Ethnomathematics in a European Context: Towards an Enriched Meaning of Ethnomathematics

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Abstract

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

Keywords: 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 discipline of ethnomathematics,

scientists collect empirical data about the mathematical practices of culturally differentiated groups, literate or not (Gordon, 2004; Pica, Lemer, Izard & Dehaene 2004; Stathopoulou, 2006; Moreira & Pires). 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 this point on, ethnomathematics became meaningful to every classroom since multicultural classroom settings are generalized all over the world. Every classroom today is characterized by diversity (ethnic, linguistic, gender, social, cultural, etc.). Teachers in general but also mathematics teachers have to deal with the existing cultural diversity since mathematics is defined as human and cultural knowledge, like 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. In the European context, 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 now was called "Cultural diversity and mathematics education" and at the CERME 7 (2011) the working group was called "Diversity and mathematics education: Social, cultural and political challenges/issues." Since then, and in line with the theoretical development of the concept of ethnomathematics, there has been an explicit consideration of the notion of cultural diversity. Looking at the spaces beyond Europe one can observe a similar evolution in the research field of ethnomathematics. It became a research field within mathematics education that is concerned with the social and political aspects of the learning of mathematics. In this sense the difference between Critical Mathematics Education (CME) and ethnomathematics became vague as mentioned by Ole Skovsmose in a recent interview:

> I see CME as represented by many different approaches in mathematics education, and certainly by many approaches that do not use the label of CME. For instance, the whole movement of mathematics education for social justice I see as an example of CME. The approach suggested by Renuka Vithal talking about "a pedagogy of conflict and dialogue" can also be an example. Different examples are found in many discussions of mathematical modelling. *Much work in ethnomathematics shares the interest and concern of CME*. And today several people in Brazil contribute explicitly to the development of CME.
> Such different approaches represent concerns with respect to mathematics education that to me indicates a critical position. (italics my own emphasis, Alrø, Ravn & Valero, 2010: 4).

In this quote one can immediately observe the common interest of CME and ethnomathematics. One approach cannot be reduced to the other although both approaches share a critical position that can enrich the theory and practice of mathematics education and the specific concern on social, cultural and political challenges.

Dealing With Cultural Diversity in the Classroom

Ethnomathematics applied in education had a Brazilian origin, but the research field of ethnomathematics eventually became a common interest all over the world. The research field has been extended from a so called exotic interpretation (connected to race and origin) to a way of intercultural learning that is applicable within any learning context where the teacher is dealing with the social and cultural diversity of all children and their background. Dealing with cultural diversity in the classroom is the universal context within which each specific context has its place. The common and universal concern is the fact that children's background needs to be taken into account. The specificity of each learning process is the diversity that appears at each context related to the diverse backgrounds of the children. The meaning of the ethno concept 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: 19). This list could still be added to 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*. The meaning of this concept of cultural diversity in the field of mathematics is also used by Bishop (2002) to identify the nature of mathematics as a human and cultural knowledge. 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 these studies (see e.g. Stathopoulou, 2006; Pinxten & François, 2007) 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 1994:14). In the following paragraph I will illustrate some of these first 'ethno mathematical' moves that are made, even before dealing with cultural diversity arose.

Diversity within mathematical practices was considered as a practice 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 so called '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 almost endless (Bazin & Tamez 2002). Notwithstanding the good intentions of these and similar projects, referring to Powell &

Frankenstein (1997) I would like to emphasize that these initiatives may well turn into some kind of folklore while originally intending to offer intercultural education.

> However, I also stress that I am 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: 254)

In line with the empirical research by Pinxten & François (2007) on mathematical practices in classroom settings, one can verify many appropriate examples of pupils' mathematical practices that 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 principle of the new orientation towards realistic mathematics education and the development of innovative classroom practices (Prediger 2007). A central question that one needs to address here is how the teacher acquires knowledge of the students out of school and how they can bring the students' daily mathematical practices into the learning process. In other words, how one can move from a teacher-centered learning process towards a pupil-centered learning process where pupils' mathematical practices can enter the classroom? The answer is initially given by Cohen & Lotan (1997). They describe how cooperative 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 (as a specific variant of cooperative learning) was developed which they implemented in education. Meanwhile this didactical approach has had an international take-up in Europe, Israel and the United States and it has been elaborated to the didactics 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: 137, Neves 1997: 181, Ben-Ari 1997: 193). The acquisition of mathematical content was also part of this research. Complex Instruction is a teaching method with the equality of all pupils as its main objective. It tries to reach all children and tries to involve them in the learning

process, irrespective of their diverse backgrounds (François & Bracke 2006). In order not to peg cultural diversity down to a specific kind of diversity, in this context Cohen (1997: 3) 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.

The Complex Instruction teaching method implies the integration of the daily experiences of the children since it uses open tasks that can be worked on based on the practices children bring from home. It is not rare that even parents are involved in the learning process. During the interactive learning process children have to negotiate how to solve the problem, e.g. how to measure, what to use for measuring, what kind of reference is used and which example is worked on (see e.g. Pinxten & Francois, 2007 on Navajo children in a North American context and Turkey immigrants in Flemish schools). If pupil-centered learning is taken seriously, teachers are challenged to deal with the present mathematical practices while teaching mathematics. This way, ethnomathematics becomes a way of teaching mathematics where cultural diversity of pupils' everyday mathematical practices are taken into account (François 2007).

Ethnomathematics in Every Classroom

The extended notion of 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 valued and treated as 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: 61-84). 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 of ethnomathematics to cultural diversity and mathematics education, the distinction between mathematics and ethnomathematics seems to disappear. If every mathematical practice is a cultural embedded and thus contingent practice (which the author agrees with), the concept of ethnomathematics seems to become superfluous. Hence the critical question can be raised whether the achievements of ethnomathematics will not then become lost. On the contrary, the distinction between ethnomathematics and mathematics can only disappear by acknowledging and implementing the achievements of ethnomathematics in mathematics education. The issue of the distinction between ethnomathematics and mathematics has been raised before within the theory development of ethnomathematics (Setati 2002). Being critical of the dominant Western mathematics was the basis out of which the discipline of ethnomathematics has developed and now the time is right to also raise the critical questions 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 ethnomathematics as a theoretical discipline that is dissociated and distinguished 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: 31). Every mathematics teacher is supposed to use a series of standards that are connected with the profession and with obtaining qualifications. 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 are indeed that distinctive.

It cannot be denied that ethnomathematics is based on an emancipatory and critical attitude that promotes the emancipation and equality of discriminated-against groups (Powell & Frankenstein 1997). This general idea of emancipation can also be found in the UNESCO's view of education. Moreover one can see in its mission a tight connection with socio-economic development, with working on an enduring and peaceful world, while respecting diversity and maintaining human rights. In this mission statement, education is obviously connected with the political factor. One can question if this mission statement is also characteristic of mathematics education in general. Research on social justice in mathematics education (e.g. Apple 1992; Burton 2003; Gutstein 2003, 2006; Gutstein & Peterson 2005) shows that this is not even close to the case. This is why ethnomathematics and CME are valuable research programs to this objective of equality in mathematics education.

> UNESCO believes that education is a 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 one can 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 boundaries of inequality and the boundaries 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 their own mathematical practice and its role and place in society (D’Ambrosio 2007a: 33). It also offers the opportunity to philosophize and critically reflect on their 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 and cooperative 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: 121). With the extended notion of 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 disconnected from its original (exotic) cradle. Both the theory and practice of ethnomathematics have opened eyes and broadened 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 emancipatory theory and as a movement that aimed to give all pupils equal chances. In a final section about ethnomathematics I would like to link mathematics education, politics and human rights.

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: 37)

This specification of mathematical literacy clearly implies that this form of literacy is a human right for every child, such that the child gets a chance to participate to the world in a full, constructive, relevant and thoughtful way. This proposition recurs later in the essays of Alan J. Bishop (2006) where he demonstrates the link between mathematics, ethnomathematics, values and politics (Bishop 2006: 7).

Mentioning mathematics education and values education in one and the same breath does not sound unambiguous because mathematics is undeniably 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: 228)

We will give some examples from literature how this values come to play in school curricula and in the classroom. Bishop (1997) presents different sets of ideals and values associated with mathematics. He differentiates six categories: rationalism and objectism (dimension of ideology), control and progress (dimension of sentiment), openness and mystery (dimension of sociology). In addition Ernest (2003) inquires on the inherent values in mathematics. Abstract is valued over concrete, formal over informal, objective over subjective, justification over discovery, rationality over intuition, reason over emotion, general over particular, theory over practice, the work of the brain over the work of the hand, and so on. These examples are recognized and reflected in empirical research on classroom practice as François (2007) shows for the case of rationalism and objectivism in Flanders secondary mathematics curriculum.

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. According to D'Ambrosio still too many people are convinced that mathematics education and politics have nothing in common (D'Ambrosio 2007a: 27). He challenges this cliché. In his recent work D'Ambrosio (2007a, 2007b) takes as his starting point 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 mathematics 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*. We first will explain what D'Ambrosio means by this concepts. Afterwards we make the comparison with the work of Skovsmose (1994).

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.

One can observe a tight connection with the analysis Skovsmose (1994) makes in his research on mathematical knowledge. He provides us a well defined meaning of mathemacy when he explains how mathematics education in general can be organized so as to develop different types of knowledge. He makes the distinction between mathematical knowing, technological knowing and finally reflective knowing. The first type of knowing is associated with the skills developed in traditional teaching; the second type is associated with the competence in mathematical model building and finally the reflective knowing is associated with the competence in evaluating applications of mathematics. To Skovsmose, a CME must integrate the three types of knowledge; the mathematical knowing, the technological knowing as well as the reflective knowing. One example Skovsmose (1994) gives us to better understand his notion of reflective knowing is the relation between technology and mathematics education. In a standard curriculum of mathematics education, this connection is understood as the use of computers in the classroom. However the connection between technology and mathematics education can be understood in a broader sense, connected to societal and political concerns about the impact of technology on society. Here we enter a critical stance in mathematics education. Besides the development of the mathematical and the technological knowing, a reflective knowing is developed with the mathematics curriculum.

If we compare Skovsmose's (1994) analysis of the concept *mathemacy* with D'Ambrosio's (1990) analysis of the concept ethnomathematics we can identify an interesting comparison. D'Ambrosio's (1990) analyses the concepts of ethnomathematics by looking at the three constitutive parts of the concept, namely *mathema*, *technés* (or *tics*) ann *ethno*:

> I call *mathema* the actions of explaining and understanding in order to survive. Throughout all our own life histories and throughout the history of mankind, *technés* (of *tics*) of *mathema* have been developed in very different and diversified cultural environments, i.e. in the divers ethnos. So, in order to satisfy the drives towards survival and transcendence, human beings have developed and continue to develop, in every new experience and in diverse cultural environments, their *ethno-mathema-tics*. (D'Ambrosio 1990: 369)

In this analysis we can identify the traditional knowledge, a way of explaining and understanding in order to survive. Secondly we can observe the techniques, the applications and the models by which the mathematical knowledge is handled and practiced. Thirdly we enter the critical part that, in the analysis of D'Ambrosio, refers to the existence of the diverse ways in which all diverse mathematics are constituted, used and applied. This is D'Ambrosio's reflective part, the notion of *ethnos* that refers to the diverse nature of mathematics.

Conclusion

This paper considered the shifted meaning of ethnomathematics and its role within mathematics education. Ethnomathematics is no longer reserved for so-called nonliterate people; it now refers to the cultural diversity in mathematics education. Mathematics 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: 418). D'Ambrosio even puts it more sharply: "Yes, ethnomathematics is political correctness (D'Ambrosio 2007a: 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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