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The interdisciplinarity of ethnomathematics: challenges of ethnomathematics to mathematics and its education

La interdisciplinariedad de las etnomatemáticas: desafíos de las etnomatemáticas a la matemática y su educación

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Abstract

Since the creation of the International Study Group on Ethnomathematics, several researchers have debated on how could or should a theory of ethnomathematics exist, and, if so, how it is to be conceptualized. So far, there exists no consensus on how this theory should be defined.
During the last International Conference on Ethnomathematics (ICEm-4) in Towson, Maryland (July, 2010), Rik Pinxten emphasized on the necessity of reopening this debate. Ethnomathematics will only be acknowledged by other scientific communities if we, as ethnomathematicians, are able to establish a proper conceptualization of this field of study.
This article aims to at least one possible approach to a conceptualization of a theory of ethnomathematics. As we will show, this theory needs to be regarded as an interdisciplinary discipline that covers theories from both the exact and social sciences.

Key words: Ethnomathematics; Interdisciplinarity; Ethnography; Ethnology; Universalism.

Resumen

Desde la creación del Grupo Internacional de Estudios Etnomatemáticos, diversos investigadores han debatido sobre cómo podría o debería existir la teoría de las Etnomatemáticas y si ese es el caso, sobre cómo debería ser conceptualizada. Hasta este momento no existe consenso sobre cómo debería ser definida esta teoría.
Durante la conferencia internacional de Etnomatemáticas (ICEm-4) en Towson, Maryland (julio, 2010), Rik Pinxten enfatizó en la necesidad de reabrir este debate. Las Etnomatemáticas solo podrán ser reconocidas por otras comunidades científicas solo si, como Etnomatemáticos, se es posible establecer una conceptualización apropiada para este campo de estudio.
Este artículo tiene como objetivo dar al menos una aproximación sobre la conceptualización de una teoría de la Etnomatemáticas. Como se verá, esta teoría tiene que ser considerada como una disciplina interdisciplinaria que abarca las teorías de las ciencias exactas y sociales.

Palabras claves: Etnomatemática; Interdisciplinariedad; Etnografía; Etnología; Universalismo.

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INTRODUCTION

A recurrent issue in the ethnomathematics movement has been the debate regarding the existence of a theory of ethnomathematics, whether such a theory could or should exist and, if so, how it is to be achieved. In the first newsletter of the ISGEm (International Study Group on Ethnomathematics), D'Ambrosio posed the question "how theoretical can [ethnomathematics] be?" (ISGEm-Newsletter, 1985-2003, 1(1)). In 1988, a meeting of the ISGEm was held by Gloria Gilmer in the Sixth International Conference on Mathematics Education (ICME-6, Hungary) in which the conceptual and theoretical foundations of ethnomathematics appeared as one of the thrusts of ISGEm (ISGEm-Newsletter, 1985-2003, 4(1)). During the second ICEm (International Conference on Ethnomathematics), in 2002, there was a roundtable dedicated to debating the conception and theorization issues in ethnomathematics: Alangui and Barton (2002) addressed the methodological questions for considering it a valid field of research and Domite (2002) explored the issue "theory of ethnomathematics?"

Recently, Pais (2011) presented several contradictions that are present in ethnomathematics, and due to the lack of consensus in a proper conceptualization and theorization of ethnomathematics. He has showed that "educational proposals raised by ethnomathematics research are not consensual even among ethnomathematicians." (Pais, 2011). Claiming that curricular changes in mathematics are very strict, Pais suggested that the insertion of ethnomathematics in school may not result as a valorization of different cultures among students.

In order to deal with the issues presented by Pais (2011), we need also to deal with the challenges ethnomathematics presents to mathematics. Moreover, the relation between mathematics education and mathematics has to be understood as complementary, i.e., the view that mathematics education grows by receiving contributions from mathematics is denied (Schubring, 2011). The intention of this paper is to propose at least one possible approach to a conceptualization of a theory of ethnomathematics.

THEORETICAL APPROACHES TO ETHNOMATHEMATICS

The question on how theoretical ethnomathematics is has been discussed since the creation of the ISGEm, in 1985. Clearly, ethnomathematics is a practice oriented field of study and it raises doubts, and sometimes mistrusts, among the "exact" scientific communities. The exact

sciences may question the validity of the different methods and methodologies that ethnomathematics uses to undertake research: they claim that these methodologies correspond to social scientific disciplines.

Nonetheless, Sebastiani Ferreira and Gerdes have already aimed to establishing an appropriate theory of ethnomathematics. Sebastiani (1991) was able to assert the existence of a paradigm to ethnomathematics, this being the paramount condition for the acknowledgment as a Kuhnian theory, even so he denied that ethnomathematics has achieved the status of theory. This seems to be related with his identification of ethnomathematics as belonging exclusively to mathematics education. Sebastiani's approach is nonetheless consistent with Kuhn's conceptions since Kuhn admits that paradigms can and do exist prior to theories (Masterman, 1970).

Gerdes, on the other hand, has clearly affirmed that ethnomathematics is a well defined field of study, based primarily on the above mentioned definition, but, moreover, concretizing it in the following way: "this research area is aware of the existence of many mathematics, which are in a certain way specific for definite (sub-)cultures." (Gerdes, 1997)

ETHNOMATHEMATICS AS A KUHNIAN THEORY

Kuhn's theory of scientific development is relevant to this study from two points of view: firstly, for the issue of achieving the theoretical status of ethnomathematics and secondly, for discussing the relation of ethnomathematics to mathematics. Rohrer (2010) has already outlined that the notion of conceptual change became relevant for historical, epistemological and sociological studies in science. Kuhn's seminal book "The Structure of Scientific Revolutions" (1962), which paved the way for such studies, can be understood as expressing the cognitive turn in history of science (Nersessian, 2003). Within the framework of this conceptualization, the "mathematics" and "science" knowledge evidenced in *Naturvölker* or "primitive people" constitute not only elements of curiosity, cataloged as ethnology, but contributions to ethnoscience, and in our case to ethnomathematics; they are elements of science, and hence of mathematics, too. The status of the relation between ethnomathematics and mathematics presents a revealing challenge for the self-understanding of mathematics; this issue has been further discussed by Rohrer and Schubring (2011).

Sebastiani (1991) has discussed whether the development of ethnomathematics can be understood in terms of Kuhn's conceptualization. According to Sebastiani, ethnomathematical research can be seen under different points of view: as part of ethnoscience, as a research area within the history of mathematics, and as the development of an educational theory (Sebastiani, 1991).

While opting exclusively for the third approach, envisioning ethnomathematics as an educational theory, Sebastiani asks for the paradigm of this science. Agreeing with the three meanings of paradigm elaborated by Masterman (1970) and assuming that they are by no means mutually exclusive, he affirmed that ethnomathematics has succeeded in achieving a paradigm. He claimed it to be what Gerdes had stated as one of the research aims: to reveal and to analyze the influences of socio-cultural factors on the teaching, learning and development of mathematics (Sebastiani, 1991).

Although Sebastiani (1991) ethnomathematics has achieved the status of theory, it is possible to determine more indicators in Kuhn's conception, which can be used to determine the state of development of ethnomathematics.

The first of these indicators is the existence of a pre-paradigm period. In fact, we have seen that, since the first half of the twentieth century, several scholars developed ethnological research on mathematical practices and were working as isolated individuals and unable to communicate with each other. It was during this period that the term "ethnomathematics" had already been established as we were able to show (see Rohrer and Schubring, 2011). This preparadigmatic stage lasted until about the 1960s.

After this period, more intense and differentiated research work was initiated, resulting in the emergence of communication that could establish networks. This is due in large part to the ethnomathematics movement, which created a scientific community of researchers and teachers of the discipline, and continues to provide extensive modes of publishing. Ethnomathematics constitutes a discipline with a strong practice-oriented theory. Ethnomathematics has several fields of application, just like other typical scientific disciplines. Besides the canonical way of academic teaching, it is applied directly in education, such as the teaching of mathematics in schools. In particular, the application of ethnomathematics has focused on decolonized countries and those countries with significant ethnic minorities where

ethnomathematics has proved to make the learning more meaningful. Other applications are in history of mathematics, in epistemology and in sociology.

ETHNOMATHEMATICS AND INTERDISCIPLINARITY

Heckhausen has studied different approaches and concepts of interdisciplinarity. For this, he has defined disciplinarity to be "the specialized scientific exploration of a given homogeneous subject matter producing new knowledge and making obsolete old knowledge." (Heckhausen, 1972) He furthermore established seven criteria to determine the nature of a discipline. These are: material field (the set of study objects of each discipline), subject matter (the circumscribed subset of observables of a material field), level of theoretical integration, methods, analytical tools, applications of a discipline in fields of practice, and historical contingencies (Heckhausen, 1972).

By having these criteria that characterize disciplines, Heckhausen distinguished six types of interdisciplinarity, ordered according to its maturity: *indiscriminate interdisciplinarity*, consisting of all encyclopedic endeavors, *pseudo-interdisciplinarity*, consisting of disciplines which share the same analytical tools, *auxiliary interdisciplinarity*, consisting of one discipline borrowing the methods from another, *composite interdisciplinarity*, consisting of quite diverse disciplines which seek to solve historical contingencies, *supplementary interdisciplinarity*, consisting of disciplines which partially overlap creating a supplementary relationship, and *unifying interdisciplinarity*, consisting of those disciplines which have an increased consistency in their subject matter as well as in their theoretical integration levels (Heckhausen, 1972).

Within this framework, we propose ethnomathematics as being supplementary interdisciplinary. Supplementary interdisciplinarity consists of accounting for disciplines such that they partially overlap, creating a supplementary relationship between the common subject matters. This is achieved by establishing a correspondence between the levels of theoretical integration of these subject matters, which will have category gaps, *i. e.*, some theories cannot be related and need to be tolerated. "The correspondence is looked for and tentatively established in order to reconstruct life or social processes more fully." (Heckhausen, 1972)

We suggest that ethnomathematics has not yet achieved a mature scientific level and, hence, cannot be regarded as a normal science, in Kuhnian terms. Ethnomathematics needs to attain a

theoretical interdisciplinary level, since we will then be able to claim that its "research synthesizes or contrasts concepts, models or theories from more than one field in order to develop new theoretical tools fro interdisciplinary analysis. The function of integration is to create generic links between fields, inhabit a new territory of knowledge, or establish a new paradigm of inquiry." (Huutoniemi *et al.*, 2010, p. 84)

An interdisciplinary approach has already been considered by Falsirol (1959) and Gerdes (2007). In the first case, Falsirol characterized Fettweis' research and scientific interests as the intersection of ethnology and mathematics, thus producing ethnomathematics (Falsirol, 1959). Gerdes has defined ethnomathematics as "the cultural anthropology of mathematics and mathematics education." (Gerdes, 2007) It is possible to understand this initial approach in terms of a composite interdisciplinarity, *i. e.*, these two disciplines borrow theoretical concepts from each other (Huutoniemi *et al.*, 2010).

Within a more specific approach, ethnomathematics is represented by the intersection between, on the one hand, mathematics, history and historiography of mathematics and mathematics education and, on the other hand, cultural anthropology, ethnology, ethnoscience and ethnography, as showed in Fig. 1. The ethnomathematical studies presented in Rohrer (2010) have proved to require, up to a certain extent, all these disciplines; it is not possible, nor plausible, to consider them as being part of a greater "discipline-set."

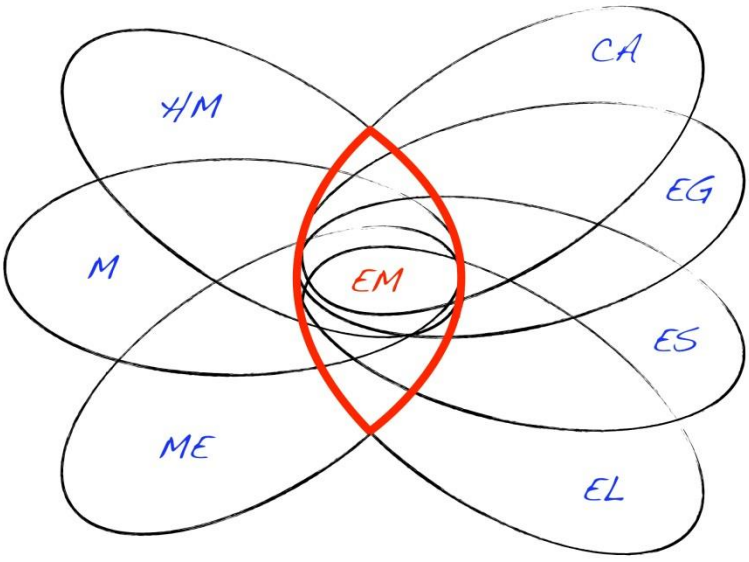

Figure 1: Ethnomathematics as supplementary interdisciplinary

As a consequence, we do not think that ethnomathematics should be regarded as a discipline within mathematics education. Ethnomathematics attempts to find and determine which cultural traditions could be included in different curricula all over the world. In this sense, it partially overlaps with mathematics education, but is still a field of research in itself.

Furthermore, ethnomathematics seeks to revive mathematics living in different traditions and cultures, not by considering them to be exotic, but by including them in the new historiography of mathematics. And, it aims at challenging the universality of mathematics, which will be presented in the next section.

CHALLENGES OF ETHNOMATHEMATICS TO MATHEMATICS

The relation of ethnomathematics to mathematics has so far constituted controversial issues. According to traditional ethnology, the mathematical knowledge of the so-called primitive peoples was usually considered to be rather elementary and did not bear any relevance for present-day mathematics. On the other hand, some proponents of ethnomathematics propagate a likewise extreme separation nowadays: denouncing present-day highly-developed mathematics as Western mathematics and denouncing its valorization as eurocentrism, they claim a higher value for ethnomathematical knowledge, at least in curricular applications. Such separation and, moreover, rejection was already inherent in D'Ambrosio's reflections on ethnomathematics: he understood ethnomathematics as encompassing all mathematical ideas that are not exposed by the "mainstream" (in his words, American or European) mathematics (D'Ambrosio, 1985, 1989).

As shown by Rohrer and Schubring (2011), Fettweis had rejected the traditional notion of cognitive inferiority of the *Naturvölker* and had rather attributed to them cognitive abilities analogous to the so-called "civilized" peoples. By considering as a starting point his assertion of humankind taken as a categorical unity, one is led to the assumption of having mathematics as the union of numerous, at least culturally different mathematics. The so-called Western mathematics would be just one among many other forms of mathematics; it could no longer be distinguished as having traditional priority. And these facts immediately open up questions on whether and how would it be possible to claim universality and an objectivity of mathematics.

Schubring (2011) has proposed a notion of relative objectivity and universality of mathematics, based on the notions of constructivism:

> It is not only in learning that meanings of concepts are subject to negotiation processes, so that differences in meanings established by various groups might disappear as the result of interactions when these groups get into communication and achieved shared meanings; in science, too, a common understanding will at first be restricted to social communities, which are tied together by certain conditions to form a basic unit of communication, say by sharing a common culture and language. Let me call this basic unit a scientific community of first order. In general, one can assume that these first order communities will share, too, a certain epistemological view of their subject. While there might co-exist different epistemological and conceptual views of mathematics in separate mathematical communities, there should begin processes of interaction at the moment when such separate communities come into contact with each other. Consequently, either the values and conceptions remain mutually alien so that – if there are no other pressures for establishing shared conceptions – the communities will continue to be separated, or a negotiation concerning the differences will begin with the effect of either certain compromises between the two sides or of the domination of one side by the other. (Schubring, 2011, p. 97)

We would like to apply these conceptions to the case of ethnomathematics and its relation to mathematics. The various kinds of mathematics developed according to definite cultural and/or national contexts constitute a "worldmathematics"[3] and, once an effective communication has been established, also a relatively universal and objective mathematics. It is ethnomathematics, taken as a partial overlap with mathematics, which constitutes a challenge for this mathematics to be conscious and aware of its culturally defined elements.

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[3] Gerdes (1989) has defined "worldmathematics" as the union of all ethnomathematics.

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