवा	२.००	१.००	०.५०	२.००	१.००	०.५०	१.५०	०.७५	०.३८
फापर	१.५०	०.७५	०.३८	१.५०	०.७५	०.३८	१.००	०.५०	०.२५
अदवा अलैंची	२.५०	१.२५	०.६३	१.५०	०.७५	०.३८	२.५०	१.२५	०.६३
आलु	११.००	५.५०	२.७५	७.००	३.५०	१.७५	५.००	२.५०	१.२५
तरकारी बाली सागपात जात	१०.००	५.००	२.५०	९.००	४.५०	२.२५	४.००	२.००	१.००
तरकारी बाली जरे जात	१०.००	५.००	२.५०	९.००	४.५०	२.२५	४.००	२.००	१.००
हरियो केराउ	०.७५	०.३८	०.१९	२.००	१.००	०.५०	६.००	३.००	१.५०
काँको	७.००	३.५०	१.७५	२.००	१.००	०.५०	५.००	२.५०	१.२५
जुकिनि	१३.००	६.००	३.००	९.००	४.५०	२.२५	३.००	१.५०	०.७५
गोलभेंडा (सुजना)	१०.००	५.००	२.५०	९.००	४.५०	२.२५	४.००	२.००	१.००
गोलभेडा (होचा अन्य जात	१०.००	५.००	२.५०	१०.००	५.००	२.५०	७.५०	३.७५	१.८८
भाण्टा	१०.००	५.००	२.५०	९.००	४.५०	२.२५	४.००	२.००	१.००
रामतोरिया	१०.००	५.००	२.५०	९.००	४.५०	२.२५	३.००	१.५०	०.७५
काउली (लोकल)	१०.००	५.००	२.५०	६.००	३.००	१.५०	४.००	२.००	१.००
काउली (हाईब्रिड)	१०.००	५.००	२.५०	६.००	३.००	१.५०	४.००	२.००	१.००
बन्दा	१३.००	६.००	३.००	९.००	४.५०	२.२५	४.००	२.००	१.२५
सिमि	४.००	२.००	१.००	६.००	३.००	१.५०	३.००	१.५०	०.७५
तितेकरेला	१०.००	५.००	२.५०	६.००	३.००	१.५०	३.००	१.५०	०.७५
तने बोडि	४.००	२.००	१.००	६.००	३.००	१.५०	२.००	१.००	०.५०
भेडे खुर्सानी	१०.००	५.००	२.५०	५.००	२.५०	१.२५	५.००	२.५०	१.२५
प्याज	१२.००	६००	३.००	९.००	४.५०	२.२५	४.००	२.००	१.००

(प्राविधिक) (प्रमाणित गर्ने)

APPENDIX 2

Regd. No.: 1898/527/241/050/51
VAT No.: 500189115

AGRICULTURAL TECHNOLOGY CENTRE (ATC)
Kupondole, Lalitpur, Nepal
Tel. No. : 01-5425956
E-mail: agritech1993@gmail.com

Soil Sample Analysis Report

Report No.	78-R-69	**Sample Received Date**	2078/08/17
Entry No.	78068	**Date Completed**	2078/09/05
Client	Sanjaya Kumar Pant	**Sampled By**	Client
Contact No.	9851147243		

S.N.	Sample Code	Sample Identification	pH	N %	P_2O_5 kg/ha	K_2O kg/ha	O.M.%	Sand %	Silt %	Clay %	Soil Texture
1	078/917	Control only Water	5.33	0.08	13.53	455.60	0.69	41.06	41.76	17.18	L
2	078/918	Tunnel-2 Chemical Fertilizer	6.02	0.12	54.11	643.20	0.53	47.06	37.76	15.18	L
3	078/919	Tunnel-3( ) Water+Urine+Ash	5.52	0.15	25.12	683.40	0.53	45.06	39.76	15.18	L
4	078/920	Tunnel-3 ( ) Urine+Water	4.20	0.15	21.26	871.00	0.47	45.06	37.76	17.18	L

Test Methods

- ***Total Nitrogen:*** *Kjeldahl Digestion Distillation Method*
- ***Available Phosphorus:*** *Modified Olsen's Bicarbonate Method*
- ***Available Potassium:*** *Ammonium Acetate (Flame Photometric Method)*
- ***Soil pH:*** *Potentiometric (1:2.5) Method*
- ***Soil Organic Carbon:*** *Walkley and Black Method*
- ***Soil Texture****: Hydrometer Method*

Checked By

D. Laxmi
Soil Specialist

APPENDIX 3
VIGNETTES FROM LOCAL ENTREPRENEURS

Though we met several local inhabitants, but our engagement with these four farmers, i.e. late Bir Bahadur Pariyar, Mr. Sundar Bahadur Tamang, Mr. Netra Bahadur Bishwokarma (or Gajale kaka), and Mr. Kajiman Tamang of Namobuddha made a marked influence in shaping our journey to contextualize school garden. One of the thing common in all of these local farmers was they are/were entrepreneur working in local region. Dissatisfied from the urban climes they had returned back to their home village for better niches. The late Bir Bahadur Pariyar who lost his life from nCOV-19 infection, was a tailor master with a small tailor shop, as well as lead musician of Panche baja (a set of five traditional musical instruments that are played during ceremonies). Often times, he visited school garden and shared the significance of his skills in the development of community. Realised from the discourses we had with him, we were making plan to share and transfer his knowledge to the school community and then formally design a curriculum in the area of ethno-music/ local music. But, we could not translate this into practice because of his sad and untimely demise. However, I believe that realization is a primary process of transformation. And, co-researchers involved during these processes might consider this in the days to come.

Mr. Sundar Bahadur Tamang, a retired Nepali Army and now a Pheasants farmer had a farm house on the way to Namobuddha. We came to know about his farm from one of a school teacher who was his neighbor. Farm was spread in two ropanies of land, and was covered from all sides and the top with net to prevent birds from escaping. We visited his farm house and learnt how he dedicated his retired life entirely in new career of farming. I found something different in this farming as he had vehement feeling of love for his work. In most places of country, farmers and their occupation is considered as 'low-level task' compared to teaching or other profession. But, Sundar Bahadur reflected considerable love, respect and patience for what he has been working. We found it significant to incorporate his philosophy of farming in the school garden as well. Co-researchers exhibited interest to incorporate Pheasant farming in their forthcoming plan as well.

Figure 57

Local entrepreneur in Namobuddha (Sundar bahadur)

(Source: https://www.youtube.com/watch?v=QB7ehjMuDbA)

Mr. Netra Bahadur Bishwokarma (popularly called by Gajale kaka), a goldsmith by profession was an active social worker. While learning various forms and nature of local knowledge and understand their importance in school garden, we met Gajale kaka. In the daytime, we caught him busy in his 'Aarhan' (a traditional maker-space of metal weapons) crafting weapons. He had been fulfilling the demands of villagers since many three decades.

"In this profession, one can earn more than one hundred thousand rupees, but new generation is no more interested to carry on our profession. I have two sons, one is a driver and other works in jewelry shop. I am afraid that people might forget our profession in near future" he shared.

We found that Aarhan could be an excellent place to learn numerous concepts of physical science such as, simple machine, energy, work, pressure, heat, metal and metallurgy etc. In informal discussion with co-researchers, most of them realised urgent need to integrate these local knowledge in the curriculum. Since long time, our local knowledge and local profession have been neglected and now they are at the verge of extinction. We must be capable enough to skim off the dominant nature of modern world view prevalent in every aspect of life. When we rightly understand the significance of our knowledge tradition inherent in the workplace of our people and include these indigenous and local knowledges in our curricula, then in true sense curricula is said to be contextualized.

Figure 58

Local entrepreneur in Namobuddha (Netra bahadur)

(Source: https://www.youtube.com/watch?v=ipqWR7TPQOg)

Fourth and most influential local entrepreneur we had ever met during our research project was Mr. Kajiman Tamang. He had a permaculture (a name for permanent agriculture or sustainable agriculture) zone spread in nearly ten ropanies of land. And, a small and beautiful mountain river flowed through its edge. There was no easy access of road to reach the agro site as the place was quite isolated from local community. In an integrated approach, he has cultivated Kiwi fruit along with Bee keeping and animal husbandry. Annually, he made a turnover of five million rupees from his farm. When I inquired about how he learnt integrated farming and horticulture, he gave an innocent smile and said,

"…… I have not taken any extensive training or educational courses regarding horticulture but it is the plants who teach me all these skill I require."

He seemed to recognize deep-seated love for nature and gardening. We found him very empathetic and he had taught several farmers and farmers group to initiate Kiwi farming and had distributed Kiwi plantlets prepared in his nurseries. He accepted our request to share his knowledge about integrated farming and Kiwi plantation in school garden. With his support and guidance we initiated Kiwi and lemon farming in four ropanies of land in School garden.

Figure 59

Learning Kiwi farming with Local entrepreneur (Kajiman)

(Sources: https://www.youtube.com/watch?v=gx5fVpeU0BM&t=479s

3https://www.youtube.com/watch?v=U3Nv18kAHwg&t=340s)