Enculturation with Ethnomathematical Microprojects: From Culture to Mathematics

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Abstract

Ethnomathematics is a research program that focuses on the relationships between mathematics and culture. What impact does this vision have on mathematics education? We approach this question from two points of view that require: 1) some substantial methodological changes and 2) some changes on how to approach the content. We wish to focus here on teachers training in primary education in Argentina. We present a way to integrate methodology and content: the Microproject and we report an experience with Argentinian pre-service teachers.

Key Words: Ethnomathematics; teachers training; teaching project; sociocultural perspective.

Resumen

La Etnomatemática es un programa de investigación que se centra en las relaciones que se establecen entre la matemática y la cultura. ¿Qué repercusiones tiene esta visión en la educación matemática? Abordamos esta pregunta desde dos puntos de vista que demandan: 1) unos cambios metodológicos sustanciales y 2) unos cambios respecto a cómo abordar el contenido. En particular nos ceñimos la Formación de Maestros de Educación Primaria in Argentina. Presentamos una manera de integrar metodología y contenido: el Microproyecto y relatamos una experiencia con futuros profesores argentinos.

Palabras Clave: Etnomatemáticas, formación docente, proyecto de aprendizaje, perspectiva sociocultural.

Ethnomathematics and Education

This work is part of a research project on Ethnomathematics dealing with its anthropological and educational aspects. In particular we wish to focus here on one of the greatest challenges that Ethnomathematics has posed in recent years: its role in education (Gavarrete, 2013) and specifically, in teachers training in primary education in Argentina.

Ethnomathematics is a research program that focuses on the relationships between mathematics and culture. The central idea is that mathematics is the product of a socio-historical and cultural process that has been developed with contributions from various societies and cultures, and has given rise to what we now understand in the school context as mathematics. In particular, this mathematics is the result of one of the possible evolutions of this system of knowledge (D'Ambrosio, 2008). However, there are other alternatives which can present with this system some similarities and differences. These other Ethnomathematics -- and we add *ethno* to emphasize their sociocultural origins -- are found in different societies with different cultures, certain guild or craft practices, and in everyday life.

What impact does this vision have on mathematics education? We approach this question from two points of view that require: 1) some substantial methodological changes and 2) some changes on how to approach the content.

Methodology of Ethnomathematics Enculturation

The ethnomathematical perspective promotes the development of new educational methodologies based on experiences that enable: adjust instructional contents and patterns to the interests and learning styles of students, integrate work with diverse cultural groups that hold different views of mathematics, addressing the variety of contents, thoughts and mathematical contributions and therefore the relationship between mathematics and culture (Shirley, 1998, 2001; Gavarrete and Oliveras, 2012).

These methodologies take the concept of enculturation as reference (Bishop, 1999; Gavarrete, 2012). The word *enculturate*, from its etymology, means within the culture. The process of enculturation may be associated with entering a culture or 'to take root in a culture' (Gavarrete, 2012, p. 96). It is a form of education in which a process of instruction is not understood as passive transmission of knowledge by an expert; rather enculturation is a way of learning that involves direct experience and research: the student experiences mathematical attitudes, contact and participation in mathematical inquiry (D'Ambrosio, 1988; Oliveras, 1996). We proposed to carry out a research project on aspects of the students' own cultural background, with the aim of developing mathematical ideas from it (Presmeg, 1998; Gavarrete, 2012; Oliveras and Gavarrete, 2012). During fieldwork the student learns the importance of socio-cultural factors for learning, such as the context, interpersonal relationships and motivation; the diversity of the construction processes of mathematical ideas is experienced: imitation, trial and error or guidance of an expert (Gerdes, 1998). Construction of knowledge is achieved through consensus and sharing experiences with active work in small groups and using examples of intercultural, ethnomathematical and anthropological educational literature as sources of exemplification and reflection (Presmeg, 1998; Oliveras; 2006; Aroca, 2010). The teacher as enculturator guides and proposes with flexibility (Oliveras, 1996).

Ethnomathematical Content: Cultural Sign

How to enculturate in mathematics starting from culture?

We consider culture as a network of meanings constructed by humans and through which we look at the world (Geertz, quoted in Oliveras, 1996).

The atomic model of Huxley (quoted in Albanese, 2011) states that the manifestations of culture are specified in: 1) *Mentifacts*: abstract and mental elements, which are the most durable aspects of a culture: the language, the myths, the artistic traditions and folklore and the like. They relate to the human ability to think and formulate ideas, and shape the ideals and images by which other cultural aspects are measured, 2) *Sociofacts* are those aspects of a culture that relate to links between individuals (family structures) and groups (political and educational systems); 3) *Artifacts* are the physical manifestations of the culture.

We regard as a *cultural sign* any element of the former that is characteristic and identifies a culture. We propose a new way of approaching the content starting from a cultural sign that is chosen as appropriate for its mathematical potential. The cultural sign is studied from two perspectives, *emic* and *etic* (Rosa and Orey, 2012). The *emic* perspective is that of the culture in which the sign is developed, used or constructed; it is the mathematical way of thinking of the sign from the point of view of the people who experience it in their profession or in daily life. The *etic* perspective is from the standpoint of the observer's culture, particularly here, the view from school mathematics. The ethnomathematical perspective involves integrating these two perspectives in order to find relationships, whether of similarity or difference, between the various systems of mathematical knowledge.

Integrated Methodology and Content: Microprojects

How to achieve mathematical enculturation from a cultural sign?

To achieve a process of enculturation from an ethnomathematical perspective, Bishop (1999) proposed creating projects and Oliveras (1996, 2005) ethnomathematical microprojects that link mathematics with cultural knowledge. The work through integrated and collaborative microprojects (Figure 1), based on Ethnomathematics, draws together the knowledge around a cultural sign (an element of culture) with mathematical potentialities that must be explored previously by the teacher. In this way, future teachers' cultural mathematical knowledge is strengthened, but so is their cultural identity and critical sense of teaching (Gavarrete, 2012).

STAGE 1

Phase 1. **Choosing the cultural sign**:

a. Title and characterization of the cultural sign to be investigated

b. Issues of interest for mathematics: explanation of aspects to be investigated.

c. Importance of the sign: the justification of the choice of sign, its cultural and social role, its mathematical potential and personal motivation.

Phase 2. **'Ethnographic' research of the sign (consulting an expert):**

a. Describing an object or activity that is representative (finished work or product) for the culture. Detailing the stages in the making of the cultural sign: describing the steps or procedures used by the craftsperson to produce that object chosen as a sign or to practice the chosen activity. Very detailed observations is needed of the making process (work in progress), writing down all the steps performed by the expert (for example the design of the object is made or the sequences of actions in the activity), and all oral and written explanations that the expert provides (work explained).

b. Considering other relevant factors such as, for an object, the preparation and properties of the necessary materials, the calculation of the amount of materials needed, what tools or techniques (for example, counting or measuring) are used, the economic aspects of marketing (how to set the prices, production ...) and social use of the object. For en activity, the numbers of people involved, their organization, their movements.

c. Describing the *instruments of data collecting*, explaining who was asked and about what, recording procedures and actions that are observed, noting the researcher's own reflections that emerged during the observation.

At each stage of production or action and factor of interest, indicating the mathematical aspects present, *respecting* the presentation and language of the expert (emic perspective).

Phase 3. **'Thawing' the implicit mathematical knowledge:** analyzing the data collected describing the mathematics involved in the development or use of the cultural sign. Usually the mathematics are implicit and "we must make clear what is invisible to the eye", that is highlight what mathematical knowledge is involved in the cultural sign under research. This analysis will be performed in each of the phases of production, in the sequence that they occur in reality, as well as the relevant factors, and writing down the mathematical content, properties or relationships found (integrating the etic and emic perspective)

STAGE 2

Phase 4. **Reflection on the process of enculturation experienced**.

a. Setting out what has been learnt about the epistemology of mathematics and methodology of enculturation.

b. Designing activities to be used in a class about the mathematics of the cultural sign.

Figure 1. Script for carrying out an ethnomathematical microproject.

To determine the structure of an ethnomathematical microproject, we consider the contributions of Oliveras (1995, 1996, 2005), Gavarrete (2012), Oliveras and Albanese (2011) and Martinez (2012). An ethnomathematical microproject consists of two stages, with Stage 1 further divided into phases (Figure 1).

1) The first stage is made up of ethnographic research about the cultural sign that includes the justification of choice, an ethnographic approach to a deep knowledge of the sign and a subsequent analysis of its mathematical potentiality.

In these last two phases it is important to distinguish clearly between the two perspectives addressed, the *emic* and the *etic* one (Rosa and Orey, 2012). The *emic* perspective is assumed in the ethnographic research phase. The etic perspective is integrated with the former in the prior analysis of the mathematical potentialities of the cultural sign. The aim of this stage is to bring to light the relationships of similarity and difference between the two visions.

2) From the results of the relationship between *ethnomathematics* found above, in the second stage the idea is to identify an aspect of the cultural sign around which a potential classroom activity that future teachers can do with children is proposed.

Report of an Argentinean Experience

The Argentinean National Education Act of 2006 promotes active teaching methodologies in which students participate directly in their own learning, exploring the environment in order to understand it through modelling and the development of creative and critical attitudes. Furthermore, the Act promotes the recovery of culture as a source of significant learning (Albanese, Oliveras and Perales, 2012).

The experience we report here refers to a course that took place in June 2013 in a tertiary institute for the training of primary school teachers in the city of Presidencia Roque Saénz Peña (Chaco Province, Argentina). A total of 61 pre-service teachers in their fourth and final year of training participated in the course.

The sign chosen around which the Microprojects and sessions were developed was an Argentinean folk dance, the *chacarera* (Figure 2). Earlier ethnomathematical research had revealed the potential of this cultural sign for school learning. Sardella's (2004) work analyzed the choreography of different Argentinean folk dances, bringing to light the geometric shapes that govern these movements.

The innovative goal of the course was to find out if working on ethnomathematical Microprojects could strengthen the prospective teachers' mathematical knowledge and consolidate their abilities to relate school mathematics with specific cultural *ethnomathematical* contexts.

The course consisted of three sessions: the first was devoted to discovering the pre-service teachers' previous ideas about Ethnomathematics, to handle the notions of cultural sign and Microproject and to establish the working groups, and to Phase 1 of this (Figure 1) beginning with the choice of a folk dance for each group. The second session was devoted to Phase 3 of the Microproject starting from the ethnographic research (Phase 2) that pre-service teachers brought as a homework task; the third session was devoted to the pre-service teachers' presentation of Phase 4.

Now we present two results that come from educational ethnography that we have done over the sessions (Woods, 2001) concerning the chacarera dance, a dance in couples where the dancers do not touch:

- ✓ about the circumference: pre-service teachers proposed that from an *etic* perspective – that of school mathematics¬- the circumference is defined as *all points equidistant from a center* and they recognized, however, that from the *emic* perspective of the folklore dancer, the circumference that represents the movement of the turn and rotation of the choreography (Figure 1) is not conceived as equidistant from the center but as a regular polygon that *tends to have no angles*.
- ✓ about the distinction between square and rhombus: the pre-service teachers, from the *etic* perspective of the school mathematics, identified the substantial difference

between these two quadrilaterals in the angles, all equal and right angles in the square, with only the two opposite ones the same - two acute and two obtuse – in the rhombus. Meanwhile, from the *emic* perspective of the dancer, they identified the substantial difference in the diagonals, the same in the square, different in the rhombus. because the *advance and retreat* movement (Figure 1) of the choreography represented by the rhombus involves a direction (a diagonal) that dominates over the other because it is greater.

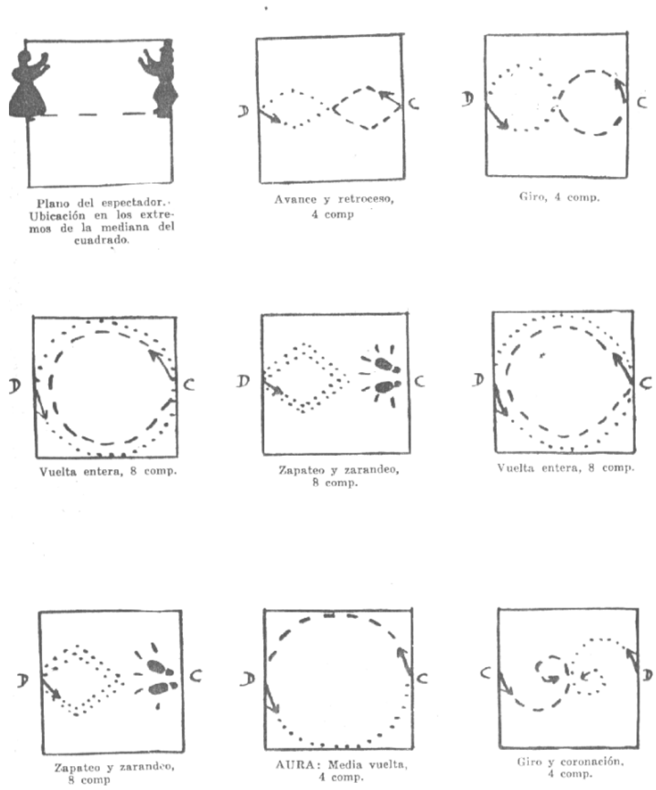

Figure 2. Chacarera choreography taken from two of the micro-projects of future teachers. Key: D (Dama) is Lady; C (Caballero) is Gentleman. L to R, starting with the top row: 1) Spectator's view—Dancers poised at edges of the square. 2) D and C advance to meet in middle of the square and then retreat back to the edges; 4 bars. 3) Dancers move in a circle within the square in opposite directions; 4 bars. 4) Dancers turn in a complete circle within the square in opposite directions; 8 bars. 5) G stamps his feet and L swirls her skirt; 8 bars. 6) Dancers turn in a complete circle within the square in opposite directions; 8 bars. 7) G stamps his feet and L swirls her skirt; 8 bars. 8) Dancers hold their arms above their heads and turn a half circle; 4 bars. 9) The dancers twist round and finally meet in the middle; 4 bars.

Final Reflections

We emphasize that in this work the key idea has been to seek bridges between school mathematics and the mathematics of everyday life (Carraher, Carraher and Schliemann, 1995; Rosa and Orey, 2013). We have to keep in mind that these bridges can sometimes be forced, in the same way that a translation can be forced between two different languages. But the purpose of

Ethnomathematics, analogous to interpretation, is to bring the contexts closer together to find meeting points of mutual understanding, respecting the vision of each one.

We believe this work is innovative in focussing the use of ethnomathematical Microprojects as a helpful tool for prospective teachers to promote the understanding of school mathematics by adopting a multiple gaze- *etic* and *emic* perspectives - in relation to the contexts.

The highly motivating component of research and working in small groups observed in the attitude of prospective teachers is worth noting. Although not the direct object of analysis, we observed some negative initial attitudes (fears) about mathematics and a lack of confidence in their own mathematical knowledge. Carrying out the Microprojects and experiencing the enculturation of those who took part in them fostered in the prospective teachers an active quest to return to delve more deeply into this mathematical knowledge in which they felt unsure; moreover, it created a climate of trust that allowed them to ask about issues that during sessions of “traditional" classes they would not have dared to raise (according to their own accounts).

Moreover, we believe in the potential of working with ethnomathematical Microprojects about other signs of cultural identity. We think that, to begin with, the curriculum of primary education may be the most accessible to work with, but we do not exclude the possibility of proposing such work with prospective teachers of other educational levels and involving other curriculum subjects (for example, natural sciences and physics). In any event, we want to stress the importance of working with cultural signs that are close to the community of the school where it is proposed, possibly from the local culture or from minorities who are present in the territory.

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