PROJECT WORK IN STATISTICS: STATISTICS LEARNING AS A TOOL TO HELP STUDENTS' KNOWLEDGE ABOUT THEIR EDUCATIONAL COMMUNITY

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The development of students' competencies expressed in current curricular documents is a complex task that teachers have to perform (Brocardo, 2005). Project work is a practice that can allow for this development (Abrantes, 1994). According to the Portuguese Department of Basic Education (2001), project work, namely in statistics, is one of the learning experiences that all students should have the opportunity to engage in. This study is a part of the research project Interaction and Knowledge, whose main goal is to study and implement collaborative work within classrooms. We discuss how students from two 7th grade classes (compulsory education, 12/13 years old) used project work in statistics to learn more about statistical contents, about their colleagues, and to develop social, cognitive and affective competencies.

INTRODUCTION

The Portuguese curriculum for mathematics education has set a new emphasis on students' mobilisation and development of competencies that can allow them to solve real life problems (Abrantes, 1994; Abrantes, Serrazina, and Oliveira, 1999). However, this development cannot be accomplished in a "traditional understanding of school mathematics" (OECD, 2003, p. 38) for it demands students to be faced with problems that can be an approach to the real world, and therefore of a more complex nature.

In statistics learning we can find a wide variety of situations where this subject is useful and meaningful to better understand the context where the students live (Boland, 2002). Nevertheless, we can also take into account students' problems and the questions they would like to know the answers to, or which they are concerned with. In these problems, many of them related to teenage experiences, we can find grounds for the development of a project work capable of promoting a significant learning experience (Guimarães, Silva, Ponte, Santos, Abrantes, and Abrantes, 2005).

THEORETICAL BACKGROUND

In the report about teachers' practices in mathematics education (APM, 1998), one recommendation is to use project work in teachers' daily practices as it can "focus on meaningful problems to students" (p. 34). It develops students' autonomy, cooperation and responsibility, which are some points stressed in the documents of educational policy (DEB, 2001). Another important feature of project work is that it allows less motivated students to become involved in the tasks and achieve higher performances, participating actively in the construction of the project (Abrantes, 1994; César, in press). Guimarães *et al*. (2005) describe some of the project work characteristics: "it is an intentional activity" (p. 137); the initiative and autonomy of the individuals developing the project is a part of the work; "authenticity is another fundamental characteristic" (p. 138); it "involves complexity and uncertainty" (p. 138), and it is developed over a long period of time, that includes different phases.

For Abrantes (1994), group work is an important element in project work. It facilitates the development of communicational competencies, but he stresses the need for some previous experience with this methodology. The development of project work in groups of students working collaboratively can allow students to appropriate more easily new statistical knowledge and mobilize and develop competencies (César, in press). Therefore, project work can be seen as a mediation tool (Vygotsky, 1978) in the appropriation of concepts and development of competencies. For César (2003), the organization of student groups can be a key element in the promotion of rich social interactions among peers. As Carvalho and César (2002) state, "in a social interaction, students face a socio-cognitive conflict when they have to confront themselves with a resolution that differs from that which they originally considered." (p. 2). The resolution of

this conflict contributes to knowledge appropriation as well as to the development of social, cognitive and affective competencies.

While implementing project work in school settings teachers need to provide students with a coherent didactic contract (César, 2003, in press), allowing the creation of a secure class climate, to develop students' autonomy and responsibility, as well as their critical sense (César, in press). Thus, the teachers' role is essential in order to mediate students' cultural roots and knowledge and academic demands so as to facilitate students' meaningful learning (César and Oliveira, 2005).

METHOD

This work is part of a wider research project, *Interaction and Knowledge*, whose main goal is to study and promote collaborative work in the classroom context. The project has two levels: (1) *quasi-experimental* studies, in which different characteristics of dyads and the ways they interact are known and analysed; (2) action-research level, where different teachers implement collaborative work and innovative tasks, as a mediation tool for knowledge appropriation and the development of students' competencies (César, 2003, in press). This second level is implemented at least during a whole school year. This work is integrated in the second level and it uses a qualitative approach, based on ethnographic methods. The participants are two 7^{th} grade classes from a mainstream school in Lisbon, working collaboratively since the beginning of the school year, and the teacher/researcher. As usual in this research project, teachers/researchers also work collaboratively among themselves, sharing materials and doubts, reflecting upon their practices, discussing cases, or deciding about spreading the research results. Class X has 16 students (8 girls and 8 boys) whose ages vary from 12 to 15 years old; Class Z has 20 students (10 girls and 10 boys) between 11 and 13 years of age. The data collection instruments were participant observation (registered in the teacher's diary, and on photos), students' protocols, and students' questionnaires, answered at the beginning of the school year and at the end of the project work.

With respect to teachers' practices developed during this research, project work was undertaken in the 2^{nd} and 3^{rd} terms, every 15 days for 12 lessons (45 minutes each). In the other mathematics lessons of these terms students were learning equations and proportionality. The students were always aware of this schedule and when it was necessary to make decisions (e.g., if we should postpone one lesson) there was a discussion with all students, allowing them to participate actively in the decisions concerning their project work. This is pointed out by Abrantes (1994), and by Guimarães et al. (2005) as being important features in project work.

In the first lesson students were introduced to the idea of developing a project work in statistics and the theme for the work was selected. Because it was important to engage the students in this project, the theme was selected by them. Students gave some ideas of a theme they wanted to study, and then only one of the themes was selected. In class X the theme selected was *Characteristics of the school students*; class Z selected the theme *Alcohol consumption, smoking habits and drugs*. The different phases of a statistical study were also discussed with students: Problem definition – work planning – data gathering – data representation – data analysis and interpretation – result diffusion (César, in press).

In the two following lessons dyads produced a group of questions on the subject that they would like to study. As a support for this activity students had access to a scheme with some ideas to have in mind for the construction of a questionnaire, in order to avoid too complex questions, or questions pointing to a specific answer. The proposals were gathered by the teacher who compiled them in a questionnaire that was discussed in the following lesson, elaborating the final version of the questionnaire. The population was already chosen, but students had to decide about the sample, considering several constraints, like the available time for the project. In class X students decided by vote to study the 7^{th} and 8^{th} grade, while in class Z they studied the 9^{th} grade students of that school. The following 5 lessons were used for data collection (questionnaires), selection of the groups of students who would focus on each part of the questionnaire, organising the data in tables, choosing which type of graphs to use for each question, and what to write about the results (presentation, and discussion). The choice of the questions was based on one important element: to allow all groups to treat the different types of data (e.g., one group in class X studied

the musical choices of students and the others studied the sport choices, while all groups studied students' ages, as this scale allowed the calculation of the mean). The following 2 lessons were for the construction of the poster and preparation of the oral presentation which took place in the last lesson of the project work, in order to share with the other groups what each group had been studying both about statistics and about the school students. Thus all statistics contents that are part of the curricula were explored, as well as many of the transversal competencies.

RESULTS

The data that we collected from students' questionnaires illuminate that students considered this work interesting, fun and an effective statistics learning experience:

I think it's interesting and we also get to know more (Michael, Class X)
I think it's a good way of learning statistics (Anna, Class Z)

Around 40% of the students expressed their thoughts using arguments related to the opportunity of better knowing what their colleagues think about the studied items:

Statistics work was useful for us to understand the existing problems in part of the school (Ruth, Class Z)
It helped us to understand today's teenagers better! And we also acquire more knowledge (Susy, Class X)

To communicate the data information collected through the questionnaires, students wrote small phrases that could be a support for people reading their work. As an example, in the second group of Class X we can read the following comment associated to a bar graph concerning the question "What sport you most like to practice":

"According to the graph less than half the 7th grade students (40%) like football and half the students in the 8th grade (50%) also like it."

We can see connections between different mathematical concepts, such as percentage and fractions (half), and the number of students that choose football, represented in the bar graph.

The presentation and discussion of the project work were two aspects mentioned in the questionnaire by 25% of the participants. The presentation of each group's work was able to raise some questions among students, especially as regards the type of study developed. Some students sustained that it was a census, while others stated that it was based on a sample. The discussion revolved around what population they wanted to study and if they had just questioned a sample or the whole population. The implications of their studies were also questioned. The following example comes from Group 1 in class X, that had worked on the question "Which musical style do you like the most?":

Teacher – *How could you use the information that you've gathered and analyse it in relation to music preferences?*
Ruth – *For example, in the school radio they could have more Hip-Hop music for this is the kind most students prefer.*

In the final questionnaire students were asked to write down 5 aspects of project work that they considered important to them. The aspect most pointed out by students (around 70%) was related to graphic construction and representation. These students constructed circular graphs by themselves for the first time, based on the mathematics textbook information. During classes we could realise the engagement they devoted to graphic construction.

It is in the 7th grade that students usually contact for the first time with relative frequency tables and circular graphs. At the end of the project work most of the students were able to construct circular graphs and relative frequency tables, and also to critically discuss the information that was given by these two forms of presenting data.

Another important aspect mentioned by half the students about project work in statistics was that it facilitated students' development, including socialisation. One student wrote the following sentence, in brackets, after his answer: *I even made new friends* (John).

FINAL REMARKS

The work developed in these classes was a new learning experience that allowed some of these students to establish connections to previous mathematical knowledge they had already appropriated in the previous school years, such as data organization – counting tables and absolute frequency tables – and representation – pictograms and bar graphs, and to appropriate new statistical knowledge, based on a meaningful task.

Group work was another element that students stressed as being important to them. Besides providing students with the opportunity to know their colleagues better it also allowed students to collaborate in the construction of an oral presentation to the class. With this activity students were able to use mathematical knowledge to understand a little the ideas of some of their colleagues better, developing their communicational competencies, both in mathematics/statistics, and in daily life subjects, like the ones they were exploring through project work.

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