FILLING THE GAP BETWEEN GLOBAL AND LOCAL MATHEMATICS

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The changing cultural contexts of today's societies demand new roles of schooling but also require new attitudes and ways of interaction with different social groups, their knowledge and values. Teachers are central figures in the educative process that mediate knowledge and social interaction between individuals in classrooms that are more and more multicultural. The main argument of this paper is that in order to facilitate students' understanding of mathematical knowledge it is crucial to develop teaching approaches that enable students to draw in their local mathematics. To address this issue, I analyze recent investigation focused on the mental calculus of Portuguese gypsy children. Next, I relate it with situations that require global mathematical knowledge and with ways of teachers' training to interconnect different kinds of mathematical knowledge.

INTRODUCTION

Since the 1970s, there have been studies aiming to show the importance and relationships of cultural, social and linguistic factors in the learning and teaching of mathematics. These studies consider the socio-cultural dimension of students' experiences and backgrounds to better understand and critically examine the increasing complexity of the pedagogical processes in multicultural classes. Research reveals that different cultural patterns of socialization and language systems lead to different perceptions in mathematical concepts and relations (Barton, 2001), and different engagements in socio-cultural practices to support school (Abreu, 2005; Moreira, 2002). In addition, research has also pointed out that to make mathematics a familiar subject, students must participate in mathematical accounts, and take their own realities as locus and motivation for mathematical representation and problem solving (Secada, Fennema &Adajian, 1995; Gorgorió & Planas, 2001; Knijnik, 1996). In addition, ethnomathematical studies have shown that social groups are the locus of "proper mathematics" that is necessary to study along with school practices to optimize mathematical comprehension of all social groups (D' Ambrósio, 1997; Gerdes, 1996a)

Moreover, comprehending the relevance of mathematics in our daily lives and its multifunctional roles in contemporary society is a central issue in schooling and a complex phenomenon that affects mathematics education. As Skovsmose and Nielsen (1996) noted "The globality and universality of mathematics education became a barrier for the students in seeing the relevance of mathematics in relation to their daily life and their society" (p. 1260). I now propose to focus attention on the connection between the universality and locality of mathematics, and on teachers' role in promoting this connection.

GLOBALIZATION AND EDUCATION

Several studies have shown that global culture is interpreted and used in different ways by local cultures (Appadurai, 1996; India & Rosaldo, 2002). "Globalization" refers "to the intensification of global interconnectedness, suggesting a world full of movement and mixture, contact and linkages, and persistent cultural interaction and exchanges" (India & Rosaldo, 2002, p. 2). Ultimately, these studies show how the global dimension is already present in the local cultural reality, and how each particular community is linked to a broader level of culture.

In the global culture, schools have experienced complex changes. Not only do they have to train students for economic and professional purposes, they also have to spread the technological paradigm as well as promote a democratic rationality among students to participate in society as informed and critical citizens. These goals aim at promoting competence to deal both with daily life situations and globalization by gathering examples and ideas to use from the daily life of students as well as from more distant and abstract situations.

However, education is a complex process with several protagonists (located in the family, peer groups, schools or community groups) having their own epistemologies, strategies and technologies of learning. In fact, each social group has ideas about what a new member has to know and how he or she should behave to be considered a member of the group. Not only does the group have ideas about educational content, but also how this content should be taught. Group educative theory, or its way of thinking about how to educate, leads to actions that unchain a practical form of making to learn what should be learnt (Gee, 1990; Heath, 1983; Lave & Wenger, 1997, 1991; Reed-Danahay, 1996; Street, 1993). Therefore, within each social group learning is culturally situated and linked with a set of specific behavioral and social processes that are fundamental to the learning success. These processes are sustained by the group in regard to the new members, and emerge as fundamental to frame not only the act of learning, but also the content matter of learning itself. Thus, social groups familiar with schooling possess already social processes to frame the school content and also have acquired the adequate manners to learn them (Bourdieu, 1979).

MATHEMATICS

From the 17th century, mathematics has become a symbol of global society, indispensable to development and globalization, and a crucial tool for the universalization of knowledge. We can understand the impact of mathematics on society at large by observing how contemporary societies are mathematically behaved and dependent. This, in turn, demands mathematical literacy to interpret social and natural phenomena and to critically participate in social life (Bishop, 1991; Skovsmose, 1994).

On the other hand, since the 1970s, the research findings from the field of Ethnomathematics have pointed out i) how different cultural groups possess

particular ways of approaching mathematics ii) the social, cultural and political nature of the variables and processes involved in Mathematics Education and iii) the complexity of the articulation between the mathematical knowledge based in primary culture and that promoted by schools, highlighting the dissociation of the school mathematics from daily life.

If the dynamics of globalization is taken into consideration to discuss mathematics in multicultural classes, global processes are re-interpreted and re-appropriated by local culture. To deal with them means to construct linkages between ways of thinking and acting locally and ways of thinking and acting in other dimensions of society. Nevertheless, the use of mathematics as a tool for globalization and its role in the universalization of knowledge continues to be incomprehensible to individuals, in general.

Consequently, since globalization is a fact or life, if people do not develop the competencies to access its process of constructing knowledge, they hardly might function in contemporary society. To be capable of critically participating in society, to know how to relate local interests to a global society requires to have an explicit idea about how to express throughout mathematical concepts and how they are used in problems which may affect some or all the humankind.

In short, we need to focus our attention simultaneously, both on the importance of mathematics at a local level, and on its relevance to global phenomena. On one hand there is the need to introduce students to a global way of dealing with mathematics because mathematics is explicitly related to economic development, technology, and democratic competence, and is present in different ways in different communities-- what I call "global mathematics". On the other hand, there is the need to be local in the sense that people need to develop their own ways of knowing and learning and to keep their local culture alive, including their mathematics. Both are indispensable to creating updated mathematical meaning in contemporaneous societies.

Ethnomathematics is an effective medium between local mathematics and global mathematics and to critically interpret the interactions between the local and global dimensions of society. In this regard, some illuminating experiments where carried out, for example, by Knijnik (1996) working with the landless community in Brazil.

LOCAL MATHEMATICS

The disconnection between the school mathematical curriculum and students' daily lives has been largely discussed inside the community of Mathematics Education. As I am arguing, part of this dissociation is related to the connection between local and global knowledge, which also includes different strategies and technologies of knowledge.

A consensus about the necessity of school mathematics contextualization, demands that students actively participate in it, and that the teacher, in a dialogical process, "involve students in a permanent problematization about their existential situations"

(Freire, 1985, p. 56), in order to conduct the application of mathematics on the contexts of students' experiences and thinking. Otherwise the use of mathematics continues to be restricted to "another world" that neither belongs nor is appropriated to "our world".

To comprehend the necessity to learn about global mathematics, students need to have their own authorship in the construction of mathematical knowledge in classes. This means that students should be actively involved in the search of contexts recognized by them as relevant to mathematization by means of their rational thought originating in their own experience and group context. In other words, the interest of knowing mathematics needs to combine interpretations from the local and in the global contexts to benefit future society, and each social group.

The dialogue between global and local mathematics encourages students to investigate their own culture and mathematical activity; consequently the role of teachers to legitimize cultural knowledge and to help students in this process of mathematical contextualization is of great importance.

TEACHERS AS RESEARCHERS

To enunciate clearly the teachers' professional competencies to face both the challenging of mathematics teaching and the social transformations of both the current classroom and society is a complex task. There is a consensus in considering that mathematical knowledge, conceptions about learning and teaching, the comprehension of students´ thinking and problem solving are the main issues to changing approaches to teaching mathematics (Fennema & Franke, 1992).

Regarding the specific challenges of teaching mathematics in multicultural classrooms, Cesar and Favilli (2005) observe that "teachers recognize the need for innovative practices, namely intercultural ones, but they do not change their practices according to the cultural roots and diversity existing in their classes" (p. 9). In respect to teachers' education and their professional development, the perspective of Ethnomatematics poses as a central issue the importance of the appropriation of theoretical-methodological tools to help teachers to comprehend the diversity of mathematical activity. Namely, to integrate local mathematics in teaching, into the organization of teaching practices and in the elaboration of didactical materials and tasks. As Gerdes (1996b) notes, teachers education should include training

> "to investigate ideas and practices from their own cultural, ethic and linguistic communities and to search ways of constructing their teaching from them on (…) and to contribute to the mutual comprehension, the respect and the valorization of (sub) cultures and activities" (p. 126)

Domite (2004) also highlights that one of the major contributions of Ethnomathematics to teachers' education is to bring into focus "students", ways of legitimizing their knowledge and the possibilities "to work on *learning's from*

outside school and from school" (p. 420). In this framework is central the idea of the teacher of mathematics as an ethnomatemathical researcher (Stillman & Balatti, 2001).

Another important issue to teachers' education for multicultural settings is the role of schools in education. Considering that the development of knowledge reflects social, cultural and power relationships, and that schools are a place of knowledge transmission, it is necessary to reflect upon the social goals of school knowledge, questioning both the criteria underlying the choices of what to teach in schools and the challenges to face cultural diversity.

In short, the role claimed for teachers both as researchers of local mathematical practices and as critical mediators of the different ways of knowing and learning mathematics, requires theoretical and methodological training. Moreover the use of local mathematical ideas and practices into the curricula as tools for intervention in a global world assumes that teachers are capable not only of knowing about them but also of contextualizing them locally and discussing their potentialities and limitations.
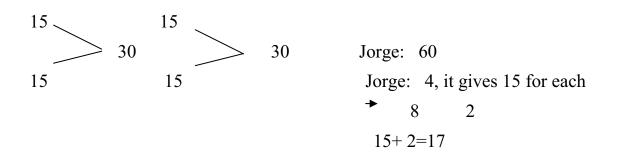
EXAMPLE: Portuguese gypsy children and mental calculations

Elementary teachers have illustrated that the predisposition to mathematics is notable among Portuguese gypsy children, despite their high dropout rate. Recent investigations developed in three Portuguese gypsy communities in different locations show that, in general, not only do gypsy children prefer mathematics, but also that they have fewer difficulties than in other school subjects (Cadeia, 2006; Ferreira, 2003; Pires, 2005). Using participant observation methods, from one to two years, these investigations documented Portuguese gypsy children's strategies of mental calculations and gather elements of their relationship with school mathematics. The data were collected among children, in their gypsy communities, and in fairs and schools (playgrounds and classes).

For example, Jorge, a nine-year old gypsy child enrolled in third grade, who used to go to the fairs with his parents during weekends or after school, not only used to help his parents by making known what to sell, but also helped by doing the calculation of the prices. His father trusted fully in his son calculations.

The following situations, fully described in Pires (2005), show how Jorge, actually, does his mental calculations.

To calculate 68: 4 =, Jorge reasoning was the following:

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In the division, 369:3=, Jorge gave the answer right way: "123". In regard to the division 643:2=, Jorge took a few seconds more than in the previous situation to give the answer: "321", explaining that "it remainders 1". When was asked, by the researcher, to explain his reasoning and to try to write down his thinking, he wrote the following notes:
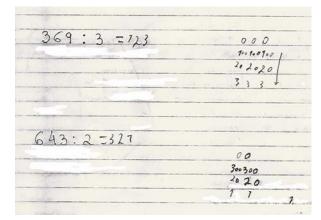

Figure 1 – Jorge notes in his notebook

Source: Pires (2005, p. 155).

On the right side, it is possible to observe his reasoning in both divisions, which was to divide by three (in the first division) and by two (in the second) each decimal class of each number. This is, to perform "369:3", the three cents, in 369, was decomposed in 100+100+100; the six tens was decomposed in 20+20+20, and the nine units in 3+3+3. To perform "643:2" the six cents were decomposed in 300+300, the four tens in 20+20 and the three units in 1+1, resting one.

Another example, taken from Ferreira (2003, pp. 85-86), tells us about Gustavo, a ten years old boy enrolled in fourth grade, who, after giving good answers based on mental calculations to questions such as: the double of 12, the double of 25, the triple of 63, when the researcher asked him to solve the following operation, the child wrote 4010.

$$\begin{array}{r} 25 \\ +25 \\ \hline \end{array}$$

Gustavo's answer reflects his reasoning which was to add twenty plus twenty, and them five plus five.

The following example taken from Cadeia (2006, pp. 89-90) illustrates how Cristiana, a twelve-year old girl enrolled in third grade, calculates.

Researcher: Cristiana, tell me how much someone should pay for three pieces, seven euros and seventy-five cents, each?

Cristiana: It does not exist. What a strange price!

Cristiana: Ok. How many pieces?

Researcher: Three pieces, seven euros and seventy-five cents, each.

Cristiana: Five plus five plus five make fifteen. Now, sixty plus sixty makes one hundred and twenty plus sixty makes one hundred and eighty. One hundred and eighty plus fifteen makes …one hundred and ninety five.

Researcher: One hundred and ninety five corresponds to what?

Cristiana: The amount of the three pieces.

Researcher: Did you forget something?

Cristiana: Ah teacher, wait a moment. The one hundred and ninety five cents makes one euro and five cents. Now, three pieces, seven euros each. It makes…seven plus seven makes fourteen plus seven makes twenty-one. It seems that little song that our teacher teaches us; seven monkeys and you are one.

Researcher: Are you calling me a monkey? Go ahead. Finish your calculation.

Cristiana: Twenty-one euros plus one euro, it is twenty-two euros and ninety-five cents.

Researcher: You make it. Was it hard?

Cristiana: It was very hard. Let me rest for a while.

The main base of gipsy children's learning processes continues to be done inside their families and communities. Learning is done especially by observation and reproduction of what they hear and see, while taking an active role and participating in the practices of their communities. Within familiar and effective contexts and throughout oral transmission, knowledge, practices and techniques are observed, experienced and imitated by children, who in this way learn and reproduce the knowledge of their social group. Actually, the education and socialization of gypsy children are not only mostly developed inside their communities but significantly children go along with their parents to work, especially to markets and fairs (Cadeia, 2006; Ferreira, 2003; Fraser, 1992/1995; Okely, 1983/1993; Pires, 2005; San Roman, 1980).

These three children's contacts with commercial activities in their communities immerse them in contexts of mathematical activity, resulting in knowledge and agility towards mental calculus. Therefore, Portuguese gypsy children' predisposition to mathematics, observed by their elementary teachers is grounded in their communities-based practices. Moreover, these three investigations also show that the strategies of mental calculations used by these children were not considered in classes.

As far as the research can tell us, we consider that the example of the mathematical predisposition of Portuguese gypsy children, especially in regard to mental calculations is a good example of the dissociation that exists between global and local

mathematics. Mathematical process used in these children' communities were not linked with the process used in school. If these mental strategies to calculate can be efficient in markets and fairs situations, they are impossible to carry out when problems involved another magnitude of numbers, for example. Cristiana was already sensitive to this situation when she observed that seven euros and seventy-five cents was a strange price for a piece.

FINAL REMARKS

Different social groups become pedagogically interesting for school based educative processes if schools learn how to use their resources in classrooms. In addition it is necessary to connect the local need of mathematics with global necessities.

In this perspective, only a school mathematical attitude that opens up the communication with local experience of mathematics allows negotiation among abstraction, mathematical content and local mathematics to move on into the role of mathematics in the process of the universalization knowledge. Students' authorship in the contextualization of local mathematics is crucial to confer meaning and utility to mathematical behaviors inside and outside school and to develop imagery where mathematics is present.

Agility in mental calculations, appropriated by Portuguese gypsy children in their community-based educative process deserves to be legitimized in classes and explored to enrich the learning of multicultural mathematics. Namely, such agility should be used to show the importance of local mathematics, how it operates and how it can be improved. Moreover it is also a good example to explore the need for a global mathematics. Nevertheless, in this particular case, if teachers are not aware of children's mental calculation processes and do not use them to know more about the role of local mathematics in mathematical knowledge in contemporary society, a good opportunity to educate the citizens of the world is lost. Therefore, teachers' training programs should include the need to educate for the ethnomatematical research teacher. This aspect deserves the utmost attention. Not only it is crucial to develop approaches to teaching that enables the students to draw in their local mathematics for the students' own learning, but also teachers, and students with their help, need to be able to search local mathematical practices bring them inside classes with other social practices where mathematics is essential. From elementary school, classrooms are the proper places to start bridging the gap between local and global mathematics, by presenting opportunities, grounded in local examples, to children understand why and in what occasions their local mathematical knowledge is good to solve problems and to plan and organize activities, or has limitations since, ultimately, they need to work out more complex problems and perform global mathematics inside and outside his community.

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