ONE STEP BEYOND FORMULAS: STATISTICAL PROJECTS FOR FUTURE MATHEMATICS TEACHERS

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Statistical Projects incorporating questions relative to quantitative literacy for interdisciplinary work are presented as a very appropriate learning strategy for Brazilian Mathematics teachers in Fundamental and Middle Education. In order to work well on projects, it is necessary that future Mathematics teachers have this experience during their Teacher Training years of 2004 and 2005. For this purpose we have developed Statistical Projects with students in the Mathematics Teacher Training Course of a private University in Campinas, São Paulo, Brazil. These students worked in groups on project themes relative to the field of Mathematics' teacher actuation. In spite of difficulties encountered by the Professor as well as the students, the final result can be considered positive.

INTRODUCTION

In Brazil, since the end of the decade of 90s, the National Curriculum Parameters (Brasil, 1997, 1999) proposed that inserting statistical contents should begin in the initial grades of Fundamental Education, indicating that *the level of deepening contents ought to be administered in function of the possibilities of the student's comprehension* (Brasil, 1997, p. 58); thus it is possible to construct a sequence in which the Statistics knowledge should be deepened grade by grade (or cycle by cycle, as these Parameters propose).

According to that suggestion, it is possible in Middle Education contemplate the abilities and competencies required for Natural Sciences, Mathematics and their Technologies, and what is referred to as statistical knowledge, as it follows:

- *Understand the random and not deterministic character of natural and social phenomena and utilize instruments suitable for measurements, determination of samples and calculation of probabilities;*
- *Identify, analyze and apply knowledge about values of variables represented in graphs, diagrams or algebraic expressions, realizing forecasts of tendencies, extrapolations and interpolations, and interpretations;*
- *Qualitatively analyzing quantitative data represented graphically or algebraically related to socio-economic, scientific or everyday contexts* (Brasil, 1999, p. 96).

Besides to the relative questions to the students' statistical literacy, Brazilian teachers have been frequently asked to work on projects (Nogueira, 2001), but due to some situations that have been developed during their Teacher Training many teachers still believe that working on a project is only synonymous with gathering data.

According to the American Statistical Association (2002) a s*tatistical project is a process of responding to a research question, utilizing statistical techniques and presenting the work in a written report.* Applying this definition to our school reality, we can see that Statistical Projects are inserted into a very ample context incorporating questions relative to quantitative literacy required for interdisciplinary work as well as providing the integration of various concepts presented in the classes of various subjects.

In spite of all the possible advantages of introducing this type of teaching, it is not very easy to put it into practice. It requires, above all, a change of posture, beliefs, attitude and concepts of the Mathematics teacher, not to mention the questions relative to training the Mathematics teacher as a Statistics user.

Regarding this aspect, it must be remembered that in order to work confidently with statistical concepts, being able to motivate their students to engage in discussions and coherent interpretations, Mathematics teachers must feel apt to the task. But it must be admitted that in many mathematics teacher training courses, besides not dealing with the inferential part of

Statistics, the descriptive part is treated in a mathematical way without any connection with the contents proposed for Fundamental and Middle Education.

Being aware of these needs, in 2004 and 2005, our general objective was to develop Statistical Projects with students of the Mathematics Teacher Training Course at a private University in Campinas, São Paulo, Brazil. In this Institution, the Mathematics Course has brought statistics contents distributed over Statistics I and Statistics II that are taught respectively in the 3rd and 4th semesters of the referred course.

IMPLEMENTATION

For Statistics I as well as Statistics II, the class load is 68 hours divided into 34 hours of theory and 34 of practice, understanding that 1 class/hour is equal to 45 minutes. Theoretical classes are in general expositive and are given in a conventional classroom with exercises solved individually as well as in groups with the help of a scientific calculator; practical classes are given at a Computer Laboratory with two students per computer.

Statistics I studies concepts of population and sampling, collection, organization and description of sample data, position and dispersion measurements, linear correlation and regression and probability. Specific objectives of this subject are: exploration of Descriptive Statistics contents as important instruments for analyzing data and preparing the future Mathematics teacher to work in the classroom on several levels of teaching with these contents, utilizing Excel as a computer tool. We choose this software for the classes of Stats I because the most part of Brazilian schools use it in their Computer Labs and so it is necessary that the future Mathematics teachers dominate it.

Evaluation occurs in four moments: two theoretical ones, a practical one (made in the Computer Laboratory) and another for planning the statistical project. The theoretical as well as the practical evaluation are made individually on each students' materials consultation, on the other side, the statistical project must be evaluated on groups of up to five students who had already drawn up their own research plans.

Statistics II studies distributions of probability and statistical inference, presenting the hypothetical methodology test used to analyze quantitative and categorical data. Its specific objective is the exploration of Inferential Statistics contents for critical interpretation of data published by the Media using SPSS as a computer tool. On this subject can also occur for evaluation moments as a theoretical one, a practical one and two others referring to the statistical project since the students have already been evaluated by their oral and written exposition.

In 2004, during the first week of Statistics I classes, the students were presented with the subject's programmed content, objectives and ways of evaluation; when we proposed the work to be researched, the students seem to be interested but a bit apprehensive because Mathematics Teacher Training Course does not have subjects about Research Methodology which could help on a scientific writing according to the norms proposed by ABNT – Brazilian Association of Technical Norms.

In the execution of the projects, we followed the steps proposed by Mendes (2003) since this methodology enables students to be co-responsible in all process stages; we proposed the following rules:

- students should work in groups of up to five people and each group should choose a theme related to the actuation field of the Mathematics teacher, which provides the possibility of collecting data by means of questionnaires or forms;
- samples would have an appropriate size defined *a priori*, considering the number of people in each group, that is to say, each member of the group should interview 25 participants for their study.

After settling all these initial doubts about defining the themes, at the end of the first week the groups would choose the following: difficulties in Mathematics, distance education, difficulties in Algebra, applications of Mathematics and concepts concerning Mathematics.

As an outside classroom task, each group should make a bibliographic survey about its theme. In our training classes in order to improve the students' research we taught them how to make a better use of a bibliography searched on reliable databases. After overcoming this

problem, each group was oriented to define their objectives as well as the research population in order to be able to organize an instrument for collecting data.

From this point on, theoretical as well as practical classes would develop the program's stipulated content, reserving on average 30 minutes at the end of each class to resolve doubts related to the project.

Throughout the first semester of 2004, the students looked for bibliography, elaborated and re-elaborated the data collection instrument (the same being subjected to numerous corrections by the professor) and composed the initial project.

Taking into consideration the need to be ethical in educational research, it was explained that all those who would be interviewed ought receive, before any data was collected, a consent agreement they were supposed to sign. It should be clarified what the objective of the research was, the purpose of the collected data and that they would be free to refuse being a volunteer. Thus, only people who were aware of these terms would sign the agreement.

At the end of the semester, the students turned in a partial report according to the format proposed by ABNT. After being evaluated, these reports were returned with annotations highlighting how some errors should be corrected, completing the theoretical part and the data collection that would be complemented in the following semester.

During the first week of classes in Statistics II, the available time was used to orient how to continue the research work. The following weeks were dedicated to theoretical classes about the new programmed contents and the practical classes in initial contact with SPSS. In spite of the fact that Brazilian schools for Middle and Fundamental Education don't have the SPSS in their Computer Labs it was used in Stats II classes to improve our students' comprehension about the data analyzes presented in several researches in Mathematics and Statistics Education that refer to the use of this software.

After the adaptation period to this software, practical classes began to be dedicated to exploration of the collected data by each one of the groups beginning with the descriptive part. Afterwards, to the degree that the Inferential Statistics contents were presented in the theoretical classes, they were also able to be applied to the research works in an effort to confirm or not the hypotheses established for the same.

During the course, we could see difficulties that some students found on the application of the concepts already seen theoretically to the real data, especially those referring to statistical tests as well as in the interpretation of results presented by the statistical software. Consequently for solving these doubts it was necessary to schedule some extra-classes hours with each group.

At that time, another problem arose: some students presented difficulty for working in groups and was necessary to have a private conversation with them to propose a solution and to avoid a delay of the work development.

At the end of the second semester of 2004, when the final reports were almost finished, the students were directed about how they should proceed in the oral presentation.

Taking as a basis the results obtained in 2004 (Mendes, 2005), we decided to resume the work with projects in 2005. This year, themes chosen by Mathematics Teacher Training students were: concepts of university students about Statistics, geometric knowledge of Fundamental Education students, expectation of parents concerning Mathematics education, didactic games, Astronomy knowledge, difficulties in Mathematics of those preparing to the college entrance examination and the teachers' concept about their students' difficulties in Mathematics.

Since in Brazil the second school semester ends around the middle of December, the Statistical Projects have not concluded yet. Works of seven groups are in the phase of analyzing and discussing about the obtained data, in order to compose the final report of the study and subsequently preparing for the oral presentation.

CONCLUSIONS

We believe that working with projects is one of the possible ways to put into practice the proposals for teaching Statistics contents in an interdisciplinary manner (Mendes and Brumatti, 2003; Mendes and Alves, 2004). To be able to really put it into practice, it is important for the future teacher to have this experience during the Teacher Training Course.

Certainly, there are difficulties for its implementation in the training courses of Mathematics teachers; and we felt some of them during our work in 2004 and 2005. One of those refers to the extra work required from professors who work with this strategy because they must be prepared to deal with any doubts that students present during the process.

Furthermore, it must be noticed that those students who attend the course at night, and work during the day; will have the outside class activities to be developed on weekends.

Another important point, not considered a difficulty but rather a warning advice, that is, not enough to teach statistical contents because many times the students' doubts are about methodological and/or ethical questions. Teachers who want to work with projects also need to be aware that they ought know the technical norms to write out scientific works.

Students are forced to read and interpret texts according to their own degree, and should elaborate their themes coherently for the final report, all of which are not usual in Statistics classes.

All things being considered, we can believe that the final result obtained in 2004, after reading the final reports of the Statistical Projects, observed the individual evolution, self-confidence in their own oral presentation, was actually gratifying and surely this will be repeated at the end of 2005.

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