STATISTICS LEARNING AND BATIKS: AN INNOVATIVE WAY OF DOING MATHEMATICS

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Students should appropriate statistics knowledge through diverse/meaningful learning experiences connected to their daily life. We discuss an intercultural and interdisciplinary project (IDMAMIM) developed in Granada (Spain), Pisa (Italy) and Lisbon (Portugal). We focus on the Portuguese data. Statistics learning was based on the elaboration of batiks. We assume an interpretative approach and a case study design. Participants were students from the 8th/9th grades (12/14-year-olds), their mathematics teachers, teachers from other subjects, external observers and significant others. Students worked in small groups. Data were collected through observation (audio/video taped; photographed), questionnaires, interviews, documents, reports and students' protocols. Results, based on the analysis of a statistical task, illuminate how an intercultural micro-project could promote group work and statistics learning, engaging students in a common project.

INTRODUCTION AND THEORETICAL BACKGROUND

Statistics literacy is important in a knowledge society. Students' huge access to information through different ways, such as the Internet, has stressed the need for a quality education, including the ability to select and process that information. We consider that students should appropriate statistics knowledge through diverse and meaningful learning experiences connected to their daily life. Batanero and Godino (2001) underline that "in Statistics we can develop small investigations or projects which put learning in context" (p. 15). Abrantes, Serrazina and Oliveira (1998) assume a similar position, stressing the advantages of project work when related to statistics.

School is one of the most privileged scenarios to develop statistics projects (César, 2008; César & Dias, 2006) and to develop statistics and probabilities tasks (Carvalho & César, 2002; César & Santos, 2006; Teles & César, 2006). The Portuguese curricula suggest students should develop projects and group work (Abrantes et al., 1998). However, we face some problems with the lack of meaning some students find in School in general and in mathematics tasks in particular. Thus, it is important that those projects, group work or tasks are well adapted to students' characteristics and cultures (César, 2008; Teles & César, 2005). The nature of any task proposed to students plays a relevant role in their engagement and their performances (César, 2008; César, Oliveira, & Teles, 2004). Doise and Mugny (1981) underline the importance of the social marking of tasks in order to allow students to create bridges between their daily/previous knowledge, and the academic knowledge they must appropriate. Teachers should also develop teaching practices and learning experiences that facilitate students' autonomy in their learning process.

METHODS

We assume an interpretative approach (Hamido & César, 2009) and an intrinsic case study design (Stake, 1995). This study is based on two research projects: *Interaction and Knowledge* (*IK*) and *IDMAMIM*. The *IK* project was developed during 12 years (1994/95-2005/06) and its main aims were to study and promote social interactions in formal educational scenarios (César, 2007, 2009). The *IDMAMIM* project was developed in Granada (Spain), Pisa (Italy) and Lisbon (Portugal). Its main aims were: (1) to identify didactic needs in order to develop an intercultural mathematics education; and (2) to elaborate intercultural didactic materials (e.g. those based on the batiks), and to explore them in mathematics classes (Favilli, César, & Oliveras, 2004). We focus on the Portuguese data. In Portugal, students from the 8th and 9th grades (12 to14-year-olds) developed intercultural and pluri/interdisciplinary micro-projects, in different public schools. These students elaborated batiks and studied mathematics through their elaboration process. The batik is a handicraft from Java that was also developed in many other parts of the world (e.g. Cape Verde). It is a pure cotton wrap tainted with colours where a drawing is contrasted. Batiks are elaborated in different ways in different countries or regions. We used the Cape Verde method. The differences in methods are related to cultures and economic conditions. After the elaboration of the batiks, students solved some tasks based on their own work. Each task was elaborated to explore a

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mathematical content: direct proportionality; inverse proportionality; isometries, translations, areas and perimeters; percentages; proportions; and statistics. In each class students explored some of these tasks. We present and discuss the statistical task that was prepared in Portugal.

RESULTS

Students worked in small groups (of 3-4 elements) to elaborate batiks. Later the elaboration of the batiks was used to explore some contents. Statistics is a compulsory content in every grade until the 9th grade. Thus, the mathematics teachers who participated in the *IDMAMIM* project decided to elaborate a task that allows students to study statistics (7th to 9th grades).
The statistical task starts with a brief contextualization: What is Statistics? What is studied by Statistics? (See Figure 1).

STATISTICS

STATISTICS is a mathematics subject content that aims at studying a certain **population** (or a universe). We can elaborate a **STATISTICAL STUDY**, i.e., we choose a **representative sample** of this population (or the whole population and we do a census); and we collect, organize and analyse data in order to draw some conclusions and make predictions.

What is studied in statistics?

For example, if we want to make a statistical study about this school's students, we can study different characteristics such as: colour of their hair; height; weight; age; gender; shoe size; mathematics marks; number of brothers/sisters; favourite TV programme; etc.

Some of these characteristics are numerical (or quantitative), such as height, weight, _____ , _____ , _____ and _____. These are **QUANTITATIVE VARIABLES.**

The others are not quantitative. They are qualitative, such as hair colour , _____, _____ and _____, these are **QUALITATIVE VARIABLES.**

Figure 1. Statistics task – The beginning

All students who participated in the *IDMAMIM* micro-projects worked collaboratively in mathematics classes. They were also co-responsible for their own learning processes. Many tasks, such as the statistical ones, were elaborated by teachers so as to promote interactive experiences. Students should work together with their group colleagues, analyzing the task and discussing their reasoning and solving strategies in order to reach a consensus.

How do we elaborate a statistical study?

1st Step: Define the aim of the study and the population we want to study.

2nd Step: *Collect data*. Select a representative sample of the population we want to study (or use the whole population and make a census) and decide how to collect data. It is possible to use surveys, questionnaires, observations, experimentations, bibliographic searches, polls, census, etc.

3rd Step: *Organize data*. After collecting the data we need to count and to group them in order to study them. Then, we use tables of absolute and relative frequencies and graphic representations (bar graphs, pictograms, circular graphics, histograms).

4th Step: *Analyse, interpret data and draw conclusions.* Determine the **measures of central tendencies:** mode, mean and median, interpret these results and draw conclusions according to the aim of the study.

Note: We can only compute a mean and median when data are numerical, i.e., when a variable is a quantitative one.

Figure 2. Statistics task – Moving on

This task continues with a brief description about how we should elaborate a statistical study. Students should develop a statistical study based on the batiks micro-project. They had elaborated the batiks previously, in mathematics classes, and now they should select a part of that micro-project as the base of their statistical study.

Each group selects one theme and follows the steps shown above, based on their own experience. Students had already elaborated batiks by themselves and they knew what had been done better than anyone else. To accomplish this task they need to remember everything they did, and how and why they did it as they did.

GROUP WORK

Let's go further and elaborate a statistical study!...

To know something more about the process of elaboration of the batiks, each group develops a small statistical study. Each group should select one of the following themes or think about another one that interests you:

- ✓ Used colours;
- ✓ Price of inks;
- ✓ Number of people who used gloves during the batiks elaboration;
- ✓ Number of damaged batiks;
- ✓ Dimensions of batiks;
- ✓ Number of students in this school who know what a batik is;
- ✓ Others.

After selecting the theme, you should start by identifying the type of variable you chose (qualitative or quantitative). After that, you only need to follow the steps of a statistical study and organize it as you think suitable.

Note: Do not forget: your work/study should be well structured and identified (school's name, subject, title, authors, date).

Figure 3. Statistics task – Moving on

The task ends with students' proposals of a schedule in order to organize their work. At the bottom part of the task teachers also included a list with the evaluation criteria that would be used to classify students' work (See Figure 4.). This decision is coherent with the didactic contract implemented in mathematics classes (César, 2009; César & Santos, 2006; Schubauer-Leoni & Perret-Clermont, 1997). Students were co-responsible for their learning processes and the evaluation was a transparent process. Thus, students previously knew the criteria of their evaluation process and they even discussed the evaluation criteria in previous classes.

Day	***Activity***
___ / ___ / 200_	✓ To start group work.
___ / ___ / 200_ to ___ / ___ / 200_	✓ Data collection.
___ / ___ / 200_	✓ To bring all materials needed to elaborate the study. ✓ To elaborate the study in the class. ✓ To deliver the study to the teacher.
___ / ___ / 200_	✓ To present the study to the whole class.

Evaluation criteria:

- Structure; - Creativity/Originality; - Wording;
- Work done by each student in class; - Written presentation;
- Oral presentation.

Figure 4. Statistics task – The end

This task was elaborated in order to allow students to develop a group work based on some statistical knowledge they had already learned in previous school grades. Developing this work facilitated the mobilization/development of some competencies such as students' autonomy, critical spirit, and working together to achieve a common project. It also allowed them to elaborate their first project work from bottom to top.

FINAL REMARKS

The social marking of this task is its most important characteristic. The task is based on group work about a batiks micro-project that students developed beforehand. They had to base their work on their own experience, which could contribute to students' engagement and to improve their performances, as other authors have observed (Abrantes, 1994; César, 2008). It is also a way to give statistics, mathematics and School a meaning, which is an essential step for some students.

This task is part of a large group of tasks elaborated by the *IDMAMIM* project. Students were to solve these tasks after elaborating the batiks. They are situated (César, 2007) as they are based on students' experiences and on their own work. But above all this statistical task must be

understood as much more than a single task. It is part of a major experience and project that seeks to contribute to an intercultural and inclusive mathematics education (César, 2009; César & Santos, 2006; Favilli et al., 2004) and to a meaningful school, mathematics and statistical learning.

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