TEACHING STATISTICS TO PSYCHOLOGY STUDENTS: TWO STRATEGIES TO OVERCOME SOME LIMITATIONS

Eduardo León Bologna, MarceloVaiman, Débora Jeanette Mola, Antonella Bobbio, Milagros Martínez and Gabriela Rivarola Montejano
Department of Psychostatistics, National University of Córdoba, Argentina
eduardo,leon.bologna@unc.edu.ar

Psychostatistics is a subject that is taught in the first year of the Psychology degree at the National University of Córdoba. The main difficulties that our students encounter are: understanding the usefulness of statistics in the profession and achieving an appropriation of the concepts and procedures that allow their application in subjects of subsequent courses, such as Psychometric Techniques and Research Methodology. To face these difficulties, two strategies are developed, the first is mandatory and consists of using real data to apply the techniques that are covered throughout the subject. The second is an optional "game", a competition in which problems are presented whose resolution leads to points. In this work we compare the results of the second partial exam between students who participated and did not participate in the optional activity. In order to homogenize the groups, the Propensity Score Matching technique is used.

INTRODUCTION

In introductory courses to statistics in psychology, a significant part of the students face difficulties related to the usefulness of statistics in their future professions, which is added to the lack of confidence in their own abilities to address highly structured content, often expressed in a formalized way (Counsell & Cribbie, 2020; Walker & Brakke, 2017). Frequently, the decision to study Psychology implies the belief that it will not be necessary to return to the mathematical contents, often remembered as threatening. These prior beliefs refer to the "cognitive competence" and "value" components of the SATS (Survey of Attitudes Toward Statistics; Schau, 2003), and appear as the main drawbacks for learning statistics (Jatnika, 2015), and appear as the main drawbacks for learning statistics. Existing literature shows the clear relationship between attitudes and academic performance.

Schau (2003) proposed that attitudes toward statistics are associated with six aspects: (1) affect (students' feelings toward statistics), (2) cognitive competence (students' attitudes about their knowledge and skills when applying statistics), (3) value (students' attitudes about the usefulness, relevance, and benefits of statistics in personal and professional life), (4) difficulty (students' attitudes about the difficulty of statistics as a subject), (5) interest (students' interest in statistics), and (6) effort (students' efforts to learn statistics). On the other hand, Jatnika (2015) suggested that in statistical learning, attitudes include distinct factors such as hope for success (i.e., students' self-concept of their ability to understand statistics) and the value of the task (i.e., students' perceptions of the value of using statistics). Attitudes have also been defined as individuals' dispositions to respond positively or negatively to various aspects of statistics.

The majority of psychology students tend to express negative attitudes toward statistics and often limit their attendance to required classes (Onwuegbuzie, 2004; Schau, 2003). Consequently, attitudes significantly influence the utilization of statistics in the classroom and academic achievement. Previous studies have demonstrated a positive correlation between attitudes toward statistics and students' performance in statistics courses, as well as their overall academic performance (Emmioğlu & Capa-Aydin, 2012). For instance, Nasser (2004) found a positive association between mathematics aptitudes, statistics attitudes, and the performance of pre-service teachers enrolled in an introductory statistics course. Moreover, Chiesi and Primi (2010) observed that attitudes at the beginning of the course and mathematical knowledge had an impact on attitudes at the end of the course, subsequently influencing achievement. Finally, Lavidas et al. (2020) identified direct links between perceived competence in mathematics and attitudes, as well as a direct effect of perceived competence in mathematics on students' performance in the statistics course. The researchers also noted that engagement in the learning process had a direct impact on students' performance.

In: EM Jones (Ed.), *Fostering Learning of Statistics and Data Science*
Proceedings of the Satellite conference of the International Association for Statistical Education (IASE),
July 2023, Toronto, Canada. http://iase-web.org

The Department of Psychostatistics - Faculty of Psychology - Universidad Nacional de Córdoba (Argentina) proposes:

- to make statistical learning meaningful.
- to link analytical strategies to real issues in psychology.
- to make learning lasting for its future application in courses of quantitative methodology and psychometrics.

THE STRATEGIES

To face the aforementioned limitations when taking an introductory course in statistics in the first year of the degree, a two-level strategy was implemented. On the one hand, the contents are introduced from real data, prepared by the students themselves, and the analysis operations are presented as answers to questions about the data. On the other hand, optionally, for more motivated students, an activity also focused on the data is proposed, to delve into the contents in a playful context. This paper refers to the evaluation of the effect of the second strategy, called "Pearson Awards", on the grades of the second partial exam.

This activity consists of a set of individual and group tasks that imply not only a conceptual evaluation, but also the application of the contents to specific situations through instructions such as the design and application of surveys, preparation of data matrices and interpretation of results, writing of recommendations or suggestions to public organizations based on the results found, preparation of explanatory videos of statistical concepts aimed at children, participation in discussion forums on biases and misleading uses of statistics. As a result of solving the activities, the participants obtain individual and group points. If they reach a certain score, the student accredits one of the integrating evaluation activities of the subject. These activities are distributed in different categories:

- Reflection, critical thinking with participation in debates on different topics in forums and decision-making.
- Technique, which includes the use of software, preparation of charts, APA standards, database assembly.
- Survey, with data collection activities and/or survey preparation.
- Resolution of theoretical-practical exercises.

DATA AND METHOD

The data comes from: i) the Moodle system where the results of the partial exams are recorded, ii) the information system used in our university, called "Guaraní" that provides characteristics of the students and iii) the department's own records on the students who participated in the activity.

The activity was carried out during the second semester of 2021 and the output variable is the result of the second partial, administered in October of that year. We want to know if participation in the activity had a positive impact on the results of the second partial exam.

Because the participation in the activity did not come from a random selection but was voluntary, the results of the participating group cannot be directly compared with the rest of the students. To build a group similar to the one that participated, the Propensity Score Matching technique (Rosenbaum & Rubin, 1983) is used, which consists of pairing the cases that participated with students who did not participate but who are similar in some observable aspects. This technique is used in the evaluation of interventions to reduce the bias of other variables that affect belonging to the treated group.

RESULTS

243 students voluntarily participate in the activity and complete data was obtained from 189 of them. The PSM technique was applied to generate another group of similar non-participants. The following two tables summarize the means of the groups before and after the pairing.

Table 1: Distribution of the selected variables before matching

	Means	
	Treated	Control
Grade first partial exam	7.57	6.02
Age	23.87	24.04
Gender Female	0.86	0.77
Work	0.24	0.27

The group that participated has an average of 1.6 points higher in the first partial exam than the group that did not, is slightly younger (23.9 vs. 24 years), has a higher proportion of women (86% vs. 77%) and works to a lesser extent (23 vs 27%).

Once paired, these differences are reduced.

Table 2: Distribution of the selected variables after matching

	Means	
	Treated	Control
Grade first partial exam	7.57	7.51
Age	23.87	23.54
Gender Female	0.86	0.83
Work	0.24	0.21

Now the marks of the second partial exam can be compared between the participating and non-participating groups. Since the distribution of the marks of the second partial does not comply with the assumption of normality (in the Shapiro-Wilk test, $p<.0001$), the non-parametric Wilcoxon test is used to compare the groups , which results in $W = 11942$, p-value = 0.001107. Thus, it is concluded that the groups differ significantly.

Although there are other individual variables that could have influenced the motivation to participate, it can be considered that this intervention has a positive impact on the results of the exams. In the second half of 2023, it is planned to extend the scope of this activity, making more efforts to communicate it and encourage participation.

CONCLUSION

To improve the engagement that psychology students have towards statistics, an optional activity was proposed in which students had to carry out, during the second semester of 2021, activities to earn points in a competition. Participation in this activity is expected to have a positive effect on the results of the second partial exam, which was administered in October. However, the comparison of the groups of participants cannot be direct, because the decision to participate in this activity is influenced by characteristics of the students, such as the availability of time, which depends on age and employment status, so they have a different propensity to participate in the proposed activity. In order to compare the results of the second partial exam between the group of participants and that of non-participants, a sample of non-participants was selected, who had a composition by gender, employment status and age similar to that of the group that did participate. In addition, the result of the first partial exam was added as pairing criteria. The application of the PSM technique generated two more homogeneous groups in these variables than the original. It is recognized that there are unobservable variables, such as motivation towards the subject or secondary school education, on which the groups cannot be homogenized.

The groups are compared by means of a non-parametric test and a significant difference is found in the result of the second partial exam. It is concluded that, controlling for the aforementioned variables, participation in the optional activity contributes to improving the results.

REFERENCES

Brezavscek, A., Sparl, P., & Znidarsic, A. (2016). Factors influencing the behavioural intention to use statistical software: The perspective of the Slovenian students of social sciences. EURASIA Journal of Mathematics, Science and Technology Education, 13(3), 953–986. https://doi.org/10.12973/eurasia.2017.00652a

Chiesi, F., & Primi, C. (2010). Cognitive and non-cognitive factors related to students' statistics achievement. Statistics Education Research Journal. 9, 6-26. 10.52041/serj.v9i1.385.

Counsell, A., & Cribbie, R. (2020). Student attitudes toward learning statistics with R. Psychology Teaching Review, 26(2), 36–56. https://doi.org/10.31234/osf.io/76w2p

Emmioğlu, E.S.M.A. & Capa-Aydin, Y. (2012). Attitudes and achievement in statistics: A meta-analysis study. Statistics Education Research Journal, 11, 95–102.

Jatnika, R. (2015). The effect of SPSS course to students attitudes toward statistics and achievement in statistics. International Journal of Information and Education Technology, 5(11), 818–821. https://doi.org/10.7763/IJIET.2015.V5.618

Lavidas, K., Barkatsas, T., Manesis, D., & Gialamas, V. (2020). A structural equation model investigating the impact of tertiary students' attitudes toward statistics, perceived competence at mathematics, and engagement on statistics performance. Statistics Education Research Journal, 19(2), 27–41. https://doi.org/10.52041/serj.v19i2.108

Nasser, F. (2004). Structural model of the effects of cognitive and affective factors on the achievement of Arabic-speaking pre-service teachers in introductory statistics. Journal of Statistics Education, 12(1). [Online: www.amstat.org/publications/ jse/v12n1/nasser.html]

Onwuegbuzie, A.J. (2004). Academic procrastination and statistics anxiety. Assessment & Evaluation in Higher Education, 29, 3–19. doi:10.1080/0260293042000160384

Rosenbaum, P. & Rubin, D. (1983). The central role of the propensity score in observational studies for causal effects. Biometrika 70 (1): 41-55. doi:10.1093/biomet/70.1.41

Schau, C. (2003).Students' attitudes: The "other" important outcome in statistics education. Presented at 2003 Joint Statistical Meetings - Section on Statistical Education, 2003.

Walker, E. R., & Brakke, K. E. (2017). Undergraduate psychology students' efficacy and attitudes across introductory and advanced statistics courses. Scholarship of Teaching and Learning in Psychology, 3(2), 132–140. https://doi.org/10.1037/stl0000088