

Ethnomathematical Study on Cultural Artifacts: An Ethnographic Field to Classroom Practice

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Abstract: The implicit mathematical ideas, practices, and experiences in the everyday life of children outside the classroom could be a powerful and interesting pedagogical tool to communicate formal mathematical concepts. The main objective of this study is to explore the ethnomathematical ideas embedded in the cultural artifacts and assess their contribution to the process of teaching and learning of school mathematics. The methodological procedures include in-depth interviews and observation of students and teachers regarding mathematical ideas comprised in cultural artifacts at different moments. The mathematical knowledge hidden in the various cultural artifacts has been analyzed based on written documents, photographs, and video graphs. The findings indicated that the cultural artifacts provide an ample opportunity to understand different mathematical concepts. In addition, students have wonderful learning experiences beyond the four walls of the classroom and connect ethnomathematical ideas to conceptualize formal mathematics.

Key Keywords: *Cultural artifacts, Ethnography, Ethnomathematics, School mathematics*

Introduction

Every human culture developed its own mathematical ideas and practices to perform everyday activities. The mathematical ideas and practices used by people of different cultural groups are known as ethnomathematics. The term ethnomathematics has been coined from different perspectives. A number of scholars define it in different ways. Ascher and Ascher (1997) defined ethnomathematics as the study of the mathematical ideas of non-literate people. For, D'Ambrosio (2006), ethnomathematics is a research program about the history and philosophy of mathematics and it is also the program of the way in which cultural groups understand, articulate, and use the concepts and practices, which we describe as mathematical, whether or not the cultural group has a concept of mathematics. Some believe ethnomathematics is the methodological posture in the learning process of formal mathematics. Thus, ethnomathematics may be described as the study of mathematical ideas and activities embedded in the cultural context of different groups of people.

Cultural artifacts are anything or objects that are created by the culture of a particular group of people that help them define their culture. There are different types of cultural artifacts, which reflect the cultural identities of different groups of people. Some of them are dresses, houses, utensils, baskets, ornaments, paintings, and designs. All of these artifacts give information about the culture of their creators and the ideas associated with these objects. Bonotto (2007) viewed that the extensive use of cultural artifacts makes school mathematics more meaningful. For him, the cultural artifacts introduced into mathematics classrooms are concrete materials, which children typically meet in real-life situations. Ethnomathematics helps to conceptualize abstract mathematical ideas by connecting children's everyday activities. But, the ethnomathematical ideas of the group of people have generally been excluded from discussions of formal and academic mathematics. Rosa and Gavarrete (2017) also viewed that local mathematical knowledge and learning approaches are not taken into consideration in the formal school mathematics curricula. The mathematical ideas from the group of working-class people culture, the acknowledgment of their ways of knowledge generation and transmission, and students' experiences should be blended with formal mathematics in the classrooms (Pradhan, 2017). Mathematics teaching and learning would be more interesting and effective if the appropriate connection is made between out-of-school contexts and the school mathematics. Gay and Cole (1967) assumed the need for the incorporation of ethnomathematical ideas of indigenous students in achieving better results. It is considered that the inclusion of ethnomathematical perspectives in school mathematics valued students' cultural backgrounds and experiences. In this paper, I explored mathematical ideas embedded in cultural artifacts and their contribution to the process of teaching and learning of school mathematics. To achieve these objectives, the research questions were formulated as: What mathematical ideas are embedded in cultural artifacts? How do these cultural artifacts contribute to the teaching and learning of school mathematics?

Conceptual Framework

The primary goal of my research is to connect the learners' out-of-school mathematical ideas and knowledge embedded in cultural artifacts with school mathematics. The framework developed in this study shows how cultural artifacts can be a mediated tool for the teaching and learning of school mathematics based on a constructivist-learning environment. The learners' culture and everyday activities regarding ethnomathematical ideas are an integral part of education in general and learning mathematics in particular. My argument in this study is that ethnomathematical ideas embedded in cultural artifacts facilitate the understanding of

school mathematics. This framework highlighted the integration of the mathematical concepts and practices originating in the learner's culture with those of school mathematics (Alangui, 2017). It is believed that classrooms and other learning environments cannot be isolated from the communities in which they are embedded, and students come to school bringing with them values, norms, and concepts they have acquired from their culture and environment. This suggests that it is possible to connect school mathematics through the ethnomathematical ideas and the out-of-school context of the learners.

Methods and Procedures

This study was intended to explore the ethnomathematical ideas embedded in cultural artifacts and examine the possibility to connect school mathematics. Choosing the most appropriate methodology, that reflective process led me to select ethnography. I chose ethnography as the methodology because it looks at mathematical ideas and practices in different cultural activities of a group of people as a socio-cultural process (Taylor & Bogdan, 1998). While conducting this research, I continuously addressed the questions of interest involving mathematical ideas embedded in different cultural artifacts. A total of four school mathematics teachers and thirty-two students from grades six to ten were selected for the study. The data regarding the mathematical ideas embedded in cultural artifacts were collected through the observation of their activities, listening, and asking appropriate questions to the group of people in a natural setting. This was done with the help of interview guidelines and an observation checklist. I carefully recorded all the possible conversations with the help of the video camera and took field notes as much as I could. I reviewed all of the data gathered from the multiple sources of data and then organized them into categories or themes that cut across all of the data sources. And, I converted the conversations and interviews into themes so that I could easily analyze and interpret them. In this study, the analysis of the research was validated and made more reliable by triangulating the statements among the research participants and their ways of presenting the text during several data collection periods.

Ethnomathematical Ideas in Cultural Artifacts

The connection of out-of-school mathematical ideas to formal mathematics is considered one of the difficulties for most teachers and educators. My objective in this study was to explore mathematical ideas embedded in different cultural artifacts and analyze their possibilities of incorporation in teaching and learning school mathematics. For this, I decided to take the students to the field visit. And the place I decided for the field visit was the historical *Purano*



Image 1: Cultural artifacts as a tool to develop mathematical

(old) Guheshwori temple. Finally, the day came to take the students to the field along with the teacher fellows. After reaching the field place, the students were requested to observe the temple and its surroundings and note down the geometrical objects and the probable mathematical concept that they could identify. The mathematical ideas embedded in cultural artifacts in out-of-school contexts could be a powerful tool for the teaching and learning of school mathematics. In this study, students explored many mathematical ideas embedded in cultural artifacts in the surrounding of the temple. The mathematical ideas they explored were different two-dimensional and three-dimensional geometrical objects, the center of a circular mandala, concepts of symmetry, and their properties. Students used their preconceived knowledge for the study of cultural artifacts. They also got an opportunity to verify the mathematical properties learned in the classroom by observing and measuring the geometrical objects found on the temple premises. They observed different geometrical objects, measured them with measuring instruments, and found them consistent and accurate. The circular mandala, concentric circles, and the images of twelve petals carved on it would provide many opportunities to study the coordinate axes, axes of symmetry, and other properties of circular objects.

There are many cultural artifacts on the temple premises as the source for the study of mathematical ideas. The images carved on wooden and stone-made structures seem beautiful and eye-pleasing. And, the images probably were beautiful due to the preservation of

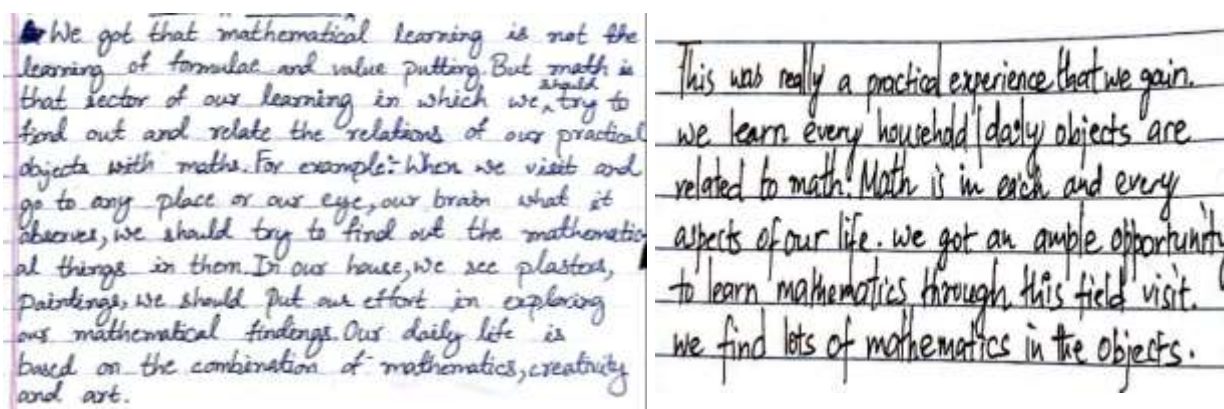


Image 2: Students' reflection on Cultural Project Based Learning

mathematical properties of symmetry. From the observation of the workplace of the carver, it was found that the coordinate axes, symmetry, and reflection were the mathematical ideas embedded in their drawing of any pattern. The pieces of stone they brought to carve different stuff was more likely to be rectangular form. I asked one of the participants, “Why do you make the stuff in a circular shape even though it is difficult and time-consuming?” Regarding the answer to this, the image that he carved possesses mathematical properties of symmetry in order to make the stuff more beautiful and fascinating. He said that the circular object seems to be more fascinating rather than the rectangular form. The carver had implicit and tacit knowledge of symmetry that helped him to make the images more beautiful and eye-pleasing. They construct different geometrical patterns and designs in their works with a prevalence of symmetry. However, these artifacts were constructed centuries ago. People of those days used sophisticated mathematical knowledge in their construction. The implicit mathematical ideas and knowledge of different people in their everyday activities would motivate the students about the applicability of mathematics in our everyday lives and develop positive attitudes of students towards mathematics.

Image 2 depicted the perception of students about the use of cultural artifacts in teaching and learning mathematics. Their report shows that they had empirical knowledge to solve the mathematical problem in an out-of-school context. The observation of cultural artifacts in the surrounding of the temple provides an opportunity to explore much mathematical knowledge. Throughout the field study, I kept on observing the behavioral and psychological aspects of the students. I could feel their excitement and joy to learn from the artifacts and cultural objects. Their enhanced facial expressions that seemed to have shining faces were enjoying each step of their work. They were showing active participation and involvement in the task. The involvement of different grade level students provided an opportunity to learn diverse mathematical concepts, even of the higher level, being in a collaborative learning framework. This really proved the effectiveness of the use of cultural artifacts ‘to communicate’ mathematical ideas.

Concluding Remarks

The cultural artifacts, household-based knowledge, everyday practices, monuments, and gameplay that involve ethnomathematical ideas were considered as the powerful pedagogical tool for the teaching and learning of school mathematics. The ethnomathematical ideas and knowledge that are practiced and used are the sources for the understanding of abstract mathematical ideas. The existence of mathematical ideas beyond the four walls of the

classroom and textbook is evident. The observation of the cultural artifacts and the mathematical ideas embedded in those artifacts motivate and encourage students to explore more mathematics. It also develops the positive attitude of the students towards school mathematics. Students were encouraged to explore the different mathematical ideas and provide an opportunity to learn in a collaborative framework.

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