

Development of Mathematical Thinking through Integration of Ethnomathematic Folklore Game in Math Instruction

Abu Qouder Fouze ^{1*}, Miriam Amit ¹

¹ Ben-Gurion University of the Negev, ISRAEL

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ABSTRACT

In light of all the difficulties and challenges facing us today in improving math education, questions arise regarding how to develop students' mathematical thinking and conception, how to increase student motivation to learn math, how to improve achievement in math, and how to maintain an interesting, enjoyable, and successful learning process in math. In this paper we will present one solution to these questions according to the ethnomathematical approach, which combines culture and math instruction: the integration of ethnomathematical folklore games in the instruction of math. On this background, the proposed paper will discuss the following issues: (1) the definition and essence of ethnomathematics; (2) the historical development of the ethnomathematical approach; (3) the political aspect of ethnomathematics; (4) Lev Vigotsky's constructivist theory and its relation to ethnomathematics; (5) the importance of developing a curriculum that integrates cultural values; (6) the contributions of an ethnomathematical curriculum; (7) various approaches regarding the ethnomathematical curricula; (8) proposals for the development of ethnomathematical curricula; (9) What is a mathematical game; (10) Discussion; (11) Summary and suggestions.

Keywords: ethnomathematics, ethnomathematical curriculum, development of mathematical thinking, motivation, academic achievement, ethnomathematical folklore games

INTRODUCTION

As experienced educators, in general and particularly in math instruction, we can say that we are currently suffering from various difficulties and challenges such as low motivation to learn math, difficulties in grasping and understanding complex mathematical concepts, codes, and values, attention and concentration deficits in class, and more all of which negatively affect academic achievement and cause a joyless, incurious math learning process for our students.

In this light we have made a serious effort during our many years of math instruction to experiment and find ways to make math lessons more interesting and successful and to make the subject in its entirety less intimidating. One of the solutions we have found is to integrate culture and math instruction by utilizing ethnomathematical folklore games from the students' culture, which contain various mathematical values and which can be used in math lesson as instructional aides. Such a strategy assists in developing the students' self-conception and helps in simplifying the learning materials and making the subject more accessible. In addition, since children love to play, using games is a very good way to engage the students. Although games cannot replace the traditional method of teaching with chalk and blackboard, they can successfully complement it. Fun, culture-based activities can help with the repetition and assimilation of material, can strengthen mastery of material, and boost self-confidence. Furthermore, some of the play activities are intended to strengthen logical thinking. In general, games help associate math with fun and help decrease the negative effect based on past, unsuccessful experiences in math.

That said, these advantages should not be overstated. Experience shows that such activities should not be conducted too frequently; a short activity of 30 minutes at the end of a lesson every two or three weeks is

Contribution of this paper to the literature

- This paper discusses factors that contribute to an interesting and successful learning process in math education. It refers to learning difficulties encountered by students when learning math and that are caused by the level of difficulty of the learning topics and their lack of meaning, logic, and connection to reality.
- This paper discusses how integrating concepts and values from the students' culture—and ethnomathematical folklore games in particular—in the instruction of math contributes to the development of students' mathematical thinking.
- This paper emphasizes the contribution of the ethnomathematical approach, which integrates a variety of learning strategies and methods, such as mathematical cultural values and folklore games, to the development of mathematical thinking.

recommended, along with one annual, hour-long activity. The younger the students the more frequent such activities should be. For some students with attention deficits this is practically the only way to reach them. Capable students enjoy such activities no less than weaker ones, and although they require them to a lesser degree didactically-speaking, they do benefit from the more relaxed climate.

Maximal participation of students is an important goal that must be emphasized. In group activities, all students must be encouraged to participate, not only the capable ones. To do this, a medium- to low-level of mathematical materials must be used in these activities, relative to the level of the participating students. Sometimes, when the activity is not competitive, some instruction can be inserted by the way for weaker students, in order to keep them in the picture. Success for such students, even when accompanied by some instruction, is viewed by the other students as real success, which is no trifling matter. Teachers must have access to a variety of ethnomathematical and didactical activities, with instructions for each game so that when they need such an activity on a specific subject it is ready and available for them.

THE DEFINITION AND ESSENCE OF ETHNOMATHEMATICS

Ethnomathematics comprises the mathematical opinions of people, which appear in various forms, written and verbal. Educators have a large influence over shaping the boundaries between the two fields of formal mathematics and ethnomathematics and on the comprehensive integration of daily mathematical activities into mathematics. The cultural mathematics of cultural groups is considered part of their life characteristics. Ethnomathematics is developed by the cultural group and serves their natural interests, which derive from their social situation (Anderson, 1990).

One of the primary goals of ethnomathematics is to recognize the fact that there are different points of view and to respect everyone's right to choose their own. In other words, mathematics can assist in promoting tolerance in an era of abundance that lacks it. The goal of math instruction must be the discovery of new facts about the self, society, and culture of the learner, who must be able to make better decisions and reconstruct the link between mathematical principles, concrete situations, and personal experience. All these are essential to the balanced development of every country or society (Fasheh, 1982).

THE HISTORICAL DEVELOPMENT OF THE ETHNOMATHEMATICAL APPROACH

The development of mathematical knowledge, and in particular the development of ethnomathematical knowledge as a basis of math education, has proceeded gradually in accordance with social, economic, political, and cultural changes. When ethnomathematics was suggested for the first time in the 1970s and 1980s as a new field in math education, it was seen as something new and exotic. The idea of observing mathematics in other cultures and using the findings in everyday classes seemed strange for the teachers, and at best was considered no more than a type of enrichment. In many parts of the world, the instruction of mathematics relied solely on the European content model, structure, and algorithms. School curricula and teacher instruction underwent reforms and changes such as the new math program in the 1960s, but they remained centered, nonetheless, around the European patterns (and, later, the American patterns) that had been established decades earlier.

The complete turn made by D'Ambrosio (1984) in the Fifth Congress of Mathematics, in a paper titled "The Basis for the Socio-cultural Instruction of Math", was considered quite surprising in its reference of social and cultural issues in math, and it was not discussed in a thorough manner, though some research regarding gender comparison was conducted. The common feeling was that mathematics is mathematics (meaning only that mathematics is European). There may exist sociological issues in terms of mathematical implementations, but

learning and instruction in schools seemed stable and remote from cultural issues. It seemed that the history and culture of math were no more than a decorative enrichment.

However, this was before multicultural studies flooded all fields of instruction and curricula, before the population all over the world became more diverse. Also, math educators realized that math education must extend a lengthy arm to the populations that are under-represented in this field, for the sake of diversity. The American human rights movement, the new independence of the Third World countries, and a more liberal outlook of education culminated in a cry for a broader curriculum. Engagement with this issue increased quickly in the 1980s and 1990s (The National Research Council; 1989; Trentacosta, 1997). Multicultural examples were inserted into course materials, and sometimes entire courses were developed on the basis of multiculturalism, which even became the subject of entire degrees in some universities.

The ethnomathematical approach has developed significantly in the past two decades and has spread more widely than before. It has become a more used, routine approach, which is implemented in curricula by researchers and teachers around the world. This process of development is evident in numerous ways: math books at all levels include multicultural subjects such as examples and exercises, in addition to enrichment frameworks. The ethnomathematical approach became the foundation of numerous curricula in national and local jurisdictions. National accrediting institutions, such as the American NCATE, actually *require* programs to train teachers so that they will be able embrace an international approach and demonstrate diversity in the curriculum, the student council, and faculty.

THE POLITICAL DIMENSION OF ETHNOMATHEMATICS

As an educational matter, ethnomathematics are significantly affected by the patterns of government in any given country and society. The policy of those in power and the criteria according to which internal institutions are managed in society is manifested in the education system, among others. Education in general and math education in particular are affected by the governing body and educators who cannot act freely, because they are committed to governmental programs that are determined by political criteria. As stated by D'Ambrosio (1999, p.34)

It is obvious that mathematics is strongly integrated in technological, industrial, military, economic, and political systems and that mathematics has relied on these systems as a material basis for its advancement. It is important to investigate the role of mathematics and math education in arriving at the deviant behavior of the human race.

Changing approaches, values, assumptions, relations, and structures exacts a personal price from teachers who attempt it. There is a price to pay for teaching mathematics in a manner that reflects other aspects of society and culture, which in turn may develop the critical consciousness of the learner. The price paid by the teacher changes according to the power of those ruling and the efficiency of the teacher. Fear of paying this price is a major factor in the deviation of education from its natural path and its assumption of meaningless, remote forms (Fasheh, 1982).

The development of education in general and math education in particular may also be affected by external or foreign forces. Researchers such as Berry (1985) and Gerdes (1990) have cautioned against a situation in which foreigners are involved in creating curricula for other countries or ethnic groups, for several reasons, including (1) the violation of the sovereignty of the nation; (2) lack of sensitivity to the local culture. The second reason alludes to the cultural aspect of math instruction, which has been widely researched. One of the heights of this body of literature was D'Ambrosio's (1985) proposal of ethnomathematics.

In the current culturally sensitive situation, is involvement in math education by another country a matter of well-intentioned prying or another form of colonialism in the name of international cooperation? Whatever the answer may be, cultural sensitivity does not permit us to avoid conversing with other countries or not caring about their situation.

LEV VYGOTSKY'S CONSTRUCTIVIST THEORY AND ITS RELATION TO ETHNOMATHEMATICS

The social construction of knowledge leads us to Lev Vygotsky's constructivist theory. The main idea in this social-psychological theory is that social interaction and verbal communication of students with their environment fulfill a key role in their cognitive development (Driscoll, 2000). Vygotsky (1978) formulated the idea of "the Zone of Proximal Development", which is the distance between the current level of development of the child as determined by independent problem-solving, and his potential level of development, as determined by problem-solving guided by an adult or in cooperation with his peers of higher ability than him. The goal of learning is to shorten this distance by learning-social interactions in which the individual receives contribution from the groups, such as ideas, patterns of thought, information, reflection and more, enabling him to create new meanings as he cooperates with his peers. Vygotsky argues that the development of thought is determined by language, and

consequently the learning environment includes not only the students and the learning materials and processes, but also interactive communication. People construct knowledge on the basis of their existing knowledge, which is related to their environment and culture and both nourish and establish knowledge. In fact, the students' cultural background empowers their learning ability.

Vygotsky's constructivist theory is related to the ethnomathematics approach, which emphasizes the role of culture in students' development and learning and the importance of the students' interaction with cultural values and elements in order to acquire knowledge. According to the constructivist theory, students initially acquire cultural mathematical concepts from their environment, which actually mediates between the students and the cultural values and concepts, and continue to acquire and solidify them in school, which scientifically processes and organizes knowledge.

THE IMPORTANCE OF DEVELOPING A CURRICULUM THAT INTEGRATES CULTURAL VALUES

Following the development of the ethnomathematical trend as an educational-cultural field, several proposals were suggested and numerous attempts were made to develop curricula with multicultural mathematical ideas that include traditional cultural values, traditions, symbols, and mechanisms for the purpose of aiding the instruction of mathematical subjects. This trend testifies to the importance and centrality of ethnomathematics, which appears now not only as a matter of enrichment or the property of a certain society of power, but as a matter that requires an overall effort to develop. Therefore, cultural values must be utilized in mathematical education and instruction, out of solidarity and respect for all cultures as such, while preserving their future existence (Shirley, 2001).

According to D'Ambrosio (2002), educators are responsible for the learning process and therefore they must develop informal curricula that refer to the reality in which the student lives, while integrating traditional values in their cultural-educational context in the mathematical instruction and learning process. As he stated:

Education must impart respect of culture and take into account cultural values. This matter requires much more than is offered in the regular curriculum. The situation of math is particularly grave. It has no relation to the experience of children. We need more mathematical content that creates interest (pp. 3-5).

Teaching mathematics without cultural context on the pretext that it is abstract and universal is the reason for the failure of students in this subject. On the other hand, when students are exposed to various cultural links and reflect upon them together, they develop a desire to learn and their self-confidence grows. A similar result was found in a research we conducted and that included the development and implementation of an ethnomathematical curriculum among two groups of Bedouin students in Israel (Amit & Abu Qouder, 2015).

Teaching math in a completely abstract, symbolic, and meaningless manner that is remote from cultural aspects is not merely ineffective; it is actually harmful to the students, society, math itself, and future generations. As educators we must encourage children to see what they are aiming for; not what we are aiming for. The numbers and symbols that we use with children are meaningless to them, and their meaning goes beyond what we intend or note. Children have their own priorities regarding symbols, which in some cases turn into strong feelings and adamant decisions. Math teachers and educators usually ignore these issues or fail to understand how culture is related to the students and their learning process (Fasheh, 1982). Through ethnomathematics, which is linked to human life, learners can be more active in solving problems because they are related to their lives (D'Ambrosio, 1987). However, much of the curricula used by teachers do not correspond to the social and cultural reality of the students and therefore they do not cooperate (D'Ambrosio, 2001). Teaching math without cultural context on the pretext that it is perfect, abstract, and universal is the reason for students' declining achievements and their failure (Gilmer, 1990). To remedy this situation, we must find ways to help students learn about their cultural mathematics.

When students are exposed to different mathematical cultural values and reflect upon them together they discover that they know more than they thought they knew when they were judging themselves by the formal, traditional mathematics. Furthermore, in this way they develop a desire to learn and their self-confidence grows. Also, ethnomathematics helps them solve more complex problems (Powell & Frankenstein, 1997). Implementing situations from the local culture in the classroom is one way in which to assist students in seeing the relevancy of math to their culture, and subsequently use this link to assist in teaching math. One project that does this is a project called "Increasing the Participation of Native Americans in Higher Mathematics", conducted in Oklahoma (Aichele, Douglas & Downing, Carl, 1985).

The development of ethnomathematics is a long-term project due to the numerous changes occurring in society, which entail the replacement of old structures with new ones. Therefore, we must focus not only on attempts to develop formal curricula; we must also develop proposals and means that can serve ethnomathematics in order to develop anthropological structures related to ethnomathematics. The biggest challenge facing educators and math

teachers is finding the correct way to impart mathematical rules and content in an effective, enjoyable, and successful manner that will enable students to learn and master modern mathematics. Ethnomathematics curricula can be one way to achieve this goal.

In their research among American-Indians, Davison and Reyhner (1986) reported that they identified three areas in which local students encountered difficulties in learning math: language, culture, and ways of learning. It is easy to attribute the difficulties encountered by minority students in learning math teach element separately. Thus, minority students demonstrate low levels of achievement in standard tests beginning from the third or fourth grade, while in earlier years their achievements are closer to the average (De Avila, 1988; Leap, 1988). Standards tests naturally emphasize language skills, so that a student who does not read well or does not have a reasonable level of English and vocabulary is beginning from a severe disadvantage. As Davison noted (1990, pp. 2-3): "It is easy to attribute the difficulties encountered by minority students in math to each factor separately. For instance, minority students have low achievements in standard tests beginning from the third or fourth grades, while in earlier years they are closer to the average. Standard tests by their very nature emphasize the importance of language skills. Students who do not read well and have little mastery of English and its vocabulary are at a serious disadvantage."

Thus, a language deficit will lead to a math deficit. The difference between the language and culture of the students and the ways of teaching may affect their achievements, particularly if none of these elements change. Similarly, in our work as educators in higher education we encounter on a daily basis Arab students from the Bedouin sector in Israel who have learning difficulties because the language they speak differs from the written language in which they study and because their cultural background is different.

THE CONTRIBUTION OF AN ETHNOMATHEMATICAL CURRICULUM

The effectiveness of math education and its effect on student achievements is high on the agenda of numerous countries (Keitel, Damero, Bishop, & Gerdes, 1989), which is one reason why numerous researchers have developed and implemented ethnomathematics curricula. Studies that have been conducted on such curricula testify to its effectiveness in various aspect of math education. For instance, Lipka, Wong, and Ihrke (2012) presented findings from an educational project conducted among American Indians and American-Alaskans for the purpose of examining the effect of the local culture on math instruction for these students. The researchers worked with the elders of the Yup'ik tribe in order to include daily cultural activities in the school curriculum. Accordingly, the students initially learned in theory the traditional methods of math education and then implemented them in practice.

Similar results were found in a research conducted by the authors (Amit & Abu Qouder, 2015) among a Bedouin population in Israel. This study included the development and implementation of an ethnomathematics curriculum based on integrating Bedouin cultural values and elements for an especially constructed learning unit on the subject of units of measurement. Four 7th grade classes—two classes in the experiment and two as a control—were the research population. Findings showed a clear improvement for the experimental group in various outcomes such as motivation and self-conception, which were at higher levels after the implementation of the ethnomathematics program compared to before. For the control group, these values did not change between the two measurements and in fact slightly dropped. The study also affected the students' positions toward their culture and the adults in their society, making these positions more positive. However, the findings showed no effect on the math achievements of the students.

In addition, several researchers developed and implemented a theoretical structure to analyze students' lack of desire to participate in a cultural course for teachers (Verner, Massarwe & Bshouty, 2013). Participants were pre-service and in-service teachers, Arabs and Jews, religious and secular, who studied geometry through inquiry into geometric ornaments drawn from diverse cultures, and acquired knowledge and skills in multicultural education. The methodology of engagement structures recently proposed by Goldin et al. (2011) was used to analyze the emotional behaviors in the course. The research findings showed that engagement structures were a powerful tool for examining the students' lack of motivation to study math. The constructivist ethnomathematical approach highlighted the structures that matched our instructional goals and diminished those related to students' feelings of dissatisfaction and inequity. The researchers suggested a new engagement structure "Acknowledge my culture" that nurtures math education. Findings also showed that the participants perceived this type of learning as a meaningful experience that, contrary to other learning methods, enhances their positive feelings toward other students and teachers and contributed to a lively discourse among them and raised their level of motivation. Studies show that knowledge based on faith and affiliation to a group leads to cultural coexistence and inner peace (Amit, Fried & Abu-Naja, 2007), which in turn improve the students' self-conception and achievements.

CONCEPTIONS REGARDING THE DEVELOPMENT OF ETHNOMATHEMATICAL CURRICULUM

Researchers of ethnomathematics identified five possibilities for curricula in ethnomathematics, based on the belief that the cultural aspects of the students' environment must be integrated holistically, including the epistemology of mathematics, its content, the class culture, and the approach to math instruction.

The first conception: for an ethnomathematical curriculum is an approach to mathematics. This can be called "mathematics in a meaningful context". This perspective is epistemological in the sense that mathematics is presented as a cultural response to human needs. It assumes that every culture has mathematical responses and that the responses of the learners' culture are how students think about mathematics and not how they learn it (Bishop, 1988; Zaslavsky, 1991).

The second conception: ethnomathematics is unique content that differs from conventional mathematical concepts taught in most schools. It includes special models and decorative shapes, spatial systems used in navigation, idiosyncratic practices such as Lusona drawings, and mathematical concepts such as measurements or planning found in the engineering profession such as shipbuilding (Asher, 1991; Gerdes, 1991; Zaslavsky, 1996). Ethnomathematics can construct any part of a curriculum, large or small.

The third conception: A curriculum can be built on the idea that ethnomathematics is a more advanced stage in mathematical thinking, a stage that every child must go through in his mathematical education. This approach assumes that learning math begins from the child's mathematical world and advances through the child's cultural world of math until it arrives at the global world of math. The ethnomathematical curriculum is the exact same one as in the first conception except that it focuses on the child's culture (Beeg, 2001).

The fourth conception: An ethnomathematical curriculum can be the mathematical portion of the idea that all classes are located in a cultural context. This context includes values and benefits related to learning, the goals of education, cultural and individual theories, methods of learning, and the class environment. The perspective is individual as related to math classes that include teaching math in writing or verbally, the type of required mathematical authority, and the type of evaluation. This type of approach to the curriculum was proposed by Bishop (1988) in his discussion of "the culture of math".

The fifth conception supports integrating principles and methods from the learners' culture with formal standard academic mathematics. The mathematical experiences from the learners' culture help the students understand how to formulate and implement mathematical principles. As educators we must know how to integrate cultural values and be aware of the means that can be used and the most appropriate methods for achieving educational mathematical goals as successfully as possible.

PROPOSALS FOR THE DEVELOPMENT OF AN ETHNOMATHEMATICAL CURRICULUM

Various proposals have been published concerning the development of curricula that emphasize the importance of the cultural principle as an educational-instructional principle that contributes to the improvement of academic achievement but also enables preserving the traditional cultural existence of numerous societies and particularly minority ones.

D'Ambrosio's proposal: D'Ambrosio was a renowned mathematics researcher who developed and proposed a new curriculum in the 1980s called "The socio-cultural basis for mathematics education" (D'Ambrosio, 1984). This proposal emphasized the importance of integrating cultural aspects of the instruction of mathematics within the learned subjects. This practice helps students absorb the materials and understand them better. He suggested recognizing three aspects: reading and writing, "mathocracy", and "technocracy".

The first principle: In his plan, D'Ambrosio referred to the principle of reading and writing in a new way, when he discussed a commitment to reading with newer means such as "reading a movie or a TV program". In his view, the ability to read and write involves a mathematical ability that is usually based on reading comprehension and interpreting graphs and tables. In his proposal he calls for a revolution in the field of education and a shift away from students who use paper and pencil in the educational process to the use of screens.

Second principle: "Mathocracy", which is the ability to reach conclusions from data and formulate hypotheses, which is the first step toward forming an intellectual stance.

Third principle: technocracy, which is critically close to technology. Its operative aspects are in most cases accessible to laymen but the basic idea underlying the technological mechanisms are vital questions that children must be exposed to at early stages. D'Ambrosio's proposal, which linked math and culture, was considered revolutionary in the world of math education.

Bishop's proposal (1988), "Math in a meaningful context", is a different type of curriculum, based on an epistemological perspective in the sense that mathematics is presented as a cultural reaction to various human needs. It is assumed that every culture contains both various mathematical responses and responses from the culture of the learners (Zaslavsky, 1991; Bishop, 1991). Bishop (1988) proposed this type of curriculum in his book "Mathematical Enculturation: A Cultural Perspective on Mathematics Education", in which he documents his search for elements that can improve students' understanding of math. These include teacher decision making, spatial abilities, visualization and geometry, cultural and social aspects of math education, a social-political measure for math education, and links between research and math. He also noted several educational values that are part of the ethnomathematical approach. These include (1) mathematical values, rules, and laws developed by Western educators; (2) general educational values, which are related to the norms in a given society and particularly a given school; (3) mathematical-educational values, which are embodied in the curriculum, the study books, instruction methods and more.

Bishop (1988) proposed five principles for constructing mathematical curricula and sustaining a cultural mathematical learning process: (1) development of a broad and deep understanding of mathematics as a cultural phenomenon; (2) development of a meaningful, in-depth understanding of cultural mathematical values; (3) improving the students' understanding and skills regarding technological and mathematical symbols and development of the students' knowledge and understanding at the technical level; (4) development of a conception regarding the math-learning process in its cultural context, which is termed "Enculturation". In the research conducted by Bishop (1988) the integration of cultural values and formal mathematics affected math achievements of students.

WHAT IS A MATHEMATICAL GAME?

When considering the use of games for teaching mathematics, educators should distinguish between an 'activity' and a 'game'. Gough (1999) states that "A 'game' needs to have two or more players, who take turns, each competing to achieve a 'winning' situation of some kind, each able to exercise some choice about how to move at any time through the playing". The key idea in this statement is that of 'choice'. In this sense, something like Snakes and Ladders is NOT a game because winning relies totally on chance. The players make no decisions, nor do that have to think further than counting. There is also no interaction between players - nothing that one player does affects other players' turns in any way.

Oldfield (1991) says that mathematical games are 'activities' which:

- involve a challenge, usually against one or more opponents; a
- are governed by a set of rules and have a clear underlying structure;
- normally have a distinct finishing point;
- have specific mathematical cognitive objectives.

BENEFITS OF USING GAMES

The advantages of using games in a mathematical programme have been summarised in an article by Davies (1995) who researched the literature available at the time.

- Meaningful situations - for the application of mathematical skills are created by games
- Motivation - children freely choose to participate and enjoy playing
- Positive attitude - Games provide opportunities for building self-concept and developing positive attitudes towards mathematics, through reducing the fear of failure and error;
- Increased learning - in comparison to more formal activities, greater learning can occur through games due to the increased interaction between children, opportunities to test intuitive ideas and problem solving strategies
- Different levels - Games can allow children to operate at different levels of thinking and to learn from each other. In a group of children playing a game, one child might be encountering a concept for the first time, another may be developing his/her understanding of the concept, a third consolidating previously learned concepts
- Assessment - children's thinking often becomes apparent through the actions and decisions they make during a game, so the teacher has the opportunity to carry out diagnosis and assessment of learning in a non-threatening situation

- Home and school - Games provide 'hands-on' interactive tasks for both school and home
- Independence - Children can work independently of the teacher. The rules of the game and the children's motivation usually keep them on task.

HERE ARE SOME OF HINTS FOR SUCCESSFUL CLASSROOM GAMES

These tips come from Alridge & Badham (1993):

- Make sure the game matches the mathematical objective
- Use games for specific purposes, not just time-fillers
- Keep the number of players from two to four, so that turns come around quickly
- The game should have enough of an element of chance so that it allows weaker students to feel that they a chance of winning
- Keep the game completion time short
- Use five or six 'basic' game structures so the children become familiar with the rules - vary the mathematics rather than the rules
- Send an established game home with a child for homework
- Invite children to create their own board games or variations of known games.

THE FOLKLORE BEDOUINS GAMES

Games are susceptible to mathematical and logical analyses, hence, play is an activity integrally connected to cultural heritage and to the world that surrounds the players. Many games induce competition, along with a drive to improve one's play, and as a result, players may apply analytical thinking to further their understandings of games for which strategy might be possible. Games may relate to players' cultural heritage, which is an integral part of the society to which they belong. Various games played by the Negev Bedouins, elders and children's alike are a major part of leisure culture in the desert. Some of these games include mathematical values that help to develop mathematical thinking and can be integrated and used as a teaching strategy in the process of mathematical education.

HERE ARE THREE EXAMPLES OF BEDOUIN FOLKLORE GAMES THAT INCLUDE MATHEMATICAL VALUES AND HELP DEVELOP MATHEMATICAL THINKING

Ta'ab - The Stick Game

Game description

Four sticks of equal length are prepared from branches of tamarisk, acacia, or eucalyptus tree, at sizes ranging from 15 to 20 cm. The bark is peeled off half of the stick, with the other half remaining untouched, leaving the stick rounded. The peeled side is called white and the other black. The game requires that players decide on an even number of gravel stone to use as markers, half of one color, half of a different color, for each player, respectively. The stones have a diameter of approximately 2 cm, and if stones are not handy, camel dung works instead. A square arrangement of holes is made in the ground with the thumb, which Bedouins call the toe finger, for moving the stones from hole to hole during the game. The game is intended for two players, with each throwing the sticks alternately and each player moving his stones across the board according to the results of tossing the sticks on the ground or on a tree stem placed on the ground.

Rules for scoring

1. blacks and 1 white = Ta'ab, receiving 1 point and another throw;
2. blacks and 2 whites = 2 ta'abs, receiving 2 points;
3. whites and 1 black = 3 points;
4. whites = 4 points.
5. blacks = 6 points and the right for another throw.



Figure 1. The (folklore) Ta'ab – The Stick Game



Figure 2. The modern Ta'ab – The Stick Game

Game rules

1. Each player chooses gravel stone of the same color and arranges them in the first row of the square on his side.
2. Players take turns tossing the sticks and checking the way they land, white or black sides up. Scoring does not begin until one of the players makes Ta'ab, 3 blacks and 1 white. Color combinations determine the points received by the player.
3. The game continues through counting of points received with each throw and moving the markers across the board according to the number of points per turn, until all of them arrive at the opposite side of the board, i.e., the marker row of the opponent.

Game objectives in the area of mathematics

1. Recording the count for each turn in numerical symbols.
2. Practicing mathematical actions by counting and adding
3. Development of winning strategies by playing multiple times & reflecting.
4. Communicating their thinking.
5. Having informal experience with chance by attending to outcomes of tossing the sticks.

Games are susceptible to mathematical and logical analyses, hence, play is an activity integrally connected to cultural heritage and to the world that surrounds the players. Many games induce competition, along with a drive to improve one's play, and as a result, players may apply analytical thinking to further their understandings of games for which strategy might be possible. Games may relate to players' cultural heritage, which is an integral part of the society to which they belong. Various games played by the Negev Bedouins, elders and children's alike are a major part of leisure culture in the desert. Some of these games include mathematical values that help to develop mathematical thinking and can be integrated and used as a teaching strategy in the process of mathematical education.

Mozkat - 5 Stone Game - (Game Description)

The players use their judgment to discriminate between "little" and "large," comparatively sized as in the photo. The game is intended for two or more players, each of whom, in his turn, throws the Mozkat and distributes the little stones according to the rules of each stage. The description below applies to two players, but by turns it can include more than two players. The objective is to do two things simultaneously: catch the Mozkat and arrange the

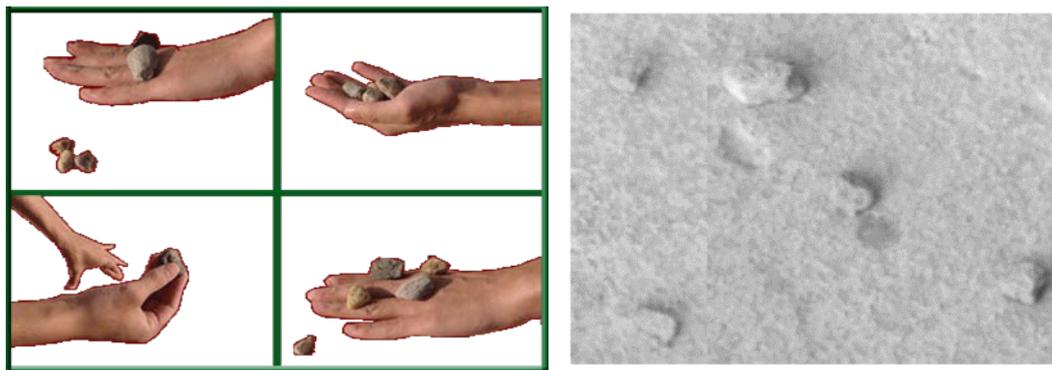


Figure 3. 5 Stones in "Mozkat" Bedouin Game

stones, each stage offering different combinations. Each player tries to go through all the six stages, and if the player accomplishes them successfully, he wins 4 points. The winning player is the one who scores the most points. Before they begin the game, the players decide on the winning number of points.

Game objectives in the area of mathematics

1. Counting and adding of numbers. 2. Grouping the four pebbles into possible, allowable permutations, which are a subset of the complete set of partitions that sum to 4. Obviously, this game requires considerable concentration ability.

Seega Game

Game description

The board is drawn up in the sand after digging to a depth of approximately 3 cm. 25 holes distanced about 2 cm from each other and made by the toe finger of the right hand are made, creating 5 rows with 5 holes each, a 5 x 5 array. This is a two-player game, with each having 12 distinctive markers, stones, dry camel dung, or snails. In the modern game the pieces are called *dogs* or *pups*, and hence the other name of the game, appearing only among the Bedouins, "eat the dog". Unlike in Chess, for example, in Seega the pieces are not arranged in two bottom rows on opposite sides of the board with each piece occupying a square next to another piece. Rather, they are scattered across the board. In Seega there is crucial strategic importance for occupying a place on the board for one's pieces before starting the game, which more than occasionally can decide between winning and losing. Each player strives toward a situation where a piece of the other player is caught, sandwiched, between his pieces, allowing him to 'eat' the piece of his opponent, that is, remove it from the board. When he has finished figuratively eating pieces, it is the other player's turn to move with his piece. Stones may be moved only to adjacent open squares, and diagonal moves are not allowed. Usually, at the beginning of the game, some player can be blocked-in and cannot make any moves. Then he is allowed to remove any one of the opponent's pieces to clear a path. This game necessitates planning ahead, situational analysis, and some intuition at each step of moving on the board. The game is intended for adults and older children. Its popularity rises during the month of Muslim Holidays known as Ramadan. This can be a long game, just as chess can be, one that requires using intuition and sophisticated planning abilities.

Game rules

1. For the 5 x 5 hole, each player takes 12 pieces of one color, and the game begins with their placing pieces in the holes, as indicated below.
2. The first player chooses 2 holes and occupies them with 2 pieces of his own. Then the second player puts 2 pieces of his own in two other holes, and so on, until each player has arranged all of his 12 pieces. The center hole must be left empty, as this hole is used to begin the game by player 1.
3. After placing the pieces the game begins. Diagonal movement is not allowed. Player 1 moves one his pieces into the center hole, and then his opponent makes his move. The game is played in turns by moving one's pieces and eliminating those of the opponent. Whenever a player traps his opponent's piece, or pieces, between two of his own, either horizontally or vertically, the trapped piece is removed from play and is said to be "eaten." Some configurations enable trapping of more than one piece at a time.



Figure 4. A sand board for (folklore) Seega game



Figure 5. The modern Seega game

4. The game continues until one of the players loses all his pieces. The winner is the one who has the last piece, or pieces, on the board.

Game objectives in the area of mathematics

1. Finding the center square on the board; and understanding horizontal, vertical, and diagonal directions.
2. Thought development in the form of logical reasoning and thinking ahead.
3. Strategic thinking aimed at optimizing opportunity to “eat” the opponent’s pieces.
4. Development of winning strategies by playing multiple times & reflecting.
5. Communicating their thinking.

DISCUSSION

Undoubtedly, the more students are engaged in the learning process, the more they are joyful and “in the experience”, the more they will be willing to study, to go deeper, and to make an effort to understand concepts and ideas that are difficult. Games are a primary key to experiential learning. They assist in developing creativity and imagination and in turning learning into a challenging experience. Creativity is an important foundation in the students’ intellectual development, so that games can further this development too. As educators we must consider the individual creativity of each child. Thus, when selecting a game, we must make sure that it is suitable for the students’ age and intelligence, in order to achieve a meaningful result for the students.

The children’s social environment and particularly their peers are their greatest source of influence. Most games are social and teach children various social skills such as sharing, waiting in turn, giving and receiving, listening, planning, and arguing. Games can be an incredible force of development for children, allowing them to feel success and failure in friendly social conditions. This strengthens their self-confidence and creates a good foundation for future life.

Learning is a slow, developmental process, with no shortcuts. Therefore we must not expect immediate results. Yet, shaping habits through games help form the person. Learning through experience, slowly and correctly, can shape excellent habits for future learning. Instruction that integrates games from the students’ culture and daily life that contain mathematical values and elements simplify learning for the students, assist in grasping mathematical rules and concepts, and add motivation, desire, joy, curiosity, determination, and creativity. Children make an

effort to think logically in order to find a way to win. Games strengthen students' sense of belonging and makes learning meaningful, easy, and natural. Since all students have their own learning pace, games are suitable for addressing this variance among students. Games increase students' attention and concentration and help develop skills of listening and speaking about mathematical concepts such as length, height, depth, symmetry, and so on.

SUMMARY AND SUGGESTIONS

We view ethnomathematics as a means to improve student mathematical achievements, which in turn will revolutionize their social mobility capabilities. Educators are responsible for the learning process, which includes the development of curricula and learning strategies based on the integration of cultural elements and values, and particularly ethnomathematical games, in math instruction. The use of games from the students' culture and of cultural values and previous knowledge in this endeavor may contribute greatly to the students' learning process, help them better understand the study material, raise their motivation and, ultimately, improve their achievements in math. This process may also contribute to an increase in students' sense of belonging to their immediate environment and their cultural values and traditions. We believe that the ethnomathematical approach can revolutionize the thinking and perspectives of math educators.

On this background, we would like to propose several suggestions to empower learning based on the development and implementation of an ethnomathematical curriculum that integrates cultural games in math education:

1. Planning and organizing curricula for all ages, from elementary school to higher education, that integrates cultural elements and games in the instruction of math.
2. Emphasizing this principle in schools by planning learning units or special books that emphasize the integration of cultural values and games in the learning materials and providing special lessons for supporting and enriching students' cultural knowledge.
3. The level of math in the activity must be relatively low in order to avoid periods of thought that are too lengthy and to guarantee the participation of students of all levels. Teachers must keep in mind that the goal of the activity is usually not to learn material but to exercise and assimilate it, and to boost the students' self-confidence and enjoyment. Obviously, such goals are incompatible with failure.
4. Prioritize the integration of culture in learning materials through the use of technological means such as films, TV, and the internet, which allow a visual, aural, and sensory learning process. In this way students will learn in a simpler manner, which will increase their chances of understanding the material and their desire to learn math.
5. Work must be conducted in relatively small groups. If possible, aides should be appointed and the class divided into study groups that are as small as possible. If the students are relatively mature, they can also be utilized as aides.
6. Before beginning, teachers must make sure that all the students understand the rules of the activity.
7. Teachers must enhance their cultural knowledge and must be trained in multicultural teaching skills. Such a reform in education in general and in math education in particular will increase the chances of improving math education.

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