ENGAGING STUDENTS TO LEARN FORECASTING METHODS

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Abstract

Presently, higher education institutions are faced with the challenge of developing student's abilities and skills needed in their future workplace.

In what concerns technological skills, the use of spreadsheets for calculations, analysis of data and forecasting is a common and important practice in companies. Particularly, the MS Excel software is widely used by professionals from all fields. In this sense, Economic, Business and Marketing graduates need competencies in forecasting methods, extremely useful for decision-making processes. It thus becomes imperative to implement pedagogical practices to encourage students to use these technological tools. The later will promote the development of competencies in forecasting methods to solve future real problems.

In this paper, we attempt to address these issues by analysing the MS Excel software capabilities as a teaching tool in a forecasting methods course. It was proposed to the students to carry out a learning project involving statistical concepts, namely linear regression, performed in MS Excel. We examine the performance and engagement of two samples of students with different backgrounds and from distinct realities. One group is composed of ERASMUS' students from several nationalities and fields of study and other group consists of Portuguese students of the Marketing Bachelor degree, both enrolled in an optional course of the bachelor degree in Marketing taught at Porto Accounting and Business School from Polytechnic of Porto.

The effectiveness of this approach is shown through the analysis of results of students' projects. We verify that students in both groups achieved the task proposed goals and applied appropriately the required concepts in an engaged way.

Keywords: Higher education, Excel, forecasting, linear regression.

1 INTRODUCTION

The need for change and innovation in the European higher education through new modes of teaching and learning is being raised in the literature [1], [2] and in European and national policy [3], [4], [5]. These transformations in education are required to address the new skills and competences that will be crucial in a competitive and constantly changing world.

Studies revising methods of teaching statistics, "suggest changes which should be implemented to enable students to receive training which is both up-to-date and relevant to society's needs" [6, p.11].

Into an age of information people need to be statistically literate in their everyday life and also in the workplace. It has been recognized that integrate technology and computer-based methods into teaching statistics promotes engagement and deeper learning experiences. In this study we analyse the MS Excel software capabilities as a teaching tool in a forecasting methods course at Porto Accounting and Business School from Polytechnic of Porto (ISCAP). It was proposed to students to carry out a learning project involving statistical concepts, namely linear regression, performed in MS Excel. We examine the performance and engagement of two groups of students: one group is composed of ERASMUS' students from several nationalities and fields of study and other group consists of Portuguese students, both enrolled in an optional course of the second year of the bachelor degree in Marketing taught at ISCAP.

This paper is structured in the following way: section 2 presents a literature review to provide a deep insight into the addressed subject, section 3 describes the methodology and section 4 exhibits the data analysis and results. We conclude with some considerations in Section 5.

2 LITERATURE REVIEW

Actually statistics is increasingly important in most professional fields [7], and as such, it is taught in courses across many programmes and it is recognized as one of the most important quantitative subjects in a university curriculum [6]. Specifically, at ISCAP most of all programmes include courses with statistical subjects. However, acquiring statistical skills and knowledge poses significant challenges for many students due the high level of abstraction and because it requires logical reasoning, critical thinking, and interpretation skills [7]. Several studies report students' difficulties in dealing with these issues [8], [9], [10] and statistics is still accepted to be a difficult subject [11], [12], [10]. It is therefore difficult to motivate and engage students to learn statistics and, deal with their different backgrounds and abilities is a demanding challenge for teachers. Consequently, it is important to go deeper into this topic, ascertain problems and understand how students learn and what kind of activities could be more valuable in fostering reasoning and thinking statistical subjects.

Research has identified several problems related with teaching and learning statistics, we highlight (to an extended review see [6]):

1 Focus on mathematical and mechanical aspects of knowledge

2 Negative attitude towards statistics (and maths) or statistics anxiety

3 Deficiencies in basic statistics and mathematical background

4 Inadequacies in prerequisite mathematics skills and abstract reasoning

5 Statistics courses often taught not linked to the subject area

6 Unappropriated assessment methods to evaluate interpretive skills, statistical literacy and reasoning

7 Lack of statistical literacy and inability of students to apply statistician everyday life.

To be more effective, teaching strategies should be based on pedagogical principles and theories of learning. A long time ago [13] proposed ten general principles for learning statistics grounded on the constructivism theory. More recently [14] regrouped the previously stated principles as follows:

1 Students learn by constructing knowledge, connecting new information to previously one

2 Students learn by active involvement in learning activities and working cooperatively in small groups (three or four) improves engagement and learning

3 Students learn to do well only what they practice doing and applying ideas in new situations

4 We often underestimate students' difficulty in understanding basic concepts of probability and statistics

5 Frequently we overestimate how well students understand basic concepts, even students with better grades

6 Learning is enhanced by having students become aware of and confront their errors in reasoning

7 Technological tools should be used to help students visualize and explore data, not just to follow algorithms to pre-determined ends

8 Students learn better if they receive consistent and helpful feedback on their performance.

Over the last years, researchers are focuses on studying the development of students' statistical literacy, reasoning and thinking in opposite to traditional approaches to teaching statistics focused on "procedural understanding, i.e. statistical techniques, formulas, computations and procedures" [14, pp. 381-382]. The emphasis is placed in promoting *learning for understanding* and developing student-centred learning environments to promote deeper knowledge. These authors stress the importance of active learning methodologies in promoting the construction of knowledge and students' engagement.

The integration of technology and computer-based methods into teaching statistics promotes engagement and is an important tool for effective teaching, as it is highlighted in the literature [15], [6], [16].

There is a wide variety of technological tools and resources to support statistical learning and teaching: statistical software packages, data repositories, spreadsheets, graphing calculators, multimedia materials available on the web, etc. To [15] the choice of a particular technology tool

should be made taking into account the easiness of use, the interactivity, dynamic connections between data/graphs/analyses, and portability. The idea is “focussing on concepts rather than computations, and offering the opportunity to experiment with data to make it engaging for students” [18, p. 648].

Spreadsheets such as MS Excel are widely used in professional environments and have much wider usage than working with tables or simple calculations. “It is versatile software that can be used in many different ways from data management to statistical analysis and simulation” [19, p. 3323]. Also [20, p. 252] refers the wide range of tools available “for financial decisions, statistical analyses, working with databases, graphical representation of data and finally for optimisation and mathematical modelling”.

Economic, Business and Marketing graduates need competencies in forecasting methods and technological skills to use standard software to apply those methods properly in decision-making. Marketing managers use spreadsheets extensively, so it is of major importance promote its use by students in forecasting courses. In a survey completed by [20] about the needs and perceptions of managers in industry, it was found that 80.5% identified MS Excel as the primary forecasting tool available to them. These authors refer that one advantage of MS Excel’s regression procedure is the easy interpretation of results. [21] found a substantial improvement in performance of students who took a microeconomics course with Excel when compared with those who attended a traditional course.

3 METHODOLOGY

The present study was conducted in the setting of the course Forecasting Methods being part of Marketing second-year program at ISCAP. It is an optional course covering subjects from linear regression to decomposition models and which presupposes some background concerning basic statistical concepts.

The mode of instruction of the course consists of theoretical and practical lessons. Lectures are supported by slides showing the theoretical concepts and including illustrative examples and in practical lessons students work in pairs solving problems using computational tools (MS Excel software).

The assessment is composed by two parts: a project and a written test.

The aim of this group project is to encourage students to the use of computational tools, namely the MS Excel software, in the study of quantitative methods and apply properly these methods to analyse and solve real problems, in order to obtain projections.

The group project was divided into 3 parts, as described below.

Part1-Report: The work should be supported by a report which should include:

1 a literature review where students should address the topics Forecasting Models and Regression Models

2 the presentation of the case study and variables (the data should be collected by the group within their interests)

3 summary of results, conclusions and bibliography

Part2-Excel: This task is performed within MS Excel and shall contain the quantitative data analysis that must include:

1 Explanatory variables and response

2 Coefficient of correlation

3 Coefficient of determination

4 Analysis of the scatter diagram

5 Least Squares Regression Line

6 Hypothesis test for the slope, non-zero, using significance levels 1% and 5%

7 Hypothesis test for the y-intercept, not null, using significance levels 1% and 5%

8 Confidence intervals for the slope (90%, 95% and 99%)

9 Confidence intervals for the y-intercept (90%, 95% and 99%)

10 Confidence interval for the mean of dependent variable for an arbitrary value of the explanatory variable (90%, 95% and 99%)

11 Prediction interval for an arbitrary value of the explanatory variable (90%, 95% and 99%)

Part3-Oral Presentation: Each project is presented to the teacher and to the other students in class.

This assignment was proposed to two different groups. One group is composed of 38 ERASMUS' students (GERAS) from several nationalities (Czech Republic, Croatia, Germany, Italy, Latvia, Macedonia, Netherlands and Poland) and fields of study (Global Business Management, Business, Marketing and Economics), and other group consists of 42 Portuguese students (GPORT) of the Marketing Bachelor degree. Both groups, GERAS and GPORT, are enrolled in the course of Forecasting Methods of the bachelor degree in Marketing taught at ISCAP.

For the accomplishment of the project it was asked to students to form a work group (maximum 3 elements). We intended to promote teamwork to develop in students' soft skills such as communication, responsibility, flexibility and adaptability.

For the GPORT, the total of the 42 students were organized in 18 groups of 2 elements and 6 students working alone, in what concern the 38 students in GERAS, were organized in 14 groups of 2 elements, 3 groups of 3 elements and a single student. This work project had a weight of 70% in the course final mark, being the remainder 30% given by the score in the individual test.The work was carried out in six practical classes, a total of 9 hours, which included the theoretical revision, data collection, presentation of the variables, data analysis and interpretation of results and conclusions. This work was made always with the supervision of the teacher responsible for the course. The written report was left to homework. The score obtained in the project is a weighted mean considering the written report, the Excel file and the oral presentation.

The objective of this paper is to compare the performance of the two groups (GPORT and GERAS) when faced with a project using the MS Excel as a tool to data analysis in the context of Forecasting Methods course. A statistical analysis was performed and the results are presented in the next section.

4 RESULTS

Table 1 shows mean scores by item obtained by participants in the study.

Table 1. *Scores obtained by item in Part2-Excel*

Items	**GPOR** N = 24	**GERAS** N = 18	**GPOR** N = 24	**GERAS** N = 18	**GPOR** N = 24	**GERAS** N = 18
	Mean		**S.D.**		**S.E.**	
Explanatory variables and response	**1**	**1**	---	---	---	---
Coefficient of correlation	0.932	**0.996**	0.173	0.011	0.035	0.003
Coefficient of determination	0.819	0.7	0.36	0.426	0.073	0.101
Analysis of the scatter diagram	0.949	0.8	0.112	0.219	0.023	0.052
Least Squares Regression Line	**0.953**	0.95	0.098	0.108	0.02	0.025
Hypothesis test for the slope	0.719	0.767	0.27	0.386	0.055	0.091
Hypothesis test for the y-intercept	**0.642**	**0.578**	0.336	0.453	0.069	0.107
Confidence intervals for the slope	0.802	0.688	0.314	0.438	0.064	0.103
Confidence intervals for the y-intercept	0.749	0.632	0.357	0.457	0.073	0.108
Confidence interval for the mean of dependent variable	0.778	0.667	0.316	0.431	0.065	0.102
Prediction Intervals for an arbitrary value of the explanatory variable	0.815	0.882	0.309	0.258	0.063	0.061
Overall Excel	0.808	0.763	0.186	0.22	0.038	0.052

There are eleven items which correspond to the points asked in Part2-Excel. The last line presents the overall Excel scores. The lowest and highest points are highlighted in the table. We observe that "Hypothesis test for the y-intercept" has the lowest mean for two groups, but even above 50%. The highest values appear in "Least Squares Regression Line" for GPOR and "Coefficient of correlation" for GERAS. All students in both groups GERAS and GPORT identified correctly the variables.

For a better visualization the mean results for all items obtained by each group are presented in percentage in Figure 1.

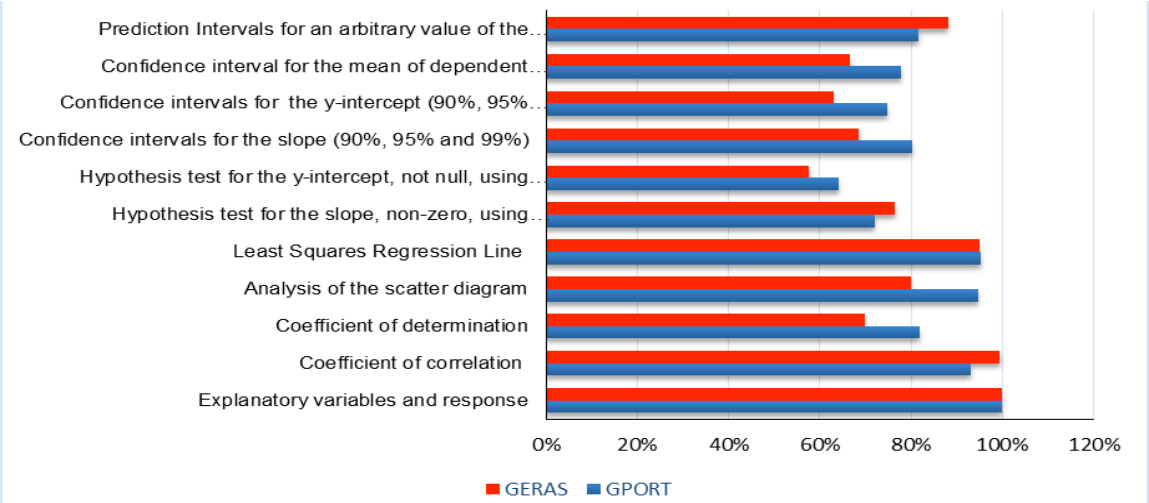

Figure 1. Scores (%) obtained by item in Part2-Excel.

To further explore the data, a Mann-Whitney test was performed to determine if the two groups differ significantly. It was found significant differences ($p<0.05$) only in the items "Coefficient of correlation" (better performance for GERAS) and "Analysis of the scatter diagram" (better performance for GPORT).

The results obtained in Part1-Report concerning to literature review (Theory), presentation of the case study and summary of results (Contents) and Part3-Oral Presentation are summarized in the table below.

Table 2. *Scores obtained in Part1-Report and Part3-Oral Presentation.*

		GPOR N = 24	**GERAS** N = 18	**GPOR** N = 24	**GERAS** N = 18	**GPOR** N = 24	**GERAS** N = 18
		Mean		**S.D.**		**S.E.**	
Report	Theory	0.754	0.744	0.233	0.245	0.047	0.058
	Contents	0.658	0.767	0.115	0.175	0.024	0.041
Oral Presentation		0.706	0.833	0.197	0.176	0.040	0.042

Next figure presents the means (in percentage) obtained by the groups in each assessment component.

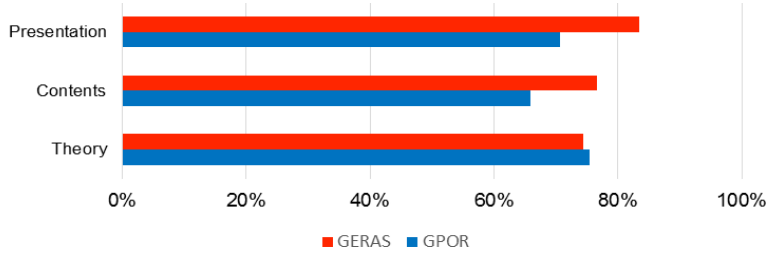

Figure 2. Overall Scores (%).

The Mann-Whitney test revealed significant differences between the two groups related to the "Contents" and "Presentation" where GERAS obtained better results ($p<0.05$).

5 CONCLUSIONS

In the literature we can find many suggestions about the need for change and innovate in education in order to address the new challenges in workplace. The present study attempt to contribute to a better understanding of the issues involved around this theme. We proposed a project involving two groups of students: a group from ERASMUS program and a group of Portuguese students. This project intends to develop competencies in forecasting methods, combining the use of technological tools within an environment that encourages teamwork cooperation. It was suggested the use of MS Excel to solve a real problem of Linear Regression where the data was collected by students. Although we highly encouraged teamwork, some students preferred work alone. The task considers three components: perform a Linear Regression in Excel, write a report and present the results in class.

The scores obtained by the two groups show that students understood the concepts involved in Linear Regression. The item "Hypothesis test for the y-intercept" was the less understood. However, the variability of results it was high which must be explained by the small sample size and, also, by different backgrounds concerning basic statistical concepts. Regarding the "Report" component "Contents" and "Oral Presentation" we verified that the group GERAS achieved the best mean results. However, comparing variabilities of results in GERAS and GPORT we realize that the second is lower than the first. Specifically the variability results in "Oral Presentation" could be explained by the fact of the GERAS' students do not present in native language.

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REFERENCES

[1] N. Naik, "The use of GBL to teach mathematics in higher education," *Innov. Educ. Teach. Int.*, vol. 54, no. 3, pp. 238–246, 2017.

[2] K. Watty, P. de Lange, R. Carr, B. O'Connell, B. Howieson, and B. Jacobsen, "Accounting Students' Feedback on Feedback in Australian Universities: They're Less Than Impressed," *Account. Educ.*, vol. 22, no. 5, pp. 467–488, 2013.

[3] J. Haywood, L. Connelly, P. Henderikx, M. Weller, and K. Williams, *The changing Pedagogical Landscape-new ways of teaching and learning and their implications for higher education policy*. Publications Office of the European Union, Luxembourg, 2015.

[4] A. F. Camilleri, U. D. Ehlers, and J. Pawlowski, "State of the Art Review of Quality Issues related to Open Educational Resources (OER)," 2014.

[5] J. Brennan, S. Broek, N. Durazzi, B. Kamphuis, M. Ranga, and S. Ryan, *Study on Innovation in Higher Education: Final report*. 2014.

[6] S. Tishkovskaya and G. A. Lancaster, "Statistical education in the 21stcentury: A review of challenges, teaching innovations and strategies for reform," *J. Stat. Educ.*, vol. 20, no. 2, pp. 1–56, 2012.

[7] C. Hommik and P. Luik, "Adapting the survey of attitudes towards statistics (Sats-36) for estonian secondary school students," *Stat. Educ. Res. J.*, vol. 16, no. 1, pp. 228–239, 2017.

[8] J. B. Ramsey, "Why Do Students Find Statistics So Difficult ?," in *Proccedings of the 52th Session of the ISI*, 1999, pp. 10–18.

[9] R. C. Delmas, J. B. Garfield, A. Ooms, and B. L. Chance, "Assessing students' conceptual understanding after a first course in statistics.," *Stat. Educ. Res. J.*, vol. 6, no. 2, pp. 28–58, 2007.

[10] T. Koparan, "Difficulties in learning and teaching statistics: teacher views," *Int. J. Math. Educ. Sci. Technol.*, vol. 46, no. 1, pp. 94–104, 2015.

[11] J. Garfield and D. Ben-zvi, “The Challenge of Developing Statistical Literacy, Reasoning and Thinking,” in *Research on Statistical Literacy, Reasoning, and Thinking: Issues, Challenges, and Implications*, no. January, 2005, pp. 397–409.

[12] A. Cook, “Improving the success rate in statistics,” 2010.

[13] J. Garfield, “How Students Learn Statistics,” *Int. Stat. Rev. / Rev. Int. Stat.*, vol. 63, no. 1, p. 25, 1995.

[14] J. Garfield and D. Ben-Zvi, “How students learn statistics revisited: A current review of research on teaching and learning statistics,” *Int. Stat. Rev.*, vol. 75, no. 3, pp. 372–396, 2007.

[15] B. Chance, D. Ben-Zvi, J. Garfield, and E. Medina, “Technology innovations in statistics education.,” *Technol. Innov. Stat. Educ.*, vol. 1, no. 1, 2007.

[16] K. McKnight, K. O’Malley, R. Ruzic, M. K. Horsley, J. J. Franey, and K. Bassett, “Teaching in a Digital Age: How Educators Use Technology to Improve Student Learning,” *J. Res. Technol. Educ.*, vol. 48, no. 3, pp. 194–211, 2016.

[17] R. Biehler, D. Ben-zvi, A. Bakker, and K. Makar, “Technological for enhancing statistical reasoning at the school level,” in *Using Tools for Learning Mathematics and Statistics*, no. January, Springer, 2014, pp. 143–152.

[18] J. Mendonça, G. Gonçalves, L. Babo, and C. Torres, “A linear regression and correlation excel task with engineering students,” *EDULEARN17 Proc.*, no. July, pp. 3322–3329, 2017.

[19] J. Jablonsky, “MS Excel based Software Support Tools for Decision Problems with Multiple Criteria,” *Procedia Econ. Financ.*, vol. 12, no. March, pp. 251–258, 2014.

[20] J. F. Kros and S. S. Nadler, “Longitudinal regression forecasting using excel,” *Mark. Educ. Rev.*, vol. 18, no. 3, pp. 67–81, 2008.

[21] H. Barreto, “Why Excel?,” *J. Econ. Educ.*, vol. 46, no. 3, pp. 300–309, 2015.