BATIKS: HOW TO LEARN MATHEMATICS A DIFFERENT WAY AND IN A PARTICULAR SCENARIO

Lucília Teles & Margarida César[1]

Universidade de Lisboa, Centro de Investigação em Educação da Faculdade de Ciências

The Dance School community is a minority but it is valued by society. This is a vocational school but students also attend subjects from the mainstream educational system. This research took place in a 9th grade class already that was used to work collaboratively. It assumed an interpretative/qualitative approach, based in an action-research project, inspired in ethnographic methods. This study was based on 2 research projects: Interaction and Knowledge (IK) and IDMAMIM. A microproject was implemented in order to elaborate batiks, using the school's name. Results illuminated students' (re)actions and accounts related to this microproject, to Mathematics' classes, namely mathematical performances. They also illuminate how important this microproject was to students' engagement and to their achievement.

INTRODUCTION

In Portugal there are minority cultures that are rejected by society and others that are recognized and appreciated. The Dance School is a minority culture that is socially valued. It is a vocational and artistic school, where only students that want to become dancers (and are potentially very talented dancers) have place. In order to make part of these community students need to succeed in dance examinations.

In the Dance School everything is organized around dance and the artistic subjects: timetables, classrooms, and so on. Mathematics plays a secondary role. The selective subjects are classic and modern dance techniques. Although students know that they cannot ignore academic subjects because they need to succeed on them too, in order to continue their dream, they also state that their favourite subjects and the ones they spend most of their time and effort are the ones directly related to dance. Thus, to learn and to teach mathematics in this scenario is different than teaching it in a mainstream school and it is a new and stimulating challenge to the teacher.

As we live on a multicultural society and we claim that intercultural practices are needed, we promoted an intercultural (and interdisciplinary) microproject based on Cape Verde culture. Cape Verde community is the biggest ethnic minority in Portugal and their uses, ways of being, reasoning or approaching mathematical tasks are not socially recognised and valued. Thus, gathering mathematical learning and valuing this culture seemed a promising enterprise.

Thus, the problem we were studying was the lack of significance that mathematics used to have for the Dance School students. The research questions we were addressing were: (1) What are the contributions of an intercultural microproject, associated to collaborative work, in order to facilitate students' mathematical

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meaning construction and mathematical knowledge appropriation?; (2) What are the contributions of an intercultural microproject in order to develop students' citizenship, namely their respect and valorisation of usually less valued minority cultures, like the one from Cape Verde?

THEORETICAL BACKGROUND

There is an enormous diversity of definitions of culture. Many authors tried to define culture and presented different claims. Nieto (2002) defined 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." (p. 53)

Thus, at school we can find an enormous diversity of cultures. Not only origin cultures but also many others, including the school's culture. In many cases this culture is so far away from students' cultures that they focus their energies on others directions (Säljö, 2004). Thus, it is important to find a way of promote interactions among the different cultures which are part of a particular school. This illuminates the need of an intercultural education, namely in mathematics (D'Ambrósio, 2002; Favilli, César, & Oliveras, 2004; Peres, 2000; Powell & Frankenstein, 1997). In 1991, Ouellet already stressed that the intercultural education was not only for the minorities but also for majority groups, based on the comprehension of each other, on the communication among them, and on the promotion of interactions. Intercultural education also include citizenship education, namely through mathematics (Skovsmose, 1998, 2005).

In the Dance School, we tried to contribute to students' citizenship education during the classes and also through the microproject. We tried to show some elements of a minority culture that is highly represented in the Portuguese society, relating this culture with school mathematics. We aimed at facilitating students' recognition of the value of Cape Verde culture and its mediation role in order to learn mathematics (Teles, 2005; Teles & César, 2005, 2006a, 2006b, 2007). Some authors argued that intercultural microprojects related to handicraft activities support an intercultural approach, giving a cultural dimension to the learning process, contributing to academic achievement (César & Azeiteiro, 2002; César, Mendes, & Azeiteiro, 2003; Favilli, 2000; Favilli, César, & Oliveras, 2003; Favilli, Oliveras, & César, 2003). They illuminated the potential of intercultural and interdisciplinary microprojects in order to promote mathematical knowledge appropriation, but also to mobilise/develop students' competencies, including social and emotional ones.

During the whole school year these 9^{th} grade students worked collaboratively in mathematics classes. They worked in dyads, discussing their reasoning and solving strategies, helping each other, and co-constructing their knowledge (Teles, 2005; Teles & César, 2005, 2006a, 2006b). Thus, the microproject was part of a coherent

didactic contract implemented during the whole school year and negotiated with students on the beginning of the year. Collaborative work was studied and promoted in other studies and stated to be a facilitator for students' knowledge appropriation when it was part of a negotiated and coherent didactic contract (César, 1998, 2007; César & Santos, 2006; Schubauer-Leoni & Perret-Clermont, 1997).

A community of learning emerged from the practices that took place in mathematics classes as there was a mutual engagement, a joint enterprise and a shared repertoire (César, 2007; Wenger, 1998). The nature of the mathematical tasks assumed a relevant role on that process (César, Oliveira, & Teles, 2004). Their social marking was essential to students' engagement (Doise & Mugny, 1981), promoting their participation in the solving strategies and during the general class discussion.

Hummel (1979) stated that "culture and education are intensively linked as verse and reverse of the same reality. It is impossible determinate where the educational ends and the cultural starts and it would be nonsense separate them" (p. 234). Thus, teachers' role also includes contributing to create bridges among cultures and education, promoting diverse and intercultural learning experiences.

METHOD

This research is an interpretative/qualitative study, inspired in ethnographic methods and based in two research projects: *IK* and *IDMAMIM*. The first one was developed during 12 years and its main goal was to study and implement social interactions in formal educational scenarios. *IDMAMIM* project was developed in some towns of Spain (Granada), Italy (Pisa) and Portugal (Lisbon). The two main goals of this project were to identify didactic needs to develop intercultural Mathematics Education, and to elaborate intercultural didactic materials.

This study was an intercultural and interdisciplinary microproject also engaging the mathematics, drawing, Portuguese, and history teachers. The mathematics teacher was also the researcher. Students elaborated batiks based in the school's name (EDCN). Later on the batiks' elaboration process was used to explore some mathematical contents such as direct and inverse proportionality. These students worked collaboratively during the whole school year and they developed this microproject in 4-students groups after being used to work in dyads in mathematics classes. To explore direct proportionality we used tasks based on the first day of the batiks' elaboration process. In that day students needed to make a paste with flour, water and lime. They had a recipe referring to the ingredients needs for 500g of dry cotton. But they only had pieces of dry cotton that weighed 80g/90g. So they needed to calculate some proportions in order to know the quantities they needed to make the paste. Through those calculations we explored direct proportionality notion and its properties. Inverse proportionality was explored through what students did on the third day: the tainting process. Each student chose two colours to his/her batiks and only two students chose the black colour. In another school, where batiks were

elaborated during the previous year, only one group of students chose the black colour and all ink was used on it. Inverse proportionality was explored through this situation, supposing that the number of black batiks could be changed but the quantity of ink could not. In this paper we focus our analysis on the batiks' elaboration process and on the first day after that, when we began exploring the mathematical contents based in the batiks' elaboration.

This research was developed with sixteen 9th grade students from the Dance School. As the Dance School is a small vocational and artistic school, these were all the students attending the 9th grade.

Data were collected through participant observation (audio and/or video taped), questionnaires (students and teachers), interviews (six students chose as main informants and the drawing teacher), several documents, and students' protocols.

The participant observation took place all over the school year and was registered in the teacher/researcher's diary. The audio and video tapes used in this paper were taped in May. Students answered to questionnaires in the beginning of the school year (September), in the beginning of the second term (January) and in the end of the school year (June). The teachers only answered in the end of the school year. All the interviews also took place after the end of the school year (July). The documents were mainly collected in the beginning and at the end of the school year, and students' protocols were collected during the whole school year.

We created six inductive categories based on an in-depth and successive content analysis: school's culture, interdisciplinarity, didactic contract, leadership, argumentation and mathematical knowledge appropriation. In this paper we focus in the microproject, students' work, and how students used their own experience to appropriate mathematical knowledge.

RESULTS

Promoting this kind of project in the Dance School was a great challenge to the teacher/researcher and it was also a great pleasure. Students were deeply engaged in the tasks related to the intercultural and interdisciplinary microproject. For instance, they have a very hectic life, as they have classes all mornings, afternoons and part of the evening and, sometimes, when they have shows, they also have the rehearsals. But they asked the dance teachers for permission to enter a bit later in their class – something unusual and usually forbidden – in order to participate on the 2nd day of batiks' elaboration, as this part had to be in an extra class time. Thus, the batiks' elaboration illuminated the need of a great organization and depended on students' motivation, responsibility and engagement. At the end of the school year these were some students' voices accounting for what they learned through the batiks:

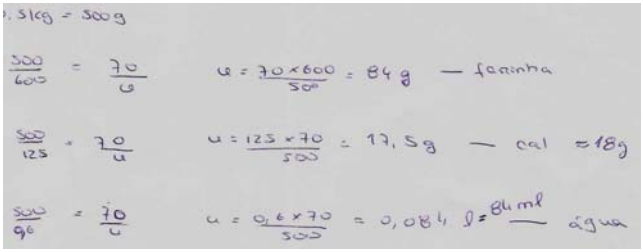
> I think that... I think that it is easier and more interesting to learn. Because many people don't like Mathematics (Madalena, I., p. 4).

> Because it is nice and funny. And we can know some cultures from other countries (Carlota, I., p. 5).

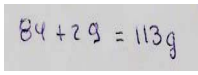
In order to elaborate the batiks students needed to make templates with the school name (EDCN). The school's name is deeply connected to this community's identity and the Dance School culture is a very powerful one. Thus, producing the templates and knowing that there would be an exhibition at the end of the school year contributed for students' engagement. These templates were made in mathematics and drawing classes, and the two teachers worked together.

During the batiks' elaboration, students had a paper with a detailed description of the steps they needed to do. On the first day, students had to do a paste with flour, water and lime. But they needed to adapt the receipt to their own conditions using direct proportionality. This is illustrated in Figure 1 which shows the computations of one of the groups, using direct proportionality.

Weigh of dry cotton: 70g



Weigh of small glass: 29g



Weigh of great glass: 46g

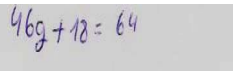


Figure 1. Students' computations (direct proportionality)

In mathematics classes after the batiks' elaboration the teacher/researcher proposed some tasks based on the microproject and what students did. The first task began with a question where students should explain they needed to keep the proportionality among all the ingredients of the first paste (1st day). And they explained it as we can see through the following example:

> Dyad's answer: We think that all ingredients should be divided proportionally in order to the paste to be consistent. If it doesn't happen, the paste doesn't be well done and thus we never could to construct batik.

The teacher/researcher elaborated the task of direct proportionality based on the relation between the wraps' weight and the quantities of each ingredient for the 1st paste. Students had to calculate proportions and drew graphs. They calculated the quantities of flour, water and lime when the wraps' weight was changed and they discussed about what happened. Students also needed to calculate the value of the constant of proportionality and discussed about its meaning on that particular context. Through the relation between the quantity of flour and the wraps' weight, students could establish the analytic expression of the function (quantity of flour depends on the wraps' weight). Finally, students represented graphically that function, and they discussed its form. After solving the task, some students went to the blackboard, answered to the questions and explained their dyad's reasoning and solving

strategies. At the end, they did a synthesis of the characteristics of a direct proportionality relation. The same kind of practices was used in order to explore the inverse proportionality.

As we stated before, students work collaboratively during the whole school year. The following photos were registered after the batiks' elaboration and it illuminates that students were all engaged in the task, that they helped each other.

Figure 2. Students solving a task based on the batiks' elaboration process

Although some students did not like the contents related to functions, no one rejected these mathematical tasks and they all worked together in their resolution. Students' enthusiasm and pride was visible because they were learning mathematics based on their own work and on a meaningful task, they performed from bottom to top, something that they liked to do, as Salvador accounted:

> Yes, I think because with batiks, I say, we pl… we learn playing. (…) We have fun elaborating batiks. And we need to make calculations to elaborate batiks. This way, we learn, we develop mathematics doing something we like (Salvador, I., p. 4).

During the classes after the batiks' elaboration it was common to listen to students' argumentations based on what they did, on their own experience, as we can see on Célia and Eduardo interaction:

23	Célia:	Quantity from the recipe: 500g. Then, flour's quantity: 600g.
24	Eduardo:	600g.
25	Célia:	Grams. Lime: 125g. Now, 0,6l of water.
26	Eduardo:	Lime. 125g of lime.
27	Célia:	Is it 600 ml?
28	Eduardo:	Quantity... (...)
29	Célia:	Teacher... it is better we do...
30	Eduardo:	No teacher, it's ok. I remember that... the result was 90 something.
31	Célia:	I'll ask the teacher.
32	Eduardo:	There is no need.

Eduardo was the less competent peer in mathematics in this dyad (César, 1998, 2007; César & Santos, 2006; Vygotsky, 1932/1978). Célia loved mathematics. She had always experienced success in this subject and she loved to help her colleagues who experienced some difficulties learning it. But, sometimes she needed her teachers'

support to feel secure, as we can observe in this episode (Talks 29 and 31). But Eduardo remembered what he did during the batiks' elaboration and he felt so confident that he did not want Célia to ask for the teacher's help, he wanted to solve the task on their own (Talks 30 and 32). One of the features of the didactic contract is that students should discuss between themselves before asking for the teacher's help (César, 1998; César & Santos, 2006).

In the next three classes, students discussed direct and inverse proportionality based on their own work and experience.

At the end of the school year, students and the mathematics, drawing, Portuguese, and history teachers organised an exhibition. Students exhibit their arts works based on the school name, the batiks applied on t-shirts, the templates, mathematics tasks, Portuguese contributions (Cape Verde song lyrics in *Creole*) and history contributions (the origins of the batiks).

FINAL REMARKS

The microproject developed with those students was a rich learning experience for them and for us, as teacher/researcher. As Salvador accounted, they learned mathematics doing something they enjoyed, by a funny way, but also through a meaningful task. Madalena and Carlota also underlined the importance of learning mathematics through an interesting and easier way. At the same time, as Carlota focused, it was a great opportunity to know more about another culture. Through this microproject students also experienced the relations between mathematics and practical activities, relating manual and mental work.

Students worked together, trying to achieve a common goal: to elaborate the batiks. They collaborated in a project that was their own project, and that they had to elaborate from bottom to top, making up their mind and assuming the consequent responsibilities about their choices. On the other hand, having the school's name on the templates facilitated the (co)construction of a sense of identity related to this microproject, as the Dance School culture is a very robust one and students who are part of this school usually chose to be there and love being there.

The collaborative work that was developed in mathematics classes since the beginning of the school year and the interactive inter-play (César, 2007) that was part of this school culture were a great help to this microproject success. Students worked as a team, and they were used to help each other, and to collaborative work, usually not in academic subjects but in dance subjects. A show means a lot of individual work but also a lot of collaborative work.

The nature of the mathematical tasks solved after the batiks' elaboration was crucial to students' engagement and for the appropriation of mathematical contents. We could see as Eduardo relied on his experience in order to solve the mathematical tasks and to discuss them with Célia. Thus, even if some students had stated before that

they did not like functions, that they were difficult and they could not understand them, when they solved tasks related to functions but also to the batiks' elaboration, they were able to appropriate the mathematical knowledge and to give a meaning to that knowledge. Thus, they were able to overcome the barriers they felt in the previous school year, when they studied functions for the first time.

At last but not least, this microproject was an opportunity to contact with a culture students did not know well, to use mathematics in a real context and to learn mathematical contents through their own experience. It was a striking experience to students and to us all, as teachers and researchers.

NOTES

1. Interaction and Knowledge project was supported by the Instituto de Inovação Educacional medida SIQE 2, in 1996/97 and 1997/98 and IDMAMIM by the EC, Socrates/Comenius programme, being coordinated by Prof. Franco Favilli (University of Pisa, Italy). Centro de Investigação em Educação da Faculdade de Ciências da Universidade de Lisboa also supported both projects. Our deepest thanks to the students and teachers of Dance School (Escola de Dança do Conservatório Nacional, Lisboa) and our research colleagues that made these projects possible.

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