WORKING GROUP 10
Mathematics education in multicultural settings

CONTENTS

ISSUES AND CHALLENGES IN RESEARCHING MATHEMATICS EDUCATION IN MULTICULTURAL SETTINGS

Guida de Abreu, *Oxford Brookes University, England*

Margarida César, *Universidade de Lisboa, Portugal*

Núria Gorgorió, *Universitat Autònoma de Barcelona, Spain*

Paola Valero, *Aalborg University, Denmark*

CERME 4, in Sant Feliu de Guíxols, 2005, was the second time the special group, WG10, focusing on teaching and learning mathematics in multicultural settings, met. As organisers of this group we believe this was a much needed and timely inclusion. Though research into the impact of cultures on mathematical learning is not new (see for instance, Bishop, 1988; D'Ambrosio, 1985), processes of globalisation (Hermans & Kemp, 1998) and the unprecedented level of migration and people mobility in our current society create new challenges. The increasing number of migrant people, refugees, and displaced persons, and therefore, of youngsters living in places with languages and cultures different from that of their families, is a result of the world globalisation process. Issues that in the past have been dismissed as being only relevant to those in the margins, in poor and unschooled communities, in the streets, in quite different societies, cannot be seen any more as "the problem of the other". The social fabric that we will have in the near future depends, to a great extent, on the way that schools serve –meaning giving service and being useful– those that at present are considered as not belonging to the mainstream social group and culture. In several European Countries (and indeed in many other parts of the world) the great majority of teachers may now expect to work with pupils from ethnic, linguistic and cultural groups distinct from their own. Cultural, linguistic, political and social issues in mathematics education that very often were seen as distant, "exotic", and the problems of "others" are a reality that need to be seriously addressed by mathematics educators.

Interconnections and contact between people from different cultural origins are part of our everyday practices. What concerns researchers in our working group is how to understand and promote mathematical educational practices that are inclusive of the cultural diversity of the participants. As already noted by cultural psychologists, such as Hermans and Kemp (1998), to understand the impact of globalisation on the self it is necessary to construct new theoretical perspectives. For instance, they argue against the old dichotomy conceptualisations of cultures as "internally homogeneous and externally distinctive", and suggest that it would be more productive to explore the "contact zones" between cultures.

Considering identity as the fact of being who or what a person is, and focusing on the

characteristics that determine this, we necessarily come to the idea of the individual cultural identity. We understand the student's cultural identity as the traits of their identity that are shaped by the cultures of the groups they are part of. We do not refer to the student's cultural identity as the student having all the traits that could characterize the culture 'at large' of the groups the student belongs to. We do not regard the individual's idiosyncrasy as a direct image of a large culture. The individual's way of acting, thinking, feeling or understanding does not necessarily have a direct and unique correspondence with the meanings of their groups' cultures (Gorgorió & Planas 2005). How do the different, multiple cultures of individuals become apparent when they are to work and live together in the mathematics classroom? Different cultural artifacts, like different algorithms or number symbols, mediate the students' learning processes. However, there are other more subtle ways for different cultures to be present. The different ways of understanding the teaching and learning of mathematics itself and how it has to take place, or the value attributed to having or not having mathematical knowledge, are cultural factors that shape how individuals act and interact within the mathematics classroom (Gorgorió & Planas 2005).

By contact zones Hermans and Kempen mean the zones where people meet (physically or virtually). This then informs questions such as "How do the meanings and practices of the contacting partners change as a result of their communication, understandings and misunderstandings and conflict and power differences in these contact zones?" (p. 1117). We found the "contact zone" approach a useful point of reference to conceptualise learning in multicultural settings (Abreu, 2005). So, we will use some vignettes of how a pupil, a parent and a teacher described their contact with educational practices in the "immigration zone". These vignettes were extracted from papers presented in our working group, and indeed we could have selected many others. Our purpose however, is not to highlight specific papers, but to reflect on issues emerging in the "contact zones" and how these challenge the current theorising, methodologies and educational practices.

Vignette 1: ""Maths is just numbers"

> Maths was one of my biggest problems because I was a really good student in Maths in Portugal. I was an "A" (standard) student and when I came over here because they did everything so different, I couldn't understand. I felt completely lost and that was the worst thing because I thought, oh at least I can do good in Maths because it's just numbers, but no. (Liliana, taken from Abreu & Lambert, 2003, p. 195).

This quotation emerged from an interview with a Portuguese student who had migrated to England and was now learning mathematics in a different context from her own home country. Her words express her perception of what had happened with her in this change of context. She knew there were going to be many changes when

moving to England, but she never expected to have problems with mathematics. Mathematics is about numbers and numbers are the same everywhere. She realized that her strength became an obstacle in this new situation. Liliana's story exemplifies the dilemmas that many students are facing nowadays in European classrooms. As immigration increases and the diversity of students becomes more visible, challenges also arise for mathematics teaching and learning. These challenges have constituted the interest and focus of research of the participants in this working group.

Vignette 2: "Who are we here? Nobodies"

Interviewer: So, how do you think you can support your children in maths?

Mrs S: Well, sometimes I say: "Come on, children, learn! You've got to learn if you don't want to be emptying bins or scrubbing toilets." We all have degrees. All of us have normal jobs there. And then we came here. And who are we here? Nobodies! "And look at your Mom. She goes charring, she cleans other people's toilets".

This conversation was selected by Britta Hawighorst to illustrate the framework within which repatriate German parents, originated from Russia, educate their children. Though they have high levels of education the return to Germany has lowered their social status, and they work in jobs below their level of competence. Britta observed that this construction of experiences in comparison terms of the "past", in the Soviet Union, and the "present, in Germany, also apply to parents specific frames of reference of what counts as school mathematics.

Eminent cultural psychologists, such as Valsiner (2004), would not be surprised with the above observations. For him the experience of immigration is more than the physical act of relocation. At the psychological level the person makes sense of the immigrant experience through dialogic oppositions between the "old" and the "new" world. He further argues that the dialogic oppositions are not a transition stage, but can colour the person's life course. This view of the psychological experience clearly questions one-sided educational practices that do not provide opportunities for dialogue and negotiation. However, as illustrated in the following vignette this is not a simple issue, which only depends on the good will of educators.

Vignette 3: "I felt a little bit afraid"

"(...) This year I have an Ucranian pupil and in this case I felt, at the beginning of the year, a little bit afraid... afraid because I didn't know how to react and she didn't know a word of Portuguese... so the first classes I spoke to her in English..." (Marta, Portugal)

The above quote was extracted from one of Margarida César's interviews with a Portuguese teacher, but in fact, it could have been from many other teachers in many European countries, who after being trained to teach monolingual children find themselves in multilingual and multicultural classrooms. One can ask why it is expected that teachers who never had any professional training to teach in

multicultural classrooms should have the competencies and resources to teach children from different cultural backgrounds. The issue here, however, may need addressing at another level and the actual questions should be: (i) Why research on teaching and learning in multiethnic classrooms is not a bigger priority? (Abreu & Elbers, 2005). Why issues of teaching in multicultural settings are not central in teacher training? (see for example, Cline et al., 2002).

The cases presented in the three vignettes are just 'cases'. However, they should not be considered, at all, isolated cases. They represent the voices of the many more children that experience difficult transition processes (Abreu et al., 2002; Gorgorió et al., 2002) when they have to cope with a school culture different from their home culture, the culture of their origins or the culture experienced in the school system where they have been previously. Most of these children are an 'added difficulty or challenge' to their teachers, as in Marta's case above, when they do not become invisible to them. The immigrant children's difficulties become another emotional burden to their parents who do not know how to help with the situation their children live through.

The cultural distance arising in a multicultural mathematics classroom may become an obstacle to some students' construction of cultural and social identities as well as their identities as mathematics learners (Gorgorió & Planas 2005). Although challenging and complex, getting the 'culturally different children' to find their feet within the mathematics classroom is a crucial task, for it is at the very basis of working towards equity in mathematics education. Ladson-Billings (1997) suggested the need of first developing a conceptual interpretation of underlying problems and issues when addressing the subject of equity. Therefore, the working group "Mathematics education in multicultural settings" called for theoretical, methodological, empirical or developmental papers on issues such as:

Social and cultural aspects involved in teaching and learning processes and uses of mathematics;

Learning practices meaning, and social, cultural and mathematical background and identities in multicultural mathematics settings;

Language(s), communication and discourses in multicultural educational settings;

Gender and ethnicity in multicultural educational settings;

Learners' transitions between home and school numeracy practices;

Perspectives and lived experiences of teachers, parents and students in multicultural contexts/ communities;

Relationships between school policies and practices in the multicultural mathematics classrooms;

Teaching or curricular strategies that promote culturally inclusive mathematics classrooms;

Educational policies that promote culturally inclusive mathematics education;

Issues related to the teaching and learning of children of migration (recent immigrants, refugees, returned emigrants);

Relationships between social and political discourses and mathematics classroom discourse.

After the peer-review process, eleven papers were accepted for discussion during CERME4. In the papers researchers dealt with a variety of key elements in the study of mathematics education in multicultural settings, and adopted a diversity of theoretical perspectives and methodological strategies. The papers also addressed some problems of multicultural mathematics education in countries such as Denmark, England, Germany, Italy, the Netherlands, Portugal, Spain, and the USA. Since the researchers involved in WG10 are all committed towards equity, the challenge for us during the meeting in Sant Feliu was to discuss different issues to better understand mathematics education in multicultural situations, under different headings (we invite readers to refer directly to the papers in the group collected in these proceedings).

As interesting as the papers discussed, we have addressed five clusters of issues that were not only central topics in our meetings, but also areas that need further reflection and attention in our research. These five clusters are important for us as a group since they are related to the working agenda for the next meeting of CERME:

Conceptual clarification: What is multicultural mathematics education? How do we define concepts such as multiculturalism, interculturalism, dialogue, discourse, student's mathematical identity, etc. in this context?

Theoretical and methodological issues: How to integrate theoretical frameworks, methods and data analyses? How do we deal with the borrowing of theories and methods from other disciplines in mathematics education? How the methods and theory that we develop may have an influence in the field of mathematics education research?

Researcher's positioning: What is the role of the researcher? How do we acknowledge the researcher's influence on the subjects of study? How the researcher's personal beliefs and experiences contribute to construct their goals, theoretical lenses and objects of study?

Mathematical specificity: What is specific to mathematics education in our research of multicultural mathematics classrooms? What do we gain/lose by narrowing/widening the perspective?

Implications: What are the ultimate goals of our research? What are the implications for practice, for educational policies and for teacher training? What are the implications for the field of mathematics education research?

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CULTURAL IDENTITIES IN THE MULTIETHNIC MATHEMATICAL CLASSROOM

Guida de Abreu[1], *Oxford Brookes University, United Kingdom*

Abstract:*This paper explores the significance of cultural identities in the multiethnic mathematical classroom from students' and teachers' perspectives. The analysis draws on current socio-cultural theorising and on empirical studies, which involved interviews with students and their teachers. The findings show that students developed awareness of how their home cultural identities intersect with their school identities as mathematical learners. However, only a minority of the teachers interviewed "accept cultural differences", as involving a cultural identity dimension. The majority of the teachers tended to "play down cultural differences" on the basis of universal (and culture free) constructions of child development and understanding of "equity" as treating "everybody as equals".*

Keywords: cultural identities; multiethnic mathematical classroom; cultural differences; teachers; students.

Introduction

This paper explores the significance of cultural identities in the multiethnic mathematical classroom. This significance is examined from students' and teachers' perspectives. The analysis draws on current socio-cultural theorising and on empirical studies, which involved interviews with students and teachers (e.g., Abreu, Cline, & Shamsi, 1999; Cline et al., 2002; O'Toole, & Abreu, 2004; O'Toole, 2004). The interviews were conducted in primary and secondary schools in England as part of a wider research programme focused on the learning of children and young people from immigrant and minority ethnic backgrounds.

England is a country that has a long history of receiving immigrants from their previous colonies or from other countries for social, political and economic reasons. The composition of the minority groups in the schools is complex: second generation children, who were born in the country to which their parents or grandparents migrated, sit next to children from families who came to the country as recent migrants or refugees. As a country with a long history of immigration some basic structures for the integration of minority children in their mainstream schools have already been developed, for example, it is common that schools provide language

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support for non-English speaking children. However, there are still many challenges in order to understand the nature of learning and development in multiethnic British schools.

Though issues of identity are not totally new in accounts of learning, they have somehow been neglected to a secondary plane, or conceptualised at a group level. The quantitative studies of gender, ethnic identity and achievement in school mathematics are examples of this approach. Identity in this perspective is basically seen as a "given", "fixed", and "static" individual characteristic associated with a group membership. Studies informed by this view typically explore how people from a certain ethnic group perform in school mathematics when compared with other groups. This particular focus has been useful in exposing inequities in the mathematical performance of people from certain backgrounds. As such, one can argue these studies are important, as tools that in a democratic society provide public information of the access to available cultural capital. However, in terms of providing understanding of the processes that promote successful participation in school mathematical practices a different focus is needed. The information that students from a particular background generally achieve below, or achieve above, other groups is of very limited use for the planning of interventions if the reasons for the differences are not addressed. Indeed, this information may have a detrimental and stereotypical impact. It may be used to ascribe identities as "weak" or "poor" mathematical learners on the basis of cultural memberships.

Current socio-cultural theorising asks for more fluid and dynamic conceptualisations of processes of identity development. They ask for accounts, which consider both some continuity with the past of the cultural groups one is part of, and for the ruptures and profound discontinuities groups and individuals experience in the course of particular life histories (Hall, 1990; Hermans, 2001). This more dynamic perspective on identity seems to be more useful in accounting for learning in multiethnic classrooms, which potentially involve many sources of discontinuities for both learners and teachers.

In England, like in many other European countries, immigrant and minority ethnic learners often live 'in-between' the mathematical practices of their home culture and those of the school (Abreu, & Elbers, 2005; Chronaki, 2005; Gorgorió, & Planas, 2005). Teachers trained to teach monolingual and monocultural students from their own culture, teach students who may speak a different language and come from cultures they are not familiar with (César, & Favilli, 2005; Gorgorió, & Planas, 2001). However, in England, as a country with more tradition of receiving immigrants, some teachers themselves have already had to negotiate the practices of the home and school culture. This complex situation may add insight into the ways that cultural identities come to be constructed as significant for the school mathematical learning. Next, I will explore these constructions starting with the minority students' perspectives and concluding with the perspective of teachers.

Significance of cultural identities from the students' perspectives

Many studies with immigrant and minority students have now illustrated that they become aware of the differences between their home and their school practices (see Abreu, Bishop, & Presmeg, 2002). In addition, some studies have also shown that students talked about these differences in relation to how they perceived their home cultural identities as intersecting with their school mathematical learning. Gorgorió, Planas and Vilella (2002) clearly illustrated this intersection when they reported the case of Saima, a 15 year-old Indian girl, who expressed the feeling of being displaced in the Catalonian mathematical classroom. As she said

> "Miss, I 'm wrong in your class... I do the same mathematics as boys, but I will not do the same work... I do not want to be a mechanic. Please, can I do mathematics for girls?" (p. 44).

Saima's positioning was constructed at the intersection of her gender identity, her cultural identity and her identity as a mathematical learner. In a study looking at Portuguese students in British schools, Liliana, an 18 year-old student, born in Portugal, who came to England at the age of 15, also talked about how cultural differences affected her identity in school mathematics.

> "Maths was one of my biggest problems because I was a really good student in Maths in Portugal. I was an 'A'[standard] student and when I came over here because they did everything so different, I couldn't understand. I felt completely lost and that was the worst thing because I thought, oh at least I can do good in Maths because it's just numbers, but no" (Abreu, & Lambert, 2003, p. 195).

What is fascinating in Liliana's account is that she sees the intersection at the level of the school mathematical cultures in Portugal and in England. Her feeling of displacement originated from realizing that mathematics was not "just numbers" (or as we would say, a culture free subject).

Case studies, such as Saima's and Liliana's, illustrate that some students develop acute awareness of the significance of their cultural identity in their school mathematical learning. However, the dynamics that create particular types of intersections need more investigation. I argue that key social actors, such as teachers and parents play a role in shaping intersections of identities. Relevant others have a key role in orchestrating practices and interactions that provide resources for a person understanding and development of a sense of who they are, and for the person's recognition of their positions within social and cultural relationships.

When exploring how pupils of a Pakistani origin experienced their relationship between home and school mathematics, Abreu and Cline, (in press-a) found that some parents intentionally organised mathematical practices at home to cover content they perceived as fundamental, but not covered in the school curriculum. Abreu and Cline also found evidence that children from these families often develop awareness

of the differences between home and school mathematics, and that these include understanding of their identities as doers of mathematics in each context. Saeeda, an 11 year-old girl, learned to do long division at home with her father before doing it at school. As a consequence she became aware of some differences when division was introduced at school. She also realised that the school's answer was the same as when she used her "dad's way". However, when asked if she had showed her father's procedure to the teacher she said no, and then explained that she tried to use the "home way" at home and the "school way" at school. One can see that for Saeeda home and school mathematics were connected with particular identities, which she tried to keep apart.

O'Toole (2004; O'Toole, & Abreu, 2004) also found evidence of a similar developmental process in her study with learners in multiethnic mathematical classrooms. They examined the case of Monifa, a 10 year-old daughter of a Black African (Nigerian) family, who developed awareness that the differences between the mathematical practices of her father and her teacher were linked to their cultural identities. As she explained to the interviewer:

> "Sometimes they just explain it differently … Because my dad would have done it differently and it's where we come from because my dad was taught in Nigeria, and he taught in Nigeria. And Miss Durham has been here. So, they do it in different ways." (O'Toole, 2004)

She clearly positioned herself as a learner 'in-between' when recounting an event where the teacher tried to convince her that her father's solution was not appropriate. As she said:

> "I wasn't too keen but I understand my dad's more so I went with my dad. But she's my schoolteacher in school, so." (O'Toole, 2004)

Monifa suggested that the best way of coping for her would be to stick to each mathematical practice according to the context. But, as she explained, the practices of the school and home often made requests on her that made her feel as if she were "two people":

> "Its like I'm two people at the same time and its just hard" (O'Toole, 2004)

When O'Toole explored Monifa's teacher's view on the involvement of her parents with her school mathematical learning it emerged that she was aware of differences, but the intersecting of these with Monifa's home cultural identity was not addressed. Instead, it was conceptualised as an example of the practices promoted in the Numeracy Strategy, and linked to being a "top maths" set student. It may be the case that children who do well in school mathematics feel more comfortable at explicitly bringing their home maths into school. Nevertheless, one wonders why Monifa's teacher, who used as examples two students from a minority cultural background did not refer to this dimension. Next I will attempt to address this issue further by examining the significance of culture and ethnicity in the accounts of children's

mathematics learning at school given by teachers from different backgrounds, and involved in different research projects.

Significance of cultural identities from the teachers' perspectives

Overall, in the studies examined here (Abreu et al., 1999; Cline et al., 2002; O'Toole, & Abreu, 2004) two clear positionings have emerged in teachers' accounts of the significance of cultural and ethnic background on their pupils' mathematical learning. One positioning stressed "playing down differences" the other positioning stressed "accepting differences". These different positioning are similar to those mentioned by Gorgorió and Planas (2001). No doubt that the teachers' subscription to one or the other may have implications for their classroom practices. Here, however, what I would like to examine is the underlying representations for each positioning and associated identities.

"Playing down differences"

The teachers who expressed a view that stressed playing down cultural differences among their pupils, evoked two types of representations. One type of representation draws fundamentally on the notion that "the child's ability" is the key determinant factor in their mathematical learning. This "universal construction of children" takes priority over ethnic and cultural backgrounds, as expressed by teachers in the following extracts.

> "As far as I'm concerned, you teach Maths according to the child's ability – not their ethnic minority [laughs] ... I don't treat them any differently to any other… and I wouldn't expect them to behave any differently to any other child." (Primary school maths co-ordinator; Cline et al., 2002, p. 101)

> "I think (…) there's an inherent ability. I think there is an ability to deal with numbers that's inherited. And given that children often, unless they meet a teacher that undermines that early on, they will develop that. Because they can grasp things and concepts quickly. Even without the language the mother tongue being the language of instruction. Because they deal with the numbers, they can, they picture it in their head." (Primary school teacher, Abreu, Cline & Shamsi, 1999)

The other type of representation associated with playing down differences draws on the notion of "equity". This view is illustrated in the following extract from and interview with the Head of Maths in a secondary school, who referred to treating "everyone as equals" based on their "merits", as a justification for not taking into account ethnic differences.

> "I certainly think that within our department that we do extremely well and treat everyone as equals, everyone on their merits. There is no prejudice whatsoever that I have ever picked up here with regards to the different ethnic minorities. I think that is part of the reason that we haven't really considered that. We do a lot of results analysis. That is a big thing at the

moment. We have never really looked at the ethnic minority. I know you are compiling data about how the ethnic minorities do at the GCSE's. We have never done that. Really it has never come to our minds because we do see everybody as equals." (Cline et al., 2002, p. 101)

The above views were typical among a sample of 10 teachers interviewed by Abreu, Cline and Shamsi (1999). They were also typical among the 77 teachers (including the maths co-ordinators) interviewed in 14 mainly white schools in England, by Cline et. al (2002). Teachers who draw on the notion of "ability" and on the notion that "everyone is equal" extend to their students, identities as mathematical learners, which are "culture-free". Teachers' lack of recognition of the cultural nature of mathematical practices may restrict opportunities for the children to openly negotiate the differences at school. This can then explain the difficulties that pupils, such as Monifa (O'Toole, 2004), experience in constructing identities as school mathematical learners, that can include their home cultural identity, without feeling that they are "two people".

"*Accepting cultural differences*"

The teachers who expressed a view "accepting cultural differences" also drew on more than one type of representation of the cultural differences. Language and socio-cultural background were key dimensions of these representations. However, the way they were conceptualised varied in terms of the relevance given to cultural identity in the accounts. When for instance drawing on language to elaborate the differences, two distinct representations emerged. One representation constructed the difference along a cognitive line, that is, in terms of the specific language required in the mathematical classroom.

> "Because we felt that when you're using something like maths there is an awful lot of very subject specific language that they're using. But language that they aren't always gonna come across in the rest of their life. And a lot of the children who have English as an additional language have a more limited range of vocabulary even when they're fairly fluent they may say, you know perhaps expressing something. (Primary school teacher, Abreu, Cline, & Shamsi, 1999).

This teacher's conception of developing language that is instrumental to school mathematical learning is predominantly cognitive. She acknowledges that home environments may constrain a child's language development but this is then translated into a limited range of vocabulary that impairs understanding and therefore needs to be developed.

Sasha, a minority ethnic classroom assistant, interviewed in the same study (Abreu et al., 1999), talked about the role of language from a different angle:

"It's very difficult, you know, to pinpoint specifically but you know it might just be sort a flash thing where a child says something and I say -well hold on this is what it actually means in Urdu. And ... did you realise this or you know it might be just one word that's spoken, and I've said to them well hold on- this word actually means this in English but it means this is in our language and did you know it means this in Italian or something you know. But it's, I think when you do things like that it shows them that they're not isolated. That you know this is not just a language for home." (Abreu, & Cline, in press-b)

Sasha's representation of language included features related to the minority pupil cultural identity. She constructed language as being a tool of identification, which she described as understanding that being bilingual does not imply feeling "isolated" and that the family language is just "for home". This view of language as identity mediator seems to be rooted in her own experiences when she was a child in an English school. To survive school she had to exclude and silence her Pakistani home culture. She recounted this experience in the following way:

"I think the thing is that sometimes when you are from a bilingual background I mean I can only relate this back to myself (...) I can always remember when I went to school. It wasn't like it is now, where these children have, there's so much emphasis placed on their mother tongue, I mean I'm here, you know, supporting them in their mother tongue. I can remember when I was in school and I wouldn't dream of ever saying any word in my own language at school. Just the embarrassment of it would kill me you know. But yeah, I am much more stronger because I think I have, I have that other language." (Abreu, & Cline, in press-b)

In the current analysis is the teacher who herself has been a child in-between, who stressed the differences between home and school, and by doing this described strategies to enable her pupils to construct identities as school learners that include their home cultural identities. She represented a minority voice outside the consensus that mathematics is a culture-free subject and that ability is the main factor in the mathematical learning of minority ethnic learners. Her experiences and positioning are more similar to those reported by minority students such as Saeeda, who referred to keeping her home maths apart, which is the equivalent to Sasha's hiding her home language at school.

Some concluding thoughts

The analysis presented in this paper shows that cultural identities are an important aspect in the understanding of how minority ethnic pupils experience their mathematical learning at school. This conclusion was based on case studies of students who demonstrated awareness of these identities and how they intersect with school identities. Four particular cases were sampled: Saima, a 15-year old Indian girl studying in Catalonia, Spain (Gorgorio, Planas, & Vilella, 2002); Liliana a 18-year

old Portuguese girl studying in England (Abreu & Lambert, 2003); Saeeda, a 11-year old girl Pakistani girl studying in England (Abreu & Cline, in press-a); and Monifa, a 10-year old daughter of a Nigerian family studying in England (O'Toole, 2004)[2]. The reason for selecting these students was the fact that they clearly articulated the intersection between their home cultures and identities and their school mathematics learning. However, there were many other minority ethnic students participating in these studies, so one can ask the extent to which these other students also reported similar experiences. The answer to this question will be 'yes' for some students, and 'no' for others. Does the <u>no</u> mean that cultural identities may be significant for some minority learners and not significant for others? Theoretically this is a possibility, in the sense that human development may follow different paths. In fact, examples illustrating that the shape of the intersections interacts with engagement with practices orchestrated by key social actors, such as parents and teachers, points out towards different pathways. However, an alternative and/or complimentary explanation is that there is not a simple direct relationship between being able to articulate the significance of a cultural identity and its impact on one's lived experiences. This suggests a need to develop methodologies, which are less dependent on learners' ability to express their experiences through talking.

With regard to the teachers, the studies examined suggested a great divide on the teachers' views on the significance of cultural identity in the mathematical classroom. This divide includes teachers who "play down cultural differences" on the basis of universal (and culture free) constructions of child development and understanding of "equity" as treating "everybody as equals". In the studies reported this was the dominant representation, in the sense that was shared by the majority of our participants, but also in the sense that the institutional structures facilitated drawing on this view. For instance, often teachers referred to their professional training, the National Curriculum and the teaching materials as constraining their practices in multiethnic classrooms. Teachers, who "accept cultural differences", as involving a cultural identity dimension, were a minority in our studies. Interestingly, they were teachers who could resource their views drawing on their own personal experiences of being of a minority ethnic origin, and others drawing on interactions and learning from their own minority students.

These two main teachers' positionings reminded me of dominant trends in the psychology of human development, in terms of their focus either on universals or in culture specific aspects. What is missing in these conceptualisations is the notion that one aspect does not eliminate the other (Wertsch, 1991), and that educational practices and research will benefit from a better understanding of the cultural dimension. However, the extent to which representations that stress the importance of cultural identities can be used as resources for change from culture-free to culturally

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[2] *Though the cases sampled were all girls examples involving boys are also available in the literature (e.g. Cline et al. 2002).*

sensitive practices is a question for further research. The fact that in the findings from the current projects the views of cultural identities as mediators of school mathematical learning have been mostly found among minority ethnic teachers, can be seen as a consequence of the dominant cultural practices and representations. By this I mean, for example the practices in teacher training, who give little attention to preparing teachers to understand the cultural nature of learning and human development. Secondly, implicit conceptions of the social and emotional development of the child at school draw on representations of childhood, which often do not take into account the multicultural diversity of current societies.

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CULTURE, DIVERSITY AND CONFLICT
IN LANDSCAPES OF MATHEMATICS LEARNING

Helle Alrø, *Aalborg University, Denmark*

Ole Skovsmose, *Aalborg University, Denmark*

Paola Valero, *Aalborg University, Denmark*

Abstract:*In researching mathematics education in multicultural settings we define a "learning landscape", which refers to the field of investigation constituted by the different components of mathematics education practices which have an impact in the ways in which learning and teaching takes place in multicultural classrooms. We explore some of the aspects of such a landscape through the discussion of three nodal notions: culture, diversity and conflict. We situate these reflections in the particular context of Denmark and the current challenges to the mathematical education of students with a non-Danish background.*

Keywords: conflict, culture, diversity, landscapes of mathematics learning, learning landscape, multicultural setting.

Introduction

In Denmark, as in many other countries in Europe, immigrant population has become an issue of political debate and a concern for and challenge to democratic stability. When compared with other countries, the Danish immigration policy has in recent years become one of the most strict and tight, as a result of determined political action to influence the development of the composition of the population and the economic sustainability of the country, among others (MFII, 2004). Discussions about 'ethnic people' as opposed to being 'Danish' (which is obviously not considered as being ethnic) are daily bread. The tone of the debates, however, is not the most positive of all, as seen in the newspaper article below:

When Danish parents acknowledge colour

By Sanne Nyland Christensen and Katinka Agger

The older students in Holly Cross School have difficulties in understanding why one calls their school 'Danish' when 80% of the students speak two languages. They are of the opinion that Danish parents fail when they keep their children away from classrooms with ethnic students.

It's noon. It's almost 12 and the students at Holly Cross School keep a sharp eye on the big clock in the yard to see for how long they can play before the books have to be taken out of the bags again. The long lunch break is coming to an end, and shortly the neighbourhood version of a Danish school will be filled with black curls and heavy

accent. For 80% of the students in the school are bilingual and, despite the school leaders' efforts to attract more Danish students living in the area, there is no change in the fact that only 9.2% are blue-eyed.

'At the beginning there were more Danes in the class. But they were slowly changed to another school by their parents', explains Xhina, 15. She comes from the former Yugoslavia but had to flee with her parents when she was three. The family's plan has always been to integrate themselves as good as possible in Danish society. Therefore Xhina and her sister are in the Danish public school. But without success. As she says: 'How can I learn to speak without a dialect and understand Danish customs in this class? Apart from Dennis there are no more Danes. That is a pity because we could learn very much from each other'. Xhina thinks that in one or another way Danish parents are foolish when they move their children from the public school for fear from those who speak two languages. 'Of course I can understand that they are afraid if they believe on what they read in the newspapers about second generation immigrants. But if they sent their children to the same school than us, then they would probably find out that we are not that bad at all', says Xhina while her friends Melisa and Suzana enthusiastically manifest their agreement. They are both born in Denmark from refugee parents and know very few Danes. But according to the girls the situation will hopefully change when they all go to high school next year. (Our translation from Urban Newspaper, October 24 2003, http://www.urbanavis.dk/article.php?id=1011)

Debates are plagued with conflict of different type emerging from different sources, and fundamental questions are being raised about what is 'Danish' and what is 'the other', and about the possibilities of peaceful co-existence. In such a conflictive context schools and mathematics teachers meet a diversity of students, and in this context mathematical learning takes place. Our research project, 'Learning from diversity' (http://www.lfd.learning.aau.dk, Alrø, Skovsmose & Valero, 2003), addresses the learning of mathematics in such a context.

In this paper we will outline what we consider to be the field of our investigation through the idea of a 'learning landscape'. In particular we are going to comment on the notions of 'culture', 'diversity' and 'conflict'. These notions we find of importance to illuminate the current situation in multicultural mathematics classrooms from socio-political perspectives.

Landscapes of learning

What to look at, and where to look in order to gain an understanding of the complexity of mathematical learning in multicultural situations? One possibility is to study the classroom. However, it turns out to be very difficult to point out to what is inside and outside of it that is of significance for understanding the learning going on. One could certainly try to observe the interaction in one mathematics classroom. However, should we consider what is taking place in other classrooms in other schools or even in other subjects? And what is happening during the breaks? Should we consider what is happening on the students' way to and from school? And what is happening at home? Should we consider the parents' cultural background? And how

the teachers are talking about the students in the staff room? Should we consider policy guidelines, which the teachers have to comply with? Should we consider how teachers might be involved in political activities? Should we consider the whole socio-political setting?

Somehow all these questions seem important because, if we accept the assumption that mathematics education and mathematics learning are complex social practices constituted in a multiplicity of contexts of action, it is plausible to conjecture that grasping those practices will demand looking at those multiple levels of action (Valero, 2004). However, our study could easily explode in an un-researchable complexity. Naturally, we cannot explore everything, but we can identify some dimensions along which we try to establish connections between events in the classroom and the social life outside of it. This brings us to consider a *learning landscape*, interpreted as the scenario, in all its complexity, where the learning and teaching of mathematics is acted out.

In our investigations we restrict ourselves to select eight *features* of a learning landscape, which we consider to be of importance in the constitution of the practices of mathematics teaching and learning in multicultural settings. Such importance is justified in terms of what literature in the field has found to be of relevance, or in terms of our own theoretical assumptions about the focus of our study.[1] These features are: (1) Classroom interaction among students and between students and teacher (documented by Gorgorió & Planas, 2003 and Alrø & Skovsmose, 2002). (2) Cultural elements which are the base of students' construction of identity. (3) Students' foregrounds, which refer to students' interpretation of learning and 'life' opportunities that the socio-political context seems to make available to students (Skovsmose, in print) (4) Teacher's perspectives, opinions and priorities of teaching. (5) Parents and friends who are reference groups for the construction of students' identities (documented by Gutstein, 2003). (6) Mathematical referent for classroom interaction, including forms and priorities for how mathematics should be taught and learnt. (7) Tools or resources for learning that students might have available and might consider relevant for the learning of mathematics. (8) Public discourses about immigrants, schooling and multiculturalism (documented by Martín-Rojo, 2003).

In particular, we are interested in considering connections between the different features of a learning landscape. Thus, what happens in a classroom interaction might resonate with some of the students' hopes and aspirations; and the latter might also resonate with priorities the students have picked up from parents or friends. Students' foreground might resonate with public controversies: For example, the way in which immigrants are treated may have an impact on what immigrant students might consider to be their future opportunities. This could turn into motives (or

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[1] There is no doubt that we could have selected rather different features of the learning landscape. The selection is done a priori to the analysis of data, but it is far from any a priori *given*. It just represents a first tentative guess of what to include as features of a landscape of learning.

obstructions) for learning. A landscape of learning functions as a chart to map the routes for analysing relationships between highly different elements of significance for mathematical learning.

Since the features of a learning landscape are quite different in nature, it is not simple to identify a unified terminology to use in order to refer to its components. However, we are going to present three concepts (*culture*, *diversity* and *conflict*), which we consider to be nodal points in our conceptual framework since many of the different features of our learning landscape relate to each of these concepts.[2] In what follows we will explore these concepts and try to provide illustrations of the way in which they connect the different features of our learning landscape.

Culture

One of the features of a landscape of learning we have referred to is the 'cultural elements'. Thus, it is necessary to discuss the notion of culture in order to deal with other features, as well as with their interrelationships. We follow Nieto who defines *culture* as 'the ever-changing values, traditions, social and political relationships, and worldview created and shared by a group of people bound together by a combination of factors (which can include a common history, geographic location, language, social class, and/or religion), and how these are transformed by those who share them' (Nieto, 1996, p. 390, quoted in Nieto, 2002, p. 53).

This definition refers to the changing commonalities of a group of people given a series of shared experiences. This formulation could be interpreted as if a person belongs to one and only one culture, and therefore address only one dimension of what we consider to be culture. We would like to add to this definition the idea that a person or a group of people can at the same time belong to different cultures in relation to individual or collective activity. That is, in certain practices in a particular context, people may adhere to the values, traditions, relationships and worldviews that are defined by the field of practice within which the activity they engage in is located. This implies that individuals and groups may identify themselves with more than one culture at one given moment, that they may share one or more of these cultures, and that such an identification with cultures is changing not only with time (as suggested by Nieto), but also according to activity and situation (suggested by Gullestrup, 2003).

This brings us to the notion of *multiple cultures*. A person could be born and have lived in a certain part of Denmark, North Jutland for instance, and in many situations it makes sense to say that the person belongs to or represents the culture of North Jutland. This includes values, traditions, priorities with respect to food and drink, dialect, expressions, types of jokes, etc. Such elements show the difference to other cultures in Denmark. The same person might also be referred to as a Dane. If a

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[2] A fourth important concept in dealing with features of a learning landscape is *power*. We reserve, however, a different presentation for dealing with this concept.

differentiation should be made with respect to Turkish cultures, then some other cultural qualities might be highlighted. It could also be emphasised that the person is working at the university, and that she makes part of an academic community. In this respect she might share many more perspectives and values with her Turkish colleague than with a neighbour working as a salesman. A person might belong to different cultures, depending on the context, and depending on the roles played at a certain moment.

This notion of culture implies that most of situations where people meet are *multi-cultural* situations. A mathematics classroom, for example, is a space where several more or less well-defined cultures, literally speaking, sit next to each other. This means that participants in classroom activities construct different groupings and share different cultures around a variety of elements such as their origin, mother tongue or second language, mathematical ability, gender, religion, political orientation, future possibilities, etc. These cultures come in place in different times according to the activity being carried out in the classroom. The formation of different cultural groups is related to the collective dynamics of activity in that class, while the role that each person plays in those groups is related to the individual construction of identity through participation in activity. It is in this interplay between individual and collective construction of groupings and identity that the classroom interaction becomes a social space for cultural encounter.

An important example of this multiplicity of culture is operating in inclusion-exclusion discourses referring to immigrants.[3] According to the official documents of the Ministry of Refugee, Integration and Immigration Affairs (MFII, 2004), there are three labels to refer to the different people living in Denmark. These labels are statistical definitions of the population according to the Danish Statistical Institute: (1) A person is a *Dane*, if at least one of the person's parents is both Danish and born in Denmark. It doesn't matter if the person her/him self has Danish citizenship or if the person is born in Denmark. If a person is not a Dane, then the person is either: (2) A *foreigner*, if the person is not born in Denmark. (3) A *descendant* if the person is born in Denmark. This classification of people living in Denmark (Danes, foreigners and descendants) might appear simple enough from a statistical point of view, however it might become highly problematic to live along such lines of classification.

Immigrants (called 'foreigners' or 'first generation immigrants') have moved from their home country. They have lived in Denmark and have their families here (such as Xhana's family). They have got children (called 'descendants', 'second generation immigrants', 'bilingual children' or 'ethnic children'), who have gone to Danish schools and who speak Danish fluently (such as Melisa and Suzana at Holly Cross School). The everyday language of parents and children may be different. The notion of mother tongue has a new meaning; so does the notion of 'bilingualism'. In the school these children may be seen as Danish, at least as Danish they could be in as

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[3] The case of Denmark appears to represent a general phenomenon (see for example Martín-Rojo, 2003).

many situations as possible. In school, however, the cultural differences could always be brought in operation. Descendants may experience that inclusion-exclusion processes, drawing on cultural references, can be brought in operation whenever somebody find it opportune. They become positioned at a new cultural borderline. They may experience that multiple-cultures mean to switch between cultures. Sometimes they could do the switching themselves, sometimes the switching could be imposed on them.[4] Furthermore, if we consider 'third generation immigrants', then, within the same family, all three statistical groupings and all labels emerging from public discourse can be present.

Processes of inclusion and exclusion are important features of a learning landscape. Whether one belongs to a certain cultural group (with reference to a certain practice), or one is outside can be imposed on people, as exemplified by the statistical classification, but demarcations can also be done through a variety of other processes. Children locate themselves with reference to groups of friends. One can be inside or outside, depending on agreement, acceptances, tolerance, or the opposite. Processes of inclusion and exclusion bring about different conditions for the students to experience their learning situation. These processes can be reflected in the classroom communication and in the students' foregrounds. This brings us directly to the notion of diversity.

Diversity

Diversity is everywhere where people meet and interact and everybody has to deal with diversity. Who am I in relation to the Other(s)? How can I deal with differences, inequalities, contradictions, disagreements etc.? To deal with such challenges is part of our everyday life and it is a source for shaping our identity.

School is an institutional context of diversity including cultural diversity. Diversity in the multicultural classroom can be approached from different angles, but there seems to be two competing paradigms: Diversity can be seen as a problem and as an obstacle to learning. From this point of view homogeneity is seen as important to a well functioning learning environment, and the problem of diversity should be eliminated as quickly as possible by trying to make 'the others' be like 'us'. However, diversity can also be considered a resource for learning, because of the presence of multiple experiences and perspectives. This can, for instance, be seen in the academic world, when researchers from different countries collaborate on a project, or in art when different cultural approaches are brought together. The (Danish) school system, however, seems to maintain a deficit perspective on cultural diversity. The landscape of learning is highly influenced by these two discourses: We can refer to them as the *sameness discourse* and the *diversity discourse*.

The sameness discourse includes forms of talking which easily turns into a deficit

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[4] Staunæs (2004) documents such a complexity of identity in her book about gender, ethnicity and school life of immigrants in Denmark.

discourse. The basic assumption is: while 'sameness' facilitates learning, then 'diversity' is an obstruction to learning. This assumption has been cultivated in the Danish political debate and, under pressure from right-wing policy, it has developed into a more general educational policy. Counter examples to this discourse can be found, for instance, in South Africa, where, after the end of the apartheid regime, the acknowledgement of 11 official languages has been celebrated as an important step in the development of democracy, and where the rights of the children to learn in their mother tongue has been emphasised as an important political achievement.

In Denmark, the sameness discourse has spread into a variety of discourses, which highlight that diversity causes problems – it is not seen as a resource for learning. And this idea brings about a well-defined strategy: Diversity has to be eliminated. Thus, in case children operates with two languages, a mother tongue and Danish, maybe in a more elementary format, this problem of diversity has to be eliminated by developing as fast a possible Danish as an operational language for everybody in the classroom. Sameness has been nominated as a prerequisite for learning efficiency. The notion of 'bilingual children' is used as a description of non-native children meaning children whose mother tongue is not Danish and who are still in lack of sufficient Danish language skills. So, the diversity of ethnic Danes and ethnic Others is viewed first of all as a problem of missing Danish skills. An obvious objection to that is that speaking more than one language should be seen as a resource rather than a problem in a global society.

One way of eliminating cultural diversity is to make it 'invisible' in the classroom environment. Teaching goes on as if there were only ethnic Danish children in the classroom, although there might be some assistant teachers moving around in the classroom in order to help the immigrant students understand the Danish language. The students are allowed to use their mother tongue until Danish is achieved. This approach deals with diversity from a sameness perspective. And sameness is supposed to appear when 'they' become like 'us'. In this way diversity should not turn into conflict. The question is, however, whether making conflicts invisible also means making them disappear. As Núria Gorgorió stated at CERME 3 (2003): 'Often the apparent lack of conflict only means that it is invisible to the observers'.

Let us take a look at an example from a Danish 3rd grade with 23 children of which 5 are Somalis. In the classroom, however, the only signs of diversity are the colour of the skin and the different cultural origin of the children's names that are signed on their personal boxes for educational material. However, one Somali girl is wearing a scarf, and two Danish girls wear cap peaks. One wall is covered by a big painting that has been created by the students. The painting shows a historical time line from before Christ to present time. On another wall there is an exhibition of children's drawings about past, present and future of Danish history. There are no artefacts whatsoever with a Somali or Muslim content. This is one way of making cultural differences 'invisible'. But it might also be a potential for conflict, because the 'absence' of Somali culture can be interpreted in terms of not important for the

learning environment. This again might turn into learning resistance, because as Nieto puts it: 'To agree to learn from a stranger who does not respect your integrity causes a major loss of self' (Nieto, 2002, p. 21).

The Somali students are 'bilingual children', and a main school effort is training in Danish. Good skills in Danish language are seen as the main road to learning. And the other way around the Somali children are not supposed to learn anything even in mathematics before they have achieved an acceptable level of speaking and understanding Danish. According to the sameness discourse: When differences occur in the classroom, they have to be ignored or eliminated. Thus, there are no extra resources to be found in bilingualism, which is just one example of the sameness discourse turns into a deficit discourse.

The diversity discourse represents an alternative view. Diversity occurs in interaction and can be handled in interaction. Sometimes diversity is what interaction and communication is all about. Diversity can be observed as differences in gender, colour, age, language, religion, etc., but diversity can also be observed as differences of perspectives in the interaction. The experience of diversity can be followed by a wish to persuade or convince the other, and argument and discussion can lead to disagreement and conflict. On the other hand diversity and the experience of different perspectives might lead to a curiosity towards diversity and a wish to get to know more about the perspective of the other. In that case diversity can be handled in the interaction as an openness to inquiry of different perspectives, guided by mutual respect of differences, trying to understand and to learn from what is different. This is what we have characterised as dialogue in interaction (Alrø & Skovsmose, 2002).

The sameness and diversity discourse is reflected in different features of our learning landscape. One could refer to public discourses addressing schooling and multiculturalism. The newspaper article at the beginning of this paper is an example of a type of hot debate in Denmark at the moment (particularly now when parliamentary elections are getting closer). One hears formulations about 'de sorte skoler' ('the black schools'). This metaphor combines two connotations. Within the last many years 'den sorte skole' ('the black school) referred to traditional school principles emphasizing the importance of strict teaching of a classic curriculum (being Latin a predilect subject). 'Den sorte skole' is rich of unpleasant connotations. However, when used nowadays, the terms are in plural and the word 'sort' ('black') gets ethnic connotations (such as in 'black curls and heavy accent' in the newspaper article above). Now 'de sorte skoler' refers to schools with a majority of immigrant students such as Holly Cross School. Thus, immigrant students are stereotyped by their assumed physical appearance: darker skin. Furthermore, the expression 'de sorte skoler' has turned official as it is now used in, for instance, the news (the Danish TV on the 18th of October 2004).

'De sorte skoler' becomes a public expression through which not only politicians but also school administrators and teachers may express opinions and priorities. It could

become part of teachers' staffroom discourse. It affects parents' (both Danes and non-Danes) ways of perceiving their children's possibilities (who want to have their children in a 'sort skole' over populated by bilingual students, as Xhina expressed?), and it affects the students' foreground and their perception of identity. Generally speaking, the discourse including such expressions influence the features of the learning landscape.

In the learning landscape characteristics of the eight selected features illustrate the diversity and the potential risks and advantages of it. As Pearce and Littlejohn (1997, p. 62) point, divergence and conflict can easily emerge from diversity:

> Cultural divergence becomes painful in conflict situations when others challenge our common expectations about how to proceed […]. Problems arise when one party in essence says to the other, 'People like us don't do it that way'. Behind this feeling is a more fundamental fact: 'People like us don't think about things that way.' Thus, thinking itself differs from one culture to another, making cultural forms fundamentally moral.

Conflict

In a multicultural setting conflict operates in different, but often mutual related arenas. There can be intrapersonal conflicts within an individual; interpersonal conflicts between people or groups of people, and there are conflicts on national and international levels of society. When we speak of conflicts with reference to a multicultural learning landscape, we think of intrapersonal, interpersonal as well as intergroup conflicts. Furthermore, international conflicts such as ethnic and religious conflicts are present, being either articulated or silenced.

Many conflicts emerge in interaction. Some even argue that 'people produce conflicts through interaction' (Pearce & Littlejohn, 1997, p. ix) or that conflict simply is the interaction 'of interdependent people who perceive incompatible goals and interference from each other in achieving those goals.' (Folger, Poole & Stutman, 2001, p. 5). In this concept of conflict people do not enter a conflict. They create or construct it in their interaction. Not necessarily on purpose, but inevitably because of the always existing manifold of personal, social and international diversity in society. According to Pearce and Littlejohn, conflicts 'happen when people deeply enmeshed in incommensurate social worlds come to clash.' (Pearce & Littlejohn, 1997, p. 49). So conflict emerging from diversity is inevitably present in many relationships. However, it is important to point out, that diversity does not per se lead to conflict. It is a source of conflict. Conflict only emerges when diversity 'comes to clash', e.g. when it comes to fight and defence of different perspectives. This can be the case even if differences are silenced as is the case in the sameness discourse.

Diversity might produce conflict, but it might also produce other things, e.g. ignorance, disagreement, interest, searching for harmony/sameness, curiosity, dialogue, love. Diversity can strengthen a relationship or open new possibilities depending on the way people deal with it. In the newspaper article we hear the slender voice of the diversity discourse in Xhina's words, which allude to the

possibilities of 'learning from each other' if diverse views that Danish parents have about 'second generation immigrants' are overcome. Learning from diversity in this sense could mean investigating differences through an open dialogue.

So, diversity could lead to conflict and to dialogue as well. And both conflict and dialogue could produce learning. Thus, we do not consider conflict in negative terms only. Conflicts can be expressed and handled in interaction between the conflicting parties, and they can turn out to be productive or destructive depending on the way they are handled. Working through conflict can be a potential for learning.

A negative and destructive way of dealing with conflict is through the use of violence. At an international level of conflict this could mean war and the use of physical and psychical power. This could also be the case at an interpersonal level of conflict. Another way of coping with conflict would be to go to court. This does not include violence, but it certainly includes the use of power. In school conflict on different institutional levels can be met with the use of power, and this also counts for conflict in the multicultural classroom. But there are other ways of conflict management, which actively include the parties involved. In such cases dialogue could be used as a way of coping with conflict.

Of course, conflict can be understood in negative terms as something that should be avoided or solved. Our notion of conflict, though, includes problematic/destructive elements as well as dynamic/constructive elements. For example, conflicts in a multicultural classroom are not necessarily solved by introducing a common, unifying language –for example Danish– or by introducing a common contextualisation for a mathematical subject. Conflicts refer to contradictions, disagreements and problems that need to be solved, but they also include potentials for learning and development.

This duality of conflict can be seen in the sameness and the diversity discourse. In the sameness discourse conflict is problematic and related to what is 'unfamiliar' and 'different'. This leads to an attempt to normalise and assimilate what is different in order to integrate. Here the potentials of conflict and diversity are neglected. The diversity discourse makes a virtue of differences. It contributes to the destruction of the deficit idea about making 'them' become like 'us'. This can make not only an entrance to tolerance and human accept and respect, but also to potentials for learning.

It becomes difficult to talk about features of a learning landscape and their relationships without considering the notion of conflict. We can experience conflicts with respect to classroom communication, with respect to cultural diversities, with respect to public discourses etc. We have emphasized that diversity is part of our everyday life, and so is conflict. And conditions of learning are affected by such conflicts and the way they are addressed (or ignored).

Concluding remarks

We do research with an intention, and nobody needs to doubt that we feel troubled with the way immigrants in Denmark are treated. We do not feel much sympathy with the discourse of sameness, while we put more hope into the discourse of diversity. We share many of the concerns which Nieto has brought into the definition of multicultural education:

> Multicultural education is a process of comprehensive school reform and basic education for all students. It challenges and rejects racism and other forms of discrimination in schools and society and accepts and affirms the pluralism (ethnic, racial, linguistic, religious, economic, and gender, among others) that students, their communities, and teachers reflect. Multicultural education permeates the schools' curriculum and instructional strategies, as well as the interaction among teachers, students, and families, and the very way that schools conceptualize the nature of teaching and learning. Because it uses critical pedagogy as its underlying philosophy and focuses on knowledge, reflection, and action (*praxis*) as the basis for social change, multicultural education promotes democratic principles of social justice. (Nieto, 2002, pp. 29-30)

Diversity is everywhere and the way of dealing with diversity is decisive of the outcome i.e. the quality of learning. In that sense conflict and dialogue are two contradictory ways of dealing with diversity. Conflict as fighting for one's position and perspective or giving it up and dialogue as the willingness to examine the perspectives of oneself as well as of the other. Both dialogue and conflict can lead to learning, but as conflict and dialogue have different qualities in interaction we will talk about learning with different qualities as well. Working through conflict can be viewed as a learning process. Dealing with conflict could mean learning from diversity. To us multicultural education, as described by Nieto, is a possibility. But it is a possibility easy to obstruct.

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DIVERSITY SEEN THROUGH TEACHERS' EYES:
DISCOURSES ABOUT MULTICULTURAL CLASSES

Margarida César, *Universidade de Lisboa, Portugal*

Franco Favilli, *Università di Pisa, Italy*

Introduction

Italy, Portugal and Spain were mainly emigrant countries until the last decade of the twentieth century. Then, Portugal lived a special situation as after the 1974 revolution many African children and teenagers moved to Portugal, beginning to attend regular school there. This means that nowadays, while in Italy and Spain immigrants are usually first generation ones, in Portugal we face a double reality: African students that are second generation, or even third generation as girls usually have their first children when they are very young; and many other students from different cultures (Eastern Europe, Macao, Timor, China, and Latin America, namely Brazil) who moved to Portugal in the last decade. Those whose mother tongue is not Portuguese and whose children were in school age, often face another difficulty: children begin attending Portuguese schools before learning Portuguese. But a common challenge exists in these three countries: schools have become multicultural. Heterogeneity is a reality. Teachers needed to learn how to deal with different cultures, ways of reasoning, values, beliefs, attitudes, and expectations, namely towards school. And this is no easy task... Being teachers one of the key agents in a multicultural classroom, we are going to focus on their role in order to promote an intercultural education, and on their discourses about multicultural classes. Focusing on them and mostly discussing their role and accounts does not mean that we consider they are the only element influencing students' achievement, nor that we do not assume the need of broader social changes which are needed. This is only the research focus we chose to present in this paper: How is diversity seen through their eyes, and accounted in their discourses? Are they able to change their practices according to their multicultural classes or, at least, do they want to be able to change them?

Changing is even more needed when we notice that Mathematics is one of the subjects with a higher rate of underachievement and also one of the most selective ones. But, above all, we notice that European society is very demanding about literacy and, in order to become participant and critical citizens, students must appropriate and be able to mobilise considerable mathematical knowledge. This is reflected in most policy documents which suggest that mathematical activities developed within Mathematics classes should provide a broad diversity of learning

experiences (Abrantes, Serrazina, & Oliveira, 1999) in order to develop students' competencies. But although these ideals are already expressed in policy documents' discourses, teachers' daily practices are still quite far from them. Textbooks tend to give only the mainstream cultural examples and the tasks that are presented in most classes ignore the existing cultural diversity. Being different is mostly seen and felt as being rejected –or, at least, harder to succeed– and so students tend to hide their cultural roots. The question is that this invisibility is probably one of the main elements contributing to a larger amount of underachievement and lack of consistent life plans, a common reality among students who came from other cultures and who live in Europe nowadays. But in order to change their practices, teachers need to want to change, but also to know how to change. Wanting is not the same as knowing how.

In previous informal conversations, as well as researches, teachers often complained that they would like to use other types of didactical materials, namely more adapted to intercultural practices, but that those materials were not available. They also stated that they were not able to elaborate these materials by themselves, and that their pre- and in-service education had not contributed to help them doing it. This information was the basis to decide to elaborate intercultural materials, and to include teachers in this research as active participants. But in order to achieve this goal, we needed to divide this research project in two different moments: (1) one that would allow us to identify the didactical needs (Favilli, César, & Oliveras, 2003a); (2) another that would lead to the elaboration of the intercultural materials that would be constructed in collaboration with teachers, and then used by them (Favilli, César, & Oliveras, 2003b; Favilli, Oliveras, & César, 2003). The research questions addressed in this paper are related to the first moment. The ones we chose to present are: What practices do teachers develop in multicultural classes? What are their conceptions about Mathematics and how do they influence their practices? What are their expectations towards students from other cultures? What are their beliefs concerning multicultural students? What do they account that needs to be changed in order to achieve a quality education for all? What needs do they identify in order to implement more intercultural practices? If we would sum up in a more general research question, that would be: How is diversity seen through teachers' eyes? Thus, this last question is the focus of this paper.

The data we are discussing in this paper were only collected through teachers' interviews, although in the first moment of the research we also used questionnaires (Favilli et al., 2003a) and observation of teachers' classes in order to triangulate the gathered information. Although some contradictory features already appear in their accounts from the interviews, a more in-depth analysis is needed confronting the observation data with teachers' discourses.

Theoretical background

The major aspects of the theoretical background concerning the *IDMAMIM* project are the notions of situated learning (Lave, & Wenger, 1991) and the

ethnomathematics approach (D'Ambrosio, 1985), conceived as a tool to facilitate mediation between the diverse cultures' knowledge and school knowledge (Favilli, 2001), thus corresponding to a tool that contributes to a more inclusive schooling (Ainscow, 1991; César, 2003). But in order to analyse the data referring to teachers' discourses we also need to take into account the notions of voice and discourse, borrowed from the sociocultural perspective (Bakthin, 1981; Wertsch, 1991), as well as the construct of dialogical self, developed by Hermans (2001). Both the voices and the discourse are seen as socially (re)constructed and dialectical. This means that discourse includes not only cognitive elements (e.g., ideas, conceptions) but also beliefs, feelings, and cultural *habitus*. Thus, discourse shapes the relations established among participants but it is also shaped by them, namely by the relative power perceived by each one of them, and by the interpretation of the situation they do. Being so, discourses must always be seen as situated (Lave & Wenger, 1991).

Considering knowledge appropriation as situated it is also conceiving it as influenced by culture, which means that students performances, academic achievement, expectations, and solving strategies, among other elements, are influenced by students' cultural roots (Abreu, 1995). Thus, knowing or not knowing, as well as evaluating knowledge, become more complex phenomena. Teachers are regarded as some of the key agents in educational communities, namely multicultural ones. If they are not aware of this complexity their practices will mainly value the mainstream culture way of acting, reacting, feeling, or valuing knowledge, thus promoting the exclusion of those students whose cultural backgrounds are related to minority cultures (César, 2003).

As Oliveras (1996) stated, we assume that culture includes several aspects, and that all of them play a fundamental role in knowledge appropriation and in the mobilisation/development of students' competencies. Culture includes a set of semiotic aspects (symbols, expressions, forms of communication, artistic expressions), socio-political aspects (organisation of work, of social relationships and power), interpretative aspects (mythology and religion), cognitive aspects (forms of knowledge linked to the environment), and technological aspects (products or artifacts created for the purpose of dominating nature or making work easier). Thus, there are macro-cultures, like the ones when we have students from another country, as well as micro-cultures, like those typical from a certain neighbourhood, school or teenagers' group. In order to promote an intercultural education (Bishop, 1988; Favilli et al., 2003b), all these characteristics must be respected, and one of the most demanding teachers' task is precisely to be able to implement more intercultural –and then, also more inclusive (Ainscow, 1995)– schooling settings.

The ethnomathematics approach is one of the tools we can use in order to understand the specificity of students whose mother tongue is different from the one used in the school context and whose cultural roots are also different from the mainstream culture ones. It facilitates the discussion of the historical and cultural aspects of mathematical knowledge and their application in knowledge appropriation within

school classes (Abreu, 1995; Bishop, 1988), trying to include different types of tasks according to the diversity that characterises schools nowadays (Favilli, 2000). It is also a possibility to generate an innovative way of conceiving mathematical knowledge appropriation and the mobilisation/development of competencies. In this sense, formal Mathematics is just one type of Mathematics, practised by a social group (mathematicians) and co-existing with many others that should also be valued, namely by teachers, when they are in their classes.

Stressing the relation both between culture and mathematics, and between culture and cognition (Bishop, 1988) becomes a key issue to understand students academic performances. This includes considering that teachers' expectations, beliefs, attitudes, ways of acting also shape students' performances (Planas & Gorgorió, 2005). What we are able to see, and to explain is also influenced by our conceptions, beliefs, expectations, and feelings. Knowing is not only shaped by cognition. Thus diversity seen through teachers' eyes is influenced by all these elements, and if teachers are not aware of these elements' role, just assuming a politically correct discourse may be confused with assuming intercultural practices, which do not really exist, as Gorgorió, Planas and Vilella (2000) also illuminated. Thus, analysis between what is teachers' discourses about diversity, and what are their practices is needed. Knowing their discourses is a first step, that must be continued by other steps that go further.

Conceiving learning as not only individual but also as a social process, stressing the role of social interactions, namely peer ones, as they are less often promoted within classes, has consequences (César, 2003; Elbers & de Haan, 2004). One of them is that analysing the discourse of the different agents of a learning community becomes an important step in order to promote change. Discourse is, in itself, a social construction (Valsiner, 1998). As Bakthin (1981) stated, "there are no neutral words (...) words and shapes that do not belong to anyone (...) language, for individual consciousness, is in the border between each one and the other." (p. 293). But, as any other social construction, discourse is not clear from contradictions, nor from conflicts which also need to be analysed. Conflicts that may even arise from internal contradictions, as we are dialogical selves (Hermans, 2001), composed by a multiplicity of identities which may also be contradictory.

Within classes, discourses are also shaped by the didactic contract, and by the meta-didactic contract (Schubauer-Leoni & Perret-Clermont, 1997). In order to promote the connections between different types of solving strategies, as well as to facilitate both knowledge appropriation (César, 2003) and transitions (Abreu, Bishop, & Presmeg, 2002) teachers and students need to establish an intersubjectivity (Wertsch, 1991) that allows them to have access to each one's words. This facilitates giving a voice to each participant of the learning community, empowering students from cultural minorities. Understanding if teachers are aware of all these features in their discourses about diversity is a first step to know what can be done in order to achieve a more intercultural mathematics education.

Method

The two main aims of the *IDMAMIM*[(1)] (**I**nnovazione **D**idattica **MA**tematica e sussidi tecnologici in contesti **M**ulticulturali, con alunni **I**mmigrati e **M**inoranze) project are: (1) to identify the didactic need for elaborating formative and didactic materials for teachers in Mathematics and in Multicultural contexts, with the presence of immigrant students or students from cultural minorities; and (2) to elaborate some of those materials. Intercultural didactics materials include the conception and production of 3 Cds (Favilli et al., 2003b), so as to favour didactic innovation as well as teachers' and students' technological knowledge.

This project is targeted towards teachers and students from the 6th to the 8th grades, in Italy, and from the 7th to the 9th grades, in Portugal and Spain, in schools with immigrant students and/or socio-culturally minority students. It was a three-year project whose empirical work included several classes in each one of these three countries.

In order to know the conceptions about Mathematics, beliefs, expectations, daily practices that Mathematics teachers use in their classes, and the school achievement of immigrant and/or minority culture children compared to mainstream ones, we began by submitting a questionnaire to around one hundred teachers in each country, including teachers from primary schools until the secondary schools (Favilli et al., 2003a). Then we selected twelve teachers, at least, in each country for an audio taped interview (César & Azeiteiro, 2002; Favilli & Tintori, 2002) which main aim was to go deeper into some of the points we began to explore in the questionnaires. The criteria to select these teachers were that we wanted to have teachers from all levels (primary, elementary, and secondary schools, according to the school system existing in each of these three countries), with different years of experience as teachers, as far as possible from both genders (there are more female teachers in all these countries, but we avoided having only females in the interviews), and from different types of schools (from poor areas, rich ones, having, or not, many immigrant or minority culture students, in town or in its surroundings, or from villages). Although these data can not be generalised as we had as participants teachers who accepted both to answer the questionnaires and to participate in the interviews, these data were a relevant resource to understand teachers' conceptions, beliefs, expectations, feelings, practices and needs related to multicultural classes (Favilli et al., 2003b). Thus, when we write in this paper that Portuguese, Italian and/or Spanish teachers stated something it must be understood as a language facilitator in terms of writing, and that we are referring just to the ones which are part of this study and who do not even represent each country's regions included in the study as we collected a convenience sample.

In this paper we present and analyse data from these interviews, thus related to the first aim of *IDMAMIM* project. These interviews were all audio taped and then fully transcripted. Then they were object of a content analysis in order to illuminate inductive categories emerging from teachers' accounts. After that first content

analysis, these categories were discussed among the researchers from the three countries. The presentation and discussion of the results was organised according to some of these categories. Many of these categories appear in teachers' accounts from the three countries, as illustrated in the results. Others are just mentioned by teachers from one country or mainly mentioned in that country. In this case, in the results we choose to have quotations just representing the teachers we interviewed in that country.

Results

A content analysis of the interviews illuminates some common findings in the three countries, like the existence of a high rate of underachievement. However, teachers usually neither adapt curricula nor the tasks they present to their students' characteristics in such a way as to integrate their cultural roots in their daily practices in class. Even more striking is that only a few state that this should be done:

> *"I do think so... completely..., because I think that only a few teachers take that situation into account... So I think that has an influence on the student... I mean, if the teacher has the same written test for all, the same activities for all, if the teacher doesn't realise that he needs to explain in a different way, or to speak a different language, or has to put side by side students who can help him/her with the language, I think they are impaired, even if they have a lot of abilities and they could have been amazing ..."* (Catarina, Portugal)

They mostly produce a paradoxical discourse: on the one hand they describe these students as being similar to all the other students, which means that their differences become invisible (Gorgorio, Planas, & Vilella, 2000); but later they say that these students have no life plans or that they do not succeed in school, stressing their low expectations about these students' school achievement. And we know how social value plays an important role in students' performances and academic achievement (Abreu, 1998; César, 2003). It seems that they are trying to be politically correct, and accept multicultural students' integration in school, but at the same time their beliefs, and expectations, as well as the practices they implement within classes are a barrier to a real inclusion. This paradox is illuminated in the following quotations:

> *"... working with students... from other races, other ethnic groups was... I can say, exactly the same as working with... other students."* (Nádia, Portugal)

> *"Well, working with students... from other races, from other ethnic groups was exactly the same as working with other students. What we sometimes notice in a class is a certain distance of some students... of certain students concerning those students. Well, but not anything that... as classes go by won't be overcome (...) it was exactly the same; I can't say it was difficult... I really can't say that, it's just the same."* (Sónia, Portugal)

"Mine had finished compulsory school (in the Phillipines)... he said that he had succeeded with high marks but the poor child was really poor, really poor, he couldn't understand geometry problems (A., Italy)

"I had a Chinese girl during a few months and I was unable to communicate with her, but she went away, she was transferred, she didn't speak a word of Italian but she had a fabulous computation ability, much higher than the Italian kids (...) all Chinese kids in Italian schools are very good in Mathematics, really very good, they don't even want to write, they want to do everything mentally." (N., Italy)

"(...) This year I have an Ucranian student and in this case I felt, at the beginning of the year, a little bit afraid... afraid because I didn't know how to react and she didn't know a word of Portuguese... so the first classes I spoke to her in English..." (Marta, Portugal)

"This Russian kid had no problems at all, just a little bit at the start, concerning the language, but he was easily integrated, mainly in Mathematics, because their curricula are more advanced than our own (...)" (O., Italy)

"(...) These kids have their own language, they have to learn Portuguese and then they still have to learn two other different languages. That's quite hard for them (...)." (Inês, Portugal)

A second empirical evidence illustrated in the last three quotations is that language is the only element teachers usually underline as a source of difficulty, which means they do not recognise different solving strategies or mathematical potentialities related to students' cultural roots. However, language difficulties, according to the teachers' discourse, are not that important when the minority students in question have come from a country with more demanding Mathematics curricula (like the Eastern European countries) or from countries in which computation and school performance is highly valued and developed (e.g., China). This is a curious point: language is the only element they really underline as a difficulty, but then it seems not to be that important for school achievement, as other elements implicitly play a more determinant role. Thus didactic problems only appear, in teachers' words, when the language problems are gathered with coming from a culture that is very far away from the school culture, which implicitly means that the culture of origin is much more determinant for school achievement than speaking the schooling language very fluently, at least when those children arrive for the first time in that country. Above all, because teachers also state that children from Eastern European countries quickly become quite skilled at the schooling language.

But it was also related to language that a first difference appeared: in Portugal, teachers usually feel they should find a way of communicating with foreign students who do not speak Portuguese (e.g., talking to them in English, or in another language they both know). And even when they speak Portuguese, if they are from another

mother language (e.g., *creole*, for those from Cape Verde) some of them learn their students' mother language in order to communicate better with them and, above all, with their families (e.g., Nuno, Ana, and Inês, whose schools had around 2/3 of children from Cape Verde). According to their accounts in the interviews, Italian teachers and Spanish teachers did not feel responsible for talking in another language, or learning a foreign language in order to communicate with their students. If their students did not speak Italian or Spanish they just stated it was impossible to communicate with them. These attitudes and practices are probably related to broader social phenomena: in Portugal, people are used to talk in foreign languages with people from other countries, even when they did not go to school, or formally learned foreign languages; they make gestures, they say the few words they know, but they do not usually say they can not answer or help. Portuguese people are quite convinced that foreign will not speak their language, and they are ready to try to find other ways of communicating. Thus, teachers were probably acting as it is usual in their own social community.

But the language subject leads us to another paradox when they compare minority children coming from Eastern countries with those coming from other cultures: the first ones are described as having no difficulties at all in learning Mathematics, as teachers also account in previous quotations, and only having problems with language, at the beginning of the school year (they usually develop language competencies quite soon); gypsies and students coming from African countries are described as having a greater distance from the school culture and experiencing more difficulties in succeeding, although many teachers pointed out that they have no special learning difficulties, but simply lack motivation. So, we become aware of another difference: belonging to a minority group is not always similar concerning social and academic acceptance and respect:

> *"There are nice and unkind attitudes towards some races, for instance, Chinese and South American are easily accepted while Arabians and Gypsies are usually rejected." (Manuel, Spain)*

> *"We don't notice any difference [in students from other cultures or ethnic groups] because they have been here for a long time. But gypsies are really different." (Raul, Spain)*

Despite all the diversity existing in their classes, no one elaborated multicultural tasks that could motivate them better, mainly because teachers stated they did not know students' cultures well enough in order to do that. So, some of the main needs pointed out by all teachers consisted of formative materials, informal sessions and in-service education, as well as the opportunity to discuss with experts, namely because some of them state that multicultural tasks are really needed nowadays. This empirical evidence illuminates the need to make available intercultural didactic materials. But, probably, it also indirectly stresses the need for a pre-service education that is more concerned with intercultural education.

"In Mathematics I don't think so... I don't know a lot about that [referring to multicultural tasks and intercultural education]*, but I think there are some countries in which... in which mathematical tasks are... we teach the Pythagorean theorem in a different way using... I don't know, rougher problems, problems more characteristic from that country or culture, and I believe that it would be very interesting to be able to build those bridges, than doing as we do here, the type of problems we solve here... which are directly related to our own culture... Er... the situations we find in text books are only problems that we experience... it's our own... our own characteristics, they are related to that... and I believe that in other countries, not the poorer or the richer ones, it's not related to that, I think that all of them have activities that are interesting, problems that are interesting, (...) or different ways of approaching the Pythagorean theorem..., it is in that sense that I believe it would be richer..." (Catarina, Portugal)*

"[There should be multicultural activities] mainly since elementary school, in order to promote socialisation. When you get to a certain age with a racist conscience, it's too difficult to change it." (Marina, Spain)

Last but not least, some teachers' conceptions about Mathematics, as we could already have noticed in some of the previous quotations, are that it is a static science, composed by universal truths, equal in every culture, instead of conceiving mathematical knowledge as situated (Lave & Wenger, 1991). This type of approach was mainly expressed by Spanish teachers. It may lead to many more difficulties in Mathematics classes for students coming from other cultures, as ignoring their way of reasoning neither helps them to participate nor to obtain academic achievement.

"In Mathematics there is no problem" (Manuel, Spain)

"Having strong bases in Mathematics is what really matters for their future learning." (Manolo, Spain)

"There aren't so many difficulties in mathematics as in other subjects. Some difficulties may arise when they don't understand the language, but "computation" is international" (Marina, Spain)

Taking these conceptions, beliefs, expectations, feelings and practices as a whole, we notice that, although multicultural students are not openly rejected, most of the practices that are implemented in school classes are similar for all. So, even if teachers' discourses seem quite favorable at first sight, when we read them more carefully we notice that there are many implicit difficulties for students from minority cultures, namely from those whose teachers' expectations are lower.

Final remarks

Although teachers' discourses, at a surface level of analysis, may seem quite supportive towards multicultural classes, they indeed have several marks of exclusion

within them, implicitly. There are some differences that remain invisible to teachers. But, on the other hand teachers also tend to make invisible differences that need to be illuminated in order to empower students from minority cultures. Differences should not be ignored, nor feared - they should be accepted and faced as richness in order to implement more inclusive schools (Ainscow, 1991, 1999; César, 2003). And there is no intercultural education without promoting inclusive schools and societies, which also means having the social dispositions that allow immigrant students to become legitimate participants not only at school, but also as citizens.

On the other hand, teachers recognise 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. However, they all had experience in teaching rather diversified multicultural classes and they seem to be favourable to their existence. This only does not make their practices change, which is a serious risk of exclusion for all those students whose culture is quite far from the mainstream one. This leads to known problems in our school systems: school underachievement is both selective according to cultural groups of origin and cumulative.

We hope that having innovative materials at hand might help teachers to implement this process of real inclusive schooling and intercultural education. But we are also aware that there is a long way to go, and many other elements need to be changed, such as teacher education which should also play an important role if we want to be able to respond to current school challenges, or at a macro level, the social dispositions that facilitate the existence of an inclusive society.

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HOW PARENTS VIEW MATHEMATICS AND THE LEARNING OF MATHEMATICS
AN INTERCULTURAL COMPARATIVE STUDY

Britta Hawighorst, *Universität Hamburg, Germany*

Abstract: *This paper describes an empirical study of how parents variously view mathematics and the teaching of mathematics. Based on the assumption that specific familial circumstances have a decisive effect on the procedures pupils adopt when dealing with mathematical content, the focus is on the perceptions and attitudes of parents from differing social and cultural backgrounds. The study covers parents who have immigrated to Germany as well as indigenous German parents. This paper reports on an ongoing study, includes a description of the theoretical framework as well as a description of the methodological approach employed. It concludes with a presentation of a number of aspects selected from the evaluation of the interviews conducted with "resettler" parents from countries of the former Soviet Union.*

Keywords: family background, out-of-school context, parental attitudes, socio-cultural theory, intercultural comparison

The focus of this study

Pupils' home circumstances carry over into the classroom: the specific home situation of children and young people is often cited by teachers as an explanation both for academic performance as well as for problems that may arise. This applies especially to immigrant families. Frequently, perceived deficits are attributed to national or ethnic origins, or to a supposed inability of the parents to impart to their children the basic knowledge and skills expected by the school. Although teaching in schools is, as a rule, guided by a desire to consider the individual experiences of the children and young people, often a discrepancy (and source of conflict) is felt between the real life of their families and the form and content of the education offered in the classroom. The multiculturalism and bilingualism of many children do not appear to be readily reconcilable with institutional requirements, with the result that these aspects are regarded as barriers to integration, rather than as useful resources and skills.[1]

Numerous empirical social scientific studies have investigated and confirmed the importance of the home as the place that provides the basis for success at school. Studies on related themes have tended to focus primarily on access to the educational system and on academic performance and skills depending on social and cultural

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[1] The gap between school standards and actual skills has repeatedly been described and analysed from the perspective of educational science. Examples of this are the contributions of the Special Research Field (*Sonderforschungsbereich*) of the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG) "Folgen der Arbeitsmigration für Bildung und Erziehung". Cf., for example, Gogolin/Nauck (eds.) (2000).

background. Little attention has been paid to how parents prepare adolescents for the demands of the educational system. Only recently, as a reaction to the findings of the PISA study that again documented, especially in Germany's case, the close relationship between social background and type of educational involvement, has attention been directed towards the necessity of considering the home itself as an educational site where many education-related processes occur.[2]

The family can be understood as a social system in which skills, choices of action, and social beliefs are transmitted intergenerationally. These become the basis for learning at school. Guided by widely differing forms of thinking in relation to education and associated educational traditions, it is the parents especially who pass these basic factors on to their children in the course of daily interaction.

The study presented here deals with parental attitudes towards education in families of various cultural and social backgrounds with regard to mathematics and learning mathematics. Interview findings will be used to investigate which relevant educational concepts and processes parents believe manifest themselves in family life and which can influence the way their children approach mathematics at school. The study questioned the parents of seventh-grade pupils with a Turkish linguistic or cultural background as well as resettler parents of German descent [Aussiedler] who had moved to Germany from countries of the former Soviet Union. Also questioned were native German parents.[3]

For the study, the arguments of the philosophers and educational theorists of mathematics in the social constructivist tradition who view mathematics as a product of social culture and history, play an important role (cf., for example, Hersh 1997). Following on from this approach, I work on the assumption that parents' basic ideas of, and approaches to, mathematics may diverge widely. While this does apply to native German families from different social backgrounds, it is especially true of parents from immigrant families, in which culturally moulded experiences with mathematics, possibly acquired before emigration, may affect the socialisation and upbringing of the next generation. In analysing how parents' conceptions and attitudes relate to mathematics, this study hopes to provide insight into the out-of-school context of mathematics learning and, in particular, to enhance our understanding of the learning situation of children and young people from immigrant families.

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[2] The Scientific Advisory Board for Family Affairs at the Federal Ministry of Families, Senior Citizens, Women and Youth (2002), in a statement on the significance of the family in the context of educational policies, criticised that discussions of educational policy were limited to "problems of school administration and the standardisation of performance", and neglected pre-school and out-of-school educational processes. (ibid., pp. 5–9)

[3] This project forms part of a larger research project "Mathematiklernen im Kontext sprachlich-kultureller Diversität" (Learning Mathematics in the Context of Linguistic and Cultural Diversity), supported by the DFG. The aim of this project is to investigate how pupils from immigrant families perceive and process mathematical subjects. Its propositions are grounded on the basic premise that the cultural and, in particular, the linguistic home circumstances of all pupils represent a significant backdrop to their mathematical and scientific education, although this is not adequately catered for in schools' behavioural and learning policies.

Theoretical approach

The study will concentrate on everyday educational processes within the family and the notions and attitudes manifested in these processes, from the perspective of the parents. The focus is on mathematics and mathematics teaching. It is guided by the assumption that an intergenerational cultural transfer occurs in families – a process in which education-related perceptions and conceptions manifest themselves in the everyday life of parents and children.[4] Setting the field of research in the everyday cultural practice of families directs the focus of the work at two levels: one deals with the question *what*, in the view of the parents, is acquired and passed on, i.e. what knowledge and skills, but also what beliefs and attitudes influencing upbringing, are imparted. The other will attempt to elucidate *how* transfer processes are (consciously or unconsciously) structured from the parental perspective, i.e. how do parents direct and initiate educational processes in different family cultures.[5]

The findings of research focussing on families document the complexity of the field. Everyday activities of families, even those from the same ethnic background, take place within a network of different sociocultural factors which may in their entirety explain education-related perceptions and modes of thinking. The significance of families for education cannot be explained by any one of these factors on its own. Rather, the framework conditions for this are multi-dimensional and cover individual, cultural, social and economic givens. In particular, the study of the situation of immigrant families requires a differentiated theoretical perspective, since the social and cultural conditions in the countries of origin, as well as the circumstances of emigration and immigration, may affect practices in everyday family life, in addition to the previously mentioned factors.[6]

The social environment theory ("milieu") approach, grounded in Pierre Bourdieu's theory of social practice, has proved useful in this respect for obtaining an integrative view of the various factors.[7] It facilitates understanding of the behavioural and attitudinal patterns of individuals or groups in the light of their social position. From this point of view parental thinking is anchored in cultural and social structures and shows itself in everyday habitualized practices. The resources available to a family at any given time represent an important pre-condition for the transmission and

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[4] The term transmission as used in family research stems from Bertaux & Bertaux-Wiame (cf. 1991), who have reconstructed processes of social mobility covering generations in the form of family histories. In this instance, intergenerational processes of transmission relate to a broad spectrum of circumstances: to patterns of behaviour and attitudes, to values and taboos, and to a whole range of resources from communication skills to the economic resources available to families.

[5] Several authors have recently demanded the programmatic inclusion of the transfer process – and thus the perspectives of those involved – into research into family educational processes. Cf. Diefenbach 2000; Grundmann et al. 2003; Brake & Büchner 2003.

[6] Pioneering contributions which reinforce this perspective on immigrant families have been made by Leonie Herwartz-Emden (2000) and Bernhard Nauck (1997) and their research groups. By differentiating between the various basic conditions, they have helped considerably to qualify the prevailing assumptions which have determined the way migrant families have been perceived. For example, for a long time traditional, authoritarian attitudes to parenting were identified as the reason why children and young people had difficulty coping both at school and outside of school.

[7] Cf. for the principles of this approach Vester (2001), and on family research Grundmann et al. (2003).

acquisition of education in the everyday context. The various resources available are not the focus of this study, but they are significant inasmuch as they provide an important background to parental perspectives on education.

Parental ideas, perceptions and evaluations of mathematics and mathematics education, as well as of child-rearing and conduct within the family and at school, are understood as specific resources of knowledge and experience which have a close connection to the social reality of the families. In Bourdieu's sense they may also be described as "incorporated cultural capital", which has a special status within his concept of different "types of capital" with regard to the reproduction of social structure. He describes the "transmission of cultural capital within the family" as the "most closely guarded and socially effective educational investment" (Bourdieu 1997, p. 54). In his theory the school's function is to approve the transfer of cultural capital in the family by awarding certificates. Against this backdrop, a description and analysis of parental attitudes to mathematics teaching as "incorporated cultural capital" also provides indications as to the specific preconditions for a child's success in school.

The social environment theory perspective assumes that –where the provision of cultural capital by the family is involved– parental thinking and actions pursue a "strategy" (Diefenbach & Nauck 1997, pp. 278f.), i.e. that parents' intentions are turned into educational strategies which direct their behaviour and decisions. However, practical logic is not always at the forefront. Educational objectives are not always pursued explicitly but are embedded in cultural family practices which may appear to serve quite different purposes, such as a pleasant way to pass time or maintenance of everyday customs and rituals. This also applies to mathematical practices in families. It is very likely that parents are more or less conscious of their mathematics-related attitudes, beliefs and values and that these are embedded in the transmission and acquisition of general life skills. It may be assumed that education-related everyday activities in the family have a "social purpose" (Bourdieu 1993) that goes beyond purely subjective perception. Thus educational strategies are not directly accessible, but rather, according to Brake & Büchner (2003, p. 624) can only be "surmised from present and past educational processes of those involved, their evaluation and the decisions upon which they are based."

The empirical study

The study deals primarily with the reconstruction of the subjective perspectives parents of differing social and cultural backgrounds have on family life with regard to mathematics and mathematics education. Based on the assumption that parents' fundamental understanding of and approaches to mathematics may vary considerably, my interest focuses on comparison of mothers' and fathers' perspectives as embedded in the specific circumstances of their lives. The complexity of the research subject of the "family" makes it very difficult to identify commonalities and differences even within one social context. It would be even more difficult to include the cultural

background of immigrant families as a predetermined category in a comparative approach. The research focus is therefore directed towards identifying specific characteristics of parents' teaching attitudes. That is, the aim is to reconstruct the repertoire of experiences which may differ but which may also be shared.

Against this backdrop the research focus of this study is located on two levels. On one level the objective is to *describe* mathematical education in the family context from the perspective of the parents. This perspective is determined by the analytical separation of the *what* and *how* of intergenerational transmissions described above. In this respect the question is: what conceptions, beliefs and values direct upbringing with reference to mathematics and mathematics education? And how do these aspects affect the everyday life of the family? On the second level the project concerns itself with *contextualising* parental thinking about mathematics education, that is, to relate it to the diverse framework conditions determining everyday family life which is discussed in the interviews. The questions here are: what role does the cultural, linguistic and social history of the family play?, which educational traditions manifest themselves? and which specific strategies determine parents' educational activity as described above?

The methodological approach selected was that of guideline-supported qualitative interviews. They make it possible to focus on the subject of mathematics and mathematics education while offering an opportunity for parents to articulate the many and varied experiences they have had of this subject area. Within the thematic framework outlined in the question-prompts, the mothers and fathers can express what is important to them based on their own experience and make their own emphases with regard to content.

Interviews were conducted with the parents of 12 pupils. They consisted of three groups: 4 sets of parents from the former Soviet Union, 4 sets of Turkish-speaking parents and 4 sets of non-immigrant German parents. Their children attended either a grammar school (*Gymnasium*) or a comprehensive school (*Gesamtschule*).[8] Since the sample included two mothers raising their children alone a total of 22 interviews with parents were conducted. As a rule the interviews took one to two hours and were conducted in the home of the interviewee. Each parent was interviewed alone, wherever possible the spouse and children were absent during the interview. Parents from immigrant families were offered the option of being interviewed in Russian or Turkish. Four Russian-speaking parents and all the Turkish-speaking fathers and mothers took up this offer.

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[8] The composition of the sample corresponds to the design of the research project "Mathematiklernen im Kontext sprachlich-kultureller Diversität" (cf. fn. 3), of which the work presented here forms a part. The sample on which the overall project is based is composed of pupils from six different schools: three grammar schools and three from the lower sets in comprehensive schools. Two schools have a large proportion of Russian-speaking immigrant children, two have a large proportion of young people with a Turkish background, and in two schools the great majority of the children speak only German. The composition of the group of parents interviewed reflects the composition of this sample.

The guidelines for the interviews were based on the stated problem, tested in sample interviews and modified to include experience gained through those sample interviews. They include questions on the parents' experiences of schooling and learning mathematics, with reference both to themselves and to their children. In addition, the importance of mathematics in daily life and its significance to them personally and socially are discussed. Other questions relate to upbringing and the support parents give their children, and to their demands, requirements and wishes with regard to schooling and mathematics education. Questions on concrete experiences of immigration and changes which parents have experienced in relation to schooling and in particular to mathematics lessons form one focus of the guidelines.

The interviews with the parents followed the model proposed by Flick (1999), which he calls "episodic interviews". In this procedure interviewees are encouraged to relate experiences relevant to the stated problem of the study with reference to concrete situations and circumstances in their everyday family life. They are then asked for their subjective judgements. In this way anecdotal and argumentative presentations can complement each other and be related to each other. This procedure was deemed appropriate because, in comparison to other forms of presentation, it targets concrete experiences and the context in which they occurred. Mathematics is an area which may appear very abstract to many parents, and it seems useful to relate it to concrete events.

With regard to the interviews, the research project is currently in the evaluation phase. All the interviews were recorded and transcribed and, in the case of the Russian and Turkish interviews, translated into German. The objective is a comparative evaluation of themes present in all the interview texts, rather than the sequential analysis of individual texts. Using the ATLAS.ti program, which supports qualitative data analyses, thematic codes are allocated to the different sections of text. In this way the empirical material can be sorted according to theme. Through a process of increasing abstraction, coded passages of text are constantly being compared and reordered, whilst the codes employed are combined under generic terms.[9] In the course of this categorisation there emerge those aspects which are of particular importance for the formulation of the questions, and these are then included in an overall comparative evaluation of all the interviews. Although a strictly sequential analysis of the transcripts is not performed, all the textual passages included in the evaluation are viewed within their textual context.

Some central aspects of analysis

The first step of analysis in my work aims at a reconstruction of the various notions of and attitudes towards mathematics and the teaching of mathematics. Following this

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[9] This procedure corresponds in essence to the method of "theoretical coding" as developed within the context of the "grounded theory" whereby "data are broken down, conceptualized, and put back together in new ways" (Strauss & Corbin, 1990, p. 57). The specific stages of "theoretical coding" as proposed in this theory were, however, not followed here.

I turned to the question of regularities and patterns in the data corresponding with the linguistic origins of the families. A comparative survey of all interviews showed systematic differences between the groups of origin involved. There are also, however, visibly differing views within the groups.

In the following section I will present first analysis aspects regarding resettler parents. Against the backdrop of the analysis as a whole there are some aspects that, in comparison to the other groups of interviewees, are characteristic of the way the resettler parents confront this subject.

Perceptions of mathematics in the context of migration

The resettler parents interviewed voice widely differing notions and perceptions of mathematics. These range between two concepts: on the one hand, mathematics is regarded as an intellectual tool allowing one to understand the world as governed by a meaningful order; on the other, mathematics is seen as a practical tool enabling one to handle demands occurring in everyday life. In the latter case, mathematics is reduced to arithmetical procedures such as measuring and calculating. The perceptions of mathematics held by all three groups of interviewees –which also include those of the native German parents as well as those with a Turkish linguistic background– come within this range.

Yet, some unique aspects can be discerned that constitute the framework within which resettler parents develop their notions and perceptions of mathematics and the learning of mathematics. These aspects are closely associated with the specific immigrant situation that the resettler families are facing, a situation that can be briefly described here: when the interviews were conducted, the parents had been living in Germany for two to eight years. Two families originated from Russia, one family from Turkmenistan and three families from Kazakhstan. The parents had had all their schooling in their countries of origin and, with two exceptions, their children had also attended school for some years in these countries. The families came to Germany subsequent to a time when considerable numbers of immigrants from the former Soviet Union had arrived in around 1990. This time was characterized by growing unemployment in Germany and decreasing state support for integration. The economic and social integration of these families is taking place under more straitened conditions. Most of them experience a lowering of their social status and they work in jobs that are beneath their level of competence. The following quotation by Mrs. Schneider exemplifies some of the challenges facing immigrants in this situation:

> Interviewer: "So, how do you think you can support your children in maths?" Mrs. Schneider: "Well, sometimes I say: 'Come on, children, learn! You've got to learn if you don't want to be emptying bins or scrubbing toilets.' We all have degrees. All of us had normal jobs there. And then we came here. And who are we here? Nobodies! 'And look at your Mom. She goes charring, she cleans other people's toilets.'"

It becomes evident that the parents' new economic and social situation constitutes a context factor of everyday family life that may have a significant impact on their children's education at the family site. The example from the interview illustrates that the parents' formational intentions and the educational activities originate in this experience. The general instruction "Children, learn!" expresses the enormous importance Mrs. Schneider attributes to education. The conveying of education plays a role of major importance for the other parents as well. It finds it expression in the fact that they are highly involved in the (mathematical) education of their children.

Systems of reference

The resettler parents interviewed markedly refer to their own experiences with mathematics and learning mathematics which they had in their context of origin in everyday family life or at school. Evidently, the same applies to the two other groups of interviewees. For the resettler parents, though, this aspect emerges more strongly. They perceive both mathematics and the learning of mathematics in the context of two different systems of reference: The "Then" of the Soviet Union, and the "Now" of Germany. I would like to exemplify this with the case of Mrs. Herz, who repeatedly emphasized the practical value of mathematics for, for example, "renovating" and shopping. This notion is rooted in her childhood experience. She grew up in a German village in rural Kazakhstan. When asked about the relevance of mathematics in her daily life, she says:

> Mrs. Herz: "We used to have cattle, and you need to feed them. You know, it was a real farming life. You have to do a whole lot. And that is still the same me. How many potatoes make one pound? And how many does a sack hold? And how many sacks do you need when digging potatoes? […] And that's how realistically I want to educate my children."

It becomes clear that patterns of perception acquired in her country of origin impact the mathematical education of her children. In the context of her migration she went through a drastic change of living conditions (from village to city) and keeps up her original concepts ("that is still the same me"). In her view, mathematics education has to be "realistic" in the sense of being 'useful in everyday life':

> Mrs. Herz: "I always tell my kids: If you learn math and can't use it in life at all, you haven't learnt anything".

The same criterion guides her judgement of classroom mathematics as experienced by her children. She comments on German mathematics lessons as regards the use of computers:

> Mrs. Herz: "At school they flit around with their heads in rose-coloured clouds. They don't view life realistically."

Against the background of her critical stance regarding the German teaching of mathematics Mrs. Herz considers it her responsibility to impart mathematical contents to her children. This is done by specifically confronting her children with

everyday problems containing mathematics or having them solve mathematical exercises – often with the help of Russian textbooks:

> Mrs. Herz: "At school there are no demands, but at home I demand that they work. […] Sometimes I spend hours in discussion with the kids. They have to sit down and work on exercises. We really get an argument sometimes. Yes. We really argue. And then, when I win, they have learnt something in 20 minutes."

Mrs. Herz's quotations show, that the ideas she acquired during childhood, dominate her current thinking about education and are effective in her perception of the teaching of mathematics in school as well as in her own educational behaviour.

Just as with Mrs. Herz, the perceptions and attitudes of all the resettler parents interviewed are structured around the polarities of "There" and "Here", "Then" and "Now", and "Us" (the Germans from Russia) and "Them" (the Germans). These polarities become most evident in what the parents have to say about the objectives and methods of teaching mathematics and the role of the teacher.

How mathematics lessons are perceived

The resettler parents interviewed have a very critical view of the way mathematics is taught, mostly as conveyed to them by their children. Some parents report that children of the same age they know who go to school in the countries these parents left possess superior mathematical knowledge and skills. In this, deficiencies in the teaching of mathematics in Germany are identified that serve to corroborate this observation. I would like to highlight the parents' generally critical attitude by quoting Mr. Merten:

> Mr. Merten: "Here they don't put across what's important in maths"
> Interviewer: "And what is important?"

> Mr. Merten: "Well, the basics. In primary school it's the times' tables. Later, it's formulae and things like that. Maths means being able to think and calculate logically. And here they only talk about the exercises. And once they've finished talking, it's the pocket calculator that does the calculating, not the pupils. They don't do any calculating. And if you don't have a foundation, then there's no basis for you to build a theory upon."

For other mothers and fathers, too, their reservations refer to "absence of foundations", or, respectively, to an unsatisfactory promotion of concrete arithmetic skills. In some cases, the oral discussion of mathematical problems is regarded as a deviation from the essential task. Furthermore, many parents express the view that the teaching of mathematics in Germany is not "structured" and that the syllabus is not clearly set out in advance. Alongside views such as these, there are several commonly held convictions concerning German teaching in general but evidently ones that also apply to the teaching of mathematics. Mr. Merten, for instance, says:

"We grew up in a stricter system. But I don't consider that a disadvantage. It's not about being caned or anything like that. But there's a lack of discipline in German schools. Fundamentally so! And this lack of respect towards the teachers, the familiar way they're addressed, this sitting on the desks…"

In addition to the central topic of "discipline", the parents also maintain that "demands are too low" in German schools. This becomes manifest, inter alia, in their children not being given enough homework, as well as in the more open teaching methods used, such as project or pupil-driven open-plan work.

Another issue being questioned is the role of the teacher and the perception the teachers have of themselves. According to the parents, the teachers do not offer sufficient support to the pupils and "are less committed" than the teachers had been in the countries the parents came from. Mrs. Erdmann, for example, says: "In Russia it was not a profession, it was a vocation."

Conclusions

It has been shown that individual prerequisites and contextual conditions of situation of migration work together in shaping the socialisation of the children. The resettler parents attribute a great significance to the conveying of mathematical education. This becomes already evident in their rather critical –compared to the Turkish speaking and native German parents interviewed in my study– position towards the German mathematic classes. They consider it their task purposefully to convey to their offspring not only mathematical content but attitudes to this subject as well, and, in doing so, the mothers and fathers resort to a wide variety of methods when going about this.

Given this background the extent to which the familial educational orientations can be used by the children as cultural capital (in Bourdieu's sense) at school is a question leading further. For Bourdieu, school is a world following its own logic, asking of those belonging to it the belief in its values and its forms of practice. The teaching of mathematics as in integral part of school follows its own functional logic as well, finding its expression for example in passed down cognitions and convictions, specific elaborations of language, patterns of behaviour and certain rules of conduct. Against the backdrop of the resettler parents' perspectives, it is possible to consider the demand on the children to integrate familial educational thinking and the (still not sufficiently questioned) "logic" of mathematics classes.

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NORMS, SOCIAL REPRESENTATIONS AND DISCOURSE

Núria Gorgorió, *Universitat Autònoma de Barcelona, Spain*

Núria Planas, *Universitat Autònoma de Barcelona, Spain*

Abstract: *Cultural difference is a deceitful concept, since it allows many interpretations. On the basis of 'cultural differences' one may argue that immigrant students in mainstream schools are to be taught different mathematics –or any other school subject– because they learn mathematics in a different way. Socio-mathematical norms, social representations and discourse have to do with how people behave and interact within the mathematics classroom, as well as with how their behaviours and interactions are conformed. We exemplify how the discourse in the orchestration of norms into practice allocates some immigrant students within different categories from those where local students are allocated.*

Keywords: Culture; discourse; norms of the mathematical practice; peer interaction; social representations.

Introduction

Any interpretation of cultural difference includes that of social difference. Distinguishing between cultural difference and social difference may seem somewhat artificial since the cultural and the social dimensions of the classroom life are highly intertwined. However, in our work we find it useful to make such a distinction. We use the adjective cultural when we refer to the diversity of practices and meanings of the mathematics classroom discourse. We use the adjective social when we refer to the different values and valorizations associated with these practices and meanings and to those who sustain them.

The classroom discourse provides the conditions through which cultural and social dimensions come to sight and are expressed. Discourse helps to construct the relationships between the participants in the classroom and their ways of acting and experiencing. Any exercise in either theorising the general notion of discourse, or interpreting particular classroom discourses, involves attention to social processes and practices that, in turn, reflect cultural and social differences. However, any of the different theorisations of discourse emphasizes some particular features of these social processes and suggests some particular relationships between them. There is a strong connection between the different theories of discourse and the contexts and specific social realities in which they arose and are applied. In our context, the reality of our multiethnic classrooms, and the social and political struggles that characterize our society, suggest to look at the effect of social differences on the cultural practices within the multicultural mathematics classroom.

In this paper, we focus on social differences that appear in the discourse of a classroom where immigrant and local students are together. We show that the classroom discourse can be used –intentionally or not– as the space where certain participants and practices of the mathematics classroom are legitimized while some others are not. Elsewhere (Planas & Gorgorió, 2004) we have developed an extended analysis of the data that we use here to exemplify our arguments. We reproduce here part of the analysis in order to start a discussion about the need to reinterpret the construct of classroom norms and other associated notions. In Gorgorió & Planas (in press) we provided data and discussed how social representations have an influence on the orchestration of classroom norms into practice. Here we explore the significance of social representations when interpreting certain collective preferred modes of acting, interacting and learning as permanent and legitimate norms.

An example of classroom discourse

The following sketch is part of the dialogue in a whole group discussion of a multiethnic mathematics classroom in a high school in Barcelona, Spain. The dialogue took place the second day of a new school year in a regular mathematics classroom with fifteen and sixteen-year-old students, both local and immigrant students. Students knew each other, but they had just known the teacher. During the first part of the lesson, they were organized in groups of three and were given a worksheet with a problem. The problem provided the ingredients and quantities to cook an apple cake for three people, and asked to find out the quantities needed for ten people.

The teacher had just reminded his students that there was not much time left, since he wanted to finish the problem in that session, and he opened the possibility for his students to contribute:

Teacher: OK, let's start with the first approach.

Cristina: First, we've thought out the problem as if it was a real problem, as if we had been told to cook a real apple cake.

Ramia: I got the idea!

Teacher: As if it was a real problem?

Ramia: Yes, being careful with the decimal numbers.

Teacher: What does it mean here being careful?

Cristina: It means to avoid certain types of decimal numbers.

Ramia: It means not to make errors.

Teacher: Ummm... if you both want to speak, we'd better organize ourselves. You *(to Ramia)* explain step by step what you've done, give us the result for each ingredient, without making errors, and then you *(to Cristina)* tell us in detail why you've done it in this or that way. All right?

Ramia: All right.

In this exchange, Cristina and Ramia were asked to explain their mathematical practices. However, Ramia, an immigrant student from Morocco, was not recognized as a legitimate speaker. The teacher facilitated her pedagogical participation –she was allowed to engage in the discussion– but, all the same, he obstructed her mathematical participation –she was not allowed to talk about certain mathematical practices. She was not asked to explain which was her idea, but only her algorithmic process, "step by step" and "without making errors".

The fact that Ramia showed her intention to participate and to explain her strategy could have been a clue for her teacher to let him know that she perceived herself as an agent in her mathematical learning process ("I got the idea!"). But the teacher only asked her to enumerate a series of numerical solutions ("give us the result for each ingredient"). On the contrary, Cristina, a local student, was asked to make her reasoning public ("You tell us in detail why you've done it in this or that way"). This way of handing out tasks –Ramia is to enumerate and Cristina is to discuss and argue–, with such a different level of mathematical requirements, places the two students as mathematical learners very differently. Asking Ramia to only enumerate her results may suggest that she was either not prepared enough to cope with more sophisticated mathematical tasks or, at least, that she was less prepared than Cristina. The teacher, that felt that there was not much time left, entrusted to explain in detail her strategies and her reasons for them to Cristina. This way, he was showing his confidence in Cristina's mathematical proficiency. On her side, Cristina seemed to have developed a highly positive self concept ("I've made no errors!", she said in a previous episode). However, while working in small groups, Cristina had to turn to the calculator on many situations when mental arithmetic was much more appropriate. She also required Ramia's help. Ramia was given a rather passive role in the whole group discussion, despite she was an active member of her small group. There is no evidence of these facts in the transcript extract above, but the analysis of the videotaping of this session provides the information.

How explanations and argumentations are to be used is differently interpreted through the classroom discourse depending on which students are involved. In this episode, discourse helps to distinguish between the students who can –and must– explain their reasoning and argue about their mathematical practices, from the students who are not expected to do so even though they are left some room to participate. It is through discourse that different categories of students are established.

Participants conform their contributions and adjust their engagement according to the expectations established by the categories suggested by the distinctions. Cristina trusted in her possibilities and acted as others would have expected. Ramia, however, neither insisted on wanting to explain her strategies, nor did she nominate herself to discuss others' ideas. Both students seemed to become resigned to perfom the tasks they were assigned. In particular, Ramia agreed to simply enumerate the numerical solutions, while one of her peers excelled in a more sophisticated task, for which she had initially volunteered.

Different students are expected to learn to interpret norms, such as those regarding participation, in a different way. Although teachers' expectations concerning students' knowledge and abilities have only a tentative character, they guide the students in their learning of who is who in the classroom. What it means 'to be a good student' –or what it is expected from them if they are to be considered good students– is not the same for Ramia and Cristina. In general, looking at the whole session, local students were expected to discuss and explain their strategies. On the contrary, immigrant students' efforts to contribute to eplanations and argumentations were systematically refused in more or less subtle ways. They were taught to listen to other students' explanations and not to discuss their own ideas. They were also encouraged to use real contexts but not to the extent of fully relating them to their mathematical practices.

Classroom norms are often regarded as impartial standards that transcend the different cultural and social values. However, it is not clear whether there can be common values and principles that are acceptable to (and are accepted by) all groups within the multiethnic mathematics classroom culture. Even if some cultural differences are admitted and respected, conflicts between groups and between individuals can easily appear. In particular, the prevalence of certain classroom norms is a potential source for conflicts since they suggest the disadvantaged position of those holding meanings and values differring from those promoted by the prevalent norms.

Exploring the role of social representations
The understanding of classroom norms and, in particular, the understanding of how norms are dealt with into practice, requires exploring their social components. It is not clear to what extent the research developed until now about norms in the mathematics classroom has addressed social questions. However, from our perspective, norms have profound social implications that also need to be taken into account.

Norms not only include definitions of what is acceptable, but also encompass values and valorizations within the classroom. Norms contribute to give shape to the way a person or a group makes sense of the mathematical practices, interactions and communication acts. How students adjust their meanings and behaviours to the legitimate interpretations of classroom norms has an influence on which and how personal values and social valorizations are expressed. Values and valorizations are part of the social component of norms. Values and valorizations are, in turn, expressions of wider social constructions. Social representations give meaning to values and valorizations and help to construct individual and collective ideas about how the mathematics classroom should work.

The few details from the classroom discourse that we have presented here do not proof that the differential responses to Raima and Cristina are due to the influence of social representations. However, during an informal conversation with the teacher at

the end of the session, we told him that he had hold out tasks with very different levels of mathematical requirement depending on which students were being addressed. His answer was: "I try to make students progress according to their individual possibilities". Despite that he hardly had time to get to know his students in only two sessions, he talked about their individual possibilities.

Unfortunately, too often, 'students' individual possibilities' do not refer to a cognitive reality but to a social construction. Teachers construct each student's possibilities on the basis of certain social representations established by the macro-context. The teacher in our example shares with the dominant social groups social representations of immigrant students that question their mathematical potentialities. Social representations shape teachers' expectations on their students, affect the development of classroom practices, and contribute to delimit the use of norms.

In our example, we interpret the two students' and their teacher's reactions to be a reflection of an image of an educational community that views immigrant students as lacking certain educational abilities or attitudes. When interpreting a classroom episode, the students, as well as the teacher, focus on some of its many facets, borrowing from social representations that are part of the collective images of their groups' culture.

Representations coming from the educational institution and from the whole society that host the minority groups shape norms. Immigrant students, most of them socially at risk, tend to be stereotyped as less competent and their mathematical abilities have traditionally been considered from a deficit model approach. Therefore, immigrant students and their practices are more prone to be valued negatively due to a-priori assumptions socially constructed and this valuing interferes with the orchestration of the norms that should allow their participation. We do not seek to generalize what happens in that particular episode to the multiethnic mathematics classroom, but to illustrate how the social macro-context and the classroom micro-context are mutually influenced. The subjective criteria used to assess some students affect their performance and increase their initial 'cultural distances' from the school culture.

The difficulties experienced by immigrant students when facing certain particular mathematical practices, instead of being interpreted in terms of 'lack of potentialities', may be (are to be) understood in terms of lack of actions aiming at promoting these potentialities. From that point of view, the notion of social representations is of considerable significance, for it helps to understand how teachers interpret students' identities as mathematical learners by taking into account their individual and socio-cultural identities.

The construct social representations also helps to dissociate *bad practices* from *bad teachers*. The teacher in our example described himself as having inclusive practices, although the practices we observed were not always inclusive. Teachers' practices are not necessarily a reflection of teachers' intentions, but rather mirror more general

social attitudes that lead to ways of administering classroom norms that may provoke learning obstacles and exclusion.

Social representations go far beyond a teacher's individual positioning. Teachers do not always have a direct control over the emergence and acceptance of alternative discourse categories. Students' contributions are often accountable for maintaining certain dominant discourse categories. However, although classroom discourse and social representations behind it are complex constructions build upon many factors, teachers have a privileged position when establishing discourse categories –who needs help, who is supposed to help, who is to talk, or who is to listen. Nevertheless, they will only be able to use this privilege when they are aware of the influence of social representations within the classroom.

There is still much research needed on the existence of differential treatment patterns within the mathematics classroom, and on how these patterns must be dealt with. However, when interpreting mathematics classroom situations where cultural difference is expressed through social differences in actions and expectations, social representations seem to be a key construct. Norms, social representations and discourse relate to how people behave and interact as well as to how their behaviours and interactions are formed and conformed. The above notions may help to understand how a particular mathematics classroom becomes the way it is and how the different learning opportunities and constraints are distributed.

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ENGAGING WITH PARENTS ON A CRITICAL DIALOGUE ABOUT MATHEMATICS EDUCATION

Jill Bratton, *The University of Arizona, USA*

Marta Civil, *The University of Arizona, USA*

Beatriz Quintos, *The University of Arizona, USA*

Abstract: *In this paper we present a continuing effort to engage in a dialogue with parents about mathematics education. Using the technique of the unfolding matrix (Padilla, 1993), a group of parents and researchers critically examined and reflected on the parents' mathematics educational efforts with their children and in the district. The dialogue expanded our understandings of the valorization of knowledge making evident power relations. We discuss mathematics as a cultural tool highlighting the need to acknowledge intellectual resources and ways of knowing present in the home. This research is particularly relevant to those working in low-income, ethnic / language minoritized communities (e.g., with immigrant parents).*

Keywords: Parental involvement in mathematics education; Equity; Immigration; Social class; Knowledge valorization; Socio-cultural theory.

The work reported in this paper took place within a large parental involvement project in mathematics called (MAPPS)[1]. One of the goals of this project was to develop the concept of leadership in mathematics education as it applies to parents. To this end, parents in MAPPS first engaged in a series of learning experiences in mathematics and then formed teams (with teachers in some cases) and facilitated mathematics workshops for other parents in the community. This approach to "parental involvement" is grounded on the concept of parents as intellectual resources (Civil & Andrade, 2003) and is particularly relevant in communities such as the one where our work takes place—low-income, ethnic and language minoritized communities. In those communities, parental involvement is often confined to a very traditional definition in terms of volunteering in school activities such as fund-raising events, preparing bulletin boards, or organizing supplies. Parents, especially those who are low-income, immigrant or members of certain ethnic groups, are hardly ever invited to contribute their knowledge and expertise to the academic aspects of school life.

The research we report in this paper focuses on our work with a small group of mothers, most of whom have been long-time participants in MAPPS. To further understand their perceptions about mathematics education, while at the same time continuing to engage them in mathematical explorations, we began the *"tertulias matemáticas"* [mathematics forums]. The *tertulias* emerged as an effort to facilitate additional dialogue, critical examination, and reflection about the MAPPS parents' mathematics education efforts with their children and in the district. These conversations were seen as a vehicle towards community action. In this paper we elaborate on how the parents experience and understand issues surrounding their children's mathematics education. This topic is of interest to educators across the world due to global population movements, the existence of class differences, and the differential treatment of ethnic and language groups, all of which reflect power issues at play in modern societies. For example, recent work by Abreu, Cline, and Shamsi (2002) and Gorgorió, Planas, and Vilella (2002) address issues surrounding immigrant families and mathematics in England and Spain, respectively. Their research highlights mathematics as a cultural tool and the relevance of establishing a connection between home and school knowledge.

Theoretical Framework

As with any large project, different staff as well as the participants themselves may have had differing understandings and expectations for MAPPS. For some, the primary goal was for parents to be able to help their children with their school mathematics work. For others, and this includes the three authors, MAPPS was about leadership development among parents. It was about engaging in a critical dialogue with parents in which several issues related to their children's mathematics education were jointly explored. Our approach to research is informed by the lens of cultural historical activity theory (CHAT) and in particular the framework of "ecologies of parental engagement" (EPE) (Calabrese, Drake, Perez, St. Louis, & George, 2004).

As we examine the role parents play in their children's schooling, we part from the notion that individual agency is embedded within a system of activity impacted by social, economical, and political forces (Monzó, 2004). Accordingly, it is through that sociocultural lens that we examine the issues surrounding working class / low income parents and their engagement with the schools specifically regarding the mathematics education of their children. CHAT allows us to consider the interaction of parents and schools in a broader sense by using the family and the school as units of analysis. These systems have taken shape and been transformed over time (Engeström, 2001) under the influence of the above-mentioned forces. In our work regarding parents' understanding of their role in the mathematics education of their children, CHAT also provides us with a way to explore unequal power positions and the tensions that result from the power differentials within and between the different components of these systems. As Calabrese et al. (2004) write,

> Social organizations, such as schools…are embedded with cultural values. These values manifest themselves in recurring social practices and their artifacts that give order, purpose, and continuity to life in that social organization. (p. 4)

Hence, for example, the correct way of doing mathematics is defined by the teacher and communicated to the parents and their children. Schools also define how parents should be involved. Accordingly, schools reflect and abide by the structural location of individuals in the wider society (Valdés, 1996). The knowledge that working class and minoritized parents possess is not given the same value as that which middle class parents possess and the ways that these parents are "involved" in their children's schooling experience are defined according to the ways in which middle class parents participate in their children's schooling (Horvat, Weininger, & Lareau, 2003; Lareau & orvat, 1999).

The Ecology of Parental Engagement framework (Calabrese et al, 2004) includes parents' experiences and actions in the school and in the community. As parents negotiate a space in the school through programs such as MAPPS, they draw on their various experiences and capital to frame their interactions with schools and school personnel. This capital leads to the development of tensions relating to prevalent ideas regarding parents in the system, e.g. valorization of parents' knowledge (Abreu, 1995) and pre-established views of parental involvement.

Context and Method

About the *Tertulias.* The *tertulias matemáticas* took place as MAPPS was nearing its official end. As researchers, we sensed the need to continue our dialogue with a small group of the participant-mothers. We had developed ties and rapport with several of them and we were particularly interested in creating a space of empowerment that would possibly lead to action. This need led to the development of the *tertulias matemáticas* (building on Civil & Andrade, 2003; Flecha, 2000). We sent out letters to approximately 30 mothers who had actively participated in the MAPPS program anywhere from one to four years.

The *tertulias* took place in a meeting room at a public library within the boundaries of the school district. We had 16 sessions that lasted an hour and a half each, every two to three weeks during the fall of 2003 and the spring of 2004. There were 15 participants-- 14 female, 1 male. The others invited were not able to participate due to personal commitments and scheduling issues. Each session had two main sections. The first section focused on parents learning mathematics. Sometimes we studied a specific mathematics theme such as algebra. Other times, direct connections to their children's school experiences were made through samples of homework that the participants brought in. These samples enhanced the conversation about mathematics content, the

current mathematical learning experiences of their children, the current classroom climate (e.g., standardized testing influencing teaching), and parents' values and beliefs related to mathematics education. The second section of the *tertulias* continued our efforts to have a two-way dialogue with parents about mathematics education. The discussions centered on challenges and possibilities relating to their children's mathematical education. The goal of the second component was to facilitate the development of a critical awareness leading to action. This paper focuses on this second component.

The Participants. All the mothers in the *tertulias* had been part of the MAPPS project for at least one year, most of them from 2 to 4 years. There was one father who attended the *tertulias*. He was not associated with MAPPS, but his partner had been in MAPPS for one year and was also attending the *tertulias*. All the participants but four self-identified in the parent profile as Hispanic or Mexican. All the participants had some understanding of English and Spanish, however several of them felt comfortable just in one of the two languages. The participants in the *tertulias* (and here we focus on the mothers, since they were the ones who had also been in MAPPS) are not to be taken as representative of other working-class or low-income mothers in the district. The educational background of our particular group from the *tertulias* is diverse and it is probably higher than the average education level of the parents in the district. Another characteristic of our group is that nine of the fourteen mothers had jobs related to the school system (teacher assistants, instructors at family literacy, bus driver, Parent-Teacher Organization member, substitute teacher). In addition to this, one of them was an undergraduate student of secondary education. Two participants had jobs not related to the school. This information is critical because these positions gave the parents the opportunity to form direct relationships with members of the school staff as well as to access other sources of information about the educational system. At the same time, it makes explicit our belief that a small group of parents cannot be taken as representative for all parents in the district (see Shumow, 2001, for the dangers of listening to the voices of a few "representative" parents).

Sources of data and analysis. All the tertulia sessions were videotaped. We also audiotaped parts of some sessions and took field notes. For this paper we focus on one particular approach that we followed in our analysis. We used the technique of the unfolding matrix based on a dialogical method (Padilla, 1993). This method purports that by critically examining problematic aspects of their own lives, participants can obtain a critical understanding necessary to identify viable possibilities of change. To problematize the experience and to raise the discussion to the level of the community, not just the individual participants' experiences, we asked participants to explore the question, "How can all children in the district be successful in mathematics?" Thus, various tertulias centered on group discussions focusing on knowledge and barriers that

the participants had identified related to their children's mathematics education. In the next section we present some of the findings from these group discussions. We begin with an excerpt from the matrix to further illustrate how we used this approach.

The Matrix

To encourage discussion of the question posed to the parents in the *tertulia* we used some prompts from MAPPS participants collected throughout the four years the project had been in place. These prompts were selected using grounded methodology (Charmaz, 2001), that is, they capture emergent themes present in several interviews. The *tertulia* participants responded based on the connections between their experiences and the quotes. For example, the quote below captures a theme that is a constant in our discussions, that of the changes in the teaching of mathematics. This is even more crucial to discuss when the parents went to school in a different country, as is the case with many immigrant families.

> *And talking about the children, about teaching them and learning from them, it's true that when I come home from school, the little one who's five years old says to me, "Mommy, are you going to learn so you can teach me?" "Yes, I'm going to learn so I can teach you." On the other hand, the older one that's in fifth grade [10 years old] says, "Mommy, I'm going to explain something to you that you did not learn in your class."*

Julie, one of the mothers in the tertulia, commented on this quote:

> And that's just, it's not so much that they're going to teach me what I didn't learn, it's just that the wording to me is different because if I tried to explain to her [her daughter] what she was doing and she says, "no Mom, but they didn't tell me that in school", so that's not the way she's supposed to learn.

Bertha, who immigrated from México, also chose this quote and said,

> Me, because I learned a different way in México and to me it was really difficult (…). I had to learn what he [her son] was learning in order to help him at home because I have to build the trust between my son and me because he didn't trust me at all. Because he said, "no, no, you don't know how to do it" and I know that I know, that I have the knowledge but I don't know how to explain (to) him the way that…

Some of the quotes we chose were particularly controversial, such as the one below from a teacher participant in MAPPS,

> *Where here [in this school district], whatever I do isn't really all that important, I don't think the parents really have any idea what I'm teaching their kids, it's not as important to them in this district, from what I've seen. [Referring to another district where this teacher had been before] You know some of the parents were involved and they would come in or were on the PTA*

> *[parent teacher association] and you'd see them after school and they'd ask you how their kid was doing, where I don't get that all that often here.*

This quote conveys an often-heard feeling that "certain parents do not care about education" (for a discussion on the history of the myth that Mexican American parents do not value education, see Valencia & Black, 2002). What we have found in our research is that some parents do agree with the sentiment expressed in the excerpt above, as Rhonda, a parent in the tertulia, confirms,

> I don't know how to say that without being insulting … [this teacher is] right. Because a lot of parents don't care and it's not because they don't care, it's because they don't understand what's being taught. And a lot of our parents, especially in this district, are Spanish speaking parents and not all our Spanish speaking parents are willing to stay back and let the language barrier hold them back, but the majority of them do stay back and they have no clue what they're teaching their children, none whatsoever. They can't help them with their homework, they're intimidated by their teachers, they don't want to get involved, because they're holding off because of the language part of it and as a teaching assistant, I have to agree with [this teacher] because when children bring back the homework, and we tell our parents, Spanish speaking parents, this is the way you do it. If you don't understand, please come, don't be embarrassed, come and help us out, you know, we'll explain it to you, but they don't come, they don't come and the homework is not getting done…

The discussions from this session were transcribed with several themes emerging through that process. These new themes were added to the matrix and became the stimuli for further discussion. This "spiraling" process lends itself to the development of critical awareness and possible action based on the analysis. We wonder if the fact that many of these mothers were themselves part of the school system (through their jobs and affiliations) may have led some of them to conform to the general school system view on some issues (e.g., "parents in this district don't care"). This "being part of the system" may account for some of what we (as researchers) perceived as obstacles to these parents taking action.

We organized the participants' reactions into three sections- parents, teachers, and students. Below is an excerpt from the matrix (for reasons of space, we are only including one of the sections, that of parents):

	How can all children in the district be successful in mathematics?		
	BARRIERS	**KNOWLEDGE**	**ACTIONS**
Parents	1. Learned in a different way (i.e. division) country. and/or different generation 2. Vocabulary. 3. Valuing of one education system over another.	1. How math should be taught in the US standards 2. Knowing the particular method of the teacher 3. Importance of valuing different methods. 4. Knowing that having different strategies is good for children	MAPPS helps parents to be able to help with some homework, gain credibility, understand different methods, confidence in yourself, more communication with your children

As we can see in this excerpt from the matrix, the notions of value / valorization / different methods are clearly present in the three columns. In the next section we elaborate on these notions.

Findings

Parents and personnel from the school system are motivated and constrained by rules (e.g., in our local context, new legislation limiting bilingual education); are impacted by perceived power differentials (e.g., the teacher as the mathematics expert); have different understandings of the division of labor (e.g., who is responsible for teaching the child); and have different understandings and valorizations regarding the particular tools of a system, (e.g., the curriculum of the school vs. the home as a source of knowledge). In addition, the history of both the individual parents and the school system contributes to the way in which these two institutions interact. Each parent in the *tertulia* brings with him or her past experiences with regard to mathematics learning and teaching. Likewise, the school system, including teachers and administrators, has developed its ideology regarding the teaching of mathematics over time in accordance with the context of the times.

Our findings in this paper focus on one theme that relates to the first quote given earlier. As children learn approaches to mathematics that are different from what their parents learned, the issue of comparing approaches inevitably comes up. We draw on Abreu's (2002) concept of valorization of knowledge to elaborate on parents' experiences

discussed in the *tertulias*. The notion of valorization is related to the "prestige associated with the ways of knowing of specific communities of practice" (p. 190). The results of valuing one person's knowledge over another have profound implications in the parents' and children's schooling experiences, as their knowledge may stand in contrast to schools' knowledge. The parents had an initial tendency to give higher value to their own forms of doing mathematics, which in some cases meant the way they had learned in schools in México, although it was not a group consensus. In one discussion addressing different algorithms for arithmetic operations, Marisol explained that her son's teacher had taught him a certain way to divide, which she thought was a "cochinero" (a mess). So, Marisol had taught her son her way to divide, which she had learned in México. In contrast to parents, children valued schools' form of knowledge more often over the parents' knowledge. Thus, Verónica's oldest son rejected her method of dividing because he feared the teacher would think that he was cheating, since Verónica's method includes doing some mental calculations with no written notation. Verónica was taught that writing everything and crossing out was slower and messier. Yet her son still chose the teacher's method due to his unwavering concern that if he did not show all his work the teacher would think he was cheating:

> Verónica: I tried to do the same with my child with divisions, that he wouldn't write everything, but he says, "no, no mom, the teacher is going to think that I did it on the computer", "but you don't need to write the subtraction son, just write the answer." "No, no, my teacher is going to think I did it on the computer, I have to do it like that", "ok, you have to do it like that, but I want to teach you how we learned it." And I did teach him but he keeps doing the (teacher's) method, and that way he feels sure that he will take the homework how he was told. The same when putting on top what they carry and then crossing it out, when he does that, I tell him, "Son, I remember that homework is not supposed to have things crossed out," and he says, "yes, it's Ok."

Abreu, Cline, and Shamsi (2002) discuss a similar situation in the context of multiethnic primary schools in England and conclude that, in order for parents to adjust to their children's learning they must be aware of the differences, as well as have the knowledge and confidence to tackle the differences constructively. Based on our experience, this also requires valuing diverse methods and the parents suggested that it is constructive not only for parents but also for teachers. Even though some current documents in mathematics education (e.g., in the U.S., the *Principles and Standards*, NCTM, 2000) address the benefits of diverse methods, when it comes to mathematics there is a common notion that there is a "right way" of doing things which is often associated with the textbook's/ the teacher's/ "expected" algorithm/method. Alternative approaches are often not treated equally. Approaches are given a specific value based on the social power of those who hold them. In this context, the parents' or home method is not given the same value as the teacher's or textbook method. Historical relations of power at the schools can not only be reproduced but also exacerbated through mathematics education.

Several of the parents shared feelings of frustration about their children's distrust of their ways of knowing. When trying to help with homework the parent-child relationship was affected even more when the parents were not fluent in academic English.

The concern over the discrepancy regarding the valorization of knowledge adds to the tension Mexican immigrant families experience in relation to the quality of the education their children receive. Several immigrant parents in our project wonder whether the U.S. school system is doing a good job at educating their children. These parents often make binational comparisons (for research on this, see McLaughlin, 2002; Macias, 1990). One such immigrant mother, Bertha, is very clear in her view that her children are behind in mathematics compared to her relatives or friends in México.

> Bertha: No, I'm not happy. I feel that there is repetition of a lot of things; I don't understand why the teaching is so slow, I don't like it, I don't like the system, I don't like it at all. I, when we go to México my nieces and nephews or my husband's nieces and nephews, there are children that are more or less the same age as Jaime and I see that Jaime is behind. Here they tell me that Jaime is really excellent.

Bertha's comments capture a recurrent theme in our research (and in comments about other similar settings), which is this idea that the education system in the U.S. is slow and not as advanced as that in, for example, México. This is a complex situation in which critical questions need to be addressed such as, is seeing mathematics content earlier an indicator of a higher educational level? There is a need for more cross-national data on curricular differences between México and the United States and for a further exploration of how parents form their understandings of mathematics education in the U.S.

Final Remarks

The teaching and learning of mathematics is linked to values, beliefs, and expectations (Gorgorió, Planas, & Vilella, 2002). This creates critical challenges for schools with diverse populations, especially in communities with unbalanced power relations among the participants. At the *tertulias* we engaged in a dialogue that expanded and mediated our understandings of the valorization and power relations between the parent and school activity systems. The mothers at the *tertulias* discussions acknowledged their responsibility to understand the school's knowledge, while at the same time they saw teachers as key agents to connect school and home knowledge. As Marisol said,

> This is the first problem, the teacher sends papers, the teachers want to do a better job with the kids that come from México or from people in Spanish speaking places, but they don't start thinking that it is not just the kids it is the parents and they go together.

The idea that children do not come to school as individual beings but as part of a community is true not only for Spanish speaking or immigrant families, but for all families. Schools need to be cognizant of the cultural and historical nature of

mathematics knowledge. Having these critical dialogues with parents about mathematics education as an area of power contestation may facilitate the process of empowerment that Delgado-Gaitan (2001) and Freire (1998) have called for. As Valenzuela (1999) argues, home-school relationships are a crucial component for additive schooling where there is a culturally relevant and sensitive curricula that in this specific case would acknowledge the mathematical knowledge present in minoritized communities.

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RESEARCH AS AN ACT OF LEARNING: EXPLORING STUDENT BACKGROUNDS THROUGH DIALOGUE WITH RESEARCH PARTICIPANTS

Diana Stentoft, *Aalborg University, Denmark*

Abstract: *This paper explores the possibility of introducing dialogue as a research method for data interpretation. The paper draws attention to some epistemological and methodological considerations related to this method and presents a reinterpretation of the Inquiry Cooperation Model developed by Alrø and Skovsmose (2002). By use of this model it is proposed that research and in particular data interpretation is an act of learning and that dialogue may constitute a tool for enhancing this learning process. The paper further places the application of dialogue for data interpretation in a context of research in mathematics education in the multicultural classroom and is in particular drawing attention to research into student backgrounds and student diversity.*

Keywords: Dialogue, Diversity, Dialogic epistemology, Participatory research methods.

Introduction

Exploring new settings gives rise to deliberations and considerations of the scene one is about to enter but also of the methods and methodologies best suited for this venture. Which tools and techniques are available for our research? Which qualities, properties and limitations are ascribed to these techniques? How can the use of different techniques influence our being in the research and the data we collect? From a constructivistic perspective the data collection process is in itself informing the ongoing construction of reality of the persons involved, and as such realities of researcher and research participants will inevitably change and cause a change in each other during the process. Data is a somewhat incomplete reconstruction of what was reality to interactants at the time of collection, and interpretation of data is in it self a construction of meaning based on our understanding, knowledge and experiences. Acknowledging this mutual and continuous influence places new challenges in terms of validation and reliability of data on the researcher requiring reflections beyond the data. But as will be proposed in this paper, it also opens the possibility of further explorations of participatory methods for research one of which could be data interpretation through dialogue.

In mathematics education research focus is increasingly placed not only on mathematical topics or phenomena unfolding in the specific context of the mathematics classroom but also on the social, political, cultural and historical factors influencing students and teachers in their interaction. An increasing number of

studies focus on students' backgrounds with the view to improve our understanding of interaction as it occurs in the mathematics classroom (Sullivan, Mousley and Zevenbergen 2004, Atweh, Forgasz and Nebres 2001, Valero 2002). This move towards new areas of research has further widened the interest in new research methods matching the challenges of the mathematics classroom. For example; Gogorió, Planas & Bishop (2004) actively involved mathematics teachers in their research not only in the process of collecting the data, but also in the interpretive stages of the research.

Engaging researchers and research participants in a dialogic process of data interpretation when exploring the mathematics classroom and in particular when seeking to unearth student backgrounds and diversities and their influences on classroom interaction could contribute new perspectives to the data interpretation in at least two ways. First, research participants (teachers and students) will bring a different perspective into the interpretation rooted not only in what they see in the data, but also in their diverse experiences and emotions related to the interaction in which they themselves took part. Research participants may further contribute to the interpretation with their knowledge of the classroom setting and fellow students/teachers. Second, research participants are limited by different theoretical or methodological perspectives than the researcher e.g. through their experiences of the interaction, mathematics education and their various social, cultural and political backgrounds. Hence researchers and research participants inevitably enter dialogue and negotiation of meaning from different perspectives, and it is in this space of perspectives and experiences new meanings and interpretations can be formed.

Coming to know through dialogue

Coming to know through dialogue inevitably has both epistemological and methodological consequences for research. Skovsmose (1994) proposes a dialogic epistemology as a prerequisite for critical mathematics education opening the field to negotiation of knowledge and in doing so also to potential conflicts of equally valid knowledge claims. Conflictual knowledge claims, it is argued, will lead to reflection and critique and eventually reconceptualisation of knowledge. It is further proposed that this epistemic position opens to the possibility of interpreting and negotiating knowledge and hence traditional views on knowledge as an "ultimate" or objective truth must be abandoned. With a dialogical epistemology knowledge claims can be critiqued, negotiated and reconceptualised ontologically rooted in the situation at hand and thus also ontologically rooted in the various backgrounds of interactants (Skovsmose 1994).

I would like to propose that a dialogical epistemology is not only interesting in relation to mathematics education but may also be interesting in relation to the process of researching the field. Today research in mathematics education is carried out from a wide range of approaches; from the positivistic to the interpretive. However, research and analysis from a dialogical approach including research

participants is still rare and results are mainly generated solely by the researcher and seen as conclusive. As pointed out by Brown & Dowling (1998 p. 45) "The ultimate responsibility for analysis lies with the researcher. In this sense, research is simply not a democratic activity". It is difficult to argue with this statement, as ultimately the researcher will be held responsible for results published under his name, and as such he must be able to argue for its relevance. However, opening research to a dialogical epistemology would welcome research participant into the process of interpretation and analysis of data. It would establish an environment of both researcher and research participants coming to know through interaction.

A dialogic epistemology combined with an ontology rooted in the given context entails recognition of the contributions and claims of knowledge made by others than the researcher himself. It requires an acceptance of a joint construction of reality (of the research data and analysis) which is not strictly rooted in traditional research methodologies. And it presents the challenges of reflection and critique not merely by the researcher. Data will be open to critique, reflection, negotiation and ultimately reconceptualisation by others, thus rendering the process of data collection and analysis somewhat unpredictable and impossible to plan or shape according to theory. Dialogue therefore is about taking risks and comes with no pre-established or detailed methodology (Alrø & Skovsmose 2002).

Put differently a dialogic epistemology in researching mathematics education places the researcher not only in a position of researcher but also in a position of learner. Coming to know through dialogue entails a large element of learning about the context in which the research takes place. This perspective suggests a great challenge to epistemologies of truth or objectivity or even stability of knowledge claims (Reason P. 1994). With a dialogic epistemology knowledge claims can be conflictual and may only appear valid to interactants till the appearance of new reflections or critiques. Knowledge as articulated through dialogue is therefore unstable and fragile and dependent on context.

Dialogue in research

The notion of dialogue (or inquiry) is already the subject of research in e.g. the field of education. Classroom dialogue has been proposed as a method of introducing critical education (Wells 1999, Alrø & Skovsmose 2002) and as a means of democratising education (Freire 1972, 1999). In research discourses dialogue has been introduced as an operationalising tool for critical hermeneutics (Kögler 1999) and as the main characteristic of research interviews (Kvale 1996). Dialogue is thus not a new phenomenon in research,

Dialogue can be defined to encompass numerous communicative acts as e.g. *conversation, talk, communication, interchange, discourse, argument; chat, gossip; confabulation; interlocution, duologue, colloquy...* as well as *discussion, debate, exchange of views, head-to-head, consultation, conference, parley, interview, question and answer session; negotiations* (New Oxford Thesaurus of English 2000).

Most qualitative research activities would qualify as dialogic in this all-inclusive definition thus diluting the notion of dialogue as a specific research method for data interpretation. Therefore, we need to narrow our understanding of dialogue and address the question of the contribution of dialogic methods. Two areas of contribution can be pointed out:

First, through dialogue the researcher can actively engage in the construction of data or he can set the scene for research participants engaging in their own dialogue. This form of data collection (or data construction) may appear both essential and in qualitative research almost inevitable when approaching the research from a constructivistic perspective. Here it becomes relevant to consider for example the dialogic acts in which a researcher could take part during participant observations and the effect of dialogue on the data (Brown & Dowling 1998).

Second, and of prime interest to this paper, dialogue can contribute to research as a method for interpretation. The researcher can choose to involve either research participants or other researchers in his interpretations of data by engaging in dialogic acts. Carspecken & Apple introduced dialogical data collection as a third stage in their model for critical qualitative research granting research participants a role in the process of construction and interpretation of data. However, what is understood by dialogic methods appears limited to comprise only interviews and group discussions (Carspecken & Apple 1992).

I will argue that dialogue as interpretation can take numerous other forms less structured, more informal and more participatory than interviews or discussion groups, e.g. by encouraging participants to set the agenda for discussion and for the researcher to take an active role in the discussion rather than only the role as listener. This approach will grant participants to the dialogue a sense of equality and the freedom to bring into the dialogue whichever topic they deem relevant. Inviting research participants into the interpretation process simultaneously embrace a dialogic epistemology recognising the value of negotiating, reflecting and interpreting with the goal of research participants and researchers alike coming to know about the data. There is thus no objective truth related to the data, but rather numerous and equally relevant possibilities of interpretations and reflections.

Establishing dialogue as a specific method for data interpretation it is further necessary to ascribe some particular qualities or properties to our understanding of dialogue as a unique informant of both research methodology and research methods. For this purpose I propose that the Inquiry Co-operation Model developed by Alrø & Skovsmose (2002) can serve as a framework for this conceptualisation.

The inquiry co-operation model in dialogic research

The Inquiry Co-operation Model (IC Model) was originally presented as a model of communicative acts occurring in mathematics classroom learning through dialogue. The model integrates dialogue in the learning process and thus transforming the model from a model of classroom dialogue into a model of interpretative dialogue in

research presupposes that we understand the interpretive research process as a process of learning. This in turn entails a dialogic epistemology outlined above. In the interpretive process both researcher and research participants could be seen to engage in a process of learning about the data they interpret. The answers are not immediately reachable but need to be constructed through negotiations, reflections and critiques.

The IC model is operational in what is termed a landscape of investigation which suggests a multitude of possible answers and interpretations to the situation at hand in this case the research interpretation. Hence the model allows for participants to bring in aspects of their social, cultural or political background posing questions of what if... (Alrø & Skovsmose 2002).

Relating dialogue to the learning process Alrø & Skovsmose ascribe three essential properties to the notion of dialogue; making an inquiry, running a risk and maintaining equality. These essential properties must be characteristic of the scene of interaction in order for a "learning" dialogue to occur. *Making an inquiry* means exploring what one does not yet know and sharing the desire to gain new experiences. For an inquiry to be dialogic it must be open to participants bringing their own perspectives rooted in their backgrounds into the inquiry. Participants must also be willing to suspend their own perspectives in order to consider the perspectives of others and in articulating these perspectives new and more insightful perspectives may appear. *Running a risk* refers to the uncertainty and unpredictability of the dialogic process. Participants to a dialogue propose perspectives, however navigating in a landscape of investigation means that there are no pre-established answers to emerging questions. Therefore "dialogue includes risk-taking both in an epistemological and an emotional sense". In other words participants to a dialogue will be challenged on their knowledge as well as their emotions. In order for participants to remain in the dialogic process it must be ensured that the uncertainty never appears too uncomfortable. *Maintaining equality* suggest that participants to a dialogue engage at a level of equality. Equality in this sense does not equal sameness but rather fairness. Participants may enter the dialogue in different capacities and being equal thus comes to depend on the ability of participants to embrace and accept diversity (Alrø & Skovsmose 2002).

Outlining these properties of dialogue a contour of dialogue as an interpretive research methodology is slowly emerging. Researchers and research participants would make joint investigations in the yet unknown landscape of the data inquiring into the data, exploring different perspectives in order eventually to gain new knowledge of e.g. student backgrounds influencing the mathematics classroom. The process would be uncertain and participants would run a risk of having their perspectives challenged and ultimately altered by others. The greatest challenge though is maintaining equality. In the interpretive process the researcher and research participants alike must recognise the contributions of each other as well as their respective lack of knowledge about the data to be interpreted. Again it becomes

evident how this method challenges ideas of objectivity and the researcher as someone establishing the scientific truth about the world.

Proposing dialogue as a research method contributes to the continuous struggle to move not only theories but also methodologies and research methods into the sphere of the post-modern. Insisting on equality, risk-running and joint inquiry in the dialogic process suggests process free from prejudices or rather processes embracing, critiquing and elaborating on prejudices somewhat as a form of verbal hermeneutics (Kögler 1999).

To further operationalise the use of dialogue in situations of learning the IC model suggests the presence of communicative acts; e.g. getting in contact, locating, identifying, advocating, thinking aloud, reformulating, challenging and evaluating. These acts may vary in number and according to situation and are assisting in the dialogic process. Generally, relating these communicative acts with the properties of dialogue outlined above "the IC model becomes and empirical indicator of dialogic learning taking place" (Alrø & Skovsmose 2002 p. 129).
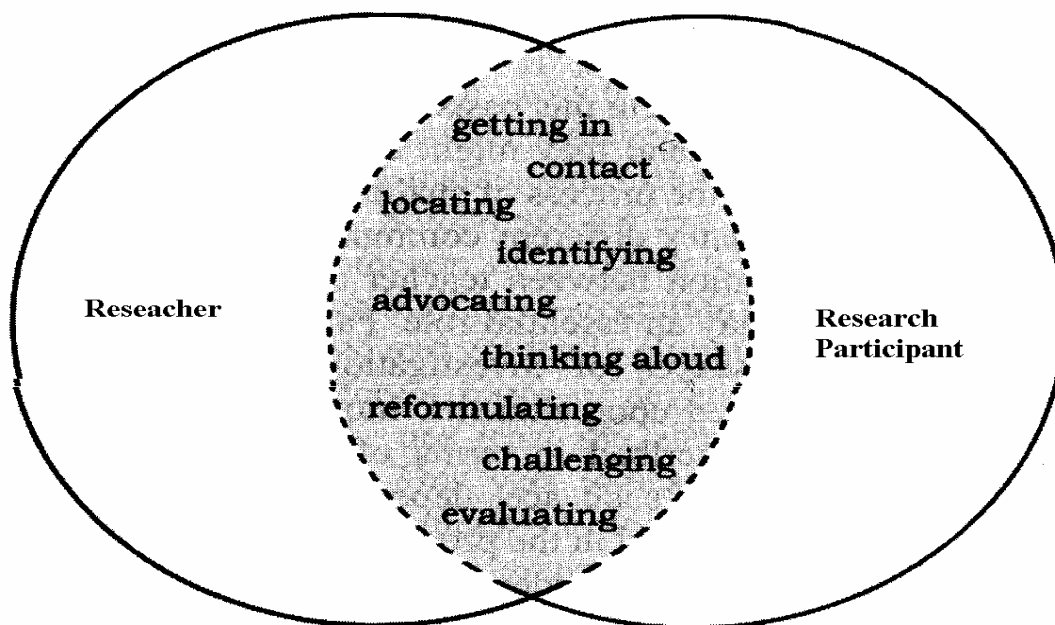

Figure 1 The Inquiry Co-operation Model adapted from Alrø and Skovsmose (2002 p. 63).

Figure one illustrates the IC model as it could appear in a dialogue between a researcher and research participants relating to the interpretation of data. The model presupposes the presence of dialogic properties and illustrates some of the

communicative acts utilised in the dialogic process. The illustration of the model further proposes that participants to the dialogue engage in the dialogue in what could be characterised as a joint space (grey area). Researcher and research participants alike bring their social, political, cultural backgrounds into the dialogue, which necessitate a shared space, where these individual background experiences are attributed a value and granted respect by other participants.

To overcome this challenge the objective for the researcher and research participants is to establish a shared space for interaction, which can accommodate for the distinctive characteristics of a dialogue. This shared space of interaction could also be characterised as a shared social identity enabling researchers and research participants in a particular point in time to establish an environment of equal interaction and strive for a mutually agreed goal (Turner 1987, Haslam 2001). In other words, whether utilising the IC Model to describe dialogue in the mathematics classroom or to establish an interpretive dialogue between researchers and research participants to uncover student backgrounds' influences on learning processes, participants must be prepared to initiate some social psychological processes in their efforts to reach a form of interaction suitable for dialogue.

Uncovering student diversities through dialogue

Researching student backgrounds in the multicultural mathematics classroom presents a number of challenges. How can we for example ensure that a study about diverse cultural backgrounds is not only our account of various cultures biased by our own cultural background? How can we take diversity into account in our research of that particular notion? Although dialogic interpretation of data cannot resolve these issues in full, it has some contributions to offer.

Considering a situation of students with diverse social, cultural or political backgrounds participating in a dialogic interpretation of data collected in the mathematics classroom the horizon for the interpretation will be substantially broader than had the researcher made the interpretation on his own. It can be argued that the landscape of investigation in a multicultural or diverse group of participants includes any perspective imaginable by any student (or researcher) based on his or her individual background. Thus any knowledge claim about the data and classroom interaction may be critiqued and negotiated not only from the theoretical and cultural stand of the researcher, but rather is scrutinised from any perspective of any participant providing a broader and more nuanced picture of classroom interaction and student diversity than could ever be established by the researcher alone. Dialogue thus comes to function as an exchange of culturally biased information among interactants and as a space for negotiation and reconceptualisation of the knowledge claims made.

Diversity is a powerful notion, which when investigated, will bring uncertainty and unpredictability to centre stage. Bringing students into a dialogic data interpretation process will inevitably highlight student diversity bringing new insights both to the

researcher, the students and the research about processes and issues of diversity emerging in classroom interaction and the various possibilities of data interpretation and knowledge claims dependent on background. Negotiating from different perspectives could further give students as well as researcher a clearer perception of their own cultural biases, and how these may influence interpretation and everyday classroom interaction. In other words, dialogic data interpretation broadens the scope of the research and simultaneously provides grants a voice to diversity itself through the participants with diverse backgrounds.

The main contribution of dialogic data interpretation to the exploration of diverse student backgrounds is the invite it provides for students to contribute their diversities at the interpretive level, and in some limited way democracy can be brought into the research process through the dialogic process.

Critiquing dialogue in research

Research methods traditionally characterised as dialogic e.g. interviews and focus groups have often been accused of producing non-scientific, subjective and invalid results, where interpretations are biased and it is difficult to apply traditional measures of validity, reliability and generalisation (Kvale 1996). A similar or even stronger critique is highly imaginable when considering dialogic research methods to include informal unstructured dialogues of research participants engaging in dialogue for data interpretation. Reason (1994) proposes to overcome such issues through what he calls critical subjectivity. Critical subjectivity entails recognition of ones knowledge being rooted in subjective experience and perspective, and that research is rooted in experience. "Critical subjectivity means that we do not suppress our primary subjective experience, that we accept that our knowing is from a perspective: it also means that we are *aware of* that perspective and of its bias, and we *articulate* it in our communication" (Reason 1994). The issue of validity in postmodern research is further addressed by Scheurich (1997) and Mason suggests that "Validity is the responsibility of the individual, within the practices of the community, to test out in their past, present, and future experience, and in the experience of others. Validity is person, place, and time dependent, and concerns the sensitivity to notice in emergent situations, not facts about situations before they happen" (Mason 2000 p. 319).

It may be argued that the researcher over the cause of a dialogic data interpretation may alter research participant's views or perceptions of the mathematics classroom, their role in this classroom and the significance of students' backgrounds on the learning process. This again raises the question of validity of the data. Is data valid in situations where dialogue between a researcher and the research participant leads to a change of mind? This question is particularly interesting, as a researcher engaging in dialogue does not necessarily have an agenda for change or action. Thus although dialogic interaction will inevitably lead to changes in the conceptualisations and knowledge claims of participants (whether researchers or research participants) these

changes are uncontrollable to all parties involved. They are ontologically rooted in the situation at hand, yet they may alter findings considerably.

Again the core of the opposing views can be found in our notion of epistemology. If the understanding of epistemology is based on scientific truths or researcher objectivity and a belief that research can paint an accurate picture of the world surrounding us, then naturally, the dialogic method falls short of meeting the requirements and standards for validity. However, the notion of dialogue in methodology and method is build around a different epistemology which not only accepts the "shortcomings" and unpredictability of dialogue, but which also embraces this unpredictability and constant changes as establishing environments for negotiating and critiquing leading to new and deeper understandings of the data being interpreted. This epistemology allows for different perspectives to meet and for the joint construction of meaning based not only on scientific theories but also on participants' different experiences and backgrounds.

Conclusions

Views on mathematics education research can differ considerably between researchers and teachers (practitioners). Dialogue in research is an inclusive methodology allowing researchers and research participants to jointly construct and interpret the data. In this capacity dialogue could be a useful tool for building a bridge between the communities of researchers and practitioners of mathematics education. On the one hand dialogue is "real". It is conversation, discussion and debate right there in the classroom, in the school yard or in the teachers lounge. On the other hand dialogue will grant the researcher insights into what constitutes the interaction in the mathematics classroom not only through the process of data collection, but also through the dialogic interpretation of the data. This appears particularly useful in situations where diversity is at the core of the research, and where a researcher's knowledge and insights into students' diverse backgrounds are inevitably limited.

The notion of dialogue has evidently both some contributions to make and some challenges to face and this paper only investigates the tip of the iceberg. For instance it would be relevant to explore in greater detail issues of validity when applying dialogue as a research method as well as the empowering or dispowering capacities of dialogue. The element of power in the dialogic process also needs addressing further. These issues aside, there is probably no better way of exploring the applicability of dialogue as a method for interpretation than to actively engage in the process. Granting a voice to research participants; students and teachers in the diverse mathematics classroom will no doubt add to the research and bring about new perspectives.

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HANDICRAFTS PERFORMING LIFE

Margarida César[*], *Universidade de Lisboa, Portugal*

Lucília Teles, *Universidade de Lisboa, Portugal*

Abstract: *Portuguese society and schools are becoming more multicultural. Many minorities are rejected by society. Others are valued but still seen as different. The Dance School community is a cultural minority facing schooling challenges mainstream students do not have. This research took place in a 9th grade class already used to work in peers. Its main aim was to study and implement collaborative work associated to project work in order to promote students' engagement in mathematical activities, knowledge appropriation and the mobilisation/development of competencies. Students participated in a micro-project (batiks) based on the school's name. Several mathematical contents were studied based on this handicraft. The results show that knowledge appropriation and students' engagement were very high. In the interviews and questionnaires all students stated they loved this activity and that learning mathematics was great.*
Keywords: Cultural minority, Micro-projects, Intercultural Education, Collaborative Work, Interdisciplinarity.

Introduction

Nowadays, the Portuguese society and school integrate many ethnic communities and cultures. Some, like the African community, have been in Portugal for a few decades; others, like the Eastern European and the Asian ones, were only very recently established in Portugal. In the first case, it is a socially undervalued ethnic minority, seldom really included in school. The latter are usually high achievers at school although the Eastern European children often arrive almost ignoring the Portuguese language. These two worlds differ not only at the social and cultural level, but also, and of more interest to us, in the way students face school and its subjects, namely Mathematics.

Although compulsory education lasts until the students are 15 years old, which means that they will accomplish the 9th grade if they never fail, Portuguese schools are still struggling with the challenge to overcome a high range of underachievement, and many early schools dropouts.

Innovative classroom practices, like collaborative work (César, 2003) and project work (Abrantes, 1994), can be used to promote knowledge appropriation as well as the mobilisation and development of competencies. Intercultural tasks are very important in multicultural classrooms (Favilli, Oliveras, & César, 2003), but they can also help to respect all cultures even when the classroom context is not a multicultural one, or when it is a special cultural minority, like Dance School students whose difference comes from their vocational choice and curricula which includes both the mainstream schools subjects as well as dance subjects, and not from their family cultural background.

This research aim consisted in the study and implementation of collaborative work joined to project work as a way to promote students' engagement in mathematical activities, their knowledge appropriation, and their mobilisation/development of competencies. Being a research-action project it aimed both at describing and interpreting the contributions of this type of work. The aim of *IDMAMIM* project in Portugal was to work with minoritized communities, like the one from Cape Verde. But soon teachers used these micro-projects with other minorities, like Dance School students. Contacting with a different culture was a very rich learning experience. Elaborating batiks in order to learn mathematics was also a way of learning how to admire and respect an African culture. This learning experience was valued by all students who describe it as very interesting and a fine way to learn both mathematics and social competencies.

In this paper we analyse the activities related to the content of direct and inverse proportionality. Several examples of students' accounts and one excerpt of a peer interaction illuminate the contributions of collaborative work associated to project work in students' knowledge appropriation and in their mobilisation/development of competencies. Being an action-research approach, based in ethnographic methods, the teacher also assumed the role of researcher. Thus, participant observation, students' protocols, interviews and questionnaires were the instruments chosen to have access to students' accounts as we aimed at listening to all voices, even those who are usually less heard.

Theoretical background

School must be able to prepare students for a society that is quickly changing at the social and technological level. School has thus to contribute to the upbringing of competent, active and interventive citizens, capable of group work, of sharing knowledge and responsibilities in the development of common projects. It is towards this goal that project work in school context is being given an increasing importance, namely in Mathematics (Abrantes, 1994; Favilli, César, & Oliveras, 2003; Martins, Santos, Ferreira, & César, 2003).

Another fundamental aspect shaping students' mathematical performance is the nature of the tasks (Teles & César, 2003; César, Oliveira, & Teles, 2004). Tasks can be a way of facilitating knowledge appropriation as well as the mobilisation and

development of competencies (César et al., 2004). The social marking of the tasks (Doise & Mugny, 1981) is also a relevant element, as these tasks become meaningful to students, stimulating their participation both in their solution and in the general class discussion.

As classrooms become multicultural tasks must take into consideration the several cultures, valuing them, interconnecting them (Bishop, 1988) and trying to make them part of the learning process. Some authors (César & Azeiteiro, 2002; César, Mendes, & Azeiteiro, 2003; Favilli, 2000; Favilli et al., 2003) have argued that intercultural micro-projects related to handicraft activities support an intercultural approach, giving a cultural dimension to the learning process, contributing to academic achievement.

In a situated perspective, Lave and Wenger (1991) consider the learning process as participation in communities of practice. New members become more active and engaged participants through the legitimation of the peripheral participation. In this legitimation process the teacher can play an extremely relevant role, working as mediator and facilitator (Vygotsky, 1978). But in order to achieve this, the teacher's practices must be coherent with the didactic contract (César, 2003; Schubauer-Leoni & Perret-Clermont, 1997). In the traditional didactic contract teachers are expected to teach, and students are expected to learn, in a passive way. When we aim at implementing an innovative didactic contract, namely empowering students and promoting collaborative work, its rules need to be made explicit so that students can engage in this type of work (César, 2003).

Several researches have illuminated the facilitating role played by collaborative work as a mediator of knowledge appropriation and promoter of more positive attitudes towards Mathematics (César, 2003; Schubauer-Leoni & Perret-Clermont, 1997; Teles & César, 2003). Collaborative work is also associated to intercultural tasks, promoting more inclusive schools (Ainscow, 1999; César, 2003) and contributing to respond to the cultural diversity. Inclusive schooling practices as well as intercultural ones are important to prepare participant citizens, no matter which is their cultural background. As D'Ambrósio (2002) states, "(…) in every culture we find manifestations related to and even identified with what we nowadays call Mathematics (…) usually mixed or hardly distinguishable from other subjects, that are currently identified with Art, Religion, Music, Techniques, Sciences" (p. 60). It is important to analyse these manifestations, looking for them in different cultures and contexts, and taking advantage of their inter-relationship.

Method

This study connects two broader projects: *Interaction and Knowledge* (action research level), whose main aim is to study and promote peer interactions in classrooms; and *IDMAMIM*, whose main goals are to identify the didactic needs for the development of an intercultural Mathematics education and to produce materials that Mathematics teachers can use in multicultural or minority culture contexts.

IDMAMIM elaborated and explored three micro-projects developed in Portugal, Spain and Italy. Each of them selected a hands-on handicraft activity typical of an ethnical minority. In Portugal it was Cape Verde's community and batiks, a pure cotton wrap tainted with colours where a drawing is contrasted. This minoritized community was chosen because it is one of the most represented ones, but also experiencing high underachievement and early school dropouts. Thus, this was a challenging cultural community, namely in what concerns mathematical learning.

This research consisted of studying the potentialities of collaborative work associated to batiks micro-project when they are applied to a different cultural minority: Dance School students. The research questions we are presenting in this paper were: (1) Does collaborative work associated to intercultural micro-projects promote students' engagement in mathematical tasks?; (2) How do they contribute to knowledge appropriation and better mathematical performances?; (3) How do they contribute to the mobilisation/development of mathematical and social competencies?; (4) How is this type of work seen by the students in their accounts?

These students cultural background is not connected to Africa, but they are also seen as a cultural minority due to their vocational choices. In fact, being part of a Dance School is a very different learning experience. Dance subjects are seen as the most important ones and so they are scheduled for the morning shift. Students who do not succeed in Dance can not go on studying at Dance School, no matter how high their marks are in the academic subjects. Thus, Mathematics is seen as a complementary subject but not as one of the main subjects, as in the mainstream schools. However, Mathematics syllabus is exactly the same, which means that Dance School students have a much more demanding curriculum as it gathers all the usual subjects and the Dance ones, making their timetable quite full. This vocational choice is very exclusive and demanding. If you are not really very good no one will give you a second chance. So, these students are faced by challenges that others really miss.

These students constitute a cultural minority as their academic life is commanded by dance. This means having rehearsals and performances several times a year, putting all their effort to become professional dancers, talking about dance most of the time, having no spare time for usual teenagers' activities like going out at night, and living their lives according to dance demands. The dance passion makes them live very intensively within school, and be seen as weird by their peers from outside school.

In what concerns their cultural backgrounds they come from different socio-economic levels, as well as from different cultures. But in the case of these 9th grade students they were all Portuguese and from the mainstream culture. Although they were in the 9th grade for academic subjects, two of them were in the 4th grade in Dance, eleven were in the 5th grade and three were in the 6th grade. The final grade in Dance is the 8th grade.

The research project studied the development of an interdisciplinary micro-project, which involved Mathematics and Art. Later, this project also had the collaboration of

Portuguese and History teachers. Being an artistic-oriented school there was great concern in making this project meaningful to the students, by contrasting in the batiks the school's graphic symbol, which represents this community's identity, which is a main element among these students.

As we were doing an action-research project which clearly had an intervention purpose, the teacher also assumed the role of researcher. The general decisions (e.g., how was the first week of classes; how were the dyads formed; how was the evaluation process) were taken within the research group which involved 42 teachers/researchers also working collaboratively among them. The specific decisions concerning his/her classes were taken by each teacher/researcher (e.g., to which contents they would apply the micro-project; when were the dyads changed; which classes were audio or video taped).

The instruments used for data collection were participant observation (classes were audio and/or video taped), students' protocols, questionnaires and interviews. During batiks elaboration there was a video camera trying to get significant episodes and that each group had a small audio-tape recording all their interactions. All these interactions were then transcript for an in-depth content analysis. All these instruments were applied or collected by the teacher/researcher but when the classes were video taped she also had a camerawoman. In order to have thick descriptions the teacher/researcher wrote field notes in/after every class. This procedure also facilitated her reflection upon practices. She also copied all her students' sheets of answers. The questionnaires were answered by all students and also by the teachers who collaborated in the research project. Six students were selected for interviews according to criteria of gender, academic achievement, and social representations about Mathematics.

The micro-project consisted of the elaboration of templates with the school's graphic symbol and batiks with these drawings. During these classes students worked in four-students groups. The batiks were applied on black T-shirts and shown to the school's community at an exhibition. It must be pointed out that the templates were made in both Mathematics and Arts classes, where the two teachers worked together. After this first step of the project, the students made the batiks in three Maths classes. This was also a totally new learning experience for students, as Portuguese school teachers usually work individually, not collaboratively. All these classes were audio and video taped in order to future content analyses that we already achieved.

In Maths classes, tasks concerning direct and inverse proportionality were explored based on the elaboration of the batiks. In these classes students worked in dyads. The inverse proportionality theme was brought up through the tainting process of batiks' elaboration (3rd day). In this class, each student made two batiks, choosing two of twelve different colours to taint them. Only two students chose the black colour, and a black ink can was spent on their two batiks. In another school, where batiks had been made the previous year, only one group of students chose the black colour for their batik. Thus they spent the whole can of black ink in just one batik. Based on

these two different realities, the inverse proportionality theme was worked out by students. All these classes were audio and video taped. Students written productions were collected by the teacher/researcher in order to further analysis.

There were no *a priori* categories. They were defined in an inductive way through the content analysis.

Results

The results of the implementation of this micro-project were very interesting at many levels. There was a clear receptivity from the students and their engagement was really great. Several times they had to work more than the scheduled time (e.g., to do the second day paste; or preparing the final exhibition) but they were always ready to do whatever was needed and enthusiastic about studying mathematics contents based in a handicraft activity. They felt like legitimate participants (Lave & Wenger, 1991) and the whole class worked as a learning community, in which every student had the possibility to participate and to use his/her one voice (César, 2003). The teacher had a fundamental role in this process of legitimation of students' participation. She began promoting their empowerment since the first week of classes, by asking all of them to show and discuss a resolution they had done and succeed, according to one of the aims of the project: to promote positive academic self-esteem (César, 2003).

Besides the mathematical contents related to the templates and the batiks (e.g., geometry, proportionality), in the following Mathematics classes other contents were explored: direct and inverse proportionality, inversely proportional measures, and the constant of proportionality. These contents were chosen because they are part of the syllabus and usually seen as difficult by students.

It was observed (field notes) and also expressed in all students' questionnaires and interviews that even the students who were usually less participative were highly active during the resolution of these tasks, as the topics had been experienced by them and they felt very comfortable with them. Mathematics classes quickly finished, and mathematical work was done in a cheerful, interesting and motivating way. The students' interventions were well adapted to the tasks, and their doubts were almost always worked out recalling the context of the batiks classes. It is important to point out that all students expressed a great satisfaction and pride on seeing their own work being used to learn Mathematics in an academic context, like we can see in the following accounts:

"I think it is quite productive as these tasks [batiks] promote a greater interest and engagement in activities during classes." (questionnaire)

"I think it is great as it helps us learning." (questionnaire)

"This new working method made me work harder. (…) I think it helps us understanding more easily the contents we are learning." (questionnaire)

"These tasks were funny and very impulsive [he/she means stimulating]." (questionnaire)

"I think it was great because everyone was able to participate in this work." (questionnaire)

"I think this is a quite interesting experience because we learned things in a different way." (questionnaire)

"We see Mathematics as more funny, more active. We can say that it is not just «cramming»." (interview)

Students' mathematics learning began since the first day of the elaboration of the batiks. They had to elaborate the first paste and they only had the recipe for a 500 gr tissue. But their batiks used tissues that varied from 70 to 90 gr. Thus, they began discussing in the groups how they should calculate the quantities of flour, lime and water. All the four groups remembered they could use direct proportionality in order to discover the quantities they needed and they registered their computations in their reports (they wrote a report in each day of the batiks elaboration).

Students' engagement in the activities, the collaboration between them, as well as their autonomy can be illustrated by the following photos:

Figure 1 – Students solving a worksheet on inverse proportionality

Based on the relation between the wraps' weight and the quantities of each ingredient for the paste, students solved a task and worked on the direct proportionality notion. As they had elaborated the batiks by themselves, these tasks had social marking for them, easily becoming meaningful.

R – Weigh of the tissue: 78 grams. Quantity of flour: now we have to…

C – Now we have to calculate!

R – Yeap. Now it is like this: now… it is like this: if we had 500 grams of tissue we had 600 of flour; to 78 how many do we have? Go on calculating the water and the lime.

C – Calculator?!

This is a short example of collaborative work associated to a micro-project. We can notice that the answer is co-constructed as both students contribute to the first calculation and then they divide tasks because they were sure they both knew how to solve this task. Thus, they were respecting the didactic contract: they had to discuss their solving strategies until they could agree about what should be done; and both of them should be able to explain this dyad's work.

Despite of being very short, this excerpt also illuminates some social and cognitive competencies that students showed during their work, such as their autonomy, respect for each one's contributions, decision making, and task engagement. From the emotional point of view we can see that there is an easy going atmosphere, and that students seem pleased while interacting. Teacher's practices were coherent with the didactic contract as she gave space and time so that students could solve the tasks on their own. Her way of acting is quite clear when we analyze the videotapes.

The task about inverse proportionality was based on the tainting process. Students established a relation between the number of black batiks and the quantity of ink used in each one. They discussed it with their peer, and then with the whole class. They also discussed the difference between the two situations of proportionality.

Number of black batiks	1	2	4	8
Quantity of ink in each batik	1 package	½ package (0,5)	¼ package (0,25)	1/8 package (0,125)

4. What is the value of the constant of proportionality in this case?

Ex: $2 \times 0,5 = 1$ - constant of proportionality

- total number of packages of black colour per class

5. Complete:

Being N the number of black batiks per class and Q the quantity of black ink per batik, we have:

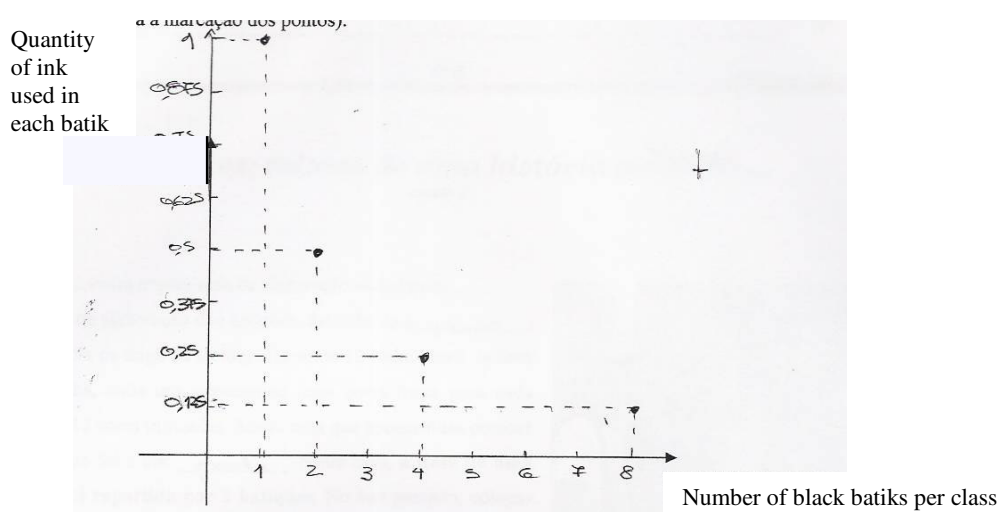$$N \times Q = ...1... \text{ - constant of proportionality}$$

Figure 2 – Excerpts from the inverse proportionality task

Another concern was to make students understand the need to use a proportion in some situations, like in the relation between the weight of wrap and the quantity of the ingredients to make the paste (e.g., flour). The next resolution shows an example of these situations and how students solved them:

> "We think that all ingredients should be divided in a proportional way so that the paste will be consistent. If it isn't like that the paste will not be well done, thus we will not be able to elaborate the batik." (students' sheet)

On the third day after batiks elaboration, when students had already solved tasks about direct and inverse proportionality, they continued to work with inverse proportionality situation but in new way: They should analyze and decide about the existence of a relation of this nature and discuss about it with his/her peer.

Students were very pleased to have the opportunity of learning in an alternative way. Anabela points out in her interview she preferred the classes in which batiks were made: "…Because it is very pleasant for us to study Mathematics far from papers" or, as Manuela accounts, "(…) we learned the subjects with much more interest".

It is also interesting to note how the students recognize the contribution of this kind of task to their own cultural enrichment. José states it clearly when he says that it is important to work on this kind of task and to learn from them "because I am now more culturally enriched." After this micro-project students viewed Mathematics in an intercultural way, and they often talked about the African culture. We must stress that these are highly sensitive students due to the artistic and aesthetic side of their activities. They love what is new, to experiment different techniques and to face challenges. Students' performances, both in these tasks and in the contents explored by them and to which they answered in their final exam, were quite high, which is not very common in dance students when it comes to Mathematics.

Final Remarks

In Portugal, there are not only socially unvalued minorities, like the one from Cape Verde, but also highly valued cultural minorities, though still seen different from the mainstream culture. There are a few schools that have some special status (vocational, professional, or other), thus constituting specific communities, with unique characteristics. It is also important to face and analyse this other reality formed by students who share particular goals and motivations, which make them belong to another culture. These students also need to have access to a meaningful academic learning. Learning opportunities should be aware of their vocational choices and interests, offering them the opportunity to develop tasks and projects that confront them with distinct realities from their own.

Far from being one of the ethnic minorities that motivated the beginning of the *IDMAMIM* project, the Dance School, as a social minority, is made up of students with particular motivations and characteristics, sharing a future project of life: becoming a dancer. Being students from an artistic school, they (and their dance teachers) regard academic subjects much more as a guaranty for the future than as a

passion. Yet, the engagement they showed in this project and the positive attitude they showed in the classes that followed the elaboration of the batiks, during the resolution of the mathematical tasks, were much higher than their initial expectations. Despite having no connections at all with the African culture, students were engaged in the project from the start, transforming it into a truly meaningful learning experience for all… students and teachers. As they accounted, they not only learned Mathematics in a meaningful way, they also learned a lot about African cultures and they talked about it even in Dance classes.

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LANGUAGE SENSITIVE MATHEMATICS TEACHING IN A MULTICULTURAL CLASSROOM
HOW STUDENTS' TALKING AND WRITING CAN ENLIGHTEN HIDDEN PROBLEMS

Dolly van Eerde, *Utrecht University, The Netherlands*

Maaike Hajer, *University of Professional Education, The Netherlands*

Abstract:*Recent studies in The Netherlands show that the poor results in mathematics of students of ethnic minority groups go beyond language issues. The problem is hidden and underestimated by both teachers and students. This paper reports on a design experiment, in which instructional materials –partly webbased- are developed to promote interaction and to support teachers and students in multiethnic mathematics classrooms. The experiment shows that working with the materials opens the way towards integrated mathematics and language learning. Observational data and test results of a multiethnic class at a Dutch secondary school show that these materials stimulate students' verbal participation in interaction and reveal students' thinking. The difference between talking about mathematics and writing about mathematics would require more attention in students' simultaneous development of math and language.*

Keywords: Multicultural, Language across the curriculum, Mathematics, Social interaction, research design

Introduction

The poor results in mathematics of pupils of ethnic minority groups in the Netherlands have often been explained in terms of increased linguistic demands that are put on learners. Following Cummins' classic distinction between Basic Interpersonal communicative Skills (BICS) and Cognitive Academic Language Proficiency (CALP) (Cummins, 1984), textbooks and learner proficiency have been analysed to define the gap between students' BICS and the required CALP in mathematics instruction. This approach reflects a static view on this gap. However, both teacher and student play an active role in establishing the learning environment. Classroom studies show, e.g. that content teachers who are aware of the limited language skills of their students tend to diminish active verbal participation by their students and lower cognitive demands. (Hajer 1996, 2000). Van den Boer, (2003) underlines these findings and shows that the real problem goes deeper than simply not knowing certain mathematical concepts. Teachers and students are not aware of the barrier that students' language proficiency

and reading strategies form for learning mathematics. They underestimate this barrier and wrongly presume mutual understanding. The study reveals that students' and teachers' ineffective strategies reinforced each other. Students refrain from asking questions, talk in short sentences, and write down very little, whereas teachers expect students to ask for clarifications and adjust their language and their demands to the students. Both Van den Boer and Hajer conclude that lessons should be carefully designed to promote classroom interaction if language is to be used as an essential tool for high quality learning, and that multidisciplinary studies are required in this field.

In this study materials for language sensitive mathematics instruction were developed as a tool for promoting this classroom interaction. The main question of this study is how the instructional materials can mediate integrated processes of learning language and mathematics.

Teaching and learning mathematics in multicultural classes

The idea that language and content learning are intertwined is not new. Efforts to develop content-based language learning (Snow et al. 1997, Ecchevaria et al. 2004) have mainly been undertaken from second language pedagogy, using e.g. second language teaching techniques to teach new subject specific vocabulary. However, discipline-based theories of learning and teaching should be integrated in this approach, if an in depth understanding is to be achieved. Thus, theories on mathematics and language teaching and learning are both relevant to our study. Dutch mathematics education has been strongly influenced by Realistic Mathematics Education (RME), which builds on social interaction between teacher and students. In this approach, mathematics has its roots in real life, and children should be guided to reinvent the mathematics developed in the past (Freudenthal,1991). Through carefully constructed tasks they learn to transform a meaningful context problem (e.g. from daily life) into a representation that can be manipulated mathematically. The teachers' role would be to provide students with the opportunity to verbalize and justify their solutions and to stimulate students to listen to each other's solutions, to compare and criticize these solutions and to ask for clarification; teachers should be 'pushing discourse'

It seems that theories on RME and second language teaching can be mutually symbiotic since sociocultural theory gains increasing influence on (second) language acquisition theory (Lantolf 2000, Gibbons 2003). Current views on language acquisition implicate that hearing or reading new concepts and structures (in jargon: 'comprehensible input') is not enough : learners also need to actively use and 'produce' new linguistic elements in meaningful context and need to receive 'feedback'. In this way, negotiating meaning in interaction is an important tool for promoting understanding. Students' active manipulation of new language forms, functions and concepts through talking as well as writing are crucial tools in the acquisition process.

Moschkovich (2002) also approaches mathematics learning for bilingual learners from a sociocultural perspective and illustrates convincingly the complex nature of linguistic skills required for learning mathematics and meanwhile refrains from a deficient view on bilingual learners. She concludes that instruction should support learners' opportunities to engage in classroom conversations.

Our study follows this approach and focuses on the way in which teachers and instructional materials can provide additional resources for the students. Our work adds a dimension as it views multilingual mathematics classes as a place where students use language as a tool for learning mathematics, but meanwhile acquire communicative competences.

We have carried out several studies integrating these viewpoints on mathematics and language learning in empirical classroom research. In these studies the following three key characteristics are examined: first, the exposure to new concepts and language while focusing on mathematics problems; second, the opportunities for language and mathematics production in the interactive process of meaning construction; and third, feedback on mathematics content, and on function and linguistic form of students' utterances. In a previous explorative study (Van Eerde et al., 2001) we found that there was very little interaction and teachers did not stimulate their students' language production (oral and written). Taking interaction as an essential condition for the integrated learning of language and mathematics, we started a design study. Design studies combine the development of theory with the development of instructional materials aimed at educational improvement (Gravemeijer, 1996).

Developing an integrated approach of language and mathematics learning

The main question of this study is how instructional materials can mediate integrated processes of learning language and mathematics. More specifically, we wanted to understand how additional lesson designs, web based materials and vocabulary tests, named Wisbaak,could help to realize three *key characteristics* of an integrated approach: to make contexts in mathematics assignments accessible (KC 1), stimulate interaction as well as language production in mathematics classes (KC2), and provide opportunities for teachers to give feedback on language (form) and mathematics (content) (KC3).

The Wisbaak package contains prototypes in a modular structure around central mathematical topics, such as graphs, formulas and geometry. Each module consists of one or two language sensitive mathematics lessons, interactive applets, and a vocabulary test. In addition we started to develop an electronic dictionary.

Data and participants

Data were collected at several multiethnic schools. The data consists of classroom observations based on videotaped lessons, pupils written work and test results. In

addition, data on teachers´ cognitions were gathered through interviews and concept mapping tasks. In this paper we focus on a selection of data from the first year of The Rainbow, a prevocational secondary school. The students, aged between 12 and 14 years, belonged all but one to the second generation mainly Moroccan and Turkish immigrant children. For many of them, the language of instruction (Dutch) was different from the language they speak at home. We will discuss fragments from classroom discourse to illustrate how oral production was promoted, followed by analyses of students' written work, and their results on a vocabulary test.

Promoting oral participation

The observations were made during one of the specially designed lessons, containing tasks both for whole group and small group activities. The interactive nature of these lessons would encourage students to think and talk about the new concepts, as can be illustrated by fragment 1.

Fragment 1 Introductory lesson 2 Graphs

D	Here you see three graphs. (*Teacher points to big graphs on the blackboard*). You must find out together now so… Here I have three things (*point to three text labels*) the mood of a football coach. What is mood Ucan?
LL	Uhh.
T	Amal keep to the rules. Don't talk if someone gives an answer (..)
S	That you are angry
T	That you are angry
S	Your thoughts
S	Him atmosphere
T	The atmosphere yes
S	What you think about it
T	What he thinks about it (*student raises finger*). Yes Amal?
S	How you are, how you behave
T	How you behave
S	How you behave
S	Your thoughts
T	Your thoughts and…? Your thoughts. Your thoughts and…?
S	Your behaviour
T	Your behaviour and your…?
S	And your feelings
T	And your feelings… OK. So one of these cards matches one of these graphs.

The teachers aimed at making key words in the mathematics assignment accessible (KC1). This comprehension check is very important in orienting the students on solving the problem. In this case one of the keywords is not mathematical but concerns daily vocabulary. The teacher gave an opportunity for language production around the concept mood (KC2) and often, without giving feedback (KC3), repeated an answer to elicit

more contributions. The students were thinking aloud about the meaning of the graph and produced short sentences. They seemed to understand the idea of matching labels and graphs. After the whole class conversation we saw in the first fragment, the students made similar assignments in small groups, matching labels and graphs. In the next fragment one of the students presents the group work in front of the class.

Fragment 2 Introductory lesson 2 Graphs

S1   (*Girl in front of the class matches the label 'number of cd's of Jennifer Lopez' with a graph*) Here (*points to graph*) the number of cd's because if a new cd comes out (*points to origin of co-ordinate system*) here at the bottom and than he rises (*points to rising part of graph*).

T   There at the bottom, there at the bottom, you always start from there. There is also written in that corner what does it always say there in a graph?

S2   (*calls*) Origin.

T   (*walks up to the front and points to the place of the origin*) the origin isn't it? Yes is completely correct. (*To girl in front of the class*) Can you explain it again?

S1   It rises up.

T   It rises, the sale of Jennifer Lopez's cd's and why does it rise more there and less there? (*points to higher part of the graph*).

S1   I think (…?)

S3   The songs are already old.

T   Songs already old. Who else has chosen the middle graph?

The student gave a justification for the match between label and graph. The teacher took the chance to ask for the mathematical concept 'origin'. One student mentioned the concept and the teacher repeated it, probably to share it with all the students. However, she did not check whether the other students were familiar with the concept. The teacher gave opportunities for clarifications and the students again only produced short sentences. She once gave feedback on language by revoicing 'rises' after the students said 'rises up'. Much remains implicit in this conversation. The teacher did not get a clear answer when she asked 'why does it rise more there and less there?'. It is not clear what the student meant with the answer that 'most songs are old'.

We can conclude that the two fragments show that the teacher stimulated the students to relate daily contexts to mathematics tasks. She gave opportunities for language production (KC2), but did not give clear feedback on how to interpret the graph within the context (KC3). Moreover, the teacher did not check whether the concept 'origin' was shared by all pupils (KC1) and might have asked more arguments for the match between label and graph.

Writing assignments

During the lessons the students were also given writing assignments. Working in pairs they had to invent a short 'story' matching a graph and write this down. In this way it

would be possible to get an impression of students' basic skills to express relations in this specific mathematical context of graphs.

The proficiency level of the students was very different, as some examples illustrate:

a.   'We have about cars. Cause we .. it per year cause it is not cheap a cars and the grap rises and therefore if it is antique because many people want antique things and then it is cheaper'.

b.   'The cows rise a lot and the farms don't that is a big problem'.

c.   'Graph 1 is about temperature, if it rises all the time it becomes warmer, if it comes down it becomes colder'.

d.   'The foreigners come more and more of for example: Chinese, Mongolians, Turks, Moroccans, Antilleans. And so it goes on and this one keeps on rising but not descending'.

A closer look shows that the students were trying to express the relationship between time and a second variable (car prices in a. or number of foreigners in d) but only a few succeed to do this in more or less comprehensible language. This stammering on paper raises the question to what extend the students are able to use the language as a tool for thinking. Even after a pair discussions, most students are unable to write a short text to describe the relationship between two variables, which is the essence of any graph. The elementary syntax (congruence in subject and verb, word order etcetera in a., d.) contains a lot of errors. Students are unable to make use of cohesive devices to build a coherent text. Their introduction of new elements in a story is not clear and the use of definite and indefinite forms is often incorrect. In the texts we found many second language difficulties that are not specific to the subject of mathematics. Even students who were active participants in the class discussion about matching labels and graphs were not able to solve a similar task that required them to write down their thoughts on paper. Mathematics requires very specific, precise language use and writing tasks reveal how deep the gap can be between students´ proficiency and teachers' expectations of their students' language use.

Vocabulary test

Data from vocabulary tests offer a third source of understanding. These addressed receptive and productive use of key concepts after the series of lessons. In these tests, not only subject specific academic (mathematical) language was included, but also more general academic language like the concept 'gradual'. We know that teachers are inclined to neglect such concepts as potential problem sources. The different levels of representation of the test questions indicate the level of understanding of certain concepts and the ability to express meaning in a more formal way. The test was administered after the chapter on graphs in the mathematics textbook had been finished.

The receptive questions often were multiple choice questions. In the productive questions students had to fill in the right concept in a sentence, for instance the word

'constant' in the next sentence: "*If a graph does not rise nor descend but stays at the same height we say that graph is ……….* " In figure 1 we give an example of a receptive item in the test that checks students' understanding of the concept 'origin'.
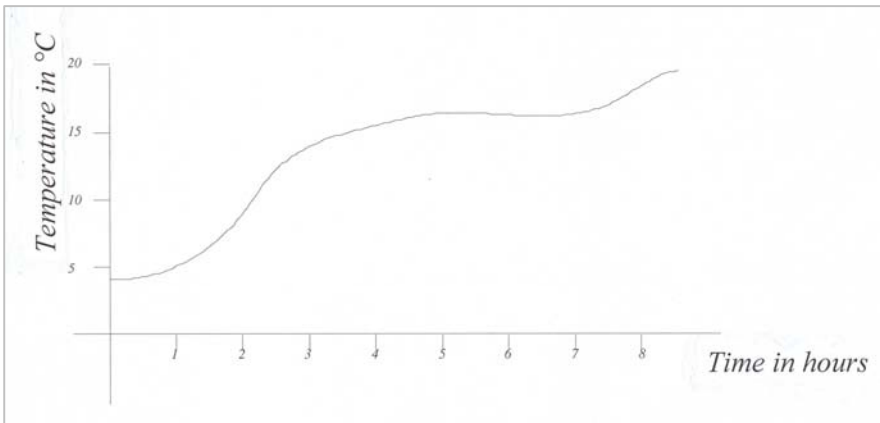
    a. Tick the ORIGIN
    b. Why do you think we call it the ORIGIN?

Figure 1: Test item on the meaning of 'origin' in a graph displaying the relation between 'temperature in degrees Celsius' and 'time in hours'.

In table 1 we present some test results.

Concept	Receptive use	Productive use
Table	15	
Co-ordinate system with graph	7	
Vertical axis	9	15
Saw tooth		3
Co-ordinates		9
Origin	11	7
Constant		6
Gradual	2	

Table 1: Number of correct answers vocabulary test Graphs, N = 19.

The results show that most students knew simple, frequently used, mathematical concepts such as: table, but only a few students were familiar with more difficult concepts such as: co-ordinate system, origin, saw tooth, gradual and constant. We notice

that after a series of 12 lessons, students seem not to have acquired the meaning of several key concepts like the difference between *vertical* and *horizontal* axes.

How can we explain this? Our hypothesis is that productive use of these concepts is missing during the lessons. We observed that most of the time the students made the written assignments in their book individually and that there was little (whole) group interaction. Student - teacher interaction about mathematics only took place when a student initiated this, asking the teacher for explanation. Hence, the textbook is the only resource for students to learn the concepts and many only read the definitions and examples in their mathematics book superficially. They seem not to be aware of the need of understanding core concepts. Without such explicit discourse about concepts and meaning, students' conceptual development can easily remain limited.

The following two examples shed additional light on the superficial and poor language proficiency of students.

The test item 'Why is it called origin?' contains a meta-linguistic questions. As was shown in table 1, seven students could indicate where the origin of a co-ordinate system is (receptive use) and 11 students could fill in the concept origin in a sentence (limited productive use). Only few students, however express understanding of the daily meaning of this mathematical concept, answering the question 'Why is it called origin?':

> a. 'Because there the lines cross'.
> b. 'Because it starts there to count'.
> c. 'Because it rises and descends all the time'.
> d. 'It is the beginning'.
> e. 'Because it is in the middle'.

Only students b. and d. seem to be familiar with the daily meaning of the concept. We presume the others have had only limited access to Dutch language input and did not acquire this less frequently used word in its daily meaning; therefore they could not transpose this to the mathematical meaning. This happens with more infrequently used concepts and vocabulary, and teachers are not aware of this problem source for second language learners.

The test item *'Make a sentence with the word gradual´* showed that hardly any students could correctly answer the meaning of the word gradual. The productive tasks show even more clearly their lack of understanding.

> f. 'The temperature in The Netherlands is gradual'.
> g. 'If two lines are at the same height you call them gradual'.
> h. 'If a graph does not rise nor descend but stays at the same height we say it is gradual'.
> i. 'Gradual can vertically mean something else'.
> j. 'I go gradually to the library'.
> k. '80 out of 100 is gradually 100%'.

Apparently, students had a slight idea about the concept '*gradual*' but when asked to produce a sentence using this same concept they completely failed. Some confused the concept with 'parallel' (g.), some with 'constant' (h.). These examples illustrate that students tried to formulate something on the verge of a formal mathematics context (f.) or in a daily, informal context (j). But they really lacked insight into the concept in either context.

We see an intriguing difference between the results of the comprehension questions and the questions where the students had to actively formulate the meaning of a concept (origin) or formulate a sentence with a concept (gradual). It would be very revealing for teachers to be able to read their students' wordings. In Dutch schools, however, there is no tradition of writing in mathematics classes.

Conclusions

In this paper we showed how specially designed lessons give opportunities for the integration of language and mathematics learning, following three key characteristics: promoting interaction to make core concepts comprehensible, stimulating participation in written and oral mathematical discourse and providing feedback on form and content of this production. In addition, these tasks enabled researchers as well as teachers to diagnose students' learning difficulties and find starting point to stimulate their learning processes. These difficulties partly have their origin in insufficient daily vocabulary, partly in limited functional language skills, and partly in insufficient development of math-specific concepts and mathematical competencies. The awareness of teachers of the huge and unexpected differences in students' language proficiency has been called a prerequisite for the integrated approach of language and mathematics learning. The tasks have shown to play a potential role in raising this awareness and we would label this as a fourth key characteristic.

Following this function of the tasks in raising teachers' awareness, we hypothesize that teachers would need to explicate the language aims within their mathematics lessons in terms of both mathematical concepts, general academic skills like expressing logical relations as well as daily concepts, needed while talking about the mathematics content. This would also focus students' attention on core concepts. The experimental tasks also indicate the value of including more productive writing in a subject specific context like mathematics.

The impact of the design experiment in this very classroom had its limitations. In the regular lessons the teacher got back to her routines, there was hardly any discourse and the pupils made the assignments in their book individually. In an attempt to explain this phenomenon, future analyses will address teachers' thinking about integrating mathematics and language learning and the development in this thinking. Not only the *use* of the Wisbaak materials can influence this thinking, but so could a more explicit

discussion with teachers of the ideas of language sensitive mathematics teaching in the Wisbaak prototypes. Therefore teachers should be more actively involved in the development of new materials, applying the principles of language sensitive mathematics teaching.

This observation of limited effects also underlines the importance of a change in social norms and discussion about it with the students (Cobb et al. 1993). The new social norms imply that a teacher stimulates students to talk about mathematics and does not accept an answer without an explanation. Meanwhile, students will need confidence to participate in classroom discourse or group work. In short, students must not only try to understand what the teacher means, but the teacher must also try to understand what the students mean (Gravemeijer, 1996). This aspect of the pedagogical climate will be discussed in future stages in the project.

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DEVELOPING A COMMUNITY IN THE CLASSROOM: IMPLICATIONS FOR MATHEMATICS EDUCATION

Marta Civil, *University of Arizona, USA*
Peter Wiles, *University of Arizona, USA*

Abstract:*This paper examines the case of a 6th grade teacher who was implementing a mathematics module as part of a treatment in a quasi-experimental study examining the impact of culturally based instruction on American Indian and Alaska Native students' academic performance. This teacher was teaching in a small rural Yup'ik community that consistently scores at the lowest levels on standardized tests. This case highlights a teacher whose class, albeit small, had the highest gain score of any class in the project, which includes high scoring urban classrooms. We examine multiple factors about this teachers' instruction that might have contributed to this success. In particular, traditional portrayals of teachers' pedagogical knowledge are expanded to include the teachers understanding of cultural contexts. In this way, elements that are sensitive to the mathematics content as well as the cultural content of the module are taken into account.*

Keywords: *classroom community, culturally relevant pedagogy, funds of knowledge.*

Introduction

Mathematics classrooms are often depicted as teacher-centered environments where students are quiet recipients of knowledge. While many efforts seek to dismantle this view of mathematics teaching, not enough attention has been paid to how alternative views of teaching accommodate the culture and experiences of indigenous people. It has been argued that a mismatch between the culture of the school and the culture of the community is a key factor in the underperformance related to academic achievement in native populations (Lipka & Mohat, 1998).

This paper was developed out of the program *Mathematics in a Cultural Context* that seeks to addresses this mismatch through the development of mathematics modules that specifically integrate traditional mathematics into the context of traditional Yup'ik practices (see Adams & Lipka, 2003). For this larger project, a quasi-experimental design was used to examine the effectiveness of this approach. Teachers were randomly assigned into treatment or control groups, where treatment teachers would teach from the mathematics modules while control teachers would use materials from their normal classroom setting. A pre- and post-test assessment was created to examine differences

between the two groups. In addition to this quantitative analysis, the program also included a qualitative component for which all of the teachers were observed and videotaped in order to develop richer descriptions of these classrooms.

In this paper, we highlight the case of a teacher, Ms. S, who participated as both a control and a treatment teacher in the project. This teacher stood out because the students in her class posted substantial gains on a pre and posttest designed for the project when compared to other classes in the study. It is not the aim of this report to completely account for these test score gains. Instead, we wish to highlight the ways that Ms. S successfully coordinates the interplay between content and culture that is emphasized in the module. We were able to identify characteristics of the mathematics modules that provided a particularly nice fit with the teachers' natural learning style. This kind of examination will give us a greater understanding of the kinds of teaching practices that support culturally based mathematics instruction.

Theoretical Framework

This paper is guided by a conceptual framework based on the funds of knowledge perspective (González, Andrade, Civil, & Moll, 2001). Funds of Knowledge are described as "the essential bodies of knowledge and information that households use to survive, to get ahead, or to thrive" (Moll, Vélez-Ibáñez, & Greenberg, et al., 1990, p. 2). According to this perspective, students' Funds of Knowledge are a key aspect of a teachers' knowledge base that can be tapped into to enhance classroom learning. This requires that teachers learn firsthand about the experiences and knowledge of their students and their families, rather than relying on generalized notions of "the culture of these students." Moreover, teachers must have the ability to transform their knowledge of the students' Funds of Knowledge into meaningful mathematical activity.

The transformation process of everyday knowledge into classroom practice was observed in The Funds of Knowledge for Teaching project (Moll, 1992; Moll, Amanti, Neff, & González, 1992). It had as a primary goal the development of teaching innovations that built on the background, knowledge, and experiences of students and their families and community. It was a collaborative research project between university faculty and teachers in schools in low-income / working class, ethnic and language minority communities. Teachers, after having received training in doing ethnographic field work, visited the home of some of their students. The goal of these visits was for teachers to <u>learn</u> about the knowledge that households have, to uncover the "funds of knowledge." This knowledge was then analyzed in study group sessions. It was there that the transformation of the household knowledge for potential use in the classroom took place. In this paper we build on this theory by examining other elements that support a teacher's use of their students' Funds of Knowledge.

Methodology

In addition to the quantitative data that were collected in the larger quasi-experimental study, teachers in both control and treatment classes were video taped in order to develop a richer description of the practices of the teachers in the program. For this paper, we examined video that was collected from Ms. S's class as both a control and a treatment teacher. Identified key aspects of Ms. S's teaching practice and the classroom environment she created. After this initial round of analysis, Ms. S. was invited to view the video data in order to gain her perspectives of the classroom activity. At these sessions, field notes were taken and all discussions were audio-taped.

Analyzing the video data in this way not only provided us with a key perspective on the classroom environment depicted in the video, but also allowed us to develop richer perspectives of Ms. S's perceptions and beliefs about mathematics teaching and learning. Moreover, her insights into the context of the videotaped lessons were critical to our understanding of the setting.

Culturally Relevant Mathematics

The module that is central to this paper is titled *Building a Fish Rack: Investigations into Proof, Properties, Perimeter, and Area* (Adams & Lipka, 2003). As the title would suggest, the central mathematical themes revolve around examining properties of shape, using these properties to develop ideas about proof, and examining ideas of measurement, perimeter, and area of shapes. The module itself is divided into 18 activities that build on these themes. Throughout the module, the activities emphasize collaborative group work and active involvement on the part of the students. As an example, early sets of activities are concerned with engaging children with investigating properties of rectangles. As groups, the students are to decide how they are going to demonstrate whether the shape they have made is actually a rectangle or not. In this process, the students must decide what the properties of being a rectangle are and how to show that the shape they have created possesses these properties. The activities are intended to be student directed, involving students' exploration of these ideas rather than having a teacher centered presentation. Having established some properties of rectangles, a later activity has the students engage in developing and proving conjectures about the diagonals and center of a rectangle. In this activity they are not only developing their knowledge of shapes and their properties, but also using these properties to make reasoned arguments. Activities like these are critical for fostering more sophisticated ideas about geometry.

The cultural contexts of the modules are treated with as much importance as the mathematics content. The cultural context is not simply used as a brief segue into more traditional mathematics activities. Rather, the students engage in extensive investigations about Yup'ik cultural heritage. For the module under discussion, the

central cultural practice is that of building a fish rack. The fish rack is a central part of the subsistence lifestyle that many Alaskans live. The fish rack is a rectangular structure that is designed to hang and dry fish. The first four activities of the module are concerned entirely with establishing the cultural and ecological backdrop through discussing fishing and the life cycles of salmon. After the context is established, the students explore building a fish rack. The module suggests that an elder in the village first does this as a demonstration. The students are to observe how the elder establishes the rectangular base of the fish rack. The elder's approach to making a rectangle is mathematically rich even though this approach may not be what academically trained people would necessarily use. The elder might establish the rectangle in informal ways, using body measures or other non-standard forms measurement. At the same time ideas that are traditionally identified with school knowledge are apparent, such as identifying the location of the corners and center of a rectangle. The elder also brings a cultural perspective about how the rectangle is to be formed that is not traditionally identified as being mathematical (e.g. orienting the fish rack toward the wind so the fish dry out faster). The module then builds off of elders' knowledge by exploring the Yup'ik language and identifying the traditional Yup'ik names for parts of the fish rack.

Considering both the cultural connections and the student-centered approach in the module, its potential can particularly be seen from a social perspective where we view learning as developing through participation within a community of learners (Rogoff, 1994). Rogoff indicates that from this perspective, "students learn the information as they collaborate with other children and with adults in carrying out activities with purposes connected explicitly with the history and current practices of the community" (p. 211). Ms. S. echoed this when she spoke about the modules, "The environment was there, they were safe to explore, they were safe to inquire. It used the cultural components… from their environment. It was designed around fish racks, and these kids know fish racks. They are everywhere in the village. They can picture that and we really got down to the math." From her perspective, establishing the cultural connection provided access to the mathematics content. Access is a critical component for learning as viewed from a situated perspective on learning (Lave & Wenger, 1991). One of the central aims of the mathematics modules is to provide access so that students can participate in the community of the school in authentic ways. The learning context of the classroom is quite different from that of the larger village community. Many of the activities in the module, though rooted in an authentic context, develop into discussions of mathematics that would not typically exist outside of a school setting. These modules represent more closely what Lave and Wenger would refer to as a "learning curriculum" which consists of, "learning resources in everyday practice *viewed from the perspective of learners"* [italics in original] (p. 97). This is opposed to a "teaching curriculum" where learning is identified only through the instructor's activity without regard to the context in which the learning is taking place. This is not to say that Ms. S's participation

in the classroom community did not play a key role. In the following sections we will examine the factors that supported the implementation of the module.

Establishing and Culture of Inquiry

Ms. S joined the study in the second year of her first teaching position. As a new teacher in a rural village, she felt particularly isolated. She was given the Alaska State Standards as her only curricular guide. She eventually was drawn to reform oriented approaches to mathematics instruction. According to Ms S., becoming introduced to reform oriented curricular materials the emphasize problem solving and inquiry. Commenting on this approach, she stated, "The kids love to do… I don't know how much this is necessarily culturally… but they love to do, they want to inquire." Without direct supervision from the district, she was given a great deal of freedom to experiment with these teaching methods.

As a control teacher, Ms. S's instructional practice was consistent with a reform-oriented approach. The problems posed by Ms. S. were open-ended and required the students to self-monitor their progress and discuss their thinking with other students. As an example of a typical episode, the students were required to find the number of different ways that four squares can be arranged to make new shapes. This task requires a high level of cognitive demand on the students, as there is no prescribed solution path given. Moreover, students must look back at their solution and reason about whether they have all possible configurations. Ms. S. supported the level of complexity of the task by giving adequate time for students to work through the problem, either alone or in groups. She also provided scaffolding for students as they were engaged in the activity. At the conclusion of the lesson, students came to the board to share their work, at which point the teacher facilitated a discussion around the central mathematical ideas of the task.

Establishing this teaching practice was not automatic for Ms. S. She reflected that her students were not familiar with this method of teaching. One of her priorities was to establish norms in the classroom that are conducive to inquiry oriented instruction:

> Inquiry was very difficult at first because they were not risk takers. We did spend a lot of time setting that up, that it is okay to get something wrong. It doesn't have to be right, it is how they get there. Looking at different solutions and different things, that there is not one right way to do something.

Whenever possible, she had the students take ownership of their own ideas. One strategy she used often was to relate the activities they were doing to the students' own experience. In addition, when mathematics vocabulary was introduced, Ms. S felt it was important that the definitions come from the students, even if they were not the same as what would be in the text-book. She also emphasized that one of her primary goals was to create an atmosphere in the classroom where the students felt safe to explore and inquire. Reflecting on her approach to teaching, Ms. S said,

I received my teacher education here in Alaska. We hear a lot of negatives about Native Alaskans, that kids don't care, that parents don't care, that kids are hooligans and so on. I just wanted to leave that behind; I didn't want it to take this with me [when she moved to the village to teach]. So, I really thought about developing a classroom environment and how important that was. It dawned on me that no one made these kids go to school; they come of their own accord, so I wanted to give them a reason for coming to school, I wanted them to own their education; I wanted them to show up and do their best.

Developing a community

In addition to establishing a classroom centered on inquiry, much of her efforts were designed toward establishing a classroom community. The teacher explained that the first thing she wanted to do is to connect with the students, to establish trust. Trust is an important concept in the villages because students are used to seeing teachers leave. The teacher turnover in the villages is quite high, which may cause students to be reluctant to become attached to a teacher. The above discussion shows a teacher who clearly rejected the deficit model approach to the education of certain groups of students. In a deficit view, these students and their families and community are seen as the source of "the problem." Instead, this teacher decided to put behind all the negative information she had received and work on establishing a relationship with these children. We believe that this teacher would be in agreement with the statement below made by González and colleagues in reference to the Funds of Knowledge for Teaching project:

A critical assumption in our work is that educational institutions do not view working-class minority students as emerging from households rich in social and intellectual resources. Rather than focusing on the knowledge these students bring to school and using it as a foundation for learning, schools have emphasized what these students lack in terms of the forms of language and knowledge sanctioned by the schools. This emphasis on so-called disadvantages has provided justification for lowered academic expectations and inaccurate portrayals of these children and their families (González et al., 1993, pp. 1-2)

The teacher was genuinely concerned with making use of the students' knowledge and experience. During the first few weeks of the school year she did hold class in the classroom. Instead, they spent their time outdoors. These children know the outdoors, "they were the experts and they started teaching me, about the river, the ripples on the sand, the way the sand goes. They have all this amazing knowledge; it's not knowledge that we may be testing on the benchmarks." This teacher viewed her students as experts

and set out to learn from them. This approach, learning from the community, is a basic premise in the Funds of Knowledge –based work.

For this teacher, developing a community in her classroom was the first priority. She wanted to create a safe environment in which her students would feel free to ask any questions and to take risks. In talking about her class, she said, "we referred to ourselves as a team." This concept of being a team transpires through most of her reflection on what she did in the classroom. As a teacher, her goals towards the development of a learning community were to a) get to know her students, their strengths, and their areas of expertise. This also meant learning to adjust her adjust her pedagogical practices (e.g. extending wait time); b) develop and nurture a safe environment in which children would take intellectual risks; c) familiarize her students with the academic talk to help them succeed in the 'school game' (e.g., standardized testing). We will look at the third goal through a discussion of one part of the mathematics module—the properties of a rectangle.

We focus in particular in how the teacher introduced the idea of proof, a fundamental concept in mathematics. The students had been exploring properties of a rectangle for a few days. As a follow-up task to making a rectangle outside, students were given tape to try to make the vertices of the rectangle. The students then had to then prove that what they had made was indeed a rectangle. Ms. S worked to establish norms for what constitutes proof. To introduce this concept, she framed it in the context of looking for evidence in investigating the disappearance of "tootsie rolls" (as an imaginary scenario). The children were actively engaged in suggesting what would constitute evidence in this case (e.g., looking for finger prints; looking for someone who has many tootsie rolls all of a sudden). She then said, "your task is to prove that what you have is a rectangle; you are going to find evidence that the shape you created is a rectangle." The teacher's talk used typical academic mathematics vocabulary and sentence structure (e.g., your task is to prove that what you have is a rectangle), but she used scaffolding (such as framing it in terms of evidence and connecting that with students' understanding of evidence) to provide access to her students to this academic talk. She also addressed an important aspect of doing mathematics: they had to prove that the shape was a rectangle. This meant that it had to be **exactly** a rectangle, not **almost** a rectangle. This is an important distinction because for everyday purposes, "almost a rectangle" may be all that is needed, yet from a mathematics point of view, that is not enough (see Kahn & Civil, 2001, for another example of the interplay of everyday and school mathematics in the context of maximizing area for a garden).

Final Remarks

Ms. S. rejected the generalized notions about Native Alaskan students, and set out to uncover their funds of knowledge by listening to her students as they taught her about

the outdoors. As the household visits often did, her spending time listening and observing her students as experts allowed her to establish a connection that was key to her goal of developing a learning community in her classroom. This teacher's pedagogical orientation was to develop a participatory approach to teaching that capitalizes on children's knowledge and experiences. As Connell (1994) writes, "To teach well in disadvantaged schools requires a shift in pedagogy and in the way the content is determined. A shift towards more negotiated curriculum and more participatory classroom practice..." (p. 137).

The mathematics curriculum provided a key support for the teacher to transform her knowledge of the students' funds of knowledge into classroom activity. From our point of view, this curriculum is a solid example of linking everyday mathematics and school mathematics (see Civil, 2002, for a discussion of these different forms of mathematics). The modules are grounded in rich cultural experiences and in the mathematical ideas that are at the basis of those experiences (e.g., how to make sure that a structure is indeed a rectangle). These mathematical ideas are then further connected to other topics that students are expected to learn in school mathematics (e.g. a rectangle can be circumscribed by a circle that both share the same center). The curriculum reflects how bringing in the community's ethnomathematics may help bridge to the more "academic" content. In doing this it responds affirmatively to the question posed by Hoyles (1991), "*is it possible to capture the power and motivation of informal non-school learning environments for use as a basis for school mathematics?*"[italics in original] (p. 149). This curriculum and most importantly the pedagogical approach that goes along with it, could address the issue of the different values assigned to the different forms of mathematics (Abreu, 1995; Nunes, 1999). Nunes (1999) argues for the need to learn about the different mathematical practices that are used by different groups. She writes, "these different practices can offer a vision of a diversity of reasoning schemas, many of which are currently not used to the learners' advantage in the classroom" (p. 50). In the module discussed in this paper we can see how the cultural practices are not only valued but can be used to explore different forms of mathematics, including "academic" mathematics.

Two key factors appear to have supported Ms. S's implementation of the Yup'ik mathematics modules, her desire to create a student centered classroom environment and her desire to establish a classroom community. Ms S focused on mathematical inquiry throughout her implementation of the module. The properties that became open for discussion and use by the students always originated from the students. This was consistent with Ms S's stated belief that the definitions of mathematical ideas should come from the students. She held on to this belief even when the students' definitions were not complete (e.g. the students decided that a rectangle should have two longer sides and two shorter sides, thus precluding a square from being a rectangle). The

instructor's role was one of facilitator rather than dispenser of knowledge. This approach is consistent with that envisioned in the module design and appears to have been a good fit to Ms. S's own instructional practice as demonstrated through her instruction as a control teacher.

The module's use of cultural contexts also provided a strong fit with Ms. S's established beliefs about teaching. In the episodes discussed above, the teacher used the cultural connection as a way of giving her students a greater sense of ownership of the mathematics they were doing. Her practice of spending the first week of school outside of the classroom in order to learn about her students and their lives reinforces the importance she placed in developing a classroom community.

It appears that the coordination of the module's design philosophy and the teacher's instructional philosophy allowed for an environment where the students were able to demonstrate significant progress. If this were the case, it gives strength to the theoretical framework within which the module as designed. We observe that in this situation, cultural connections and community development were given as much importance as the mathematics content. At the same time, significant student engagement was observed. This research also indicates that current ideas about mathematics education reform can complement the use of traditional cultural practices in school. We have seen that when combined with the cultural context, an inquiry model of teaching gave the students the opportunity to become active participants in a comfortable and relevant context. This suggests that it would be fruitful to conduct future research on the interaction between a pedagogical approach centered on inquiry with an approach designed specifically to develop classroom community. We also feel that this research provides further evidence of how informal learning environments can be used as a bridge toward more traditionally oriented mathematical concepts.

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