COLLABORATIVE WORK IN STATISTICS AMONG PRE-SERVICE MATH TEACHERS: AN EXAMPLE FROM PORTUGAL

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Collaboration is an important feature of today's teacher education. According to several researchers, teachers are open to work collaboratively, although they often work in an individual and solitary manner. Since the nineties statistics education includes the need for children to be able to pose questions, collect, organize and represent data in a spirit of investigation and exploration. This is enhanced by implementing student projects. The main research question in this paper is to clarify how three pre-service math teachers planned and prepared classes and reflected afterwards upon them. A qualitative methodology was adopted. It is shown with empirical evidence that collaborative work between teachers is an important approach to solve difficulties in statistical and didactical knowledge. Our results also show that these are the areas teachers have to improve in order to become more confident teachers of Statistics.

INTRODUCTION

In current societies a great volume of the numerical information produced needs to be handled. Therefore, statistical knowledge becomes inevitable in order to allow a critical, reflective and participatory citizenship. In fact, many of our decisions are based on critical data analysis, whether individually or collectively. Consequently, the need to form statistically competent citizens has led us to rethink the teacher's role in the teaching-learning process.

In Portugal, as in many other countries, Statistics is taught as part of Mathematics curriculum, with exception of service courses in higher education. And until students join the university, statistics is taught by Mathematics teachers. Therefore, if we want to change the way students learn statistics in math classes, math teachers must change their classroom practices.

With *Matemática 2001 Report*, Portuguese Mathematics Teachers Association sought to *elaborate a diagnostic and a set of recommendations about teaching and learning Mathematics in our country* (Abrantes *et al.*, 1998, p. 1). Regarding professional practice, this document shows that teachers carry out little collaborative work among themselves. These authors defend that

> *carrying out collaborative work is essential to improve professional practice. It is through the exchange of ideas and materials among teachers, who see eye to eye in terms of their interests and perspectives, or who have common problems and needs, that ideas emerge for the introduction of new activities, new processes or new competencies.* (p. 57)

When teachers work collaboratively the relation between each of the protagonists is very close, making it easier to share successes and hindrances, allowing each one to learn from others' contributions and therefore keep motivation high (Hargreaves, 1998; Jesus, 2002; Ponte and Serrazina, 2004).

This document also recommends that *collaborative practices should be encouraged in the classroom, at every school level* (Abrantes *et al.*, 1998, p. 58). In the classroom projects may be a promising approach to implement collaborative work because the students must connect various pieces of knowledge that suits a solution to a chosen problem. However, the literature has alerted about teachers' resistance to project work in the classroom. An explanation to this resistance may be the lack of opportunities to experiment how to do it during the trainee pre-service teaching in universities. Project work is much more demanding than learning and teaching one isolate concept after another.

This is a crucial issue to math teachers that are going to teach statistics as the international curriculum documents increase emphasis on project work. According to Starkings (1997), *project work is a method of allowing students to use what they have learned in statistics classes in a practical way* (p. 139).

METHOD

Based on this problem a larger study was carried out (Antunes, 2005). The methodological approach was qualitative and included several data collection methods, in order to obtain a greater diversity of information.

The main research question in this paper was to clarify how three pre-service (Telmo, Carmen and Vera) math teachers planned and prepared classes of the Statistics 5th grade unit and afterwards reflected upon them. The pre-service teachers prepared all the classes, materials and activities together in a context of collaborative work. They were teaching 27 students, 16 boys and 11 girls aged between nine and eleven. Among these students, there was a student who had stayed behind the previous year and another with special educational needs.

The methods used to collect data were as follows (a) observation of the planning sessions where the pre-service teachers decided what to do in their classes and also during the classes. All this moments were audio and video tapped and later transcribed; (b) documental analysis of all written materials produced by the pre-services teachers, including the materials that were given to students in the classes and also each pre-service teacher's individual written reflections about their own judgments of other pre-teachers working in the classroom with the students, or it's own judgment of his/her own work in the classroom; (c) an individual interview with one of the three pre-service teachers, related to their own motivation to become a math's teacher. This interview was audio tapped and was conducted after they had taught the Statistics unit.

THE CONTRIBUTION OF COLLABORATIVE WORK IN THE IMPLEMENTATION OF A PROJECT WORK IN THE CLASSROOM

The first two planning sessions (out of five) were aimed to elaborate the medium term plan. In the first session the activities and strategies that should be adopted to start the Statistics unit were discussed. The second session was essentially to collect the orally debated and negotiated ideas and to transform them, in group, into a written plan.

The group decided to approach the Statistics unit at two moments: the first moment was based on the question *what is the students' favorite subject?* and the second was based on a project work, the *Grandparents' Christmas*. Throughout the first moment several concepts that were part of the medium term planning were addressed: Statistics in society, different ways of collecting information, such as inquiries and interviews; ways of organizing data, such as frequency tables, pictograms, bar graphs and, finally, the notion of average. In this manner, they sought to introduce students to the collection and organization of information. The second moment favored the development of a statistical study to allow students to become familiarized with the several stages it comprises. Students would have to work with the concepts previously addressed in a more autonomous but guided manner, and in the form of project work that used several computational tools.

(...)

229 Vera: *Our idea is (...) to address Statistics at two big moments, that is, first working on a problem, which is what we're thinking about now...*

230 Telmo: *And in this problem we're working with Statistics.*

231 Vera: *Frequency tables, bar graphs... and then, as they're already prepared with all that information, (...) each group is going to work on a specific theme related to grandparents, the Grandparents' Christmas. They can suggest studying gastronomy, in the old days and now, the gifts their grandparents got and the gifts they get now and then each group works on one of those themes... that will then be presented at the grandparents' party.* (First Planning Session)

This project (Grandparents' Christmas) was developed by classroom students individually and also in working groups. Each group had a spokesperson that was also responsible for maintaining the rules regarding group work, recording the tasks carried out in each class in the evaluation grids, and, at last, filling in the grids after discussing events with the remaining elements.

The Grandparents' Christmas project was based on four essential stages: (a) formulation of the research questions; (b) preparation of tools and processes of data collection; (c) analysis of the collected data and (d) presentation of final products. These four stages were crossed by

several moments of reflection upon activities which consisted of filling in evaluation grids for the tasks carried out by the group of students.

In order to carry out the Grandparents' Christmas project, the class students were organized into working groups. The students also developed research questions they would like to see statistically analyzed. After the questions suggested by each group were collected, an inquiry was elaborated with the collaboration of a Portuguese language teacher and studying teacher. Following the inquiry by the grandparents, each group of students analyzed the information of its research question: data was counted, frequency tables were produced, and graphs were constructed.

(...) *After collecting and organizing the data in frequency tables* (…) *we presented this information in the form of bar graphs.* (...) *we decided to pass a PowerPoint presentation on the steps that have to be taken to construct bar graphs, on the Excel worksheet. As I was explaining how to work on Excel, the students were following the whole thing on their computers* (...). (Telmo, Written Individual Reflection)

This project work that the class students carried out included several moments during which they turned to different computer tools. The final outcome was the creation of a CD-Rom with a *PowerPoint* presentation of several graphs on Grandparents' gastronomy, beliefs and customs on Christmas Eve, in a comparative perspective between the old days and nowadays. These graphs were built on an *Excel* program and presented by the class students to their grandparents at the Grandparents' Christmas party, organized by the school with the collaboration of the pre-service teachers.

The time initially devoted to the didactic unit of Statistics (sixteen 45-minute classes) was considered to be insufficient by the pre-service teachers if they were to address matters that would allow students to participate in a statistical study performed by them. For this reason the pre-service teachers decided to add some extra working hours to this project. The increase in their weekly teaching schedule and guiding project work in the classroom caused some discomfort in the pre-service teachers.

(...) *This was a rather tiring consuming week, but in the end it was rewarding to see that all groups managed to finish their work in time for presenting them at the Grandparents' Christmas Party.* (...) (Telmo, Written Individual Reflection)

The activities implemented throughout the Statistics unit were suggested by the pre-service teachers, showing a constant concern in relating the Statistics unit to those previously addressed, thus promoting in-depth discussions in the classroom.

(...) *The construction of bar graphs from Excel worksheets, the analysis and interpretation of the bars and the elaboration of a PowerPoint presentation on the work developed by each work students group, showed, at a certain point, that students reached different rhythms of work and, as such, reached different levels of accomplishment. For this reason, my group colleague had to follow and support each group, providing them with the necessary indications for undergoing the different stages of work. Sometimes it was not clear for us some of this statistics concepts and how to explain it to the students.* (...) (Vera, Written Individual Reflection)

Throughout the work developed by the pre-service teachers, knowledge and doubts were shared, activities were built, classroom planning was negotiated, and strategies were discussed to overcome difficulties. In other words, a context of collaborative work developed seems to facilitate better performances of the pre-service teachers, regardless the difficulties or not in statistical and pedagogical knowledge. Therefore, this kind of work reveals countless potentialities for attaining some of the most ambitious goals of the current educational policy documents.

FINAL REMARKS

The pre-service teachers feel that a collaboratively elaborated plan of the classes has an important role for their activity because it was during the joint planning sessions that several issues were discussed and negotiated, namely the best way to clarify statistical knowledge or working on the statistics subjects with students. It was also collectively that they decided to develop more individual work with students first, and then after involving them collectively in project work.

One of the difficulties the group felt regards the actual classroom implementation of what they planned. Pre-service teachers have to make decisions individually in class, that is, their performance is based on joint planning but, faced with novel situations, sometimes they have to rethink what was planned and choose to change their course of action. The group considers it a difficult decision because it involves not only one pre-service teacher's performance, but all the work developed and discussed in group. The difficulty in predicting students' reactions and the time it takes to execute tasks is also felt by the group as an element of insecurity and subsequent resistance to the implementation of the class plan. However, the dynamics of collaborative work developed by the group strengthened and created some assurance and determination in the implementation in project work in the classroom.

The group shows great satisfaction in the fact that the internship is carried out collaboratively and refers in one of the interviews that group work runs well. As for planning, by sharing ideas this group of pre-service teachers enhanced its determination to act and increased its confidence to be able to run risks during its practices, creating the conditions to do so through dialogue, negotiation and joint reflection, so as to face the challenges resulting from a practice and promoting mutual learning.

As regards their performance, we found that the individual characteristics of each of the group elements were decisive in their performances. Although their planning was elaborated and negotiated in group, their personal characteristics prevailed during their performances, giving a personal touch to their classes.

Collaborative work contributes to reflective practices. Mutual learning through dialogue and joint reflection contributed to face challenges and problems felt by the group and also by each element of the group. During their moments of reflection, the pre-service teachers easily reflected upon the planning/performance inter-relation as performers or observers in an internship, and upon students' behavior. Nevertheless, they expressed difficulties in reflecting upon students' learning experiences and didactic and statistical knowledge.

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