Statistics in Teacher Training Colleges in Buenos Aires, Argentina: Assessment and Challenges

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1. Introduction

In most developed countries, Statistics has become part of the Mathematics curriculum in elementary, secondary (high schools) and even in kindergarten schools (National Council of Teachers of Mathematics, 2000). In the past years, many studies have emphasized the importance of including statistics contents in these instruction levels (Holmes, 1980; Hawkins et al, 1991; Wild and Pfannkuch, 1999; Gal, 2002; Franklin, et al, 2005). Through a long teaching practice at the Agronomy School (Buenos Aires University), we have realized that students who are starting their university programs have scarce or even null knowledge about Statistics. Courses taken at college are not enough for students to integrate the notions of statistical variability, since students have been taught only within deterministic paradigms. Statistical reasoning differs from mathematical reasoning, no matter how essential they are for modern life (Gattusso, 2006; Scheaffer, 2006). We believe that an early training in uncertainty and variability concepts may give way to more effective reasoning and understanding of stochastic phenomena. The focal issue is the training of those who are in charge of teaching Mathematics in both elementary and secondary schools. In Argentina, secondary school Statistics is taught by Mathematics teachers. Thus, it is very important that these teachers get robust statistical knowledge in teacher training colleges. Teaching Statistics in an effective way in high schools – and even in elementary schools- will have a beneficial impact on the building of our future society because it helps young people to rationally manage uncertainty and random information or events.

The goal of this study was to make an assessment of the Statistics basic knowledge that Mathematics college students from Buenos Aires and Greater Buenos Aires have, and find out how they apply them to everyday life situations. The CAOS4 (*Comprehensive Assessment of Outcomes in Statistics*) test (delMas, et al, 2006 (a)) developed by the Minnesota University was used. Information collected allowed to strengthen students´ teaching training. We expect to contribute to secondary teachers´ training in Statistics, because teachers lead change. To our knowledge, there is little research on this subject in our country and this study findings could be useful for comparative analysis with other countries.

2. Materials and Methods

This study population comprised all institutions- public or private- granting a Mathematics teaching degree in Buenos Aires City and Greater Buenos Aires. Samples were taken from a list of institutions provided by the National Department of Information and Educational Quality Assessment. Institutions totalled 26, 5 university institutes, 5 teacher training colleges located in Buenos Aires City and 16 in Greater Buenos Aires. Students attending the last year courses were tested. Questionnaires were administered by the research team. Test administration allotted time was 60 minutes. The test comprised 40 multiple-choice items assessing students´ knowledge about elementary concepts of Statistics and Probability. Each correct answer was awarded one point. Some personal data, such as gender and age, were also recorded. An item related to the definition of Statistics was added to collect information about the epistemological ideas that future Mathematics teachers have. It was based on definitions provided by López et al (2002).

In the first place, frequencies for correct answers, the mean and the standard deviation were estimated. Then item-total Pearson correlation was found for each individual question and total score. They showed variable magnitude and direction, indicating how strong was the relationship between both variables. Reliability was measured by Cronbach´s alpha coefficient (www.unne.edu.ar/syt/2002/09-Educacion/D-027.pdf). Student group was split in three by the test final score. Group 1 fell into the lower 27% (LG), Group 3, into the upper 27% (UG) (Kelley, 1939). The discrimination index was the difference between the correct answer percentages of the UG and LG. An item is not discriminating when the index is below .20, whereas it is highly discriminating if it is above .40. It is also desirable that the difficulty of an item –the proportion of item correct answers- is not below .20 (a very difficult item) or above .80 (a very easy item).

3. Results

Seventy-seven students from 10 institutions (6 public institutes and 4 private ones) answered the questionnaire. The average percentage of correct answers was 42%, with a minimum of 20% and a maximum of 75%. Percentile 27 corresponded to 35% and 73 to 47.5% correct answers. These percentiles were used to split the sample in three groups: Group 1, with the lowest percentage of correct answers; Group 3, with the highest percentage of correct answers. Women accounted for 75%. Average age was 29 (SD= 8), minimum of 20 and maximum of 63 years old. There were no significant differences in the percentages of correct answers by gender or age. Final qualifications the students had in prior statistical courses in their teaching programs had no significant correlation with the test percentage of correct answers. Most students studied from the notes taken during classes and only eight mentioned that they had read a text-book. Seventy-four percent had not used a PC during Statistic courses. No significant difference was found across students using or not using PCs.

Fifty-eight percent considered Statistics as a Mathematics branch, around 33% as a scientific area dealing with collecting information from numerical data. No significant differences were found in test scores by different epistemological ideas.

Cronbach coefficient of internal consistency was .46, which is a low value according to Nummally (1978). Twelve items had negative correlation with total score, thus increasing Cronbach when eliminated. Item 2 and 9 (negative coefficient) referred to box plot charts, item 19 and 25 to p- value and items 29, 30 and 31 to confidence intervals. All items with negative coefficient were poor for discriminating students with the higher and lower percentages of correct answers.

Item 6 had the lowest percentage of correct answers, even in the UG. This item referred to a frequency distribution plot of a quantitative variable and was answered correctly only by 4 students. It is likely that most students chose alternative (b), because the graphic had a bell shape which was familiar to them, but they were unable to correctly place the quantitative variable, goal percentage, in the horizontal axis.

Items 3, 5 and 13 were the best for discriminating among student groups. Item 3 was answered correctly by 75% of the UG. Item 5 referred to the representation of the uniform random distribution of digits which was correctly answered by 43% of total students, whereas incorrect answers were equally distributed in the other alternatives. Item 13, which tested understanding that comparison across groups does not necessarily need equal samples, especially if both data sets are large, was answered correctly by 94% of the UG, but only by 41% of the LG.

In items related to the variable distribution, students chose alternatives with symmetric distributions, such as the uniform or normal (items 3, 4, 5, 14, 15). In item 11 and 12, students did not have difficulties in making comparisons between groups using distributions. Students had difficulties in interpreting distribution graphics of sample means. In this respect, item 35 was answered at random. Item 32, which requires the use of standard error, was answered correctly only by one-fourth of students.

Items associated to box plot interpretation had a low percentage of correct answers. Through interviews with students' teachers, we knew that this content had not been taught. Teachers also mentioned that the hypothesis testing was not taught either due to lack of time. Items testing knowledge about –p value had a very low percentage of correct answers. Only 18% students answered correctly item 7, which tested the need for randomization in research.

Item 36 (probability) had 46% of correct answers, which was the maximum value for this subject, since items 16, 17 and 37 had very low percentages, 16%, 23% and 13%, respectively.

Students showed that they understood variability within the context of repeated measures and realized that a minor variability is expected within a specific context: i.e. a teacher's choice of ways to go to work, given specific time for five different days in each way (item 18). About three-fourth students considered correct the alternative of a way having a mean slightly higher but with less variability.

Item 22, testing correlation and causal relation, was answered correctly by less than one-third of students, whereas 41% chose the answer indicating that a statistically significant correlation determines a causal relation. Students seemed to understand bivariate relationships, however, the student percentage answering correctly was lower with the inclusion of an outlier.

4. Discussion

This study provides a panorama of the present teachers´ training in Mathematics. These future teachers will teach Statistics in coming years. It shows their general statistic knowledge background and how they apply it in daily life situations. Novel teachers graduate with lots of difficulties and lack of essential statistical knowledge that may impair their future teaching. The lack of confidence in their knowledge makes them feel uneasy at teaching, therefore they try not to teach Statistics or reduce its contents, alleging lack of time. Research carried out in other countries (Rubin and Rosebery, 2000; Makar and Confrey, 2004; Stohl, 2005) show coincident conclusions.

The percentage of correct answers was 42%, somewhat different from 51.2% of the post-test administered by Del Mas et al (2006, (b)), after a first Statistic course in universities with a non-mathematical level. In the present study, Mathematic teacher training college students surveyed had already completed their statistical training.

Most students had not used PCs in their program. Anyway, those who had did not perform better, because such use may not have a great influence on statistical concepts. PC may be effective in saving time, which could be devoted to a better concept acquisition and understanding, and could be used in analysing real data instead of time-consuming calculation (Godino, 1995).

Most of the future teachers believe that Statistics is a Mathematics branch. This epistemological view differs form the results found in a study carried out with Statistics teaching teams in Argentine Agricultural Universities, in which only 2 professors out of 23 held this view. Most professors considered Statistics as a set of self-governing procedures for decision–making (López, et al, 2002).

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