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The ethnomathematics of the Bedouin society: Integrating socio cultural elements into mathematics education

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Abstract

Our study attempted to address young Bedouin students' persistent difficulties with mathematics by integrating ethnomathematics into a standard curriculum. First, we conducted extensive interviews with 35 Bedouin elders and women to identify: (1) the mathematical elements of their daily lives - particularly traditional units of length and weight; (2) the geometrical shapes in Bedouin women's traditional dress embroidery. Then we combined these with the standard curriculum to make integrated 90-hour 7-8th grade teaching units that were implemented in Bedouin classes. Comparisons between the experimental groups (186) and the control group (62) showed that studying by the integrated curriculum improved the cognitive aspects of the students' learning, such as conceptual understanding, achievements and methods of solution. It also improved the affective aspects, such as self-confidence, motivation and attitudes towards learning in general and specifically towards mathematics.

Keywords: Ethnomathematics, Bedouin society, traditional units of length and weight.

Introduction

The importance of integrating cultural aspects into school mathematics has been advocated by researchers and educators (D'Ambrosio, 2002; Adam et al., 2003). Lipka et al. (2012) found that teaching mathematics through cultural elements changed attitudes towards math, increased mathematical understanding and significantly improved students' test scores. This study addressed students in Bedouin society, that presented low academic achievements in mathematics education at all school levels.

The Bedouins people whom this study focuses on are the indigenous people of the Negev Desert in southern Israel and today they live in small villages and "towns" in the southern Negev desert. Although over the past few decades they have been undergoing a process of transition, shifting from nomads to the life of a semi-modern, they are still keeping their former values, tradition and habits such as animal husbandry, herding and agriculture. This change is influencing their social structure and their culture and economic situation. The social changes have had a bad influence especially on the younger generation. One result is that the Bedouin students exhibit the lowest scores in national tests, as well as low levels of motivation and lack of self-esteem (Ministry of Education, 2013). Integrating ethnomathematics into the classroom has the potential to improve the above and a step to better social justice.

Numerous studies have tried to understand the causes of this phenomenon, attributing low achievement to the students and their environment, to their teachers, the curriculum, or to the remoteness and disconnect between the subject and the students' daily social reality. The latter argue that 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. This argument was supported by the results of our own previous research, which included the development and implementation of an ethnomathematical curriculum among two groups of Bedouin students in Israel (Amit & Abu Qouder, 2017).

In order to improve students' achievements, numerous changes have been made in recent decades in the formal Ministry of Education (2013) mathematics curriculum and attempts have been made to develop new instruction strategies. Nevertheless, it seems that educators in this field continue to encounter many students who exhibit low levels of achievement, low motivation, and difficulties in understanding and grasping the subject matter.

As a native member of Bedouin society and as an educator in the field of mathematics, this issue has interested me greatly. Therefore, based on the potential positive impact shown in the research literature, we decided to take an ethnomathematical approach to improving all aspects of our young Bedouins' mathematics learning experience.

Methodology

Research Aims

The aim of the research was: (a) to reveal ethnomathematical elements in traditional Bedouin society, (b) based on those elements, to develop and implement teaching units that combine the standard curriculum and the Bedouin ethnomathematical elements, and (c) to examine their affective and cognitive effect. To achieve these aims, we posed two questions.

Research questions

1. What are the ethnomathematical elements and the authentic mathematical strategies in Bedouin society in the following areas:
 - a. Measurement of length and weight: authentic Bedouin units.
 - b. Plane geometry and patterns: authentic geometry in Bedouin embroidery.
2. How and to what extent does the implementation of ethnomathematical elements affect:
 - a. Cognitive aspects: comprehension, self-conception, achievements, problem solving strategies.
 - b. Affective aspects: self-confidence, desire to study mathematics and geometry, attitudes toward mathematics and geometry, and attitudes toward school and society

The research procedure was composed of five stages:

1. Identification of mathematical-cultural elements
2. Mathematical analysis of the ethnomathematical elements in Bedouin society
3. Construction of teaching units incorporating ethnomathematics and cultural elements
4. Implementation of the teaching units in schools and in Kidumatica
5. Examination of the effect of implementing the ethnomathematical curriculum on cognitive and affective aspects.

Population and data collection

In order to answer the first question, a research population was selected, consisting of the well-known and prestigious Bedouin Azazmeh Tribe, among whom an extensive search was conducted for concepts and tools expressed in daily life and related to measurement units and Bedouin embroidery. The population that was chosen to answer the first research question was comprised of approximately 35 older Bedouins - elders, sheiks, sons of sheiks and women - from whom data was gathered through videotaped personal interviews and conversations. The analysis of the interviews was qualitative. Videos were looked at again and again, with the aid of two Arab speaking mathematics teachers and one linguistics teacher.

In order to answer the second question, a study sample was selected in which the ethnomathematical curriculum was implemented. The population for question 2 was comprised on 7th- and 8th-grade students in a Bedouin high school, and in the extracurricular program “Kidumatica” for talented students. The total number of participants was 248 (111 boys and 137 girls), of whom 62 were in the control group and 186 in the experimental group. The two groups studied the same subjects and the same number of hours, 90 altogether, with only one difference. The control group learned mathematics according to the official curriculum of the Ministry of Education, while the experimental group learned according to the ethnomathematical curriculum, which incorporates Bedouin cultural values and elements. All the teachers were experienced Bedouin teachers, including the first author of this paper. Data was gathered from teachers’ journals, students’ products during classroom sessions, a tailor-made conceptual test and “ordinary” mathematics examinations. Attitude questionnaires were developed and implemented pre and post the intervention.

Finding ethnomathematical elements

A. Traditional units of length

The interviews yielded more than 35 traditional units of length and weight. These were usually anchored in the tribal Bedouin tradition, and were once part of the Bedouins’ everyday nomadic life. As the examples below show, most of units, but not all, were associated with a specific literal meaning.

1. **Kama:** قامه - Meaning: the height of an average person. Approximately 170 cm. This unit of measurement was used to measure depth, camels and humans.
2. **Shoo :** شوط - meaning: the distance a horse rider can cover at a run in one burst without stopping. This is one of the more common measures today, and was designed for measuring particularly long distances. When we asked how far it was. One interviewee told us that it was the distance between two (ancient) towns – Lod and Ramle – or approximately 18 km.
3. **M’krat ala’sa:** مقرط العصا - meaning: stick throwing distance. This term is one of the most common amongst the Bedouins, especially the older generation. To understand this concept, it is important to clarify the most Bedouins make their living by herding sheep, goats, camels or other animals. The man in charge of the herd would generally hold an 80-150 cm-long stick (Fig 1) with which to direct the flock. The term covers a range of three to four kilometers in the direction indicated by the stick. In fact, it is a vector with a magnitude and a direction.



Figure 1: M'krat ala'sa

B. Traditional units of weight

1. **Kerbh:** قربه - meaning: vessel for carrying water or milk. The kerbh is a vessel made of goatskin for keeping milk in the tent or cooling water. This unit of measurement was used mainly for the sale of milk or its products. One kerbh is equivalent to 30 kg. (Fig 2).



Figure 2: Kerbh

2. **Kooz:** كوز - meaning: a Bedouin drinking vessel.

This is a unit of weight that has gradually faded away, especially as the Bedouin stopped using the Kooz. But it is not yet entirely gone. There are people, like my father, who still believe that the Kooz keeps water better than a refrigerator – keeping it cool but not too cold. As a unit of weight, it was meant for the sale of herbal medicines. Every Kooz is equivalent to 1 kg.



Figure 3: Kooz

3. **K'af:** كف - meaning: Palm

A unit of weight that measures the amount of flour that fits in the palm of the hand. This unit is not accurate, but it gives some indication of the amount of material. The K'af translates into approximately 30 grams.

4. **Wakeh:** وقية - meaning: none

This is the most basic Bedouin unit for weight, and it is still used in many tribes today, measured with a deep plate. Some claim that there are four Wakeh in a kilogram, so that it is worth 250 grams.

An accompanying or alternative concept is: "دبت ايدك" - "D'bt aedk", which means "what fills your hand with flour".

C. Zero and Infinity

The interview revealed two additional concepts of measurement that are not related to length or weight, but to quantities, namely **zero** and **infinity**.

Zero: "عدد نجوم الظهر في عز النهار" - Literal meaning: the number of stars in the middle of a (sunny) day. Another meaning for Zero is: "طول ظلك في الظهر" - Literal meaning: the shadow in the middle of a sunny day.

Infinity: "عدد نجوم السماء بالليل" - Literal meaning: the stars in the sky on a bright night.

Both concepts are embedded in the everyday life of tribes living in the Middle Eastern desert. The stars are an important source of orientation and navigation in the desert, and so they are referenced in relation to both zero and infinity. In the bright desert sun, naturally no stars can be seen, but on a clear, dark night, in contrast, the number of visible stars is vast.

Length units versus weight units -cultural aspects

The general characteristic of the length (distance) and weight units is that they are taken from the everyday life of the tribe and reflect the characteristics of daily living in the desert. In line with the above, there is a major difference between the two types of units: while the weight units are very **accurate**, and in that sense similar to standard units like the kilogram (or pound), with the length and distance units there is relative **inaccuracy** compared to corresponding units like meters and yards.

The explanation given by one elder is "In the desert time is not an issue; we have all the time in the world. Distance and length are not so important, the desert is large. But, every drop of water, every kilo of wheat or rice is critical. And every gram of gold is a lot of money. Therefore, weight must be accurate".

The ethnomathematics integrated teaching units

The experimental teaching units employed in this study address the topic "unit of measurement". And included an exercise for measuring length and weight in both universal "standard" units and traditional Bedouin units identified in stage one. The students in the experimental group learned the universal units (i.e., the metric system) and the traditional units simultaneously. The students experienced the actual use of the two types of units, in the classrooms and at home with their families (Fig 4). An effort was made to integrate the different traditional units in the standard curriculum that was focused on proportional reasoning. Students were asked to find ratios between traditional units, which served to increase both their familiarity with the units and their conversion skills (Fig 5).

الرقم	الموزون	الوزن بالوقيه	الوزن بالكيلو غرام
1	وزن بطيخة كبيرة	16	
2	وزن مربى الصف		60
3	وزن سيارة متوسطة		1000
4	وزن كيس قمح	200	
5	وزن خروف رضيع	40	
6	وزن بللة قش		3000
7	وزن حاسوب شخصي	3	
8	وزن حفنة ذهب		1/4

Figure 4: Conversion between standard and traditional units of weight

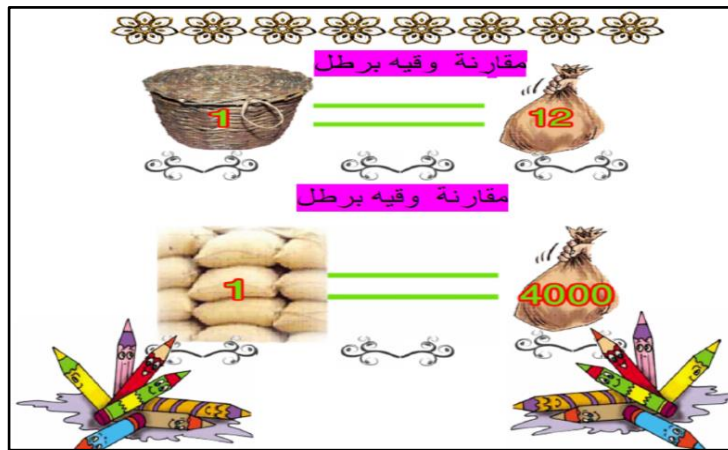


Figure 5: Relation between traditional units of measurement

Findings

The findings of the qualitative and quantitative analysis of the experimental group (186 students) revealed significant differences in most variables between the two administrations. In other words, the values of the variables (comprehension, self-conception, achievements, problem solving strategies, motivation, self-confidence, attitudes toward the subject and the instruction methods, and respect for the school and society), were higher after the implementation of the research program than before it. However, the value of one variable, self-conception, was actually lower after the implementation of the research program. In comparison, the control group (62 students) showed a decrease in variable values from the first administration to the second (Fig 6).

In summary, we can state that the implementation of the ethnomathematical research program among the experimental group positively affected the students' cognitive and affective aspects. In other words, it improved their comprehension, their success and desire to study mathematics, their self-confidence, the acquisition of skills and problem-solving strategies, their attitudes toward the subject and the instruction methods, and their respect for the school and society. The results of the research show that contemporary approaches to the instruction of mathematics, manifested in new curricula, embrace a conceptual understanding of mathematics and emphasize investigation, problem solving, and literacy. The students are expected to construct their own mathematical knowledge, while their

teachers serve as mediators: They ask questions, pose challenging tasks, and help the students think in a deeper way about various mathematical rules, concepts, ideas, and contexts.

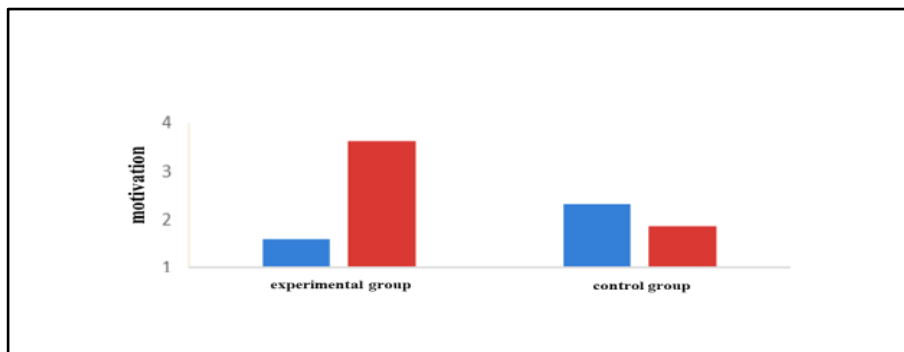


Figure 6: Average motivation dimension

Outcomes and Conclusions

This study arose from the need to find a way to help students from the Bedouin tribes improve their mathematical achievements, motivation and self-confidence, after other attempts to do so failed to produce results. Therefore, based on the potential positive impact shown in the research literature, we decided to take an ethnomathematical approach to improving all aspects of our young Bedouins' mathematics learning experience. These outcomes support the claims of our research to improve the students' achievements and are also consistent with the findings of Lipke et al. (2012), where a significant improvement in national exams was found amongst Yup'ik students who studied ethno-integrated materials. The goal of the research was firstly to identify ethnomathematical elements in the Bedouin society in the Negev, then to construct implement integrated teaching units in Bedouin tribal population. In particular, the research aimed to examine the effect of the above on cognitive aspects (such as comprehension, self-conception, achievements, problem solving strategies) and affective aspects (such as self-confidence, desire to study mathematics and geometry, attitudes toward mathematics, geometry, school, and society).

In summary, our experimental integration of ethnomathematical elements into the teaching unit firstly improved the cognitive aspects of the students' learning, such as conceptual understanding, achievements and methods of solution. Secondly, they improved the affective aspects, such as self-confidence, motivation and attitudes towards learning in general and specifically towards mathematics.

Our study carries several additional benefits. 1. This is the first time that all of these traditional Bedouin units of measurement have been systematically collected and categorized by Bedouin inhabitants, and doing so will help preserve the remnants of a culture that may soon disappear (an issue the discussion of which is beyond the scope of this paper). 2. For the students, discovering that mathematics could be found everywhere all around them - particularly in the desert - was a thrilling experience. 3. They discovered that it was the older members of their tribe, that do not drive cars or use cellular phones, who are nevertheless in possession of all this mathematical knowledge. The teaching units led the students to ask their elders about the mathematics embedded in their culture, to appreciate traditional values and empowered personal and collective self-image of the tribe- a phenomena that had the potential to further improve motivation and strive for success. The impact of the ethnomathematics if the Bedouin schools was much beyond mathematics education per-se.

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