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РОЛЬ ЭТНОМАТЕМАТИКИ В ОБРАЗОВАНИИ И СОХРАНЕНИИ КУЛЬТУРНОГО НАСЛЕДИЯ

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THE ROLE OF ETHNOMATHEMATICS IN EDUCATION AND THE PRESERVATION OF CULTURAL HERITAGE

Introduction

Ethnomathematics is a relatively new field of study that examines mathematical ideas and practices in the context of different cultures. It does not only consider how various ethnic groups perceive and use mathematics in everyday life, but also explores the unique ways of counting and measuring that are characteristic of different cultures. Ethnomathematics is especially important in the context of bilingual education, since it can serve as an example of this pedagogical approach integrating the teaching of mathematics with the use of two languages, typically a student's native language and a second language, often the official one. This approach to studying the subject creates an inclusive educational environment based on the awareness of students' cultural differences, which can increase their interest in mathematics and improve their academic performance. In addition, it helps preserve unique mathematical knowledge and broadens our understanding of mathematics as a universal language taking different forms depending on the cultural context.

As a scientific discipline ethnomathematics originated at the beginning of the 20th century, when the mathematical elements of various cultures were first described in anthropological studies. However, the historical and pedagogical foundations of this field began to form only in the 1970-80s. Professor Dyachkovskaya M.D. identifies three stages of the development of this branch of knowledge [1, c.53].

The ***first stage*** (1967-1984) covers the 1970s, when the new discipline exploring the mathematics of non-Western cultures was born. At that time there was a rejection of racist and colonial prejudices, including Eurocentrism, among math teachers in developing countries. It was emphasized that in addition to "imported school mathematics" there were other forms of mathematical knowledge. In 1973, Claudia Zaslavsky, in her book "Africa Counts: Number and Pattern in African Cultures," introduced the term "sociomathematics of Africa", focusing on the application of mathematics in the life of Africans [1, c. 53].

The ***second stage*** (1985-1990) is characterized by the works of Ubiratan d'Ambrosio, who was the first to consider enthnomathematics as an independent field of study, thus, taking it to a new level [2]. These studies contributed to the growing interest in the field, which was actively discussed at international conferences, including the 6th Inter-American Conference on Mathematics Education (VI CIAEM), held in Guadalajara, Mexico. As a result, an international research team was created, and four key areas of research were identified [1, c. 53-54].

At the beginning of the 2000s, it became possible to systematize the empirical and theoretical material on ethnomathematics accumulated in foreign educational institutions, which contributed to the development of the scientific foundations of the new discipline, thus, highlighting the beginning of the ***third stage***. This period has seen the rapid development and implementation of bilingual ethnomathematical programs in different countries.

In this article, we look into JADENKÄ, an intercultural bilingual math education program for 4-5-year-olds created by the government of Panama and implemented in the Ngäbe-Bugle region with the support from the Inter-American Development Bank and IPA. It is one of the latest successful ethnomathematical programmes to close the attainment gap between indigenous and non-indigenous schoolers.

The performance of Panamanian schoolchildren in mathematics is reported to be below average among Latin American countries. In Panama, indigenous students tend to perform lower than non-indigenous students. In the Ngäbe-Buglé Comarca, 83% of the schoolers scored "very low" or "low" on the 2018 national standardized test, compared with 49% in Panama as a whole. A study conducted in 2019 showed that in Ngäbe-Buglé fewer children attend preschool, and the percentage of school dropouts and repetition is higher than in other provinces [3, c. 16].

The project involved Ngäbe preschoolers living in the Ngäbe-Buglé Comarca, Panama's largest and most populous region. The mathematics of this tribe is very different from traditional mathematics, which is studied as part of the national program of preschool education in Panama. For example, the Ngäbe number system includes many different "roots" that are used in counting depending on the characteristics of the object being counted. It combines linguistic markers with quantifiers classifying the elements being counted (e.g., shape: round, long, flat; arithmetical: multiplication, division, addition; human being, days of the month, money, fruits and vegetables).

The JADENKÄ program was designed for 200 academic hours, 60 minutes each. Developed on the basis of the National Curriculum, therefore, it includes basic geometry, spatial relations, measurement, the ability to use and relate numbers, their basic operations, symbols and forms of expression as well as mathematical reasoning. Among the students in this study, about 73% spoke Spanish and the remainder spoke Ngäbe or both languages, with teachers not speaking Ngäbe. Classes were conducted in two languages - Spanish and children’s native language, Ngäbe.

The creators of the program worked with elders from the Comarka to understand the role of mathematics in Ngäbe culture, and with experts in Ngäbe and mathematics to integrate ethnomathematical ideas into the national mathematics curriculum for Panamanian preschoolers. To provide bilingual education in the classrooms where teachers did not speak Ngäbe, the curriculum included 108 audio lessons recorded in both languages by actors and singers to repeat all key mathematical concepts in both languages.

Each 45-minute audio was to help the teacher deliver the lesson through different activities, radio-theatre, mathematics stories, and songs. The audios were based on an inquiry- and problem-based pedagogical approach where students learnt by working in groups to solve mathematical challenges under teacher guidance and singing and dancing to songs to reinforce different mathematical notions. The last 15 minutes of each class were designed for post-audio activities to reinforce key concepts. Teachers were also instructed to use the audio lesson Monday through Thursday, and to use Friday class time for post-audio activities. They had received an initial two-day training in the use of audio lessons and post-audio activities, which was complemented by coaching visits to support and monitor the implementation [3, 9]. In addition to USB drives with the 108 audio lessons, each classroom was also equipped with a radio, a set of ethnomathematics story books in Ngäbere, a teacher guide, student worksheets, post-audio materials, and simple tangible materials such as counters.

The pilot program described in the article was implemented in 2018 and 2019, in 248 schools and lasted 2 years. In 2018, experimental classes delivered 25 of their planned 108 lessons, while 2019 averaged around 36 lessons. These difficulties were caused by both external factors, such as power outages and flooding, and internal factors, such as varying levels of interest in the program. In control classes (125 schools), mathematics was traditionally taught in Spanish.

A survey was conducted at the beginning and end of each school year to assess the program's impact on student performance (through standardized math tests and a set of Ngäbe math questions), verbal comprehension in Ngäbe and Spanish, and cultural knowledge and identity.

Despite the fact that the JADENKÄ program was not fully implemented, it demonstrated an improvement in the educational results of students, especially in the field of mathematics and ethnomathematics. Students who had gone through that program averaged 0.12-0.18 points higher on standard math tests and 0.23 higher on ethnomathematics compared to students from control groups. The most noticeable effect was reported among Ngäbe students in treatment groups, highlighting the importance of cultural identity and bilingual approach in education. They scored higher on Ngäbe's ethnic cultural identity than the control group, as the elements of their mathematical culture became more widely used in the learning process. Observations showed that in the treatment groups attitudes towards mathematics improved: students solved more complex tasks and actively participated in discussions and games, which contributed to the development of their critical thinking.

In the future, the JADENKÄ program was to be expanded and adapted for other ethnic groups and regions, given the successful experience of working with Ngäbe. This can help improve learning outcomes as well as strengthen students' cultural identities by creating a more inclusive and effective educational environment.

Like JADENKÄ, other ethnomathematics programs confirm their effectiveness as they foster a sustained interest in learning. Studying mathematics through a cultural prism, students of small language groups better master and apply mathematical ideas. In addition, studies confirm that participants in ethnomathematic programs tend to perform well in tests and exams. Finally, such programs contribute to a more inclusive educational environment where the contribution of each student is valued.

The accumulated positive experience of bilingual teaching of mathematics contributes to the growing popularity of such programs. It is obvious that in multinational classes there is an increasing need for teaching mathematics, taking into account the cultural characteristics of representatives of different nationalities. In addition, modern communities strive to strengthen the cultural identity of their peoples, and ethnomathematics plays an important role in this. Many schools and universities are introducing training courses that take into account the ethnocultural characteristics of their students.

Conclusion

However, it is important to note that there is no consensus among leading mathematicians about this direction. Proponents of ethnomathematics believe that teaching mathematics using indigenous languages and cultural elements can be useful in educational institutions where indigenous students experience more difficulties than non-indigenous ones. Teaching practices that take these differences into account can build on informal cultural knowledge acquired before formal education begins, increase students' self-esteem and motivation, affirm cultural heritage and improve the quality of learning by providing a sense of self-efficacy. On the other hand, skeptics warn that using ethnomathematical approaches can be difficult in practice and may limit students' ability to acquire the mathematical knowledge they need outside their local context. However, at present, there are insufficient data on how effective the ethnomathematical approach is in stimulating students' motivation to learn and on the mechanisms by which such an effect can be achieved, therefore ethnomathematics still represents a promising direction in education, contributing to a deeper understanding and involvement of students in the study of mathematics.

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