STRATEGIES FOR TEACHING STATISTICS BASED ON COLLABORATIVE WORK AND PROBLEM SOLVING

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Abstract
Various strategies may be applied for teaching statistics. Lectures, equipment, teamwork and guidance are all important to help students to become capable of using statistics to analyse their own work and the results produced by others. Students following the second year from the Chemistry Pharmacology and Biology curricula (QFB) in the Faculty for Higher Studies Zaragoza (FES-Z), UNAM start becoming familiar with simple concepts and procedures, such as percentage, average, mean, median, standard deviation, standard error, confidence intervals and probability. They also learn to correctly elaborate standard curves and to interpret both graphically and statistically the results of their experiments. Our university provides wired and inalambric facilities for a wide and fast access to the institutional and public networks. The information can be accessed from various devices, like tablets, smartphones, personal and institutional computers. Thus, the students can connect, search, upload, download and interact in various ways through digital means. Our institution's policy is to guarantee that limited access or insufficient knowledge of information and communication technologies (ICT) will not be a barrier for our students. Instead, they may benefit from state-of-the-art digital communication systems and guided learning to use them properly [1]. The students receive files containing full information about experiments designed to answer specific questions. Then, by using their knowledge on statistical procedures and interpretation of results, they must describe, analyse and conclude if the experiments have been properly performed and what is the significance of the results. Teams of 4 or 6 students are formed in order to promote exchange of information, collaboration and discussion. Teachers are always following their progress, making comments and helping them to resolve their doubts [2]. This tutorial-guided students’ teamwork stimulates and promotes critical analysis of information and problem solving thinking [3]. Students’ capacity to develop critical thinking and proper application of statistics are both important qualities for a solid academic development.

Keywords: Collaborative learning, Teaching statistics, Blended learning.

1 INTRODUCTION
The study plan of the QFB career in the FES Zaragoza University Campus, the signature of Sadistic is a basic plan that is imparted in the 3th semester. At the beginning of the 8th semester the student can chose terminal outputs. Industrial Pharmacy, Clinical Biochemistry and Clinical Pharmacy. As is expected several of the assignments that the student will take requires a statistical thinking that he should applied in the problematics that he encounter. [3] The study plans indicate the subjects that require to have attended statistic courses. For Intermediate cycle that courses are Pharmaceutic Technology and Evaluation of Drugs and Medicines in the 6th and 7th semester respectively. For the final cycle depending on the chosen output, the student must study some of these subjects: Experimental Design Applied to the Industrial Pharmacy, Analytical Development, Experimental Design Applied to Clinical Biochemistry, Pharmacoepidemiology, Drug Stability and Biopharmacy. In all these subjects statistical techniques will be applied such as descriptive and inferential statistical analysis, statistical quality control, analysis of variance, validation of analytical methods, and statistical process control, to mention a few. The learning of statistics is crucial for the scientific and technological training of graduates who must develop skills that allow them to apply knowledge in solving problems, as they will develop in a society characterized by the availability of information and the need to make decisions in environments of uncertainty. In order to ensure adequate learning, strategies have been implemented that incorporate Information and Communication Technologies (ICT), particularly those containing work dynamics based on virtual collaborative learning, in the blended learning modality [4]. In this paper we present a series of activities for the understanding of descriptive statistics that allow the student to link definitions and statistical procedures, using a
spreadsheet for data processing and obtaining results; For finally by observing and analyzing these, reach relevant conclusions regarding the original approaches.

Currently the students can access the network from different devices, such as tablets and smartphones in addition to personal computers (PC), so the technological tools required to perform the activities are within their reach and do not represent a barrier, Campus has computer rooms and areas with wireless signal to access the network.

2 OBJECTIVE

The student understands the basic conceptual and procedural components of descriptive statistics: on graphs statistical summaries, as well as in data analysis.

2.1 Learning objectives

Conceptual understanding of the statistical concepts of average, median, fashion, standard deviation, frequencies, percentages, accumulated frequencies and frequency distribution.

Procedural knowledge, both in the development of tables and various graphs (simple bars, bars, histograms), using the Google Docs spreadsheet.

Mathematical reasoning when using tables and graphs to express ideas formulate conjectures and support their conclusions

3 METHODOLOGY

The incorporation of technological resources in the class of statistics, supposes the continuous putting the day in the handling of these resources. Calculators and spreadsheets, as well as specialized software for statistical analysis, have been present for many years, currently the network offers a myriad of alternatives, however, it is not advisable to choose those that imply a greater effort for the student; Due to this and its accessibility, Google Drive and Google Docs are used, particularly the spreadsheet; In this space the students have access to the work files with the description of the activity to be performed, the statistics that must calculate from the data that is available in a Google Docs spreadsheet.

The collaborative work is organized from teams of between 4 and 6 members. Each team creates a copy of the data and works on it by following the directions. If there are doubts that can not be resolved between them, the teacher keeps a continuous follow up of the actions and can make comments to clear his doubts [2].

Students were informed of the characteristics of Google Docs that makes it possible to track the activities being carried out, and allows to track the participation of each team member (figure 1).

![Figure 1.](image)

The data refer to random samples independent of anthropometric measures of men and women, and the work consists of calculating the statistics of central tendency and variability (figure 2), as well as
the frequency distribution of each variable and the creation of graphs of Bars and histograms to describe the main differences between the two data sets (figure 3).

In this particular exercise, we could observe great interest and a high participation, except for few cases of abandonment or lack of interest.

Finally, a questionnaire was applied to evaluate the students’ experience

4 RESULTS

The evaluation of the group work was carried out in stages, providing support to the students during the execution of each one [5]. For each variable were performed:

- Calculation and comparison of measures of central tendency and variability.
- Elaboration of frequency tables and relative frequencies and comparison for each sex.
- Creation of bar graphs and histogram and comparison for each sex.
- Writing a report describing the observations and analysis of the data and the conclusions of the work.

An individual assessment of each student was also carried out according to the level of participation, interest shown, and correction of statistical techniques and interpretation, clarity of the report, as well as the integration of the student in the team, their individual effort and their Contribution to collective work.
A questionnaire was used to assess the reactions of the group (adapted from Brilhart, Galanes and Adams, 2001: 381) and the results were:

1. The objectives of the work were very clear for 59% of the students, 33% considered them clear and 8% considered them confusing;
2. For 75% the working atmosphere was of cooperation and cohesion, 15% felt apathetic and 10% perceived it to be competitive.
3. 85% considered that the work performed by the team was appropriate and 15% felt that it was disordered, none considered it too rigid.
4. The perception of the performance of the partner who served as leader was 74% as democratic, 23% considered him weak and 3% rated him as too authoritarian.
5. 62% felt that all the members of the group worked evenly, while 33% said that only some collaborated and 5% indicated that almost nobody was seriously involved.
6. Regarding the reflection of how he expressed the desire to participate when he had the opportunity to do it 44% indicated that it was occasional, 41% that frequently and 15% said almost never.
7. Sixty-four percent said they felt moderately satisfied with the results of the study, while 26% said they were very satisfied, none rated the experience as unsatisfactory.
8. When asked if they would like to return to work with the same team, 59% said that only if necessary, 36% said they would love it and 5% said that in no way.

48% of the respondents who extended their comments and expressed their desire for more computer activities, both in Excel and in Google Docs, considered that this activity was good and that it was to their liking, although some said that they had wanted more activities in Team to understand more topics. They indicated that it is necessary to homogenize the computer skills, to avoid that the work is complicated. Emphasis was placed on the fact that evaluation should give more weight to individual work. They considered that working in this way was easy, although the problems were focused on lack of communication. The work was perceived as democratic, with an ideal atmosphere and that gave them the opportunity to help each other to solve doubts, calling it excellent. They expressed the desire to repeat this exercise. They demand that the problems that are addressed are applied to the subjects of the terminal outputs and that the practices expand the explanation of how to interpret the graphs. It seems that one of the problems of this dynamic is the choice of the team leader and that the members commit to the work, in addition to that it is necessary that prior to the work are given clear instructions, broader explanations and examples and it manifests itself the fear of not reaching an approving grade.

5 CONCLUSIONS

This dynamic offers a stimulating alternative and makes it easier for students to acquire statistical thinking when applied to problems and data obtained in other subjects [3]. The application of statistics is essential for their academic development and above all to be successful in the subjects of the most advanced semesters. It is necessary to recognize the complexity of the evaluation function, since it must address the multiple facets of statistical knowledge (conceptual and procedural understanding, reasoning). An entire system is needed to collect data on student work and performance and it is not enough to evaluate it from the brief answers given to routine questions in a single evaluation (or examination). In this exercise, we could observe great interest and a high participation, except for few cases of abandonment or lack of interest. The students were informed of the characteristics of this tool and the possibility of tracking the activity it provides. Working in groups in the statistics class focuses the students’ attention on what statistics means as an important part of their learning as well as focusing their own identification as potential producers of statistics in relation to their own interests and problems.

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