In-Between Critical Mathematics Education and Ethnomathematics.
A Philosophical Reflection and an Empirical Case of a Romany Students' group Mathematics Education.

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Abstract

Although D' Ambrosio (2001) in his later work speaks about the political dimension of Ethnomathematics as 'an evidence' and the researchers of Critical Mathematics Education have incorporated ethnomathematical ideas in their research, these two approaches are up to now perceived as separate research fields. In this paper we briefly present the development of both research fields and we explore their similarities. An empirical study on a minority group of Romany students is presented in order to illustrate on the one hand that it is difficult to separate both research fields, and on the other hand to demonstrate the fruitfulness of a common theoretical framework. A more effective communication between EM and CME should contribute to a better understanding of mathematics education mostly for minority and marginalized groups.

Keywords: Ethnomathematics, Critical Mathematics Education, Politics, Romany Students, D'Ambrosio, Skovsmose, Education, Philosophy of Mathematics, Foundation question, Greek context.

Introduction

In this paper we want to explore the field of mathematics education that focuses on the social context. Research on the social dimension of mathematics education – the cultural, societal and institutional level – is mainly done in the field of Critical Mathematics Education and the field of Ethnomathematics. Even though Ethnomathematics is a critical research program and a critical practice regarding mathematics education, in literature it is still considered different from the so-called Critical Mathematics Education (Alrø, Ravn, & Valero, 2010).

In a first theoretical part of this paper we will investigate the historical growth, and the differences and similarities of Critical Mathematics Education and Ethnomathematics. We will argue that in spite of the different historical background, the two fields are now converting to each other based on their similarities, being a critical attitude and the focus on the social dimension of mathematics education.

In the second part of the paper we present the results of an empirical study searching the association between cultural context and mathematics teaching/learning in a Romany students' class. In the concluding section we will argue that this case study

will bring an argument for a growing communication between the two approaches and the fruitfulness of their collaboration.

Critical Mathematics Education and Ethnomathematics

In a recent inter-viewing[1] conversation with Ole Skovsmose –as part of his Festschrift– he describes Critical Mathematics Education (CME) as follows:

> 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 are our emphasis, Alrø, Ravn, & Valero, 2010, p. 4)

In this quote we can immediately observe the common interest of CME and Ethnomathematics. One approach cannot be reduced to the other and that is not what we would like to do. Instead, we would like to express the richness of both approaches and how they can enrich the theory and practice of mathematics education. Therefore we want to give more details on the specificity of both approaches. Both approaches, CME and Ethnomathematics, are concerned with the social and political aspects of the learning of mathematics despite of the fact that they developed from another geo-political context. In Skovsmose & Borba, (2004) we can observe a more detailed description of CME and the diversity of concerns CME is dealing with:

> Critical Mathematics Education is concerned with the social and political aspects of the learning of mathematics. It is concerned with providing access to mathematical ideas for everybody independent of colour of skin, gender and class. It is concerned with the use and function of mathematics in practice, being an advanced technological application or an everyday use. It is concerned with the life in the classroom, which should represent a democratic forum, where ideas are presented and negotiated. It is concerned with the development of critical citizenship.
>
> (Skovsmose & Borba, 2004, p. 207)

Also in this description one can observe an integration of ethnomathematical concerns. The question remains why CME and Ethnomathematics are still perceived as diverse research although they share the same concerns. Vithal & Skovsmose (1997) explain how CME and Ethnomathematics share the same reaction to the naive modernisation theory as the theory of progress and liberalisation based on an economical system of capitalism, industrialism and high technology. In the case of CME, it is a reaction from within the highly technological society on the destruction

[1] The term inter-viewing is written with a *hyphen* to emphasis the interactive dialogical act of *viewing together* (Alrø, Ravn& Valero, 2010).

of the life-world[2] and the new forms of suppression. In the case of Ethnomathematics it is a reaction from within the so called Third World to the paternalistic import of modernisation, including the import of western mathematics curricula.

Ethnomathematics therefore can be seen as a reaction to Eurocentrism (Stathopoulou, Francois & Moreira, 2011). Despite the diverse geo- political backgrounds, CME and Ethnomathematics are growing more and more towards each other, especially since the notion of Ethnomathematics shifted over the time. We cannot go into detail about this development we elaborated on in other papers (François & Van Kerkhove; 2010; Pinxten & François, 2011). In the further analysis on the relation between CME and Ethnomathematics we will refer to the recent developments within CME and Ethnomathematics.

Besides societal and political concerns, CME also maintains a well-defined meaning of mathemacy. Skovsmose (1994b) 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 (1994b) 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 understand 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 (1994b) 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*) anne*thno*:

> 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 , p. 369)

[2] The term life-world (*Lebenswelt*) is introduced by the intellectual father of phenomenology Edmund Husserl to take stance in the ontological discussion and to emphasis the importance of the world as human beings perceive and experience it. Skovsmose is referring to the concept life-world as used by Habermas, who further developed the concept of the life-world in his social theory.

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 divers nature of mathematics. The way this notion of ethno can be integrated in the mathematics curriculum is intensively researched on.[3] It is based on this research one can see the inherent relation between CME and Ethnomathematics. Moreover D'Ambrosio also emphasizes the political dimension of ethnomathematics:

> Ethnomathematics is today considered a sub-field of the History of Mathematics and Mathematics Education, with a very natural relation to Anthropology and Cognitive Sciences. The politicaldimension of ethnomathematics is evident.
>
> (D'Ambrosio, 2001, p. 1)

In line with D'Ambrosio's ideas Appelbaum (2004) argues for the connection between critical thinking and mathematics education and how classroom practices deal with the political:

> Ethnomathematics makes it clear that mathematics and mathematical reasoning are cultural constructions. This raises the challenge to embrace the global variety of cultures of mathematical activity and to confront the politics that would be unleashed by such attention in a typical North American school. That is, ethnomathematics demands most clearly that critical thinking in a mathematics classroom is a seriously political act
>
> (Appelbaum, 2004).

If we accept the importance of reflective knowing then we implicitly assume the impact of mathematics on society. That means that we take distance from the idealistic philosophical attitude that proposes the existence of *mathematics as such*. This is the philosophical precondition for a CME and for Ethnomathematics. Mathematics (with the emphasis on the plural of the concept) as we understand it, is a human practices which evolved over time and across different cultures. It is a dynamic body of knowledge what means that it is still under construction. This constructed body of knowledge has its impact on the way we organize political and societal life and at the same time it has its impact on how we epistemize the world. In the simple expression of Skovsmose (1994b, p. 36) we could say mathematics is "doing something" to society, an expression he develops to the more complex notion of "the formatting power" of mathematics. It is from this point of view that students need to engage in mathematics-based projects which focus on its social application (Prediger, Viggiani-Bicudo, Ernest, 2010). In the section on to the empirical case we will make clear what it means that 'mathematics is doing something to society'.

Before moving to the empirical part of the paper we have to add one more important aspect of CME that also has to do with a philosophical reflection. A main

[3] We would like to mention the recent issue of *Philosophy of Mathematics Education Journal* edited by Paul Ernest. This special issue focuses on "Critical Mathematics Education" with two articles of Ole Skovsmose, "who must be considered as one of the main figures within this particular area of our field" (Ernest, 2010).

philosophical question within Western philosophy is the question of foundation and the question of the essence of things; it characterizes the philosophy of Modernity. Indeed also CME is questioned about its real foundation and about its essence, although to conclude that there is no foundation neither an essence. Let me explain this philosophical statement Skovsmose (1994a, 1994b, 2004) elaborates on in his work.

Since CME has to do with socio-political concerns one has to conclude that mathematics can serve the good as well as the evil. The power of mathematics is double edged. On one hand great achievements in science and technology are mathematically based. On the other hand mathematics is implicated in technologically caused catastrophes (Atweh, 2007). And who has to decide the meaning and the content of this division between good and evil, let along that we can decide to think in terms of a dualistic opposition. To Skovsmose (2004) socio-political roles of mathematics are neither fixed nor determined. The socio-political role of mathematics, its meaning, its uses and its application is not essentially determined within mathematics itself. There is no intrinsic connection between mathematical knowledge and how to use it. There is no essential function connected to mathematics. In the same way, also mathematics education has no fixed way of dealing with mathematical knowledge. It is always a choice how to represent mathematics and how to handle it. Even a main curriculum that is teaching traditional mathematical knowledge implies a perspective of how mathematics is handed down from one generation to another (François, 2007). Therefore, mathematics education is critical in the sense that it departs from an uncertainty. The aspect of uncertainty is grounded in the nature of mathematics, a human practice determined by contingency at the moment of its construction. A second aspect –and perhaps the more important aspect– of uncertainty is the fact that the result of that human practice, namely the mathematical knowledge, will be applied by human beings with their diverse and sometimes opposite needs, believes and interests. That is what makes mathematics uncertain and why mathematics education is critical *per se*. The fact now that educators and researcher acknowledge these uncertainties makes mathematics education a CME. It has no fixed curriculum, nor has it a determined contend and method; it is the act of reflecting on the nature and the function of mathematics, time and again. CME gets its full meaning in the interaction with the context in which the curriculum is acted out (Skovsmose, 2004).

Mathematics education has no political nor an epistemological robust foundation. It floats on the waves of human practices, their needs, beliefs and interests. With the metaphorical words of Neurath –who was a leading member of the Vienna Circle and disagreed with epistemological foundationalism: "We are like sailors who have to rebuild their ship on the open sea, without ever being able to dismount it in dry-dock and reconstruct it from the best components" (Neurath, 1932, p. 206, translation from German).

This foundation question is never raised in the Research Program of Ethnomathematics. We argued that these differences are the result of the divers geo-political background of CME and Ethnomathematics, respectively coming from the Western high-tech society and from the Neo Colonial Developing Countries. At the same time we characterized the foundation question as a typical question within Western Modern philosophy, looking for a robust foundation and a fixed essence of things. Maybe this geo- political diverse background can explain why CME is dealing

with the foundation question while Ethnomathematics is not questioning this issue. The Research Program of Ethnomathematics departs from the philosophical principle of a contingent and cultural diverse nature of mathematics, CME is questioning this matter. However, at the end CME converge to Ethnomathematics by the conclusion that CME has no political nor an epistemological foundation and that there is no essence of mathematical education.

Based on this philosophical conclusion we can now move to the empirical case which we call an in-between CME and Ethnomathematics.

The empirical case: Romany students in a Greek context

Romany students and Romany community

Romany people in Greece constitute an old traditional group. Despite their internal differences—origins, type of establishment, integration in Greek community—they perceive themselves as members of the broad Romany Community.

The study presented here, is based on first-hand material collected on the spot by one of the authors. The ethnographical research was conducted in the context of the Ph.D. thesis: "The Connection between Cultural Context and Mathematics Teaching/Learning: An Ethnographic Study on a Class of Romany Students and on their Community of Origin" (Stathopoulou, 2003).

The main study group in this research was a first grade class of Romany children. In order to understand and interpret cultural and cognitive issues of the classroom the research expanded in the community of origin with emphasis on exploring cultural peculiarities connected with education/mathematics education.

As it was noticed, the main peculiarities that characterize this group, regarding education/mathematics education are:

- *Semi-nomadic way of life:* it has direct consequences on their schooling such as the time of starting school and the inconsistency in attendance.

- *The socio-economic organization*: it is based on family and so children are involved in their families' business and through a horizontal way of teaching they become among other things familiar with mathematical activities such as doing mental calculations[4].

- *A different perception for education:* due to the fact of being a minority and a marginalized group which is related to their background, and also to their limited expectation of education depending on their cultural context. Formal education is notan activity integrated into Romany culture. Sometimes not only do they turn away from formal education, but school is considered as antagonistic to the family, since students do not offer so much to their family, and school learning often conflicts with the values and knowledge of the community. Where parents value formal education,

[4]Because of the oral tradition of language, students had not only to memorize a list of things they have to buy but they also learn very early to do mental calculations.

their ambitions for it are often limited. Very often, the way they perceive education is connected to their identity: "*We don't go to school*"[5].

Research question

The main question in this study concerned the exploration of "how cultural context is connected to mathematics teaching and learning". The aim was to understand this connection and to explore the causes and consequences in terms of cultural as well as political concerns. The following research questions were explored:

- Do Romany children acquire different knowledge taken into consideration their cultural context?
- Which are the characteristics of this knowledge?
- Is schooling procedure for children an enculturation or an acculturation one?
- What kinds of conflicts are produced in the class?
- Does the formal education acknowledge their informal cognition?
- How does formal education exploit the informal cognition of students?

Method and Data selection: the setting of the research

The data were selected through ethnographical techniques –participant observation and interviewing— in both the classroom and students' community of origin. The school where research conducted was located in Zefyri, a marginal district of Athens, where a Romany people group live. Zefyri is on the outskirts of the city and it is a relatively depressed area.

In the school Romany students were a minority. Part of them attended standard classes (average: 2-3 students in every class) and the other students attended classes with only Romany students[6]. The class of our main fieldwork was a first grade class with the particularity the students' age was between 7-12 years. The majority of them were for first time at school while part of them had attended for a short time the previous years. According to the original design of the research the researcher was going mostly to observe the teaching process. During the period of observation, the researcher became involved in the teaching process of the older students —10 to 12 years old. Thus the selected data are coming from the teaching and the observation of the older students and the observation of the younger students when they were taught by the teacher or when they were involved in activities that the researcher posed to them. In regard to the mathematical content the research was focused on the mathematical activities of counting, measuring, and locating[7].

The duration of the research was one school year: four times every week, mostly when mathematics was taught.

[5]At the time of the research, it was attempted to change the mind of a girl who stopped schooling and a women of the community intervened with the above words.
[6]During the year that the research was conducted there were two classes with only Romany students. The reason for this -according the school's director- was the late registration of the Romany students.
[7] Three of the six universal mathematical practices as developed by Bishop (1988).

The research expanded in examining the students' community of origin, visiting their homes and observing their families' activities —for example, a small market in the community, open markets— in which also students were involved. During these visits we not only observed the students, moreover we posed mathematical tasks connected to their activities and concerning the mathematical activities of: counting, measuring, locating.

The results were examined according the following analytical categories:

- cultural conflicts in school space
- the culture of the classroom (cultural and cognitive conflicts)
- the interrelation between Romany students- Romany community and formal education
- counting and measuring
- four arithmetical operations (problems in oral and symbolic form)
- money dealings as didactical framework
- formal–informal cognition
- 'locating' in the community and in the classroom.

Findings

In this paragraph we will concentrate on two indicative cases derived from the research data (for more details see C. Stathopoulou, 2003). We will discuss the findings in order to highlight the cultural and political concerns that characterize the interconnection between mathematics teaching and learning. The first case illustrates a cultural dimension, the second one illustrates some consequences on the cognitive level. Romany students who are coming to school are confronted with cultural as well as cognitive conflicts. The following case is characteristic regarding cultural conflicts (Stathopoulou 2006, p. 137).

During a break we noticed that there were two Romany boys, about ten years old, on their bicycles and just outside the schoolyard. After a short discussion, we asked them 'why they did not come to school'. The two boys in an evident detestation pointed to the enclosure, saying: "Don't you see how they are!!!". This experience provoked the exploration of the following questions: (i)What does the school place mean pedagogically? (ii) What are its incompatibilities for Romany students? And (iii) What are the likely conflicts caused by this?

The way the external place of the school is shaped, with very high bars and a wrought iron gate, and the strict land planning, is a reason for Romany students to experience a crucial cultural conflict, as we saw characteristically in the case of the two Romany non-student boys. In their community there are no clear boarders between their houses; we either speak about barracks, or about modern houses, perhaps as a reminder of the time they were segregated nomads. Furthermore, the strict discipline with which the school place is related is one more source of conflict for Romany students, as it doesn't characterize their culture, too. Similar incidents could be presented regarding classroom. Cultural conflicts like this have as a result a large proportion of Romany students not to attend the school or to stop early the school attendance. Their cultural experience about the space and its function it is not taken into consideration in the framework of the formal education and thus very often it becomes suspense if not deterrent for school attendance.

Those students who cope with the cultural conflicts face cognitive difficulties due to cultural differences in the framework of education/mathematics education. For Romany students among others the language, and mostly the orality of language, is a cultural difference connected to their school performance (Stathopoulou &Kalabasis, 2007). The fact of its orality has some consequences, on the one hand to confront difficulties in written code, something considering as necessary for formal education at school context, and on the other hand to perform easily mental calculation. Although it is demanded teachers not only know and take into consideration these differences. Even more they do not use these differences for students' benefit.

The second case illustrates a learning situation of students dealing with an activity which is not situated in a typical learning setting. By this example it will become obvious that students in case they are not restricted to use formal type of mathematics knowledge, but opposite, they are encouraged to exploit their own experience in problem solving in which they are very effective. The problem that students had to solve, even though realised at mathematics classroom it was in a familiar context for them and it wasn't detected to students any strategy or algorithm. Actually students had to solve a typical division problem: "Vasilis' father has to distribute 372 kilograms of apples into 20 kilogram crates. How many crates are needed?".

All Romany students were effective, selecting their own strategies —although they had no any idea about the division operation and much more about the use of the typical algorithm—while the majority of the non-Romany students, at the same age, didn't solve the problem either because of a wrong selection of algorithm or a wrong application of the correct algorithm (operation). One of the selected strategies was Christos' strategy of repeated subtraction. He, a 10-year old boy, subtracted 20 from 372 and by this strategy of repeated subtraction reached the correct result. The only thing he wrote down was the final result.

Although Romany students are so effective when are they are free and encouraged to use their own strategies, the fact of their unfamiliarity with a written code causes to them difficulties to conceive problems expressed symbolically without a verbal meaning. For example through our research we observed students who could not answer the symbolically presented question "3 + 2 = ? ", but when expressed as a verbal problem such as "3 hundred coins and 2 hundred coins gives how much" students easily gave the right answer. Lack of familiarity with writing codes had also the unexpected consequence of some Romany students not being able to align the digits when setting out addition sums according to the conventional algorithm.

The most illustrating data of the research is derived from the way students responded to the mathematical activities—counting, measuring, and locating—in mathematics classroom as well asfrom the observation of the community's everyday activities. The analysis of this data leaded us to realize that students as member of the community come to school with a rich corpus of informal mathematical knowledge which is different from the mainstream students' one due to their cultural peculiarities –semi nomadic way of life, socio-economic organization, oral tradition of language, etc. Their informal knowledge and the way formal education conceive Romany students involve cultural and political issues.

Discussion

In the theoretical part we argued that CME and Ethnomathematics depart from the same philosophical precondition being that mathematics is a human practice and thus a dynamic body of knowledge with a formatting power. This philosophical precondition is not always the pedagogical principle of a mathematics curriculum. The learning of mathematical skills and contents is mostly working with a uniform curriculum for ages, even if it concerns programs to promote equality amongst students. The learning of students goes beyond the pure cognitive activity. It involves also the cultural and societal/political context.

The empirical research has highlighted the need to connect the school knowledge to be students' every day experience, since in everyday context the knowledge is produced in a meaningful way. This realization is expressed in the current curricula all around the world, too. Nasir and her colleagues (Nasir, Hand, & Taylor, 2008, p. 207) discuss the importance of the movement away from teacher-directed, top-down instruction towards engaging students in meaningful problem- based instruction, something that requires a greater consideration of aspects of students lively experiences. They also point to the fact that some researchers and educators have developed teaching approaches with the objective to teach and empower non-dominant students, families, and communities (Nasir, et al., p. 213). In some cases it is obvious an attempt to leverage students' everyday social and cultural knowledge in order to improve domain-related understanding. In these approaches it is highlighted that there is a need for the use of the rich sources of knowledge that exist outside the classroom in the varied activities of cultural life to improve students' participation in classroom activity. A rich learning context that is taking the background knowledge of the learners into account, is taking issues of race, academic identities, and access seriously. These aspects are taken into consideration in order to give student the opportunities to gain increased authority to participate in mathematics in ways that validate their everyday practices and their identities.

As Lerman (2001) notices classroom discourse practices necessarily shape what is viewed as legitimate mathematical participation and the official language of the classroom can position certain groups with power and privilege.

Mathematical knowledge is considered, in fact, as culturally free in spite of research that showed: "what it means to know and understand mathematics, and what counts as productive activity toward knowing and understanding both in our classrooms and in society, [which] is socially and culturally mediated" (Nasir, 2008, p. 207). Although, as it is mentioned above, the current curricula all around the world stress the need of the connection between every day knowledge and academic knowledge in the classes in general. Based on the results of our research observations we have to conclude that this way of leaning did not occur. Students had no chance to exploit their out of school experience and to develop a dialectic relationship between their community identity and their identity as mathematics learners. Even though culturally acquired, informal cognition can inform the formal one in particular situations which helas normally doesn't happen since teachers are strictly limited to formal procedures.

Formal education, as expressed through the teacher, either ignore or contemn this background cognition of, Romany students. Moreover in school context they are considered of low aptitude with obvious consequences for their schooling as well for

their broader social role. The failure of formal education to respond to the peculiarities of this group is understand as a failure of Romany people themselves. It becomes difficult to attribute this failures to pure cultural nor to political factors. The attitude of the Romany family towards education and the applied policy of institutional education interact in such a way that politics and cultural dimensions interweave, with the Romany students being in-between.

With the empirical case we demonstrated the in-between situation of Romany student in mathematics classes. Even when the State attempts equality by using the same curriculum and the same books, the result is that the aim of equality is not realized. Teachers and the state in general ignoring or diminishing the background knowledge of Romany students due to the marginalization and the inclusion of Romany students. Not only their educational identity is affected by this but also their social identity. More research has to be done to explore the needs to optimize the educational outcomes for Romany students. Perhaps the practices of an ethnomathematical and CME approach, associated as they are with respect to what students brings to the classroom, offer a possible pathway?

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