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Learning Mathematics beyond the Classroom through Local Knowledge and Community Practices

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Abstract: Mathematics is a formal school subject that is taught by textbooks, taught with formulas, and in class, and so many students see mathematics as continuous, abstract and far from their life. This study focuses on the processes of learning and earning in Sikdai Kamaudai ra Kamaudai Sikdai (Learn and Earn) programme and STEAM activities in JSS Secondary School in Hetauda, Nepal, where students learn mathematics based on local knowledge and community practice. The study employed a qualitative research design guided by an integrated theoretical framework of Ethno-mathematics, Situated Learning Theory and Sociocultural Theory. The open-ended interviews were conducted with three purposively selected secondary school students and analyzed thematically.

The results indicate that students had meaningful mathematical learning experiences while engaging in agricultural activities, entrepreneurship projects, visiting banks and co-operatives, observing hydropower and traditional technologies like Pani Ghatta (water mill). These authentic experiences helped students relate mathematics with real life situations like measurement, estimation, geometry, ratio, profit, loss etc. and simple and compound interest. The learning was not based on teaching in the book alone, but was done through active learning, social interaction and community involvement, so that mathematics topics become meaningful for learners.

The study adds to the body of literature on culturally responsive mathematics education by showing that a place-based learning context can supplement the formal school mathematics classroom and can offer authentic experiences for developing mathematical understanding. The incorporation of these community-based experiences in school mathematics can lead to the connection of formal and informal mathematics, culturally responsive mathematics education and meaningful learning in Nepal and other learning contexts.

Key Words: Mathematics education, local knowledge, community practices, Ethno-mathematics, culturally responsive mathematics education, Nepal..

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1. INTRODUCTION

Mathematics is commonly perceived as a discipline learned in text books, by formula and taught in the classroom. It is taught as an all-embracing knowledge, divorced from learners' social and cultural backgrounds (Ernest, 1991). This can offer a shared curriculum but can result in mathematics being perceived as abstract, challenging and unrealistic.

In fact, mathematics is an integral part of the life of the community in everyday life. Farmers estimate area and yields, shopkeepers work on profit and loss, carpenters use measurement and geometry in construction and artisans produce patterns and symmetry in their art. The following activities illustrate that mathematical reasoning is formed through involvement in social, cultural and occupational practices even if people do not explain their knowledge by formally speaking mathematical language (D'Ambrosio 2001).

Although everyone uses mathematics in their everyday lives, students still see mathematics as impractical to their lives and abstract. A gap between school mathematics and community life is a prominent issue in mathematics education research. More and more, researchers claim that the development of meaningful mathematical learning ought

to involve the ability to link the formal mathematics with the cultural knowledge of the learners and their experiences (Boaler, 2016; Bishop, 1988; D'Ambrosio, 2001).

The idea to the study is that mathematical knowledge is not limited to the classroom but is generated, developed, shared and used in the local community. It examines the mathematics learning that occurs within the local knowledge and community activities of the Sikdai Kamaudai ra Kamaudai Sikdai (Learn and Earn) program and STEAM activities at JSS Secondary School, Nepal. The study explores community life as a legitimate site for mathematical learning, and illustrates how community knowledge can enhance school mathematics and make it more meaningful and relevant.

While some research has focused on context and culturally responsive mathematics instruction, little empirical research has considered the potential of community practice itself as a legitimate mathematics learning environment. The study is focused on students' experiences in their local communities, and moves current research on teaching and learning in the classroom beyond, while adding evidence to the growing research field in community learning and teaching of mathematics in Nepal.

Mathematics Beyond the Classroom

The organisation of school mathematics has been based for many years on a standard curriculum, school texts, and exams. These offer consistency of teaching and assessment but can make mathematics seem like a set of rules, formulas and procedures to be memorized rather than understood. This view of mathematics as objective, culture-free, and disconnected from human experience was criticized by Ernest (1991) who contended that mathematical knowledge is culture and/or social dependent.

However, mathematics education researchers have been voicing a different perspective in response to this tradition that meaningful mathematical learning can even happen out of school. Boaler (2016) argued that students' perception of the importance of mathematics is limited because learning in the classroom is not related to students' everyday experiences. Consequently, students may be able to perform well on homework problems in their textbooks, but struggle to use mathematical concepts in everyday situations.

Studies have also shown that mathematical knowledge is not only present in daily life outside the classroom but is also rooted in all aspects of the culture and community. Bishop (1988) suggested that all cultures perform basic mathematical activities including counting, measuring, locating, designing, playing, and explaining. Similarly, Lave (1988) demonstrated that doing mathematics problems in real-life situations is more effective than doing them in formal school settings, indicating the need to learn by participating in authentic real-life activities.

This view is reinforced by the concept of Ethno-mathematics.This view is corroborated by the concept of Ethno-mathematics. D'Ambrosio (2001) has suggested that all culture creates its own mathematical knowledge in response to their social, cultural and environmental needs. The mathematics is not everywhere or restricted to the school; it is a product of the practices of the communities. Such an understanding of multiple mathematical knowledge helps to expand mathematical knowledge and to uncover the value of local knowledge and lived experiences in education.

As a whole, these perspectives question the perception of mathematics as a school subject. Rather they locate mathematics as a cultural and social activity that evolves in the process of being engaged in daily community life. This view is the basis of the current

study which investigates the learning of mathematics by learners in their local knowledge and community practices outside the classroom.

The Nepalese Context

In Nepal, there is a good context to the learning of mathematics by drawing upon local knowledge and community practices. There is a close linkage between the country's cultural diversity, indigenous knowledge systems and traditional occupations and Mathematical thinking. Mathematical ideas and language related to measurement, estimation, geometry, patterns, and calculations are in use in everyday activities (agriculture, local trade, traditional architecture, handicrafts, and community livelihoods). Although there is much of mathematics in these learning styles, these types of knowledge have been underutilized in formal mathematics education where learning is still mainly textbook-driven and exam-based.

This is the traditional approach that has been challenged by many scholars in Mathematics education in Nepal in the last two decades and they have supported the need for mathematics education that is contextual, culturally responsive and transformative. Luitel (2009) claimed that the mathematics education in Nepal is influenced by modernist and decontextualised traditions that have led to mathematics education being detached from the real life situations of learners. He highlighted the need to respect local knowledge, the diversity of worldviews and the cultural backgrounds of learners when teaching mathematics.

This view has been confirmed in subsequent studies. By engaging students in authentic learning activities, project-based learning has been found to enhance the students' engagement, collaboration, problem-solving ability, and conceptual understanding by Tyata et al. (2021). Similarly, the mathematics education in Nepal was criticized by Lamichhane et al. (2023) for being teacher-centred and examination-oriented, and they have suggested Drama Based Pedagogy as a means to link mathematics with students' daily life, to promote reflection learning and to empower students. Likewise, Lamichhane and Luitel (2023) called for anti-colonial and culturally responsive mathematics education that embraces Indigenous epistemologies along with formal school's mathematics. While the study was focused on STEAM education, Manandhar (2022) also illustrated that meaningful learning can be achieved if the subject matter is based on lived experiences, local realities, and critical reflection.

All these studies have contributed collectively to the promotion of contextual, participatory and transformative approaches to mathematics education in Nepal. They always say that good maths learning is when students are actively engaged in real-life experiences,that connect school learning with real life.

In spite of these significant contributions, the majority of research in Nepal has addressed how to enhance classroom pedagogy, for example, project-based learning, drama-based pedagogy, and transformative teaching. Much less effort has been directed toward studying community life as a genuine sphere of mathematical knowledge production, sharing and learning. Agriculture, local businesses, financial institutions, traditional technologies and other practices of the community have yet to be explored in terms of mathematical knowledge in mathematics education research in Nepal.

This research aims to fill this gap by investigating learning of mathematics in environments outside of the classroom—local knowledge and community practices. The study does not consider community experiences as simply examples for the school to use

in teaching school mathematics, but as a space where mathematical knowledge is created, used and shared. It does so by highlighting how local knowledge can add value to mathematics teaching and learning in the context of Nepal, which adds to the body of knowledge on culturally responsive mathematics education.

Knowledge Gap

Ethno-mathematics, Situated Learning Theory, and culturally responsive mathematics education have shown that mathematical knowledge is deeply related to the social, cultural and everyday practices (Bishop, 1988; D'Ambrosio, 2001; Lave & Wenger, 1991). Similarly, Nepalese scholars have been promoting contextual, culturally responsive and transformative mathematics education (Luitel, 2009; Manandhar, 2022; Tyata et al., 2021; Lamichhane et al., 2023). These studies have revealed the significance of mathematics in relation to the students' everyday lives and their local environment.

However, little empirical work has investigated the local knowledge and community practices as a genuine learning environment for mathematics in Nepal. The existing studies tend to target the improvement of classroom pedagogy, curriculum reform, or contextualised teaching and do not pay sufficient attention to the development of mathematical knowledge, sharing, and application in the communities of everyday life, outside school.

In this study, we aim to fill in this gap by investigating the mathematical learning that occurs when students engage in local knowledge systems and in community practices. The study extends current research work which does not consider community life as a place to learn mathematics and helps to understand culturally responsive mathematics education in Nepal.

More recently, there has been a growing focus on math education in relation to integrating Indigenous knowledge, place-based education, and culturally sustaining pedagogies. The research indicated that when students experience authentic cultural practices rather than only book learning, they will likely gain meaning in their mathematical learning. But, in South Asian context empirical evidence is limited especially in Nepal, which requires the present study.

Research Question

What role can local knowledge and community practices play in learning Mathematics out of classroom in Nepal?

2. THEORETICAL FRAMEWORK

There is an obvious connection between mathematical thinking and everyday life, but mathematics in the school is presented as knowledge that is abstract and far removed from students' social and cultural backgrounds. However, in the last few decades, mathematics education researchers have increasingly questioned this school-centred perspective, by acknowledging that mathematics knowledge is generated and used in a variety of cultural and community settings. An incongruity between mathematics and the students' lived experience has also been cited in Nepal. There are, however, only few studies that have investigated how mathematical knowledge is linked to local community practices and how they can be used in mathematics learning.

This study assumes that mathematical knowledge is not only found in classrooms, but also in the daily lives of families, workplaces, and communities. It discusses the way students build mathematical understanding as they become engaged in local knowledge systems and activities in their communities. Three theoretical frameworks are used to explore the process in the study: Ethno-mathematics, Situated Learning Theory and

Sociocultural Theory. Ethno-mathematics offers a means of examining mathematics as it exists within the local culture and community practices. Situated Learning Theory accounts for how mathematical knowledge is developed as a result of being engaged in authentic community learning activities, and Sociocultural Theory accounts for how social interaction, language, and cultural mediation contributes to the construction and transmission of mathematical knowledge. These are complementary theories and form a holistic theory to inform the analysis of how local knowledge can inform culturally responsive mathematics education in Nepal.

Ethno-mathematics Theory

Ethno-mathematics is the main theory used in this study. Ethno-mathematics is introduced by D'Ambrosio (1985, 2001), who questions the notion that mathematics is universal and culture-free knowledge. Rather, it suggests that mathematical knowledge is acquired in social, cultural, economic and environmental settings of various communities. In this view, mathematics is not confined to a classroom but is actually used in daily life activities like farming, trading, construction, weaving, and other cultural activities.

Likewise, Bishop (1988) has claimed that there are basic mathematical activities that are common to all cultures: counting, measuring, locating, designing, playing and explaining. The mathematical practices are universal, but presented in various ways in different cultures. Recent research has also highlighted the importance of acknowledging local knowledge and cultural practices to bring the education of mathematics more into meaning, relevance and cultural responsiveness (Rosa & Orey, 2021; Meaney & Trinick, 2023).

This study uses the theoretical lens of ethno-mathematics as a tool to uncover the mathematical knowledge that is embedded in the local knowledge systems and community practices. The use of mathematical ideas is visible in Nepal in various activities like measuring farm land, estimating the yield of the crops, calculating the profit and loss, building a house, using traditional technologies and managing local businesses. The common ways people use mathematics to create, apply, and pass on understanding show that mathematics is not just a product of formal education but is also produced and used in communities.

The viewpoints presented above are an integral part of the current study, which examines mathematics learning in the context of community-based activities including agriculture, entrepreneurship, financial education, hydropower project, and traditional technologies. Ethno-mathematics establishes a firm base to understand how the community practices will be helpful to enrich the school mathematics and how culturally responsive mathematics education is possible in the context of Nepal.

Sociocultural Theory

For studying mathematics learning as a socially and culturally mediated process, Vygotsky's (1978) Sociocultural Theory is important. The theory suggests that knowledge builds up by interaction with others, by using language and culture tools and by engaging in meaningful social activities, not only by individual learning. This view is of special relevance in the present study since mathematical understanding was developed as students interacted with teachers, farmers, cooperative managers, engineers, artisans and other community members in real-life learning experiences.

One of the important points in the Sociocultural Theory is Zone of Proximal Development (ZPD) in which it is said that people build new knowledge with the help of more knowledgeable people (MKO) (Daniels, 2016; Rogoff, 1990). Students themselves received

support from the resources of their communities through knowledgeable guides who helped them learn about the concepts of mathematics in the context of farming, entrepreneurship, financial literacy, hydropower learning and the traditional technologies. Thus, the Socio-cultural Theory gives a valid framework for comprehending the construction, sharing and maintenance of mathematical knowledge in the context of social interaction and cultural participation.

Situated Learning Theory

Situated Learning Theory, developed by Lave and Wenger (1991), adds to Vygotsky's sociocultural perspective by describing learning as participation in "authentic social practices. The theory suggests that knowledge can't be detached from the context and that knowledge is co-created in communities of practice through active engagement. Learners become more competent (Lave & Wenger, 1991; Wenger, 1998) as they begin to engage in more meaningful activities, moving towards greater engagement and competence in the activity.

Conceptual Integration of the Three Theories

Theory	Central Focus	Contribution to the Study
Ethno-mathematics (D'Ambrosio, 1985, 2001)	Mathematics in everyday life as a cultural activity	Recognizes mathematics in popular culture, traditional practices, work, or community life.
Situated Learning Theory (Lave & Wenger, 1991)	Learning by engaging in real communities of practice.	Describes students' learning of mathematics through activities in the real life of the community.
Sociocultural Theory (Vygotsky, 1978)	Learning as a social, linguistic, mediational and cultural process	Describes how teachers and parents, as well as elders, artisans and other members of the community work together and with children to ensure their mathematical understanding.

The present study had a similar philosophy as this perspective as students learnt mathematics through real-life community activities, in addition to classroom instruction. Students gained a mathematical understanding by observing, collaborating and solving real life problems through farming, entrepreneurism visits to banks and cooperatives, hydropower and traditional technologies. Situated Learning Theory, then, is a theory that can be used to explain how mathematical knowledge comes as a result of engagement with real everyday practices in the community, making learning more meaningful and relevant.

A Unified Theoretical Framework

The research in this study is integrated research which is a research that attempts to use several theories and models, namely Ethno-mathematics, Situated Learning Theory and Sociocultural Theory, to explain the mathematics embedded in community life and how mathematics is learned through participation in community practices. These theories are not considered individually, rather as complementary perspectives that offer a broad view of the learning of mathematics outside the classroom.

Ethno-mathematics (D'Ambrosio 1985, 2001) describes the mathematical knowledge that is present in the local culture and community practices. Acknowledges that mathematics is “in the world” in aspects of daily life, like agriculture, commerce, building and traditional technologies. Situated Learning Theory (SWT), as pioneered by Lave & Wenger (1991), is the theory which provides an explanation of how this type of knowledge is acquired through engaging in authentic community practices. Learning is also social, mediated and directed, which can be understood by the Socio Cultural Theory (Vygotsky, 1978).

These three theories constitute a coherent analytical perspective on the arena of mathematics as a cultural, social and experiential practice. Such an integrated view allows the study to locate mathematical knowledge in local contexts, to describe how this knowledge is acquired by learners when participating in social and cultural activities and to describe how social and cultural interactions facilitate meaningful learning in mathematics. The framework also closely mirrors the objective of the study and offers a solid basis to understand how the local knowledge and practices can play a role in culturally responsive mathematics education in Nepal.

These theories complement one another and offer a unified way of analyzing mathematical knowledge that is embedded in community practices and understanding how students engage in authentic learning activities and how social interactions contribute to mathematical understanding.

These theories can be taken together to offer a comprehensive framework for the understanding of mathematics as a cultural, social and experiential practice. They show how mathematical knowledge is constructed, communicated and maintained in the context of community life. This interwoven model is used to analyse the role of local knowledge in creating meaningful and culturally relevant mathematics education in Nepal.

Field Engagement Process

This study was carried out with students of JSS Secondary School, Hetauda, Makawanpur where students are involved in Sikdai Kamaudai ra Kamaudai Sikdai (Learn and Earn) programe and Sikdai Kamaudai – STEAM based community learning activities. The field engagement was designed to investigate the ways in which students learned mathematics outside of the classroom, using local knowledge and community practices. A qualitative method was used to have students' lived experience and meanings of mathematical learning clarified (Creswell & Poth, 2018).

Field engagement involved interviewing students, as well as visiting students in their learning environments during agricultural projects and entrepreneurship activities, and other community-based learning programmes. The observations informed the interview process by helping to generate context-specific questions (Maxwell, 2013; Merriam & Tisdell, 2016) and also helped to gain insights into how students acquired mathematical understanding in authentic experiences.

The fieldwork showed students had a more meaningful learning experience when learning through being active in their community practices, rather than from what was written in their textbooks. These experiences also gave me a sense of the learning potential of local knowledge and community practices as sources of learning about mathematics and meaningful learning.

Participant Selection

The subjects selected were through purposive sampling in order to obtain rich and relevant data regarding mathematics learning from local knowledge and community practices (Patton, 2015). The three students from the 9th and 10th grade were chosen as they actively participated in the school programmes on agriculture, entrepreneurship, bank/cooperative visits, hydropower observation and other community-based learning programmes.

Students who participated in this study had personal experience of using mathematics in real life community contexts and were appropriate for the purpose of the study. The varied backgrounds in agriculture, entrepreneurship, money-related literacy and community engagement allowed the study to discuss different perspectives on mathematics learning out of the classroom setting. All participants were given pseudonyms – Suman, Riya and Bikash – as a measure to protect their anonymity.

With only three participants, it is still considered qualitative research because qualitative research emphasizes cases with information rich cases instead of a large number of participants (Patton, 2015). The study leverages the experience of the participants in conducting community learning activities, which allowed for the production of rich descriptions of mathematics learning beyond the classroom. Data collection was continued until a sufficient depth was reached, and no substantially new insights were gained on the focus of the research.

Data Collection Procedures

This data was gathered, using open-ended, semi-structured interviews, which meant that the participants could talk about their experiences of learning mathematics from local knowledge and community practices in their own words. The study's purpose and the role of the participants in the interviews were explained and informed consent was obtained before each interview (Kvale & Brinkmann, 2009).

I had some opportunities to get to know students, informally, through agricultural projects, entrepreneurial events and a variety of other community-based activities prior to the formal interviews. These interactions helped build rapport and allowed participants to openly share their experiences.

The interviews were held separately, in a quiet room in the school, and took around 30–40 minutes. A conversational interview technique was used, which enabled the participant to freely share his/her experience with the researcher within the boundaries and focus of the research topic. Students' learning about mathematical concepts through agricultural activities, STEAM projects, visits to financial institutions, hydropower observations, and traditional technologies like Pani Ghatta (water mills) was explored by guiding questions. Follow-up questions (Can you tell me what happened? Who helped you learn this? Why was this experience different from learning mathematics at school?) helped to elicit detailed narratives and deeper reflections (Rubin & Rubin, 2012).

Field Notes and Reflective Memos were prepared immediately after the interviews, to document observations, ideas and initial interpretations. The writing of memos facilitated the linking of the narratives of the participants to the larger social and cultural contexts in which mathematics learning was happening (Saldaña, 2021). Then the transcripts of the interviews, field notes, and reflective memos were organized and prepared for thematic analysis with the integrated theoretical framework of the study.

Ethical Considerations

Throughout the study, ethical principles were carefully considered and followed in conducting the study within qualitative research guidelines (Creswell & Poth, 2018). Participants were briefed on the aims of the study, their involvement, their rights as research participants before the start of data collection. Verbal informed consent was obtained from all participants and the participation was voluntary. They were informed that they could withdraw from the study at any stage without any negative consequences.

All interview transcripts and research reports were de-identified by using pseudonyms and no personally identifiable information was provided to ensure the participants' privacy and confidentiality. The data collected were anonymous and only analyzed for research. A respectful and supportive environment was always maintained during the fieldwork and interviews to encourage the participants to openly and honestly share their experiences (Tracy, 2010).

Self-Reflection on the Researcher's Role and Field Engagement

I was also the participants' mathematics teacher during the study as the researcher. This was a dual role, and this brought on its own opportunities and challenges during the field engagement. I already knew the students and this helped to build trust and facilitated open discussion with them regarding their experiences of mathematics learning from community activities. Concurrently, I realised that my professional identity and previous engagement with participants could affect the interview process, and the way participants' stories were interpreted. I did not try to remove this influence but I continuously kept in mind that my assumptions, experiences, and perspectives might impact the research. This reflexivity makes the credibility and transparency of qualitative research more credible (Berger, 2015).

In the interviews I made a conscious effort to avoid assuming a role of teacher and rather that of researcher. I encouraged participants to be open and honest in sharing and told them there were no right or wrong answers. This method assisted in fostering an environment in which students were able to openly discuss their learning experiences.

Through the field engagement, I expanded my understanding of the natural learning of mathematics that takes place within the community. Students reported learning mathematical concepts in the context of agriculture, entrepreneurship, financial literacy, traditional technologies and other community based experiences. The following narratives showed that mathematical knowledge is not separated from social, cultural and economic practices of everyday life.

I kept a reflective journal to document field observations, interpretations, and methodological reflections immediately following the interviews throughout the study. These reflective memos facilitated a clear and honest analytical process (Lincoln & Guba, 1985) and enabled the voices of the participants to be clearly discerned from my interpretation of their views.

Collectively, the field experience deepened my knowledge of the educational benefits of local knowledge and practices. It additionally reinforced my dedication to investigating how mathematical learning can take place beyond the classroom and the significance of linking school mathematics to students' life experiences.

3. METHODOLOGY

Research Design

The research method used was qualitative approach, through an open-ended, semi-structured interview to gain insight into the students' experiences in learning mathematics with the local knowledge and community practices. The research was concerned with the ways in which students acquired mathematical concepts in a meaningful way outside of the classroom routine.

Participants

The three students of Grades 9 and 10 who actively participated in school's Sikdai Kamaudai ra Kamaudai Sikdai (Learn and Earn) programme and STEAM-based

community learning activities, were selected based on their first-hand experience of the phenomenon under investigation (Patton, 2015). To ensure the anonymity of the participants, pseudonyms were used in all cases:

- Suman (Grade 10)
- Riya (Grade 9)
- Bikash (Grade 10)

Data Collection

Each participant was interviewed individually about his/her experience. The participants were invited to share their experiences on their learning of mathematics through agriculture, entrepreneurship, financial education, hydropower observation, and other learning experiences in their communities. The following questions were used as guides for the interviews:

- What examples of the mathematical applications in the real world have you seen?
- What mathematics have you learned at community activities?
- What have been your experiences and how have they helped you to understand mathematics?
- In what ways are these experiences different from learning mathematics from books and in school?

Data Analysis

Interviews were conducted with the consent of the participants, and were audio-recorded and transcribed word for word immediately following each interview. The transcripts were then analyzed with the help of field notes and reflective memoirs for accuracy and to gain a holistic understanding of the participants' experiences. The researcher read and re-read the transcripts several times in order to get acquainted with the data, look for meaningful patterns, and note preliminary findings of analysis. The iterative process of familiarisation is crucial to developing a depth of understanding of qualitative data before formal coding starts (Braun & Clarke, 2022).

Data was analyzed using reflexive thematic analysis, proposed by Braun & Clarke (2022), which consists of 6 phases. Open coding was the first step of the analysis, where meaningful words, phrases, and parts of the text which displayed students' experience in learning mathematics from local knowledge and community practices were identified and labeled. Constantly reflecting and comparing across participants' stories, similar codes were then further summarized and categorized into larger categories. The categories were later condensed and then evolved into themes that were representative of patterns that occurred in the data and were highly connected to the participants' experiences (Braun & Clarke, 2022; Saldaña, 2021).

These emerging themes were reviewed and revised on a number of occasions to ensure they represented the data and answered the research question. The integrated theoretical framework influenced the final interpretation of the themes, which were guided. Ethno-mathematics was employed to discover mathematical knowledge that is contained in local cultural practices and community activities. Situated Learning Theory helped shed light on how students acquired mathematical understanding through active engagement in real community contexts, and how socio-cultural factors such as language, culture, and guidance from communities of more expert mathematicians facilitated mathematical learning (Creswell & Poth, 2018; Braun & Clarke, 2022). Combining these complementary theoretical perspectives allowed for a rich and contextually based analysis of the ways in which local knowledge and community practices supported meaningful learning experiences with mathematics beyond the classroom.

4. FINDINGS AND ANALYSIS

Agro-practices in the learning of mathematics

One of the best opportunities for students to learn mathematics outside of the classroom was in agricultural activities. Students planted crops of coriander, potato, tomato, cauliflower, seasonal vegetables and engaged in the school's Sikdai Kamaudai ra Kamaudai Sikdai (Learn and Earn) programme for several months. They used mathematical concepts in real-life situations as they prepared the land, planted seeds, watered the crops, and observed the growth of plants. The school garden proved to be a real place for learning and saw students talking to teachers about measurements, interacting with their classmates, and getting practical farming tips from local farmers.

Suman explained:During the tomato and potato planting activities, the distance between the plants, the number of seeds required for planting and the estimated amount of production were measured, calculated and predicted, respectively, which helped me comprehend the application of mathematics in farming.

In Suman's experience, when mathematical ideas (measurement, estimation and ratio, area) were used in real work in the farm, they made sense. Instead of learning formulas from books, students gained conceptual understanding by solving problems related to real-life situations they faced in the process of crop production. Math was no longer in the school classroom but a tool for decision making.

The findings highlight the ability of 'real-life' learning opportunities in agricultural activities to help students to develop mathematical understanding through collaboration, observation and problem solving. Students learned through real farming activities, rather than remember mathematical procedures, to use concepts of measurement, estimation, ratio and area. As a result of these experiences it was found that they had begun to appreciate the usefulness of mathematics in tackling everyday problems.

Learning Mathematics through Entrepreneurship

Another important context for mathematical learning was related to entrepreneurship activities. Students were the part of the annual STEAM programme at school, and they made soap in the first project and small business projects, including making calculations about the production costs, selling prices, profits and losses. Students demonstrated the following skills through the collaborative group work: mathematical understanding; making real financial choices.

Riya shared:Prior to the project, there were no formulas in the book of profit and loss; when we made and sold soap, we calculated the profit and loss for ourselves, and then I realized how important the calculating of the profit and loss is.

The story of Riya demonstrates the idea of making maths meaningful through context of real life related to business. Students developed their understanding of mathematics through application rather than rote learning of procedures; the problems involved calculation, discussion and decision making in practical situations. The concepts of cost price, selling price, percentage, profit and loss, etc. became relevant to their daily life activities.

Based on these results, it was found that the activity of entrepreneurship allowed students to apply mathematics concepts into actual decision making in finance. Students used concepts of cost price, selling price, percentage, profit and loss in their activities of real business, which gave them meaning. This experience changed the way students looked at mathematics, now it was a practical means for day to day decision making.

In general, the agricultural and entrepreneurship experiences show that significant mathematical learning takes place when students are engaged in real practices of the community. The activities helped students to make connections between school mathematics and their lives, and to understand, relate, and apply mathematical concepts to their everyday lives. The results indicate that local knowledge and community practices need to be acknowledged as important contexts in culturally responsive mathematics education.

Learning Mathematics through Banks and Cooperatives

There were several educational visits to banks and cooperatives, which enabled students to learn financial mathematics in real contexts. These visits included watching real financial transactions and meeting cooperative managers to learn how the cooperative uses mathematical concepts like simple interest, compound interest, percentages and saving in real financial transactions. In these experiences, mathematics was related to the actual practice of the economy and students were made aware of the usefulness of mathematics in practice.

One student explained:Though I knew the concepts of simple and compound interest in the classroom, the cooperative's manager explained the interest calculations on the savings and loans and I understood the formulas better after seeing them in action.

This experience shows the importance of making math more meaningful by having students see how it was applied in real financial contexts. Many students prior to the visit could repeat the formulas but didn't know what they were used for. Students analyzed real savings and loan records, and engaged in a dialogue with cooperative managers, increasing their knowledge of percentages, interest rates, and financial skills. Mathematics was no longer perceived as a host of abstract formulas but as a handy instrument that could assist in making everyday financial choices.

The results suggest that the activities of entrepreneurship allowed students to make connections between mathematical concepts and real-life financial decision making. The concepts like cost price, selling price, percentage, profit and loss became real to students as they relate them to the real business activities that they were dealing with. The experience changed the face of math from the classroom to a practical application to everyday decision making.

Leveraging the power of water and building to learn mathematics

Learning visits to hydropower projects gave pupils opportunities to make links with the ways in which mathematics is used in engineering and technological development. In these visits, students were exposed to construction activities, water flow systems, engineering structures and machinery and engaged in discussions with engineers and technical staff regarding mathematical concepts. The actual experiences helped students appreciate the relevance of mathematics in large-scale infrastructure projects.

Suman described:We watched the construction activities, measured various structures, took a look at the water flow and machinery, and learned how math is applied to the construction and operation of hydropower projects.

Suman found that when students saw how the geometric concepts and other mathematical ideas like measurement, ratio, speed, distance and estimation were used in real engineering situations, it became easier for them to understand those mathematical concepts. Instead of students studying these concepts in diagrams and through textbook

problems, they had an opportunity to learn how mathematics is used to assist with planning, building, measuring, and solving problems in technological systems. These experiences enabled students to transfer abstract concepts learned in school to the real world.

The results are similar to those of the Situated Learning Theory (SIT) (Lave & Wenger, 1991) which suggests that learning is achieved by engaging in natural social and professional processes. Students engaged in meaningful interactions with engineers and saw mathematical concepts in the context of real-world construction, thus developing mathematical understanding. The results also validate the Sociocultural Theory put forward by Vygotsky (1978) because learning took place in a social context, with the help of a guided explanation and the use of cultural and technological instruments. In addition, the experiences illustrate the principles of Ethno-mathematics (D'Ambrosio, 2001), which assert that mathematical knowledge is not just present in the classroom, but also found in the development of the community, engineering, and technological practices.

In general terms, students' knowledge of mathematics was enhanced by visiting their banks, cooperatives and hydropower project as it brought them in touch with real life in the community and brought the concept of mathematics alive in the classroom. The results underscore the need to offer students opportunities outside of the classroom to experience real-life mathematical practices, which can help foster meaningful, contextual, and culturally responsive mathematics learning.

Using traditional technologies to learn Mathematics.
Students also got the opportunity to visit a traditional water mill (Pani Ghatta) which is one of the important indigenous technologies used for grinding grain in rural communities for generations. The visit helped students to see the integration of mathematical concepts into traditional technologies and common community practices. Students observed the actions of water, the wheel turning, and the grain processing action, and related mathematical concepts to actual technological systems.

Riya explained:At the Pani Ghatta, we saw how water was used to turn a grinding wheel to crush grain, and learned some concepts about rotation, speed, measurement, and efficiency.

The experience of Riya has proven that when students can see how mathematics is being used in indigenous technologies it has a meaning for them. Rather than being taught these ideas through diagrams in textbooks, students were exposed to examples of mathematics in real-world community contexts. The visit allowed them to understand the implications of relationships between rotation, measurement, estimation, efficiency and mechanical movement in a familiar local technology. These authentic experiences enabled students' appreciation of the value of mathematical thinking within the traditional knowledge systems of their own communities.

This result corroborates D'Ambrosio's (2001) idea of Ethno-mathematics that honors the fact that mathematical knowledge is created and used in different cultural practices. The Pani Ghatta is an example of an indigenous technology that has developed over many generations from a lot of experience. Results are also consistent with Situated Learning Theory (SLLT) (Lave & Wenger, 1991) as learners acquired knowledge in mathematics by engaging in authentic, community contexts. Likewise, Vygotsky (1978) suggested that learning was acquired through observation, discussion, and interaction with members of the community who were knowledgeable and offered their hands-on experience.

Relating school mathematics to community life

In every interview, students made it clear that they had a better understanding of mathematics from community experiences rather than from lessons within their classroom. They said that mathematics is a fundamental part of agriculture, entrepreneurship, banking, hydropower and traditional technologies and not the sum of isolated formulae in textbooks. They have found that mathematical understanding is best developed when students are involved in meaningful experiences and related to everyday experiences that involve school knowledge.

The results suggest that community and local context offer authentic contexts for mathematics learning. The students gained the concepts of measurement, estimation, geometry, ratio, percentages, profit loss, financial literacy and problem solving in the context of real world activities. They learned to appreciate mathematics as a practical means of understanding and solving problems in their lives through these experiences.

The results show that mathematics is more meaningful when it is related to mathematics students' social and cultural experiences and economic contexts. CBLOs link the everyday world with the world of mathematics but also show that mathematics is a part of our lives and we live in our communities. Hence, the recognition of local knowledge as a legitimate source of mathematical learning can be a step towards more culturally responsive, contextual and meaningful learning of mathematics in Nepal.

5. DISCUSSION

This study shows that the learning of mathematics can be meaningful not only in the classroom but also in the lives of people in the real community in a social, cultural and economic context. Students acquired mathematical knowledge by engaging in agricultural practices, entrepreneurship projects, bank visits, cooperative visits, hydropower visits and traditional technologies. They were able to relate mathematical concepts like measurement, estimation, geometry, ratio, percentage, profit and loss and interest to real life situations through these authentic experiences. Students did not see mathematics as a set of abstract formulas, but as a tool to help them understand and solve problems that they faced in everyday life.

The results indicate that community-based learning provides real opportunities for them to build mathematical knowledge in an active and participatory way in real-life situations. This interpretation matches Vygotsky's (1978) Sociocultural Theory which states that learning occurs in the context of social interaction, the use of cultural tools, and the assistance of more knowledgeable others. In this study, teachers, farmers, cooperative managers, engineers, artisans, and other community members were crucial in assisting students in their mathematical learning through connecting school mathematics to real-life practices in the community. Likewise, Situated Learning Theory (SWT) (Lave & Wenger, 1991) provides insight into the learning of mathematical understanding that took place as students engaged in realistic community tasks that were not solely based on a set of textbooks. The results of this study show that mathematical learning is more meaningful when students are involved in solving real life situations that are relevant to them socially and culturally.

The findings also support the concept of Ethno-mathematics as mathematical knowledge is part of the people's local culture, their life routines, and daily life activities. D'Ambrosio (2001) stated that mathematical knowledge is a product of culture and society, and Bishop (1988) viewed every culture as having mathematical activities including counting, measurement, locating, designing, and explaining. The examples in this study

(mathematical practices in farming, entrepreneurship, banking, hydropower, and the traditional Pani Ghatta) show that mathematical thinking is not just mathematics in school, but is also present in community practices. This study validates these lived experiences in the community as valid sources of mathematical knowledge and contributes to culturally responsive mathematics instruction that respects the local knowledge and formal school mathematics.

The results of the current research are also in line with earlier research which has called for a contextual and culturally responsive approach to mathematics education. International studies have demonstrated that the deeper mathematical understanding students develop when learning is linked to authentic experiences and culture (Boaler, 2016; Meaney & Trinick, 2023; Rosa & Orey, 2021). Similarly, Nepalese research has shown that a project-based learning approach, drama-based pedagogy and transformative approaches can enhance engagement and conceptual understanding of mathematics by making it relevant to students' lives (Lamichhane et al., 2023; Tyata et al., 2021).

The study in this paper, though, goes beyond what has been done before by focusing on how to make classroom pedagogy better, to the question of whether community life is a valid place for mathematics learning. The findings do not just serve as illustrations of classroom concepts, but rather show that local contexts such as businesses, financial institutions, engineering projects, or indigenous technologies are sites of new mathematical knowledge production, sharing, and application in everyday practice.

One of the significant findings of this research study is that it expands the current discourses on culturally responsive mathematics education in Nepal. The results imply that the learning of mathematics should not be limited to textbooks, classrooms or formal learning environments. Rather, the intentional incorporation of students' access to local knowledge systems, local experts, and authentic social practices within the context of mathematics education needs to be planned. This can assist in the long acknowledged disconnect between formal school maths and students' real-life experiences and foster mathematical learning that is meaningful, culturally responsive and socio-relevant. The results also have implications for curriculum developers, teacher educators and policy makers, as they can be guided to integrate community-based learning experiences in mathematics curricula and teacher preparation programmes to enhance the linkage between school mathematics and everyday life.

6. CONCLUSION

This study aimed to understand the learning of mathematics through the local knowledge and community practices in the Sikdai Kamaudai ra Kamaudai Sikdai (Learn and Earn) programme and STEAM activities in JSS Secondary School, Nepal. The results showed that meaningful mathematical learning has taken place as a result of the following activities: Agricultural activities, entrepreneurship projects, visits to banks and co-operatives, observations on hydropower and traditional technologies like the Pani Ghatta. These experiences helped students make connections between math and the world and to gain new insights into the usefulness of math.

The study has confirmed Vygotsky's (1978) Sociocultural Theory and demonstrates that mathematical understanding emerges in social interactions, and through collaboration and participation in authentic community practices. It also underscores the significance of local knowledge and local technologies in education which can enhance school mathematics and cultural responsive learning. Students did not just learn a series of

abstract formulas, but worked with math as a tool that could be used to understand and solve real-world problems.

This study makes a contribution to mathematics education by showing that community knowledge is not a mere example to be integrated into the classroom but a source of mathematics learning. Incorporating local knowledge and community practices into school mathematics is a way to connect formal mathematics with students' life experiences, and to make mathematics learning more relevant, engaging, and socially meaningful.

The results are also applicable to curriculum designers, teacher educators, and policymakers. The mathematics curriculum should provide more opportunities for students to participate in authentic community practices, with the goal of helping them to see how the formal mathematics concepts relate to that local knowledge, and how to engage with their local lived experience. Teacher education program should likewise prepare teachers to recognise and use community resources as valuable contexts for mathematics learning.

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