STATISTICS IN LIFE AND FOR LIFE

[1]VEGA, Maria, [2]CARDEÑOSO, Jose M., [3]AZCÁRATE, Pilar
[1]Professional Schools of the Sagrada Familia of Ecija, Spain
[2]University of Granada, Spain
[3]University of Cadiz, Spain
mvega@fundacionsafa.es

ABSTRACT

We present a working option for a compulsory secondary education classroom that makes it possible to increase pupils' motivation when dealing with statistical topics. Improvement occurs because the knowledge that the pupils receive is useful to them, and it makes them re-think their view of the world around them. In this respect, the orientation we take is towards work on projects related to everyday problems, with the pupils actively participating in resolving the situations put to them. The context in which the project is presented is one of collaborative learning through working together on learning scenarios, taking as a basis the European project "EarlyStatistics" whose main goal is to improve pupils' statistics education. This project has been selected for the "2009 Best Cooperative Project Award in Statistical Literacy".

INTRODUCTION

Although the statistics content of Spain's secondary education curriculum has increased considerably over recent years, this change has not been reflected in the reality of the classroom. One often finds whole classes of pupils in the second (upper) cycle of compulsory secondary school (15–16 years) who have never had any direct contact with statistics in school. For this reason, we regarded it necessary to design a classroom unit in which pupils, each starting from their individual level of competence in statistics, would gain an increasing ability to cope with information from statistical charts and tables that they see presented in daily life (Batanero & Diaz, 2004).

This innovative proposal is the result of the authors' attempt to characterize the development of statistics competence in the secondary education pupils with whom we work. This characterization has taken shape in a PhD thesis, currently being written. It consists of a working proposal describing a teaching unit related to the development of pupils' competencies in statistics. The design and implementation of this unit were based on the educational model proposed by the IRES group (Rivero et al., 2010), a model that underpins our teaching style. The model's principles are the following:

Respect the learning pace of our pupils

In an inclusive school, in which all pupils are different, one needs to start from the level of competence that each of them already possesses, so as to offer them tasks that they are capable of doing (López, 2006). We also need to be aware that what is important is their individual evolution. All students do not all have to end in the same place, but they each must increase their level of competence.

Provide opportunities for communication in the classroom

Since humans are social beings, and teachers must prepare pupils for the world around them, instructors need to offer the students opportunities for dialogue, listening to each other, and reaching peer consensus. Group work, in groups of 2 to 5 pupils, is required so they will communicate and use the language and vocabulary of statistics. When students are defending and explaining their ideas to their classmates is when they are really developing the competencies involved in the activity (Henning, 2005). By introducing knowledge we want to teach within a learning scenario, it makes sense to the pupils; they encounter it in a familiar setting in which they feel sure of themselves and are thus prepared to take on new challenges (Lancaster, 2010).

Figure 1. Pupils conversing in order to reach an agreement.

Be clear about the purpose of the work

If we want our pupils to be mathematically literate, they need to tackle everyday problems by themselves, discovering that mathematics is not only applicable but necessary in understanding the world around them. Only in this way will they really integrate the new knowledge and become capable of applying it when needed. Moreover, only if the ultimate goal of the work is clear will students be able to overcome obstacles encountered in their learning (Lancaster, 2010). It will be helpful if pupils have to construct a referent that will serve as a guide when they feel trapped. Being clear about their goal will help them focus their reflections on their learning process.

Evaluate the process

By using a learning portfolio (Burks, 2010), we gather information about the teaching and learning process that would be impossible to obtain by other means, since the learning portfolio lets us know at what point an obstacle or a difficulty in learning occurs. Thanks to feedback from the teacher, the pupil, together with the rest of the class, can continue to reflect in a more appropriate direction. This rapid diagnosis also allows a teacher to more efficiently help pupils at the time they need it.

THE TEACHING PROCESS

It is important to note that the pupils who took part in this experience had actually never studied statistics before. Because the topic usually comes at the end of the textbook, it is seen as secondary, even though it is one of the branches of mathematics most commonly applied in everyday life. Teachers who teach statistics in secondary education in Spain are mathematics graduates, and often feel uncomfortable with the subject. They also often think statistics is not an exact science (Batanero & Diaz, 2004).

The teaching process was split into two blocks, described in the next two sections. The theoretical notions are presented in the first block. In the second block, the theories are put to use by carrying out a specific project.

Theoretical block

The first 6 class sessions are called the theoretical block because the pupils make their first contact with the notation, concepts, and procedures of statistics. We made sure that this first contact takes place in as intuitive a manner as possible, with the pupils working in small groups.

We grouped activities around four focal points of learning – population and sample; selection of the variable and questionnaire; data and its representation; and statistical parameters – to allow organization of the class sessions, plus the inclusion of the cross-sectional referent of problem solving. The activities are based on a real context, studying the Report on Youth in Spain 2008 (Instituto de la Juventud, 2008). In these activities, pupils interpret topics from the textbook, using questions related to the Report as a focal point. Collaborating in groups, students construct their own learning through the comparison and contrast in the questions they are given, and then from their reflections on the topics. They develop both basic and statistical competencies needed to work efficiently with statistics in the upcoming practical block.

We chose the aforementioned Report to implement one of the learning scenarios proposed in the EarlyStatistics program (http://www.earlystatistics.net; Socrates-Comenius Action Project 226573-CP-1-2005-1-CY-CoMENIUS-C21). Specifically, we implemented scenario number 9, which focuses on Youth Leisure.

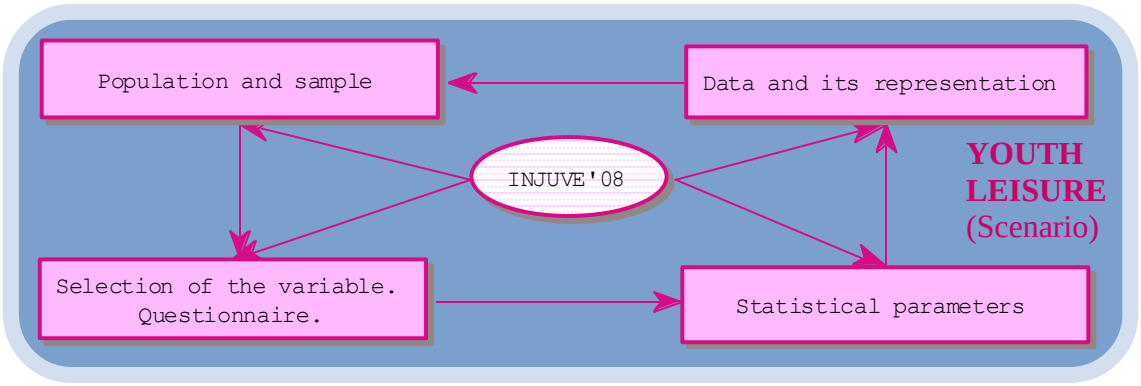

Figure 2. Distribution of tasks within the learning scenario.

Working in this way, we achieve the objectives set for the focal points of learning in Compulsory Secondary Education (CSE):

- *Population and sample*: To characterize the population and sample of a statistical study, to distinguish the two terms correctly, and to differentiate between the information provided by a population and that provided by a sample.
- *Selection of the variable; questionnaire*: To give examples of different types of variables corresponding to observed data, and to construct a frequency distribution table, FDT.
- *Data and its representation*: To make various common types of plots corresponding to an FDT.
- *Statistical parameters*: To calculate and analyze measures of central tendency and scatter in a statistical study.

As detailed in Vega, Cardeñoso & Azcárate (2010), in order to respect the pupils' own pace of learning, we designed extra summary activities for groups who completed the proposed tasks for each of the four focal points. These included the design of a rubric (Stevens & Levi, 2005) with which to evaluate the practical work they were going to do next. These also included creating a poster to present knowledge they had gained during the theoretical block.

Practical block

In the six sessions of the practical block, pupils use the concepts and competencies acquired during the theoretical block to design and carry out a project. The project consists of a statistical study completed in small groups of 2 to 5. Within each group, each pupil must have a definite function for which he or she is responsible; the student is not necessarily the author of that function, but will be responsible for its coordination.

The groups decide what they want to investigate, some aspect of leisure activities in their own environment. It is more motivating for them to work on problems of everyday interest than on standard problems. Furthermore, each group can adjust itself to its own level of initial knowledge and of the demands of their project. This respects pupils' diversity, as not all the groups will set the same goals or the same paths to attain them. All groups have to answer the following questions:

- What do we want to know?
- What do we know? What do we not know?
- What paths are we going to take to find out?
- What is each of us going to do?

In the scheme shown below in Figure 3, one observes the process, starting from the main question of what the pupils want to investigate and finishing by preparing a report that presents the information pupils obtained in the process and the conclusions drawn from it. The final step,

the report, has great importance in the project, since it is vital that pupils know what they are aiming for. They are carrying out a process that will enable them to show everyone else what they have discovered.

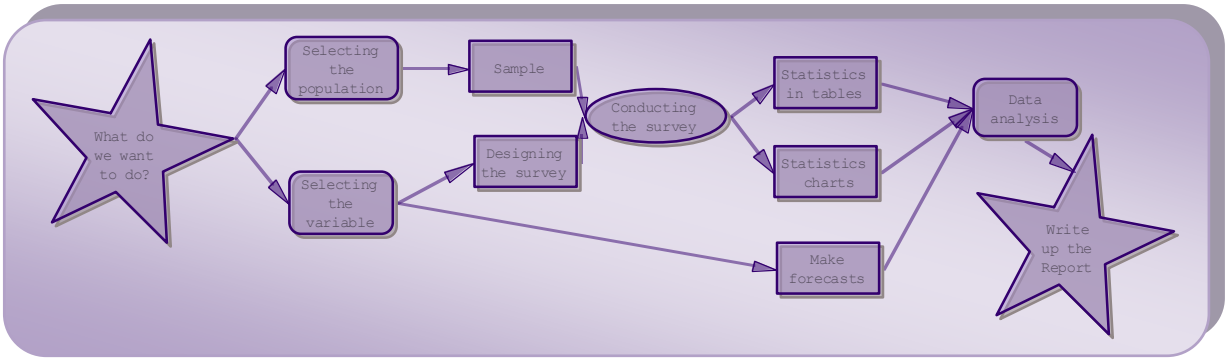

Figure 3. Path of the process of statistical investigation followed by the pupils.

This path is not the only one possible, but all groups in the class used it. In a meeting of the whole class, the pros and cons of various proposed paths were discussed. A consensus was reached that this path best matched what the different pupils wanted to get from the process.

The final report that each group has to present consists of two parts. The first is a written report, resulting in the feedback provided by the learning portfolio. We shall label this the technical project. The second is a presentation in a format chosen by the pupils, to show and explain to their classmates their conclusions and findings.

IMPROVEMENTS TO THE ORIGINAL PROJECT

In the implementation during the 2010-11 school year, we proposed to our 3rd year CSE pupils that their final presentation of the work could be a poster with which they could participate in the ISLP Poster Competition of the IASE (http:///www.stat.auckland.ac.nz/~iase/islp/home). Adding this motivation on top of the already excellent operation of the project has been a resounding success. The pupils dealt in great depth with the projects they had chosen. They were motivated to do their best to make a good final presentation, since only one poster would go on to the Spanish national phase.

Because the pupils took the contest very seriously, we decided that the choice of best poster would be by a jury composed of pupils in a higher grade. The jurors were given the rubric that the pupils of our class had drafted to evaluate their projects (Vega, Cardeñoso & Azcárate, 2009), from which they had to decide which of the posters had best attained the proposed objectives.

Figure 4. Pupils working collaboratively in preparing their poster.

Altogether, this project allows us to work in the classroom in a different way, allowing the pupils to achieve targets that would be unimaginable with other methodological approaches. Highlights of our experience during this school year include the fact that pupils are now aware of how the selection of a non-significant sample can give inadequate information. Also, pupils see how relative and absolute frequencies provide different but complementary information, and how they can choose charts of one or the other to better suit their particular interests. That the pupils

set their own questions for inquiry is very important, because free choice helps schools prepare citizens who are cultured, critical, and better informed.

Figure 5. Girls presenting their work to the jury chosen for the school's contest.

REFLECTIONS FOR TEACHING

Even now, we are still questioning the use of descriptive statistics, beyond understanding and describing the world around us. Moreover, many secondary education mathematics teachers are still asking why a branch of mathematics so closely related to the real world continues to be presented as rote learning of formulas that effectively kill any motivation our pupils might have had. We then end up with two main groups of statistics pupils – those who got lost in too much formalism, and those who get bored by the lack of practical application. With this project, when they finish CSE, our second cycle pupils no longer have any lag, in concepts or in competence, when compared to other pupils who encountered statistics in the first cycle of their secondary education (Lucero, 2003).

There is a definite need for methodological approaches of the type in this classroom experience, because they give pupils the chance to tackle open problems for which there is no single or right solution in absolute terms. They can thus discover and experience for themselves that their intuition is fairly reliably pointed in the right direction when working with mathematics, especially with this branch which is so closely in touch with their real, everyday world (Lancaster, 2010). Indeed, the competencies that the pupils have acquired by the end of the process go beyond the purely mathematical (Niss, 1999). The result we achieve is that the pupils believe in their mathematically abilities, help their classmates when they need it, and, above all, look forward to the mathematics hour (Carmichael et al., 2009).

We instructors have to keep in mind that we are preparing men and women for tomorrow's world, and in that world not everyone will need the same knowledge and skills. With this form of instruction, we achieve an education that is in a certain sense "à la carte"; the form in which each pupil is involved depends on their prior knowledge and their future needs. In contrast, the traditional style of CSE teaching gives priority to preparation for future work rather than as an end in itself, when the reality is that a great part of our pupils will not be continuing their education at higher levels.

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