THE ROLE OF ETHNOMATHEMATICS WITHIN MATHEMATICS EDUCATION

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Abstract

This paper considers the field of enquiry called ethnomathematics and its role within mathematics education. We elaborate on the shifted meaning of 'ethnomathematics'. This "enriched meaning" impacts on the philosophy of math education. Currently, the concept is no longer reserved for 'nonliterate' people, but also includes diverse mathematical practices within western classrooms. Consequently, maths teachers are challenged to handle people's cultural diversity occurring within every classroom setting. Ethnomathematics has clearly gained a prominent role, within Western curricula, becoming meaningful in the exploration of various aspects of mathematical literacy. We discuss this enriched meaning of ethnomathematics as an alternative, implicit philosophy of school mathematical practices.

Key-words: Ethnomathematics, Diversity, Politics, Philosophy, Values.

INTRODUCTION

Until the early 1980s, the notion 'ethnomathematics' was reserved for the mathematical practices of 'nonliterate' – formerly labeled as 'primitive' – peoples (Ascher & Ascher, 1997). What was needed was a detailed analysis of the sophisticated mathematical ideas within ethnomathematics, which it was claimed were related to and as complex as those of modern, 'Western' mathematics. D'Ambrosio (1997), who became the "intellectual father" of the ethnomathematics program proposed "a broader concept of 'ethno', to include all culturally identifiable groups with their jargons, codes, symbols, myths, and even specific ways of reasoning and inferring". Currently, as a result of this change within the ethnomathematics discipline, scientists collect empirical data about the mathematical practices of culturally differentiated groups, literate or not. The label 'ethno' should thus no longer be understood as referring to the exotic or as being connected with race. This changed and enriched meaning of the concept 'ethnomathematics' has had its impact on the philosophy of mathematics education. From now on, ethnomathematics became meaningful in every classroom since multicultural classroom settings are generalized all over the world. Every classroom nowadays is characterized by (ethnical, linguistic, gender, social, cultural …) diversity. Teachers in general but also math teachers have to deal with the existing cultural diversity since mathematics is defined as human and cultural knowledge as any other field of

knowledge (Bishop 2002). The shifted meaning of ethnomathematics into a broader concept of cultural diversity became meaningful within the community of researchers working on the topic of ethnomathematics, multicultural education and cultural diversity. Where the topic was absent at the first two conferences of the Conference of European Research in Mathematics Education (CERME 1, 1998; CERME 2, 2001), the topic appeared at CERME 3 (2003) as *Teaching and learning mathematics in multicultural classrooms*. At CERME 4 (2005) and CERME 5 (2007) the working group was called *Mathematics education in multicultural settings*. At CERME 6 (2009) the working group was called *Cultural diversity and mathematics education.* From now on, there is an explicit consideration to the notion of cultural diversity.

DEALING WITH CULTURAL DIVERSITY IN THE CLASSROOM

Ethnomathematics applied in education had a Brazilian origin, but it eventually became common practice all over the world. It has been extended from an exotic interpretation to a way of intercultural learning that is applicable within any learning context. Dealing with cultural diversity in the classroom is the universal context within which each specific context has its place.

The meaning of the *ethno* concept has been extended throughout its evolution. It has been viewed as an ethnical group, a national group, a racial group, a professional group, a group with a philosophical or ideological basis, a socio-cultural group and a group that is based on gender or sexual identity (Powell 2002, p.19). This list could still be completed but since lists will always be deficient, all the more because some distinctions are relevant only in a specific context, we use the all-embracing concept of *cultural diversity*. With respect to the field of mathematics, and in line with Bishop's (2002) consideration on mathematics as human and cultural knowledge, there appears to be a change in the meaning of ethnomathematics as diversity within mathematics and within mathematical practices. This view enables us to see the comparative culture studies regarding mathematics that describe the different mathematical practices, not only as revealing the diversity of mathematical practices but also to emphasize the complexity of each system. In addition there is interest in the way that these mathematical practices arise and how they are used in the everyday life of people who live and survive within a well-defined socio-cultural and historical context. Consequently there has to be a translation of this study to mathematics education where the teacher is challenged to introduce the cultural diversity of pupil's mathematical practices in the curriculum since pupils also use mathematical practices in their everyday life.

This application exceeds the mere introduction in class of the study of new cultures or – to put it dynamically – new culture fields (Pinxten 1994, p.14). These are the first 'ethno mathematical' moves that were made, even before dealing with cultural diversity arose. Diversity within mathematical practices was considered as a practise of the 'other', the 'exotic'. It was not considered relevant to mathematics pupils from a westernised culture. That is why the examples regarding mathematics (and adjacent sciences) are an enquiry of all kinds of exotic traditions such as sand drawings from

Africa, music from Brazil, games such as Patience the way it is played in Madagascar, the arithmetic system of the Incas or the Egyptians, the weaving of baskets or carpets, the Mayan calendar, the production of dyes out of natural substances, drinking tea and keeping tea warm in China, water collection in the Kalahari desert, the construction of Indian arrows, terrace cultivation in China, the baking of clay bricks in Africa, the construction of African houses. The examples are endless (Bazin & Tamez 2002). Notwithstanding the good intentions of these and similar projects, referring to Powell & Frankenstein (1997) we would like to emphasize that these initiatives may well turn into some kind of folklore while originally intending to offer intercultural education.

> However, we also stress that we are not advocating the curricular use of other people's ethnomathematical knowledge in a simplistic way, as a kind of "folkloristic" five-minute introduction to the "real" mathematics lessons. (Powell & Frankenstein 1997, p.254)

In line with the empirical research by Pinxten & François (2007) on mathematical practices in classroom settings, one can prove many appropriate examples that pupils' mathematical practices may be used in class, not as some kind of exoticism but as the utilization of a mathematical concept. Starting from pupils' mathematical knowledge and their everyday mathematical practices is a basic principal of the new orientation towards realistic mathematics education and the development of innovative classroom practices (Prediger 2007). The question remains how one can move from a teacher centered learning process towards a pupil centered learning process where pupils' mathematical practices can enter the classroom. Cohen & Lotan (1997) describe how interactive working can be structured and they also explain the benefits of interactive learning in groups to *deal with diversity*. For that purpose the *Complex Instruction* theory was developed which they implemented in education. Meanwhile this didactic has had an international breakthrough in Europe, Israel and the United States and it has been elaborated to the didactic of *Cooperative Learning in Multicultural Groups* (*CLIM*) (Cohen 1997: vii). This teaching method has been tested in a number of settings, in distinct age groups and with regard to different curricula (Cohen 1997, Neves 1997, Ben-Ari 1997). Besides the acquisition of mathematical contents was part of this. *Complex Instruction* is a teaching method with equality of all pupils as its main objective. This teaching method tries to reach all children and tries to involve them in the learning process, irrespective of their diversity (François & Bracke 2006). In order not to peg cultural diversity down to a specific kind of diversity Cohen (1997) in this context speaks of working in heterogeneous groups. Heterogeneity can be found in every group structure. Even a classroom is characterized by a diverse group of pupils where every pupil has in some way his or her everyday mathematical practices. If pupil centered learning is taken seriously, teachers are challenged to deal with this present mathematical practices while teaching mathematics. In this way, ethnomathematics became a way of teaching mathematics where cultural diversity of pupils' everyday mathematical practices art taken into account (François 2007).

ETHNOMATHEMATICS IN EVERY CLASSROOM

The extended notion ethnomathematics as dealing with pupils' everyday mathematical practices has equality of all pupils as its main objective. Ethnomathematics becomes a philosophy of mathematics education where mathematical literacy is a basic right of all pupils. The teaching process tries to reach all pupils and tries to involve them in the learning process of mathematics, irrespective of their cultural diversity. All pupils are equal. This notion of mathematics for everyone fits in with the ethical concept of *pedagogic optimism* that is connected with the theory of *egalitarianism*. This ethical-theoretical foundation on which the project of equality within education is based, assumes that the equality is measured at the end of the line. As reported by the justice theories of John Rawls (1999) and Amartya Sen (1992) pupils' starting positions can be dissimilar in such a way that a strictly equal deal will prove insufficient to achieve equality. A *meritocratic* position – which measures the equality at the start of the process – thus cannot fully guarantee equal chances (Hirtt, Nicaise & De Zutter 2007). An *egalitarian* position starts from a pedagogic optimism and it needs to take into account the diversity of those learning in order to give equality maximum chances at the end of the line.

By extending the notion ethnomathematics to cultural diversity and mathematics education, the distinction between mathematics and ethnomathematics seems to disappear. Hence the critical question can be raised whether the achievements of ethnomathematics will not become lost then. On the contrary the distinction between ethnomathematics and mathematics can only disappear by acknowledging and implementing the ethnomathematics' achievements in the mathematics education. The issue on the distinction between ethnomathematics and mathematics has been raised before within the theory development of ethnomathematics (Setati 2002). Being critical on the dominant Western mathematics was the basis out of which ethnomathematics has developed and now the time is right to raise the critical questions also internally, within the field of ethnomathematics itself. What exactly distinguishes ethnomathematics from mathematics? Setati raises this question in a critical review on the developments within the ethnomathematics as a theoretical discipline that dissociates and distinguishes from mathematics (Setati 2002). Setati sees mathematics as a mathematical practice, performed by a cultural group that identifies itself based on a philosophical and ideological perspective (Setati 2002). Every maths teacher is supposed to use a series of standards that are connected with the profession and with obtaining the qualification. The standards are philosophical (about the way of being), ideological (about the way of perceiving) and argumentative (about the way of expressing). Both mathematics and ethnomathematics are embedded in a normative framework. So the question can be raised as to whether the values of mathematics and ethnomathematics indeed are that distinctive.

It cannot be denied that ethnomathematics was based on an emancipatory and critical attitude that promotes the emancipation and equality of discriminated groups (Powell & Frankenstein 1997). This general idea of emancipation can also be found in the UNESCO's view on education. Moreover we see in its mission a tight connection with the socio-economic development, with working on an enduring and peaceful world, while respecting diversity and maintaining human rights. Education here is obviously connected with the political factor.

> UNESCO believes that education is key to social and economic development. We work for a sustainable world with just societies that value knowledge, promote a culture of peace, celebrate diversity and defend human rights, achieved by providing education for all. The mission of the UNESCO Education Sector is to provide international leadership for creating learning societies with educational opportunities for all populations; provide expertise and foster partnerships to strengthen national educational leadership and the capacity of countries to offer quality education for all. (UNESCO 1948)

Taking into account these general stipulations we have to conclude that the explicit values of the general education objective connect to the values of equal chances for all pupils which are central within ethnomathematics. Consequently the expansion of ethnomathematics as a way of teaching mathematics which takes the diversity of pupils' mathematical practices into account can be justified. There is a kind of inequality in every group and the real art is to learn to detect the skins of inequality and the skins of cultural diversity. Instead of a depreciation of the concept 'ethnomathematics' this extended notion could mean a surplus value in situations where heterogeneity and cultural diversity are less conspicuous.

Within ethnomathematics education two aspects are highlighted. First there is the curriculum's *content*. Often this is the first step when implementing ethnomathematics. Besides the mathematics that can be found in the traditional curriculum, there will now be additional space to be introduced to more exotic or traditional mathematics practices. Powell & Frankenstein (1997) also emphasize this aspect in their definition of the enrichment of a curriculum through ethnomathematics. Stressing other mathematical practices offers the opportunity to gain a better perception in the own mathematical practice and its role and place in society (D'Ambrosio 2007a). It also offers the opportunity to philosophize and critically reflect on the own mathematical practice. In language teaching it goes without saying that it is better to learn more than one language. It broadens the outlook on the world and offers a better adaptation to dealing with other people in this globalized world. Knowledge of several languages is undoubtedly an advantage and besides it broadens the knowledge of the mother tongue. This comparison could even be extended to the mathematics education where knowledge of mathematical practices of several cultural contexts and throughout time proves to be advantageous. A second aspect within ethnomathematics is the *didactics*, the way that the learning process is set up. Here an interactive approach is crucial (Cohen 1997, César 2009). The two aspects obviously have mutual grounds. An interactive approach results in

contents being defined also by the learning with an active participation in the learning process. This aspect is strongly emphasized by researchers who investigate the integration of so-called traditional groups within the academic context. This is expressed as one of Graham's key questions in his enquiry into mathematics education for aboriginal children: *what do the children bring to school?* (Graham 1988, p.121). With the extended notion ethnomathematics as cultural diversity and mathematics education and with the emphasis on dealing with pupils' everyday mathematical practices, ethnomathematical practice is now closer to the social environment of the pupil and unlinked it from its original (exotic) cradle. Both the theory and practice of ethnomathematics have opened up the eyes and broadened the minds. It immediately answers the question as to what exactly could be of benefit to the highly-educated countries – with their outstanding results in international comparative investigations – regarding ethnomathematics as it originally developed, as a critical and emancipation theory and as a movement that aimed to give all pupils equal chances. In a final section about ethnomathematics we would like to link up mathematics education and politics.

ETHNOMATHEMATICS AS HUMAN RIGHT

D'Ambrosio, who is the mathematician and educationalist of the mathematics on which ethnomathematics is based, situates mathematics education within a social, cultural and historical context. He can also be considered the first to explicitly link mathematics education and politics. Mathematics education is a lever for the development of the individual, national and global well-being (D'Ambrosio 2007a, 2007b). In other words the teaching and learning of mathematics is a mathematical practice with obviously a political grounding. D'Ambrosio advances the political proposition that mathematics education should be accessible to all pupils and not only to the privileged few. This proposition has been registered in the OECD/PISA report, which is the basis for the PISA-2003 continuation enquiry.

> Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. (OECD, 2004, p.37)

This specification of mathematical literacy clearly implies that this form of literacy is a basic right for every child, such that it gets a chance to participate to the world in a full, constructive, relevant and thoughtful way. We will see this proposition recurs later in the essays of Alan J. Bishop (2006) where he demonstrates the link between mathematics, ethnomathematics, values and politics.

Mentioning mathematics education and education of values in one and the same breath does not sound unambiguous because mathematics is undeniably being perceived as non-normative.

> It is a widespread misunderstanding that mathematics is the most value-free of all school subjects, not just among teachers but also among parents, university mathematicians and

> employers. In reality, mathematics is just as much human and cultural knowledge as any other field of knowledge, teachers inevitably teach values […]. (Bishop 2002, p.228)

It is predominantly within D'Ambrosio's' ethnomathematics research program that the link of mathematics and mathematics education with values is extended to the political domain, not in the least with the intellectual father of ethnomathematics. According to D'Ambrosio still too many people are convinced that mathematics education and politics have nothing in common (D'Ambrosio 2007a). He will take the edge of this cliché. In his recent work D'Ambrosio (2007a, 2007b) departs from the Universal Declaration of Human Rights where articles 26 and 27 highlight the right to education and to share in scientific advancements and their benefits.[1] This declaration concerning education is further developed and confirmed within the UNESCO's activities by means of the *World Declaration on Education for All* in 1990 and ratified by 155 countries. Finally the declaration has been applied in mathematical literacy in the OECD/PISA declaration of 2003. D'Ambrosio regrets that these declarations are not well-known by maths teachers since they play a key role in the emancipation process. In line with the World Declaration, 'mathematics education for all' implies a critical reflective way of teaching mathematics. According to D'Ambrosio, this way of teaching does not receive sufficient opportunities. Following Bishop (1997) he criticizes the technically-oriented curriculum with its emphasis on technique and drill and where history, philosophy and critical reflection are not given a chance. D'Ambrosio develops three concepts to focus on in a new curriculum regarding the usage of the international (UNESCO) emancipatory objectives - *literacy*, *matheracy* and *technoracy*.

Literacy has to do with communicative values and it is an opportunity to contain and use information. Here both spoken and written language is concerned but so are symbols and meanings, codes and numbers. Mathematical literacy is undoubtedly a part of it. *Matheracy* is a tool that offers the chance to deduce, to develop hypotheses and to draw conclusions from data. These are the base points for an analytical and scientific attitude. Finally there is *Technoracy* which offers the opportunity to become familiar with technology. This does not imply that every pupil should or even could get an understanding of the technological developments. This elementary form of education needs to guarantee that every user of a technology should get to know at least the basic principles, the possibilities and the risks in order to deal with this technology in a sensible way or deal not at all with it.

With these three forms of elementary education, which can be developed throughout the ethnomathematics research program, D'Ambrosio wants to meet the Universal Declaration of the Human Rights that relate to the right to education and the right to the benefits of the scientific developments.

CONCLUSION

This paper considered the shifted meaning of ethnomathematics and its role within mathematics education. Ethnomathematics is not longer reserved for so-called

nonliterate people; it now refers to the cultural diversity in mathematics education. Math teachers are therefore challenged to handle pupils' diverse everyday mathematical practices. In line with the UNESCO declaration (1948) on education and the OEDC declaration (2004) on mathematical literacy, ethnomathematics clearly gained a more prominent role. Within Western curricula, ethnomathematics became meaningful to explore as an alternative, implicit philosophy of school mathematical practices. The extended notion of ethnomathematics as dealing with pupils' cultural diversity and with their everyday mathematical practices brings mathematics closer to the social environment of the pupil. Ethnomathematics is an implicitly value-driven program and practice on mathematics and mathematics education. It is based on an emancipatory and critical attitude that promotes emancipation and equality (Powell & Frankenstein 1997). Where the so-called academic Western mathematics still is locked in the debate on whether it is impartial or value-driven, the ethnomathematics' purposes stand out clearly right from the start. The historian of mathematics Dirk Struik postulated the importance of ethnomathematics. He validates ethnomathematics as both an academic and political program. There mathematics is connected to its cultural origin as education is with social justice (Powell & Frankenstein (1999). D'Ambrosio even puts it more sharply: *Yes, ethnomathematics is political correctness* (D'Ambrosio 2007a, p.32).

The implication for research is threefold. First, research has to reveal the (explicit and implicit) values within mathematics, mathematical practices and mathematics education. Second, research has to investigate thoroughly the use and integration of pupils' mathematical practices in the curriculum. Third, pupils' daily mathematical practices have to be studied.

NOTES

1. Article 26. (1) Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit. (2) Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace. (3) Parents have a prior right to choose the kind of education that shall be given to their children. Article 27. (1) Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits. (2) Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author. (United Nations Educational, Scientific and Cultural Organization. 1948)

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