Cultural Games as a Pedagogical Tool: A Nepalese Experience of Teaching and Learning of School Mathematics

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Abstract

Game, generally, is found in every culture that allures almost all children. Many similarities in structure, rule and process are found in playing game and doing mathematics. The main objective of this paper is to observe how we can consolidate Chungi game into our day-to-day teaching and learning in order to enhance students' mathematical understanding. A total of 5 mathematics teachers and 12 students from a public school of Kathmandu districtwere selected in the research process. The whole process of the game was observed and post-game interview was taken with the participants by the help of interview guidelines and observation checklist. The possibilities of incorporation of cultural game and its pedagogical use was observed in mathematics classroom. The mathematical knowledge hidden in the various sectors of gameplay was analyzed through examining documents, observing behaviours and interviewing teachers and students. The mathematical ideas of counting, grouping, comparing, and four fundamental operations of arithmetic were found during the analysis of field data. The game also included implicit ideas and practices of algebraic and statistical concepts.

Key words - *Cultural Games, Ethnography, Ethnomathematics, Pedagogy, SchoolMathematics.*

I. INTRODUCTION

Games are one of the environmental activities of human culture. Every culture has some sort of games or/and the games like activities. The game is an activity that has clearly defined rules and regulations. In a game, participants have to follow the rules of the game. While performing a game, there is always competition to win, rule to follow and enjoyment to experience. Each player wishes to win the game while simultaneously having the same interpretation of the rules as the opponent (Nkopodi&Mosimege, 2009). Game is common activity usually associated with recreation, competition, sportsmanship, winning, losing, enjoyment, and many other similar and related notions (Ascher, 1991).

These activities help teachers to create a better teaching learning environment. It also stimulate students' participation and give them confidence. This is when students feel themselves in order to participate to get the best score in a game or even to be the best in the class. They usually feel much more confident with their performance and this makes them to learn and practice new structures, learn from their mistakes and fulfill the goals of the class. Thus games and games like activities could be the effective tools for the motivation to lean mathematics and develop the logical thinking to solve mathematical problems.

Various studies have shown that mathematics is one of the difficult subjects in school. Through the use of games, very difficult concepts and ideas can teach into very simple ways as children are very interested in playing games. In this regard, Doumbia (1989) has pointed out that the simplest game could include the difficult mathematical calculation if it is seriously analyzed. At the same time, game helps to understand the mathematical ideas and concepts from the basic to higher level. This paper intended to explore mathematical ideas embedded in the process of Chungi game and its possibilities to incorporation in mathematics classroom.

II. RESEARCH QUESTIONS

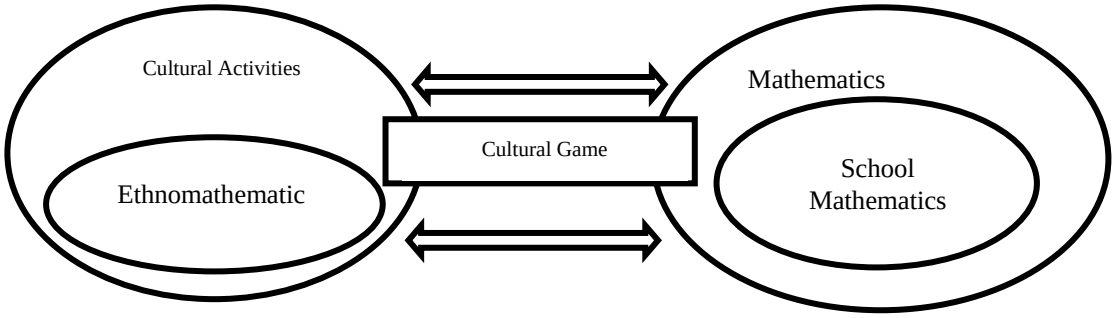
This study was intended to explore the cultural games and the pedagogical implications to assist students in enhancing their understanding of mathematical concepts at basic level of education. Considering these, the following research questions were formulated:

1. What are the ethnomathematics embedded in *Chungi* game?
2. What mathematical concepts does children learn from playing *Chungi* game?
3. How do teacher use cultural game to teach mathematics in the classroom?

III. CONCEPTUAL FRAMEWORK

The primary goal of my research was to explore mathematical ideas embedded in the Chungi game and to connect the implicit mathematical knowledge embedded in this game in the teaching and learning of school mathematics. The conceptual framework is developed in my study shows the connection of physical and mathematical world where the children live and learn simultaneously. In this framework, children possesses lot of ethnomathematical activities in their cultural activities (Pradhan, 2017) and playing is one of the common activities in this world. Students out-of-school knowledge is mostly ignore in the teaching and learning of school mathematics. Cultural game can facilitates to understand school mathematics was my argument in this study and it connects the ethnomathematics and school mathematics.

Figure 1
Cultural Game: Connecting Cultural Activities and Mathematics



The learners' culture and everyday activities regarding ethnomathematical ideas is an integral part of education in general and learning mathematics in particular. This model highlighted the integration of the mathematical concepts and practices originating in the learner's culture with those of school mathematics (Adam, 2004). It is believing 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. The students' home culture and out-of-school mathematical ideas and knowledge provides opportunities to connect to the formal mathematics (Pradhan, 2017). Above figureshows a conceptual framework to connect the students' out-of-school knowledge, embedded mathematical ideas in their cultural context and the learners' cultural metaphors to school mathematics.This suggests that it is possible to connect the school mathematics through the cultural game as a pedagogical tool.

IV. METHODS AND PROCEDURES

A. Research Design

Qualitative research relies primarily on the collection of qualitative data. Qualitative research is a field of inquiry that crosscuts disciplines and subject matters (Denzin& Lincoln, 2005). It claims to describe life-worlds from the inside out, from the point of view of the people who participate in it (Flick, Kardorff& Steinke, 2004). In my study, I chose qualitative research design as I want to make sense of the complex world of the cultural games, mathematical knowledge embedded in these games and the implications of these games in the teaching and learning of school mathematics. It would not be possible for me to quantify such ideas, perceptions and knowledge in figures and numbers. The qualitative research method is considered appropriate since I wish to obtain an in-depth understanding of how and what learners thought about the games as they play them.

The mathematical ideas embedded in cultural games and people's feeling, beliefs, perception, attitudes understanding etc. regarding the cultural games cannot be captured and converted quantitatively. Ethnography is a qualitative research methodology that seeks to understand human behavior within its own social setting. It is a process which combines the knowledge of participants who belong to certain cultures and the skills of the researcher or the ethnographer (D'Andrade, 1981). Thus the ethnographic research is an amalgam of participant observation and many of the characteristics of nonparticipant observation studies as well in an attempt to acquire as holistic a picture as possible of a particular society, group, institution, setting or situation.

B. Research Site and Participants

A public school of Kathmandu district was selected to carry out the study. A total of 5 teachers and 12 students of different graders from basic level of education were participated in this study. The different grade level students in a study provides collaborative learning environment.

C. DataCollection Procedures

My research was intended to observe ethnomathematical ideas and knowledge of the students in cultural games that the students playing in their community. It is necessary to make a plan their approach to data recording before entering to the field. To overcome my research objectives, I used in-depth interviews which are mostly known as open ended interviews or ethnographic interviews. I prepared an interview guideline for teachers and students so that it would be easier for me to generate the data in the fields.

Interviewing was one preferred method to gather alternative perspectives into the students' responses to game playing and learning in the mathematics classroom. Six randomly selected students out of twelve students were interviewed from the six game playing groups. Although the same interview questions were asked to all participants, similar to a structured interview, they were open-ended in nature to allow for a description of the students' experiences. Interviewees were asked some questions and based on their responses another question was asked to get information for the study. Interviewees were allowed to speak freely in their responses. The interview questions allowed for clarification of the students' attitude towards mathematics and games. Because taking notes can interfere with the flow of conversation, a voice recorder was used by the researcher to record all the responses from participants of interview.

I was collected the data from the multiple observation sources during the course of my study and use an observational protocol for recording information while observing (Creswell, 2009). I was collect data through examining documents, observing behavior and interviewing participants. Thus I reviewed all of the data gathered from the multiple sources of data (Creswell, 2009) and then organize it into categories or themes that cut across all of the data sources.

D. Data Collection Tools

I developed unstructured questions for the same as qualitative research does not opt for the structured questionnaire. I availed the situation so that my research participants would feel comfortable to express what they fell regarding ethnomathematical knowledge of them. I used participant observation and non-participant observation to generate the data to support my study. I carefully recorded all the possible conservations with the help of the video camera and take field notes as much as I could. Furthermore, in this connection, I want to put the words of Miles and Huberman (1994), "Qualitative data are sexy. They are source of well-grounded, rich descriptions and explanations of processes in identifiable local contexts" (p.1). My data generated from the students' community reflect how they are rich in ethnomathematical ideas and knowledge. After finishing the collection of the data, I converted the conversations and interviews into manuscripts so that I could easily analyze and interpret them. The main task in the research is to analyze and interpret the data that I collected from the field.

After observing the data, I linked with many possible theories to interpret them. I triangulated the data, triangulated the theoretical closures and gave meaning to my findings. In this process, I tried to produce the accurate descriptions of the contents. Interpretation involved attaching meaning and significance to the analysis, explaining descriptive patterns, and looking for relationships and linkages among descriptive dimensions. In my study, the cultural games in the students'community and their ways of understanding the natural phenomena, and their ethnomathematical knowledge were analyzed with the notions of pluralism. In this study the analysis of the research was validated and make more reliable by triangulating the statements among the research participants, their ways of presenting the text in the several times of data collection periods. The interpretations of the context and their reports should not be biased to the same degree.

IV. CHUNGI GAME AND MATHEMATICAL IDEAS

A *chungi* might be just a bunch of rubber bands tied together but it looks like an aster, a sunflower and a daisy. It's a kicker's game, rooted in the soil of Nepal. For children, *chungi*is a prized possession played whenever school or time permits. The craze for *Chungi, however,* disappears with adulthood. It becomes a string of dirty rubbers crawling with bacteria. Most forsake the game and prefer to slump in their couches. But children play it with the same fervour as the outgrown adults once did. They are the real envoys of this popular game. *Chungi*is noticeably seen during winters when parents encourage their young ones to go out in the sun. To become the first participant of the game, one has to kick the *Chungi*in the air without putting one's foot down for the longest time. Then the number of winning the game is decided, most often 50 or 100 kicks, played in the pattern of kicking the *chungi*and putting one's feet down.

The winner in a game of *chungi* is the one who can make the biggest score first. It requires concentration and stamina. One can play it with either leg, and every game ends with a back kick. Your back

kick should land the *chungi*in the distance decided between the players, some 10 or 20 steps away from the player. In due course of time, rubbers replaced feathers, and its shape took a symmetrical round form. Perhaps, the low cost of a *chungi*, its accessibility and simplicity are the reasons behind its wide acceptance and presence. *Chungi* is very interesting and popular game for the children of all ages. It is a very useful game both mentally and physically.*Chungi* game played on normally in empty plots, playground, or in a big room where a player has to move during the game. The player should be at least two and play with *Chungi*.

Image 1: Chungi: A Bunch of Rubber

Image 2**.** Students are Playing *Chungi*

Analysis of a mathematical concepts, principles and processes of any game reveals the extent to which mathematical concepts are embedded in the game (Nkopodi&Misimege, 2009). Various mathematical concepts and ideas were found in the analysis of *Chungi* game. The arithmetic concepts of counting of numbers, grouping, and fundamental operations of addition, subtraction, multiplication, and division were observed in the process of the *Chungi* game. Most of the mathematical concepts were put in their mind and perform the mental operations on it. The algebraic concepts and fundamentals of descriptive statistics were identified in the game play.

V. FINDINGS AND DISCUSSIONS

The different game provides rich opportunities for all children to build and extend mathematical ideas and strategic thinking. In fact, through the game, children not only build mathematical ideas but also interact with aspects of their culture. Games are helpful to develop a social attitude and explore important social behaviours. Moreover, introducing this game, either in or out of school, can help children understand that humans encode their mathematical ideas in diverse cultural products, including architecture, art, games, music, written texts, and so on. Games help students to develop quick decision making, logic and reasoning to every step in games which are the foundations of mathematics learning.

Nevertheless, games provide a variety of mathematical problem solving skills such as formulating and testing hypothesis, creating strategies and organizing information. By playing games, children develop good mental coordination, their concentration levels, memory and their ability to communicate and use mathematical language. It also provides an atmosphere for children to share ideas with their peers. Bishop (1991) viewed that education cannot be truly effective unless it is based on the culture of students. Games that children play are part of their culture. It is one of the major environmental activities of every culture. Through the various games playing in each culture, they are practicing mathematical concepts, ideas and knowledge implicitly. Dienes (1960) argues that mathematics is a gold mine for an indefinite supply of games. Given any mathematical structure, a game can be invented whose constraints correspond exactly to those present in the mathematical structure in question. Mathematics has structure, rules, and these are similar to games. Dienes (1960) approach to mathematics learning uses games, songs and dance to make it more appealing to children. Thus the students' mathematical performance can enhance by using games in the classroom teaching. It is believed that games and mathematics have strong relation as two sides of a coin. Mathematics and games have some sorts of similarity. The game has similar rules, structures, and patterns that of the mathematics. He emphasizes the learning mathematics can occur maximum if we relate it with games.

During my data collection period, I discussed with a mathematics teacher if the games played by students could be linked up with the learning of school mathematics. The methods involved during the game play made me to think that there could be numerous such concepts that could be linked up with the classroom teaching. Therefore, I asked him if we could observe the students playing the game. The teacher assisted me to the ground and we started observing the game play of the students. After the session of game play completed, I asked two playing students to meet us.

Then I started talking with them about the game that they had been playing earlier. They were playing *Chungi* and I had observed them competing to win. Then I asked them about the game.

Researcher: Who was the first player of the game today?

Boy A: Sir, me!

Researcher: What was the score you scored in the game?

Boy A: 74, sir.

Researcher: [Pointing out the other boy] then what was the score you made?

Boy B: 52. Sir but I did not lost the game. In fact, no one won the game as the bell had rung before the completion of the game.

Researcher: It was too unfortunate. How much more score was required for you to have the score leveled with your friend?

Boy B: [After few seconds] 22 more. In addition, to win the game, I was just 23 score back.

I asked them if they learnt any mathematical ideas in the process of the game. They did not uttered a single word. Then after a few descent conversations, I thanked and asked them to move towards their respective classroom. From this interaction, I came to know that the children play games just for enjoyment without any pedagogical value. However, structure, rule and process of the game holds many mathematical ideas within it.Effective teaching and learning environment could be created if school mathematics is connected with the learners' everyday experience.

My participant teacher was keen to know what I was looking forward to see in the game. My concern about the game was whether the game could incorporate the teaching learning of mathematics in classroom.I asked him if any such mathematical concepts could be associated with such methods of game play.

Teacher: There could be many such ideas for school teaching such as counting of numbers during score counting, measurement strategies required in the game and others.

Researcher: (That was true but not so limited. I was thinking that there could be some other concepts, which are generally supposed to be vague but exist in the out of classroom surrounding itself). What if any such concepts regarding algebra could be synchronized with the game play of the students?

Teacher: (He started to think too.) That would be exquisite. However, which concept of algebra could be linked with the game then?

Researcher: We observed the whole process of game in the natural setting and interviewed with the players too. On this basis, how would it be if we formulate a mathematical problem?

Then he formulated a question based on the situation as:

"Two players, A and B, played *Chungi* game for a time. After a round of game, A scored 74 and B scored 52 points.

How much points does B needs to add in his score in order to equalize his score with A? For player B to beat the score of player A, how much points he further requires?"

Researcher: That was wonderful. After we have formulated the situation, what mathematical concepts can we uncover?

Teacher: We can use this situation to explore algebraic concepts based on the formulated problem.

Table 1
Exploration of Algebraic Concepts inCultural Game

Activities in Play	**Mathematical Language**
Initial Stage: Score of player A and player B are equal.	Score of A = Score of B Mathematical condition of equality.
The game begins. After the completion of game, player A scores 74 and player B scores 56.	Counting Grouping: Group of 10
For player B to equalize the score of Player A, player B further requires the score "74- 52"	For the calculation of the required score, we introduce a algebraic variable, 'x', $x + 52 = 74$ i.e. $x = 74 – 52$ This is the algebraic equation.
For player B to beat the score of Player A, player B further requires the score ">(74- 52)"	For the calculation of the required score, we introduce a algebraic variable, 'y', $y + 52 > 74$ i.e. $y > 74 – 52$ This is the algebraic inequality.

From this discussion, I concluded that game provides an ample opportunity for the development of mathematical concepts if we seriously analyze it. Regarding the mathematical ideas embedded in the cultural games,Dumbia (1989) pointed out that even a simple game could include a lot more complex mathematical ideas. And it stands same in case of this game too. A simple game, *Chungi*was uncovered to have been embedded with different algebraic concepts of variable, equality, inequality, equations and its roots.

Table 2
Frequency Distribution of Score in Game

Player's Name	P_1	P_2	P_3	P_4
Games won	||||	|||	|||| |	||
Frequency	4	3	6	2

Teaching mathematics becomes more interesting if the contents are related to the students' familiar environments. Students' everyday interaction with the cultural environment provides more opportunities to interact and conceptualise mathematical ideas. The swing game can be extraneous metaphor (Lakoff& Nunez, 2000) for the understanding of the concepts of rotation and angle of rotation. The *Chungi* game possesses various mathematical concepts and ideas. Thus, the Chungi game serves as a metaphor for the development of algebraic concepts.Besides algebraic ideas, lot of other mathematical idea were found after the analysis of this game.

Even though the player did not write their score on paper or elsewhere, they kept it in their mind. Same results have been displayed in the study of Ismael (2002) and he revealed that the basket weavers used implicit mathematical knowledge in their process. In *Chungi*game players would conceptualise the tallying system by using their mental recording system. The idea of frequency can be developed as they count the number of tallies for each player to find the number of rounds won by each player. The player would learn the concept of mode as the player who wins the highest time wins. The table2 reveals that P_3 won the game six times and evidently, themode is 6. This game develops the calculating strength regarding addition, subtraction, multiplication and division of the numbers in mind. At the same time comparison of the numbers (greater and smaller) also imply in this game.

The cultural activities like games can use to provide a source of strong motivation for student engagement in learning and to encourage students' social, emotional and cognitive development (Kamii&DeVries, 1980). In this regard, Araya (2007) viewed that the cultural games can be a powerful metaphor in the process of teaching and learning of school mathematics. Metaphors can help to generate new knowledge when the source (known) domain and the target (Unknown/new) domain interact in the mind of the learner so that each is enriched by the other. For Ainley (1988, p. 243), the main value of mathematical games lies in the linking together of mathematical problems which are 'real' to the children, the use of such process skills as listed above, and the need such activities present for children to think in a mathematical way. The different game provides rich opportunities for all children to build and extend mathematical ideas and strategic thinking. The different cultural games are embedded mathematical knowledge, ideas and concepts which help to contextualizing mathematics teaching and learning.

VI. CLASSROOM IMPLICATIONS

The main purpose of this paper is to show that the cultural game like *Chungi* has the potential of being used with success in the teaching and learning of mathematics. The use of cultural games in mathematics classrooms provide the learners with an opportunity to relate their outside classroom experienceswith mathematical concepts and processes encountered in their mathematics classrooms. This, to a greater extent, creates familiarity between mathematics and cultural games. This help learners to overcome their fear of mathematics. The use of cultural games in the classroom also creates a relationship between culturally specific activities and classroom activities (Nkopodi&Mosimege, 2009). Selection of appropriate game facilitates the development of mathematical ideas. But when games are not seen as legitimate tools, little time must be spent to use the games as a vehicle for discussing mathematical ideas. With this regard, Swan and Marshall (2009) opine that games themselves do not teach but they provide a structure for learning which in fact can enhance the way of classroom teaching. In our context, using the game for teaching and learning is generally not favored by guardians of the children. They may not see game as a relevant tool for the development of curricular material. These attitudes may undermine the effective use of games. Teachers must help parents to understand value of games in reinforcing mathematical concepts and skills.

VII. CONCLUSIONS

There are different cultures and traditions in every society. So are the games,which are played generally by children for their recreations. The significance and rational behind the games are almost unknown

in reference to the mathematical concepts, ideas and knowledge; though the children might have been playing games for a long time. Through the use of games, different mathematical ideas, concepts and knowledge can be taught in simple ways. Every game has different mathematical ideas if it is seriously analyzed from the eyes of mathematical implication. Every person holdsimplicit mathematical knowledge while performing a game. The way that they construct is usual activities but possesses high mathematical concepts from the eyes of ethnomathematics. Using ethnomathematics as the pedagogical tools in the mathematics classroom help students learn not only mathematical concepts but also cultural elements. The *Chungi*game can provide opportunities for developing knowledge and skills related to mathematical thinking – predicting, generalizing, justifying and explaining.

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REFERENCES

[1] Adam, S. (2004). Ethnomathematical ideas in the curriculum. Mathematics Education Research Journal, 16 (2), 49-68.
[2] Ainly, J. (1988). Playing games and real mathematics. In D. Pimm (Ed), Mathematics Teacher and Children: A reader (pp. 239-248). London: Hodder and Stoughton.
[3] Araya, R. (2007). Guess what is inside this box: Look at these opened boxes for clues. CERME, 5, 101-110p
[4] Ascher, M. (1991). Ethnomathematics: A multicultural view of mathematical ideas. Pacific Grove, CA: Brooks/Cole Publishing.
[5] Bishop, A. J. (1991). Mathematical enculturation: A cultural perspective on mathematics education. Dordrecht, Netherlands: Springer.
[6] Creswell, J. W. (2009). Research design: Qualitative, quantitative and mixed methods approaches (Third Edition). New Delhi, India: Sage.
[7] D'Andrade, R. (1981). The cultural part of cognition. Cognitive Science. 5, 179-195.
[8] Denzin, N. K. & Lincoln, Y. S. (2005). Introduction: The discipline and practice of qualitative research. In N. K. Denzin& Y. S. Lincoln (Eds.), Handbook of qualitative research, (pp. 1-32). Thousand Oaks, CA: Sage.
[9] Dienes, Z. (1960). Building up mathematics (4th edition). Cloth, London: Hutchinson Educational.
[10] Doumbia, S (1989). Mathematics in African traditional games. In C. Keitel, P. Damerow, A. Bishop, P. Gerdes (Eds), Mathematics, Education and Society. Paris, France: UNESCO, 174- 175.
[11] Flick, U., Kardorff, E. V., & Steinke, I. (2004): A companion to qualitative research (eds.). London, UK: Sage.
[12] Ismael, A. (2002). An ethnomathematical study of Tchadji: About a Mancala type board game played in Mozambique and possibilities for its use in mathematics education. Unpublished Ph.D. thesis, University of Witwatersrand, Johannesburg.
[13] Kamii, C. and DeVries, R. (1980). Group games in early education: Implications of Piaget's theory. Washington, DC: National Association for the Education of Young Children.
[14] Lakoff, G. & Nunez, R. E. (2000). Where mathematics comes from: How the embodied mind brings mathematics into being. New York, NY: Basic Books.
[15] Miles, M. B. & Huberman, A. M. (1994). An expanded sourcebook: Qualitative data analysis (Second Edition). Thousand Oaks, CA: Sage.
[16] Nkopodi, N. &Mosimege, M. (2009). Incorporating the indigenous game of morabaraba in the learning of mathematics. South African Journal of Education. 29: 377-392.
[17] Pradhan, J. B. (2017). Mathematical ideas in Chundara Culture: Unfolding a Nepalese teaching and learning system. In M. Rosa, L. Shirley, M. E. Gavarrete& W. V. Alangui (Eds.), Ethnomathematics and its Diverse Approaches for Mathematics Education (pp.125-152). Cham, Switzerland: Springer.