USING GAMES TO PROMOTE MULTICULTURAL MATHEMATICS

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ABSTRACT Education in South Africa was based mainly on Western values over many years. As a result many learners from disadvantaged backgrounds could not see the connection between the education they received at school and their everyday experience. This might well have a contribution to the high failure rate amongst the learners as well as the perceived difficulty of mathematics. It is believed that ethnomathematics in general can be used to promote the teaching of mathematics in multicultural classes. In this paper examples of how traditional games can be used in teaching of mathematics are discussed. It is hoped that if teachers are aware and integrate these and similar examples in the teaching of mathematics, positive attitudes toward the subject will not only be instilled but learners will also make better sense of the science concepts.

INTRODUCTION

In South Africa, learners have a right to study at a public school of their choice. As a result, it is no longer uncommon to have learners from different cultural groupings studying under one roof. The learners therefore have different background knowledge and cultures, all of which need to be taken by into consideration by the teacher. The concept of culture means different things to different people. However, most definitions of culture include communication, geographical area and the people's life style (Ascher, 1991).

The existence of mathematics in different cultures has already been documented by many authors, for example Zaslasky (1999). However, Gerdes (1988) points out that the first person in traditional societies to do activities in which mathematics can now be identified, was engaged in mathematics. He goes on to state that those who replicate these activities are not engaged in mathematics unless someone stimulates them to reinvent such activities.

Many examples of the existence of mathematics in traditional societies can be given in South Africa. The purpose of this paper is therefore to enable the learners to develop mutual respect by appreciating the fact that mathematics does not belong to a single culture but exists and is being applied consciously or unconsciously in different cultures. An educator's role is to expose these mathematical activities to learners in such a way that they become aware that by engaging themselves in these activities, that they are in fact engaged in mathematics.

Different examples of mathematics can be identified in the different societies, which can then be related to geometry or algebra. This paper will focus on examples found in traditional games, in particular "mmila" (also known as morabaraba by the Sotho speakers and umlabalaba by the Nguni speakers) and "moruba". Zaslasky (1999) refers to mmila as "mill".

THEORETICAL BACKGROUND

According to Klafki's theory, there are five basic questions according to which learning content may be analysed (Fraser, Loubser & van Rooy, 1994):

- What particular meanings (fundamental principles, basic structures) are basic to the learning content of the subject?
- What is the significance of the learning content with regard to the acquisition of knowledge, skills, proficiency and experience by the child?
- What is the significance of the learning content with regard to the child's future?
- What is the structure of the learning content?
- How can the child be motivated to be interested in the learning content, and how can the structure of the learning content be explained to the child?

This paper addresses issues which will include the first three as well as the last question.

The importance of taking into consideration in teaching what the learner knows is well documented (Ausubel, 1968). Following constructivism, the learner constructs new knowledge based on what is already known to them. It will therefore be meaningful for learners to be taught in a way which will link mathematics concepts with mathematics encountered in everyday experience.

Van der Stoep and Louw (1981) describe play as an entertaining action or relaxation according to rules. Kirby (1992), among other uses, states that games can help to develop mathematical skills. Teachers are challenged to find ways in which play can be used to facilitate learning at school. This may be motivating to learners, as play has already been described as entertaining.

Mosimege (1997) in his research on the use of the games of "madice" and "string figures" in South African schools, noted that learners get so involved in the games that they do not see any link between the games and mathematics concepts. He therefore warns that educators should use them with care. This paper suggests that educators should be actively involved in impressing on the learners that these games are not only done for leisure but that there are mathematics in them which need to be "discovered".

GAMES

Games are there primarily for enjoyment. However, games are played according to rules. Each player plans the next move and strategies to apply with all the rules in mind. At the same time the player considers what the opponent's next move will be, based on the move he is taking and the fact that the player must follow those rules. The player in fact visualises these moves. These activities are similar to problem solving where one has to arrive at a solution according to proven rules. The important thing is that what is being used from different cultures should be familiar to all cultures. If a game from one culture is to be used, then other learners not familiar with the game should first be taught how to play the game.

Mmila and moruba are two popular games among blacks in the rural areas. We will focus on these games. Mmila is shown in figure 1.

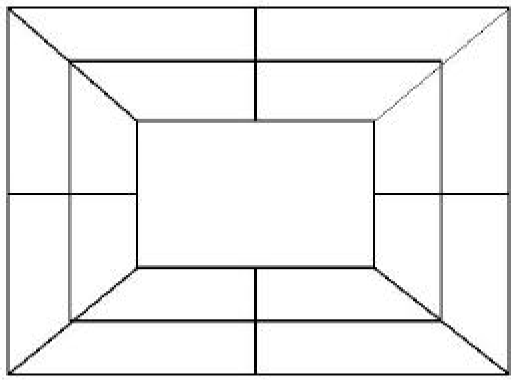

Figure 1 : Mmila

Mmila comes in different variations. However they are similar and the rules of playing the game remain the same. It can be seen that the structure of mmila consists rectangles and trapeziums. Recognition of these shapes is in itself a mathematical activity.

Two people are necessary to play this game. They each start with twelve objects, usually stones. There must be a way of identifying one player's stones from the other's, e.g. size, colour, shape, etc. The players will alternately put down one stone at a time (at a point where two lines intersect). The first to put down a stone chooses a point he/she considers most strategic. The second one chooses points he considers will counter most efficiently moves taken by the first player.

Any player who manages to get three stones in a line is entitled to a point in the form of taking any of the opponent's stones. This can be seen as the operation of subtraction from the opponent's set of stones. When all stones have finally been put down, the next phase of the game starts. Each player moves one stone at a time, striving to get three in a line. A player must also move a stone so that he/she can stop an opponent from getting his (the opponent's) three stones in line. It is possible for a player to have five stones in a line by

putting a stone at a corner where he has two stones at either side. In that case he will be entitled to two of his opponent's stones. The loser in the game is the one who will remain with two stones or less.
The game of mmila seems at first glance to be very simple because all it takes to score a point is to get three of your stones (or whatever is used) in any straight line. However to win the game ultimately needs careful thinking. You need to plan your moves in advance. A move you take should entice your opponent to take a move which is likely to lead to his/her defeat. Mmila thus teaches logical thinking.
As a tool for teaching mathematics, learners can be asked to

- identify shapes in the structure of "mmila". Variations of the game come after modifications have been done to the structure by additional lines. These variations bring about other shapes in the structure. These variations can thus enable the educator to ask additional questions about shapes
- tell how many stones the structure can accommodate. It will be of interest also to get them to say different ways in which the answer can be obtained
- identify mathematical operations taking place as the game is played
- identify and measure angles in the structure.

The above are only examples. There are many possible questions. If an educator feels a particular game is not enough to cover all questions they want to ask, they can use a different game. The game of moruba is one such possibility.
Moruba is constructed by digging parallel holes in the ground as shown in figure 2.

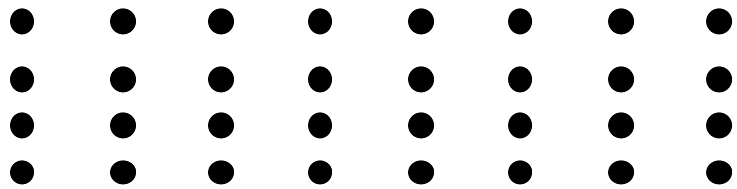

Figure 2: moruba

A South African business executive and expert in the game of moruba, Esau Mailula, explained how moruba was constructed and played.
Moruba is made by digging parallel holes in the ground as shown above. Any number of holes can be used to play the game as long as they form multiples of four and the number of columns is divisible by 4. Small stones are used for this game. The number of stones used in the game depends on the number of holes made.
The following are the features of this game:

- The number of columns of stones should be divisible by 4.
- Each player has 2 rows in which to play.
- The number of stones is determined by the number of holes as well as agreement between the players.
- In general 2 stones are placed in each hole, except the last 2 or 3. However, there are variations where 1 or 3 stones are placed in a hole.
- Consider a **4x8** moruba up to a **4x48** moruba. Each player places 2 stones in all holes where he is entitled to play except the last one which is left empty. The second last is left with only 1 stone. Therefore in total there will be a shortage of 6 stones to fill all holes if the opponent's holes and stones are included. This means a total number of 58 stones in a **4x16** moruba.

- Change comes with a $\mathbf{4x16}$ moruba up to a $\mathbf{4x48}$ moruba. Here, for each player, 2 holes are left empty while the 3rd last is left with 1 stone. Thus there will be a shortage of 10 stones to fill all the holes
- Once all the stones have been placed in the holes according to the rules, the game is ready to start. Each player moves his stones in a clockwise direction using his own position as a point of reference. He decides where to start (normally close to the empty holes) and put one in each hole until the last stone had been put in a hole.
- A player scores if he puts a stone in an empty hole which forms a column with a hole in which the opponent has a stone. A player only scores if these stones are in the inner row. The scoring player collects all the opponent's stones in that column. He must also collect stones from a hole of his choice belonging to the opponent. If a player drops his last stone in a hole which has other stones already, he picks up those stones and carry on with the process. If the last stone is placed in a hole which is in the row closest to him he gives his opponent the chance to play. The opponent will then play using the same rule.
- The winner must have collected all the opponent's stones. The game of moruba does not have room for the result of a game to be a draw. There must always be a winner and a loser.

Esau Mailula explained that it is essential for more empty holes to be left out when the size of moruba increases. He said the reason for this was to give more room of movement for the players.
Each player thus strives to do the following:

a) Keep as many of his stones as possible outside the middle row (they are protected in the outside row). However, it cannot be done indefinitely because, for the game to go on, each player must move his stone, and this will result in some of their stones occupying positions in the middle row.
b) Estimate a hole in which he is going to drop the last stone in order to hit the opponent where it will be most effective.

The game thus teaches estimation, calculation and reasoning.
A mathematics teacher can use the number of players, holes and stones used in this game to teach addition, subtraction and division. These can be extended as follows for generalisation by making use of algebraic symbols:

When n holes have been made in a game with $\mathbf{12}$ columns or fewer, a total of $2n - \mathbf{6}$ stones will be used in the game. For two players, each player will use only $\frac{n}{2}$ holes and $n - \mathbf{3}$ stones. The formula for the number of stones will change when the columns are greater than $\mathbf{12}$ because a total of $2n - \mathbf{10}$ stones will be used. Therefore each player will use $\frac{n}{2}$ holes and

$n - \mathbf{5}$ stones.

As Educators, we can let the learners perform certain activities to learn mathematics from the games. We can let the learners:

a) describe the game in their everyday language.
b) now try to express the game as far as they can in the language of mathematics.
c) formulate mathematical problems from the game, for example, if you have holes and players, how many stones does each player need?'
d) discuss the shape of the holes and if the shape has any effect in playing the game.
e) discuss the pattern made by the holes.
f) make estimates of comparisons of the length of time it would take for the game to come to an end when the following are involved in the game:
   I. expert against a novice
   II. novice against novice

III. expert against expert

These comparisons can used to estimate ratios.

Naturally in 'c' you can start with numbers. You can use different numbers and ultimately use symbols to generalise. This is where the game of moruba appears to be better than the game of mmila. Mmila always uses the same number of stones. This does not give learners an opportunity to arrive at this kind of generalisation.

The above games can be used in the teaching of mathematics to help learners towards achieving the following specific outcomes:

- use mathematical language to communicate mathematical ideas, concepts, generalisation and thought processes
- analyse natural form, cultural products and processes as representations of shape, space and time

The above specific outcomes have been stated in the learning area of mathematics, mathematical literacy and mathematical sciences in South Africa (Department of Education, 1997).

CONCLUSION

This paper has given an idea of how ethnomathematics can be used to promote multicultural education in South Africa. The present situation in South Africa reflects mainly mathematics examples as known in the Western culture. This paper does not suggest the exclusion of these examples. On the contrary, it suggests that ethnomathematics should be used as a complement to the current teaching practice in mathematics education. All cultural groups will then realise that mathematics belongs to all cultures.

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