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Secção 2: *Práticas em Educação em Ciências, Matemática e Tecnologia*

UNCOVERING ETHNOMATHEMATICS IN CULTURAL ARTEFACTS THROUGH CULTURAL PROJECT-BASED LEARNING APPROACH

DESCOBRINDO A ETNOMATEMÁTICA EM ARTEFATOS CULTURAIS ATRAVÉS DA ABORDAGEM DE APRENDIZAGEM BASEADA EM PROJETOS CULTURAIS

DESCUBRIENDO LA ETNOMATEMÁTICA EN ARTEFACTOS CULTURALES A TRAVÉS DE UN ENFOQUE DE APRENDIZAJE BASADO EN PROYECTOS CULTURALES

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ABSTRACT | Cultural Project Based Learning (CPBL) approach is a child-centered teaching and learning method based on the students' cultural activities and experiences. CPBL supports learning by engaging students in an investigation of a topic in their cultural setting. The ethnographic methodology was used to collect the data. Four mathematics teachers and thirty-two students from grade six to ten participated in the study. Students were provided a rich environment to explore mathematical ideas embedded in cultural artefacts observed in an out-of-school environment. The embedded mathematical ideas in cultural artefacts provide students to develop mathematical ideas beyond the four walls of the classroom. Both teachers and students reported that the CPBL approach provides an opportunity to explore mathematical ideas in a cultural setting and helps them to develop mathematical ideas.
KEYWORDS: CPBL approach, Cultural artefacts, Ethnography, Ethnomathematics, Mathematical ideas.

RESUMO | A abordagem de Aprendizagem Baseada em Projetos Culturais (CPBL) é um método de ensino e aprendizagem centrado na criança, baseado nas atividades e experiências culturais dos alunos. O CPBL apoia a aprendizagem ao envolver os alunos em uma investigação de um tópico em seu ambiente cultural. A metodologia etnográfica foi utilizada para a coleta de dados. Os quatro professores de matemática e trinta e dois alunos do sexto ao décimo ano participaram do estudo. Os alunos receberam um ambiente rico para explorar ideias matemáticas incorporadas em artefatos culturais observados no ambiente fora da escola. As ideias matemáticas incorporadas em artefatos culturais permitem que os alunos desenvolvam ideias matemáticas além das quatro paredes da sala de aula. Tanto professores como alunos relataram que a abordagem CPBL oferece uma oportunidade de explorar ideias matemáticas em um ambiente cultural e os ajuda a desenvolver ideias matemáticas.
PALAVRAS-CHAVE: Abordagem CPBL, Artefatos culturais, Etnografia, Etnomatemática, Ideias matemáticas.

RESUMEN | El aprendizaje basado en proyectos culturales (CPBL) es un método de enseñanza y aprendizaje centrado en el niño basado en las actividades y experiencias culturales de los estudiantes. CPBL apoya el aprendizaje al involucrar a los estudiantes en la investigación de un tema en su entorno cultural. Se utilizó metodología etnográfica para la recolección de datos. Los cuatro maestros de matemáticas y treinta y dos estudiantes de sexto a décimo grado participaron en el estudio. Los estudiantes recibieron un entorno rico para explorar ideas matemáticas incorporadas en artefactos culturales observados en el entorno fuera de la escuela. Las ideas matemáticas incrustadas en artefactos culturales permiten a los estudiantes desarrollar ideas matemáticas más allá de las cuatro paredes del aula. Tanto los profesores como los estudiantes informaron que un enfoque CPBL ofrece la oportunidad de explorar ideas matemáticas en un entorno cultural y les ayuda a desarrollar ideas matemáticas.
PALABRAS CLAVE: Enfoque CPBL, Artefactos culturales, Etnografía, Etnomatemáticas, Ideas matemáticas.

1. CULTURAL PROJECT-BASED LEARNING

There are at least two methods of teaching and learning in mathematics: that of the teacher-centered and the student-centered. One of the students centered methods is the Cultural Project Based Learning (CPBL) approach. CPBL approach is based on John Dewey's philosophy of pragmatism. Pragmatism is an educational philosophy, which focuses on real-world applications of lessons, and experiential learning, which involves learning through experience, not through simple ideas. More precisely, experiential learning is a process through which student engagement of in their cultural environment is front and centered, and focuses on creating a mindfulness, by the observation of their own cultural environment and experience that encourages them to generate new knowledge. In other words, it is based on the philosophy of learning by doing.

Project-based learning focuses on doing something to learn about something. So, it is an action-oriented method. There are many definitions of project-based learning. According to Moursund (2016), project-based learning is a systematic teaching method that engages children to learn and develop skills through an extended inquiry process structured around complex, authentic questions and carefully designed projects and tasks. The CPBL approach is a child-centered approach in which learners are provided an opportunity to learn from their cultural environment. A CPBL approach allows learners to integrate and explain the information collected from their culture based on their experience and everyday activities in order to enhance their learning. Regarding the ethnomathematical approach, Rosa and Orey (2015) argue that it helps to make mathematics more relevant to students because every culture is assumed to have mathematical responses to everyday problems, and these offer valid content for the development of mathematics lessons. Thus, the CPBL approach is the perfect catalyst to conceive mathematics as a cultural product and mediates to understand formal mathematics with the mathematical ideas and knowledge elaborated by different groups of people. The CPBL approach focuses on engagement of students in their own cultural environment that helps them to learn in a naturalistic way, exploring a subject at their own pace, interest and ambitions (Stanley, 2012). The CPBL approach is an important method to connect out-of-school context in the process of teaching and learning of formal mathematics. Projects help students to understand how much (mathematics) they can learn outside of school. The main theme of the CPBL approach is that mathematics can be taught beyond the boundaries of the four walls of the classroom. It provides an opportunity to learn by interacting with in their own cultural environment.

The study of cultural artefacts and the ethnomathematical ideas embedded in them are important sources for mathematics teaching and learning (Pradhan, 2021). Students' experiences and everyday practice in their cultural context scaffold to connect what the students know to the new mathematical concepts. Regarding this, Bonotto (2007) stated that "the connection between real-world and classroom mathematics is not easy because the two contexts differ significantly" (p. 187). However, mathematics teaching and learning would be more interesting and effective if the appropriate connection is made between out-of-school context to school mathematics. The connection with the students' everyday activities and experiences seems to be appropriate to understand school mathematics. Gay and Cole (1967) assumed the need for incorporation of what we now refer to as

"ethnomathematical" ideas of indigenous students in achieving better results. It is considered that the inclusion of ethnomathematical perspectives in school mathematics values students' cultural backgrounds and experiences. The observation of mathematical ideas embedded in different cultural artefacts in the surrounding of students' cultural context would motivate students to understand that mathematics has relevance to their lives even outside the classroom (Adam, 2004). Furthermore, Rosa and Orey (2013) mentioned that culturally relevant approaches empower students' cultural experiences as a vehicle to make mathematics learning meaningful, as well as providing students with insights towards mathematical knowledge as embedded in their own sociocultural contexts.

Ethnomathematics has emerged as a strong pedagogical program that enhances teaching and learning mathematics in school and adult education curriculum. Ethnomathematical approaches are intended to make school mathematics more relevant and meaningful to students in order to promote the overall quality of education (Rosa & Orey, 2015). Thus, ethnomathematics is a pedagogical action which connects students' everyday experiences and practices to school mathematics. In the Nepalese context, ethnomathematics has been considered as the area of research of diverse mathematical ideas by indigenous peoples. Now, the ethnomathematical ideas of different groups of people and mathematical concepts practiced in the out-of-school context has become part of teaching and learning. Teachers now are trying to connect their cultural and local ways of teaching practices with curricular activities (Pradhan, Sharma & Sharma, 2021). This is consistent with D'Ambrosio's (1990) view about ethnomathematics as a research program guiding educational and pedagogical practices.

The field observation of the cultural context of the learners provides an opportunity to learn mathematical ideas embedded in the out-of-school context. Students construct mathematical knowledge with the help of their prior knowledge, experience, and active participation in their environmental activities. The cultural activities of the children involved many implicit mathematical ideas. However, formal academic-school mathematics curriculum and teacher training in a Nepalese context largely ignore the learners' cultural activities and their ethnomathematical ideas (Pradhan, 2017, Ezeif, 2002). Rosa and Gavarrete (2017) also argues the similar views that children's ethnomathematical knowledge and learning approaches are not taken into consideration in the formal school mathematics curricula. Mathematical ideas embedded in cultural artefacts and students' experiences should be blended with formal mathematics in the classrooms. The CPBL approach in mathematics focuses on the engagement of students in their cultural setting to explore knowledge in their own ways. In this paper, we intend to achieve the following objectives:

- examine the contribution of the CPBL approach in mathematics instruction.
- assess the perception of students on the use of CPBL approach in learning mathematics.

2. FRAMEWORK FOR CPBL

In Nepal, it is now well understood that each student brings a unique set of knowledge, skills, and experiences to a new learning situation. Various research identified that the cultural artefacts and embedded ethnomathematical ideas are familiar, concrete and known to learners to develop formal mathematical ideas and knowledge (Pradhan,

2019). Paulo Freire (1970) suggested that "Children's cultural capital, the knowledge children bring to school from their home and cultural environment, should be welcomed and utilized in school for teaching and knowledge building process" (as cited in Stringer, Christensen & Baldwin, 2010, p. 24). In this way, students' out-of-school knowledge embedded in different cultural artefacts is celebrated and utilized as a pedagogical tool in the construction of mathematical meaning.

Constructivism is a widely supported educational theory that rests on the idea that students create their own knowledge in the context of their own experiences (Fosnot, 1996). It focuses on students being actively engaged in doing rather than passively engaged in receiving knowledge. The development of knowledge construction ability of students requires apprenticeship into culturally specific cognitive and social practices. The cognitive development of a child's increasing mastery over the culturally determined developmental tasks imposed by social agents. Vygotsky (1978) argued that an understanding of how knowledge develops requires an understanding of the social and historical origins of knowledge and changes in that knowledge. Throughout their lives, learners are surrounded by parents, siblings, relatives, friends, teachers, and fellow students. They communicate with one another, stimulate one another. Parents and teachers are more knowledgeable and skilled than learners. Under this framework, it is argued that the learners are actively engaged in the activity based on their interest, constructive investigation and collaborative learning. Learners acquire knowledge about their culture and history from their encounters with adults, and peers. This cultural knowledge includes shared beliefs, ways of viewing the world, patterns of interacting with people and language (Borich & Tombari, 1997). The difference between a child's individual performance and that child's performance when guided by experts is metaphorically described by Vygotsky's Zone of Proximal Development (ZPD).

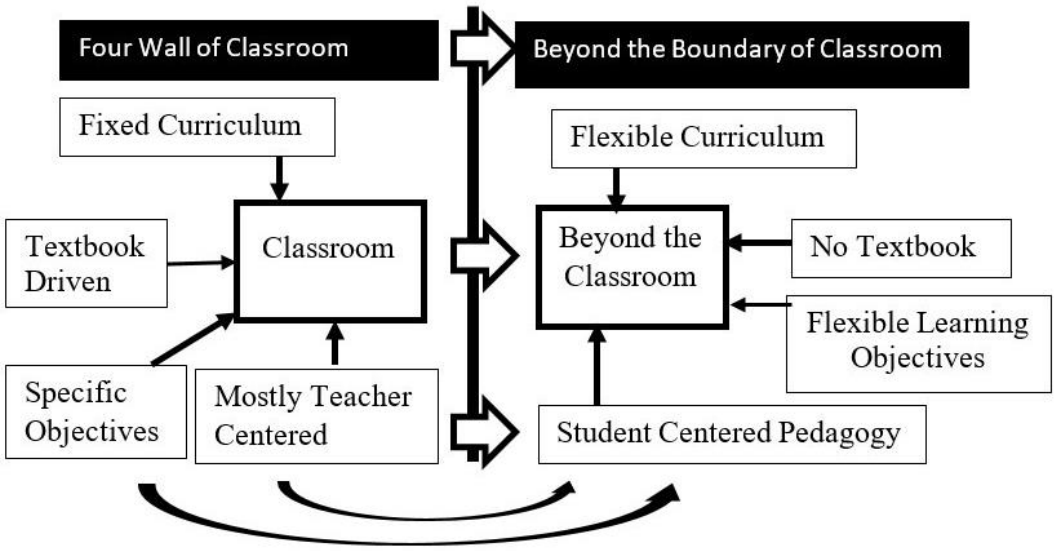


Figure 1 *Framework for Cultural Project Based Learning in Mathematics*

The framework developed in this study shows how cultural artefacts and ethnomathematical ideas observed in the out-of-school context of children can be a mediated tool to construct mathematical meaning. By this framework, it is assumed that children learn and practice mathematical ideas and concepts differently in two distinct worlds: Classroom and beyond the four walls of the classroom. The objectives of learning

mathematics have different purposes for the classroom and beyond the boundary of the classroom. Generally, children learn mathematics in a classroom for getting pass marks or good marks in the examination, but mathematical ideas have been practiced implicitly in out-of-school context in order to pursue their daily living. Even the teacher teaching pedagogy is mostly a guided model of the examination.

Our argument in this study is that the cultural context of children in Nepal, is a rich environment that can generate and distribute mathematical knowledge. This point of view highlights that cultural artefacts are good sources for the organization of a series of mathematical concepts and knowledge. If we seriously observe cultural artefacts found in the out-of-school environment, learners can unfold various mathematical ideas and knowledge hidden in cultural artefacts. In this framework, children are not bounded in fixed curricular objectives and problems given in the textbook. They are engaged in real-world problems embedded in the out-of-school environment. The major arguments for using CPBL is that it enhances motivation and fosters cognitive engagement of learners. This framework argues that if students are motivated and cognitively engaged, they will learn more and remember it better, as compared to learning through didactic instruction. Our objective in this framework is to move a pedagogical action from a conventional to a project-based approach. And the argument of this approach enhances the teaching and learning of mathematical concepts and ideas in meaningful and effective ways.

3. METHODS AND PROCEDURES FOR CPBL

This study was intended to explore the mathematical ideas embedded in cultural artefacts and perception of students on the use of ethnomathematical approach in the teaching and learning of school mathematics. The ethnomathematical approach focuses on the use of the socio-cultural context of the students in order to assist them to foster mathematical ideas. To carry out our research objectives, we resolutely situated ourselves as qualitative researchers. Choosing the most appropriate methodology, the reflective process led us to select ethnography. We chose ethnography as the methodology because it looks for various mathematical ideas found in cultural artefacts constructed by the group of people as a socio-cultural process (Taylor & Bogdan, 1998). Ethnography can be a primary methodology for collecting empirical data from the field regarding the mathematical ideas, knowledge, and practices in different cultural contexts. We use ethnographic tools to describe, interpret, and reveal the meaning of cultural activities regarding ethnomathematical ideas embedded in cultural artefacts. While conducting this research, we continuously address questions of interest involving mathematical ideas embedded in the process of constructing cultural artefacts and its use in teaching and learning school mathematics.

3.1 Selection of Study Location: Before selecting the study location, we visited some temples with one of our research assistants and considered the possibilities for incorporating these into mathematics lessons. Among various locations, the historic temple, the Old Guheshwory, includes a number of monuments and artefacts in and around the temple. Ultimately, we decided on the Old Guheshwory temple situated near to the school at Tarakeshwor Municipality of Kathmandu District as the study location.

3.2 Selection of Student Participants: The selection of student participants from each grade level was somewhat difficult because of the enthusiasm for participation in the field visit.

The objective of this study was intended to examine the effectiveness of the CPBL approach at the basic level of mathematics education; we are interested to select the students from that level only. But the teacher participants and headteacher as well suggested that we take students from the secondary level as well. It was also felt that the inclusion of secondary students in the group would provide better opportunities for collaborative learning. So, we decided to select thirty-two students from grade six to ten randomly. Out of them, we selected eight students from each grade of 6 to 8 and 4 students from grade 9 and 10 each.

3.3 Student Awareness Program: Before visiting the study area, the researchers presented the possibilities for mathematical ideas embedded in and around the temple and encouraged student participants to explore them. We had designed the Student Awareness Program (SAP) with the aim to encourage them to connect real-life situations and school mathematics. The SAP was conducted before going to field visits and lasted about one hour. Again, the thirty-two students were selected randomly from five different grades and four mathematics teachers participated for this program.

3.4 Study Tools and Materials: Students were encouraged to explore the geometrical, algebraic and arithmetical ideas with the measurement of different parts and observation of the surrounding of the temple. They were provided measuring tape, paper, pencil and other instruments that they used to explore and verify the different geometrical properties. Students were also requested to write their feelings and perceptions of field visits with respect to the mathematical ideas learned and the ways of gaining knowledge through the CPBL approach.

3.5 Formation of Collaborative Groups: Thirty-two students were selected for the CPBL approach. These students were divided into four different groups. Each group included 8 members from five different grades: 2 students each from grades 6 to 8 and one each from 9 and 10. The group thus formed would be heterogeneous and provide an opportunity for collaborative learning. Four teachers were assigned to facilitate each group.

Figure 2 *Teacher Assign the Task to his Group, Source: Pradhan (2019)*

3.6 Lesson Design and Task Assignment: After reaching the study location, the students were first provided a common task. All the students were requested to observe the temple

and its surroundings and note down the geometrical objects and probable mathematical concepts they could identify. For the CPBL approach, the teacher develops the framework for learning in which the teacher's role is to monitor and provide feedback when the CPBL approach is undertaken. We along with the teachers had to identify the tasks for the four groups of students after viewing the scenario in the temple premises. Finally, four major open-ended tasks were identified. These tasks were: to identify the center of the circle, to identify the type of quadrilateral by measuring its sides, to explore the concept of symmetry and identify the axis of reflection. Then the designed tasks were given one to each group.

3.7 Data Management: This study was based on primary data collected through the observation of cultural artefacts and monuments, interviews with teachers and students, Focus Group Discussion (FGD) of teachers and students separately. We reviewed all the data gathered from the multiple sources (Creswell, 2014) and then organized them into categories or themes that cut across all of the data sources. After observing the data, we linked them with many possible theories to interpret them. We triangulated the data, and the theoretical closures and gave meaning to my findings. We ensured anonymity and confidentiality to all research participants and briefed them on how the data were going to be used and protected.

4. UNCOVERING MATHEMATICAL IDEAS THROUGH CPBL

Mathematics is a pan-cultural phenomenon. Every culture possesses some sort of mathematics. A group of people practices their own mathematics to perform their everyday activities. The mathematics they used and the mathematical ideas and thinking they developed helped them to sustain their lives. However, the mathematics practice in the cultural setting is different from the mathematics practices in school. The ways of teaching and learning mathematics in two different settings are quite different. Indigenous people developed unique ways of counting, measuring, and designing use in their real-life contexts such as the measurement used in the construction of different cultural artefacts (Sharma & Orey, 2017). So, the knowledge generation and distribution in the out-of-school environments and contexts are obvious in traditional and historic Nepalese architecture. The mathematical ideas concerning Pythagorean triples are very common to masons' work (Pradhan, 2019), they have used the concepts of right-angled triangle, rectangle, and its axioms to solve problems faced in everyday activities tacitly. The cultural group of people uses and practice mathematics to perform their activities from generation to generation in a craft-model approach.

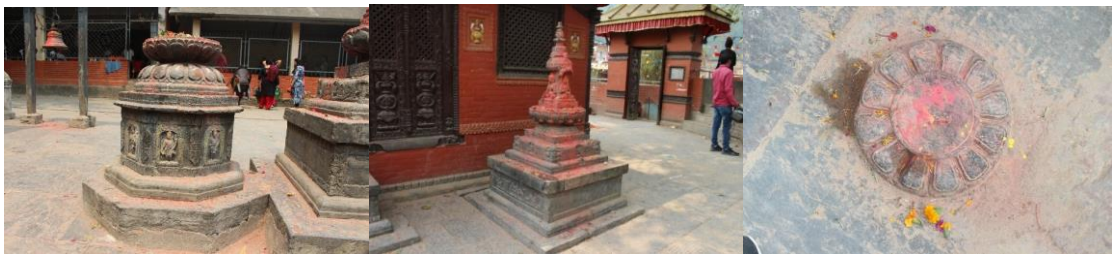


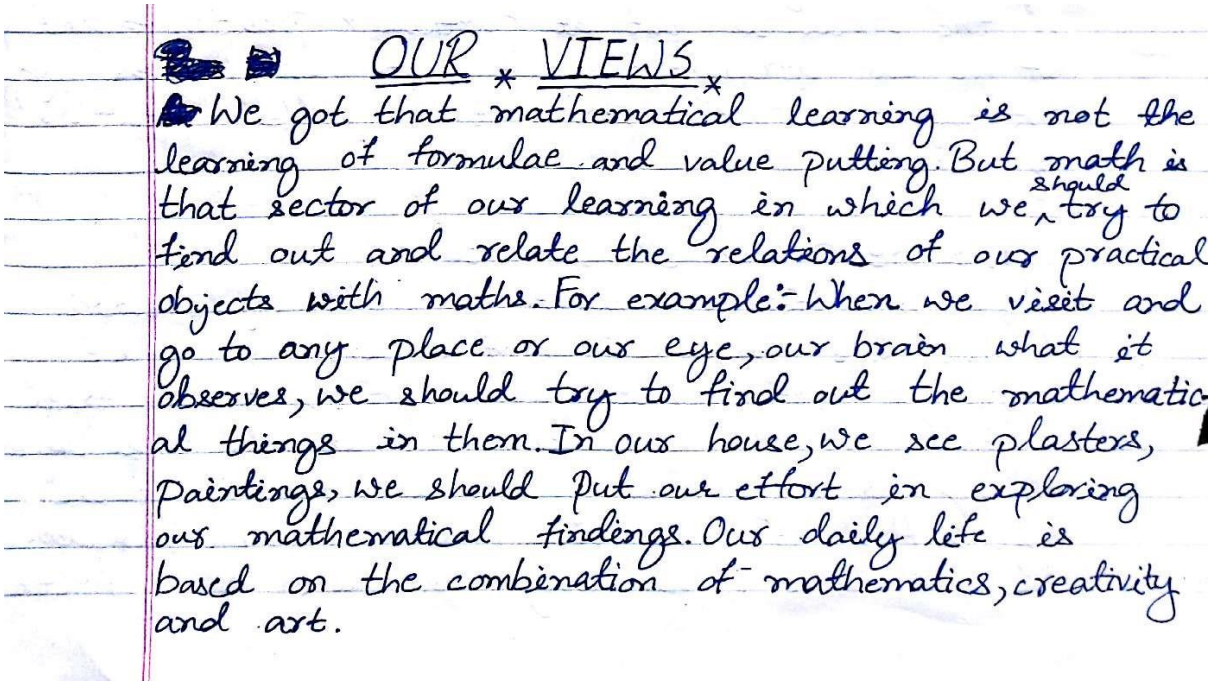
Figure 3 *Sources of Geometrical Objects in the Surrounding of Temple, Source: Pradhan (2019)*

Cultural artefacts found in Nepal, are rich sources of mathematical concepts. Many mathematical ideas and concepts can be investigated of the practices developed, used and presented in the cultural artefacts through ethnomathematical approaches. It is the study of mathematical ideas and procedures elaborated by members of distinct cultural groups in order to perform everyday situations (Rosa & Orey, 2010) that became obvious to participants in this activity.

In this context, D'Ambrosio's (1993) approach is broader in concepts, ideas, and objectives, as it considers mathematical modeling as a methodology that may be used as a tool in the ethnomathematics program. In doing so, after we reached the temple premises, we let the students observe the temple, monuments and its surroundings. We asked the participant students to note down the geometrical objects and the probable mathematical concept that they could identify in and around the temple. After some time of observation, each group was requested to present their observations and findings. Each group involved in the common task presented their findings. The common observation made by the students were the 2D shapes of the objects like triangle, square, quadrilateral, circle, oval, octagon, trapezium, parallelogram and rectangle embedded in the cultural artefacts. They also observed 3D shapes like a hemisphere, cone, frustum, sphere, cube, cuboid, cylinder, prism and pyramid. They sorted out the concepts of concentric circles, transformation, reflection, rotation, symmetry, pattern, and tessellations.

Each artefact was so precisely constructed for getting the beautiful designs in the artefacts. There was an artefact (*Chiba*) with the cuboid overlapped by other cuboids but of smaller size continuing till the top point was formed. It gave a shape like that of a pyramid. Also, there was an artefact, the mandala of *Dharmadhatu,* with an octagon shape satisfying every property to be a regular octagon. Concepts of concentric circles used to form such impressive artefacts also give us a hint on how mathematical ideas were created and used at that time being far from today's context. The consistency and homogeneity are found in the construction of cultural artefacts. Therefore, we can see that the people used implicit mathematical ideas in such creations.

As well, the students explored mathematical ideas embedded in different artefacts inside the temple premises. We observed that the students actively participated in the process of the CPBL approach. Students were seen to be independently engaged in different activities in their own way. Some of them were taking the measurements in the artefacts, while others were seen to be engaged in determining if the artefacts were symmetrical or not. They compared the halves of the artefacts and determined that the making of them required a lot of physical and mental work. In fact, the design should probably be the result of deep mental concentration for being so beautiful and pleasing to the eye. This might have resulted in the implicit knowledge of symmetricity in those beautiful minds. By which we may observe that all the fascinating creations were based on the combination of mathematics, arts and culture as said by my research participants (Figure 4).


OUR * VIEWS *

We got that mathematical learning is not the learning of formulae and value putting. But math is that sector of our learning in which we should try to find out and relate the relations of our practical objects with maths. For example:- When we visit and go to any place or our eye, our brain what it observes, we should try to find out the mathematical things in them. In our house, we see plasters, paintings, we should put our effort in exploring our mathematical findings. Our daily life is based on the combination of mathematics, creativity and art.

Figure 4 *Learning Mathematics in Out of School Context, Source: Pradhan (2019)*

The mathematical ideas and concepts observed in the construction of different patterns in stone carving found in the temple premises really engaged the students in their explorations. The stone carver used an emic (local) view of mathematical knowledge in the process. The mathematical knowledge they practiced long ago complemented their everyday lives and was developed verbally across generations.

This implicit mathematical knowledge is embedded in their activities. Mosimege and Lebeta (2000) also reported that indigenous people use different mathematical concepts like estimation, and tessellations, and symmetry in the construction of the tradition's artefacts and cultural activities. The stone carver uses a lot of mathematical concepts and knowledge. This knowledge is sufficient for performance that is consistent with their own set of rules. The field data also supports the findings of Millroy (1992) in which she observed that the carpenters' physical act of designing and building furniture involved tacit mathematical knowledge here, we could see how a stone carver also uses tacit mathematical knowledge in the process of constructing different objects. They both implicitly and tacitly practiced the mathematical ideas of the circular shape, center, and radius of the circle; circle, the coordinate axes, reflection and symmetry of different geometric patterns.

5. STUDENTS' REFLECTION ON THE USE OF THE CPBL APPROACH

The mathematical ideas embedded in the out-of-school context and the pedagogy used in their cultural setting could be a powerful tool for the teaching and learning of school mathematics (Pradhan, 2021). The CPBL approach provides an opportunity for students to explore mathematical ideas embedded in different arts and artefacts. Regarding the students' views on the CPBL approach, one of the student participants mentioned:

> "It is our first trip of this kind. I had never imagined that mathematics could be learned without a textbook and worksheets beyond the classroom. We learned a lot

of mathematical ideas and became able to explore mathematical ideas embedded in the cultural artefacts".

From the interviews with student participants, we came to know that the CPBL approach is an important pedagogy that can connect out-of-school contexts to the process of learning formal mathematics. We also argue that the CPBL approach provides rich environments to explore mathematical concepts embedded in cultural artefacts. The culture-friendly pedagogy provides students with the opportunity to explore the mathematical ideas embedded in different cultural artefacts. This approach for teaching mathematics provides an opportunity to learn mathematical concepts embedded in the cultural arts and artefacts. This systematic learning model created an environment for the students to construct mathematical knowledge and develop ideas in their own ways while identifying the center of the circular surface of *Chaitya* (Pradhan, 2021). With this connection, other research participants said:

> *I never thought that mathematics can be learned without a textbook. With the observation of different cultural artefacts in the temple and its premises, we find different mathematics objects. We verified the mathematical facts and properties with the measuring instruments and calculating their dimensions. I learned different mathematical ideas with joyful moments and enjoyed a lot with this approach.*

The CPBL approach provides students the opportunity to work well in teams and collaborate in groups. It also enabled students to be more responsible and cooperative in the group work and presentations (Pradhan, 2019). With this approach, students are entering a new learning environment and engage in actively collaborative learning activity. During CPBL approach, students acquired social skills, exchanged ideas and opinions, shared responsibilities, offered suggestions, made corrections and implemented the result. The students were given a rich learning environment and allowed to create their meaning by providing different tasks during teaching and learning using this CPBL-based approach. Since teacher acts as the facilitator as per the students' need, students feel free to perform their task and learn with the peers. As our theoretical orientation about knowledge generation is based on the premise of a constructivist philosophy, the children constructed mathematical knowledge as a result of active experience and participation in their own local-social context. In this vein, Vygotsky (1978) argued that cultural practices and resources mediate children in the process of development of thinking and can help them to learn school mathematics.

Figure 4 also reflected that a cultural artefact is full of mathematical properties. Different groups of people construct their own artefacts by portraying consistent rules of mathematics. From the observation in the field and the FGD of the students, we found that the CPBL approach is one of the effective approaches for the teaching and learning of mathematics. This approach creates an environment for students to construct mathematical knowledge and develop ideas in their own ways.

From the FGD of the students, we found that the students have come to agree that the artisans who developed the arts and artefacts, centuries ago, had implicit mathematical knowledge. Thus, mathematics is a cultural phenomenon. The CPBL approach helps to connect the cultural capital of learners and teaching and learning of school mathematics. The learner constructs mathematical knowledge based on their experience and interaction with peers. The connection of a students' familiar context in the process of teaching mathematical content provides a rich opportunity for the learners. There are many things in

the out-of-school environment that can be connected to the teaching and learning of school mathematics. The historically accumulated and culturally developed bodies of knowledge and skills of the learners essential for household functioning and well-being (Moll, Amanti, Neff & Gonzalez, 2005) refer to their own funds of knowledge. The funds of knowledge of children and their everyday activities, life experiences regarding mathematical ideas provide powerful tools in the process of teaching and learning of school mathematics. The mathematical ideas embedded in the everyday household activities of children provide an opportunity to learn school mathematics. In our observation in the field and every stage of data collection from the student participants, CPBL approach provided the opportunities to construct mathematical knowledge. With this CPBL approach of teaching and learning mathematics, we found that students were motivated, engaged and very happy as they participated actively in the field. They reported that the CPBL approach was very interesting, and learning was fun. Thus, the CPBL approach plays a significant role in the development of positive attitudes towards learning of mathematical ideas and found to be effective pedagogical approach in mathematics.

6. CONCLUDING REMARKS

The involvement of a heterogeneous group members from grades six to ten in Nepal, provided an opportunity to learn mathematics concepts, even of the higher level, in a collaborative learning framework. The CPBL was developed to the study the mathematical ideas in the monument and cultural artefacts. The observation of the cultural artefacts and the mathematical ideas embedded in those artefacts both motivated and encouraged students to explore more mathematics. It also develops a positive attitude of the students towards school mathematics. CPBL can be viewed as one of the children centered approaches to create and develop mathematical knowledge. CPBL can be used as a pedagogical tool for the teaching and learning of mathematics. The students' reflection shows that they had got empirical knowledge to solve the mathematical problem of finding the center of the circle in the case of non-given other dimensions of a circle. The CPBL approach provides students to learn mathematics in their own ways and the opportunity to develop mathematical ideas. Students from the junior classes also explored different mathematical ideas with the collaboration and help by their senior peers. It is concluded that students' knowledge construction ability requires apprenticeship into culturally specific cognitive and social practices.

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