Journal of Systemics, Cybernetics and Informatics (2021) 19(8), 82-94
https://doi.org/10.54808/JSCI.19.08.82

Statistics education in the era of COVID-19

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Abstract[1]

The present survey explores the changes in the teaching of statistics modules during the COVID-19 pandemic, including the impact of these changes on the students of the Department of Statistics and Insurance Science of the University of Piraeus. A questionnaire was prepared and administered online. The survey involved a total of 88 participants aged between 18 and 23. The main questions that were asked addressed: (i) the online structure of the statistics courses compared with the structure of the lifelong courses; (ii) the psychological adjustment of the participants to the contents and obligations of the regular courses; (iii) internet-based communication within the scope of the statistics modules and its role in developing skills relating to the use of statistical software and programming languages (i.e., SPSS, RATS, and R); and (iv) the degree of active participation in the online courses. Based on the outcomes of the survey, we concluded that the students did not notice any significant difference regarding their interest in the course or the transfer of knowledge between the online modules and the lifelong courses. Moreover, we found that courses using games and computers were more effective in terms of learning objectives, though they were more costly than conventional courses. Finally, we discovered that the students preferred the online courses over the regular ones, probably because they were richer and more versatile in structure.

Keywords: *New Technologies in Teaching, Teaching Statistics, Online Questionnaire.*

1. Introduction

Pedagogy lies at the core of teaching and learning. The need to prepare young students in order to develop into lifelong learners possessing deep knowledge of subject matter as well as broader social skills, requires a

[1] Sophia Kitsou made the final proofreading of the article

deeper comprehension of how pedagogy affects the learning process. The study by Paniagua & Istance (2018) argues that the focus on pedagogies changes the teachers' perception from acting as technicians who seek to attain the goals of education that are set by the curriculum to being true experts in the art of teaching. Moreover, the importance of innovation as regards teaching is nowadays beyond dispute. Innovative teaching implies both creativity and novelty on the teacher's perspective, since teachers are expected to change their style and teaching approaches; and adapt in accordance with technology and social developments. Educational institutions are currently putting into practice new methods and ideas, and technology innovations in order to develop the students' cognitive ability and knowledge. As noted in Kalyani & Rajasekaran (2018), innovative teaching is necessary both for the present and for the future of education in order to help students reach their full potential.

Despite the rapid advances in the use of new technologies for educational purposes, research interest concerning the statistics education is still limited. To the best of our knowledge, relevant studies are scarce and up to this date almost no studies have considered the impacts of using new technologies on student learning and retention, perceptions of instructor effectiveness, and changes in attitudes towards statistics. The present article addresses this shortage and reports the results from online questionnaires, assessing the impacts of using computers in the teaching of statistics.

The use of computer resources within the scope of statistics courses bears two main advantages for the students. More precisely, such resources provide a new means of interaction, complementing the conventional classroom instruction and facilitating the learning process. Furthermore, these resources allow the students to enrich their experiences with regard to the use of the various forms of technology, which yields positive externalities for their academic and career aspirations. It is commonly accepted that technology is becoming the dominant force in the modern society and economy. Thereby, schools and universities are confronted with the challenge to equip students for a dynamic labor market which is quickly becoming technology-driven. Finally, as noted in Hsu (2004), the contact of pupils and students with technology and the use of computers in academic

institutions for teaching purposes, is indispensable when considering the advantages of their application.

Adopting the use of computers in the teaching process has been growing substantially during the last three decades. The advantages of using such tools for the students are ample and include increasing self-confidence since students learn to collaborate through working groups, to "produce" knowledge using various tools and to solve problems employing diverse programs. Moreover, students learn to share their knowledge, experiences and opinions with others, and are offered easy and fast access to a large amount of information via the internet. Furthermore, integrating new technologies such as computers in the teaching process bears concrete advantages for the educators as well. Such advantages include facilitating the administration of the class through the use of databases for students, classes, records and class materials (notes, quizzes, etc.), which leads to higher levels of administrative efficiency; accessing information as well as material appropriate for educational purposes from various electronic sources (e.g., electronic libraries, internet, etc.); communicating with the students and other teachers via intra-net technologies and e-mails; incorporating tools such as diagrams, presentations and videos, which allow making the lessons more appealing and comprehensive; and finally, developing closer relationships with the students via the technology strand, which appeals to younger people.

2. Innovation in the learning process

The importance of our research lies in the fact that it can serve as a point of reference, sparking further research on the effects of the use of IT technologies for educational purposes. Using IT technologies within the scope of education is an almost universal reality that has come to involve, to a larger or a lesser extent, all tertiary education institutions across the globe. Nevertheless, several issues have been raised with regards to the application of new technologies in the teaching process, which essentially seeks to enhance the learning outcomes.

Contemporary research has focused on examining the impacts of the use of technology on education, as compared with conventional teaching. OTA (1995) finds similar or minor positive outcomes in terms of student performance between technology-aided and conventional teaching. In the same line, the meta-analysis of Russel (1999) concludes that no significant difference exists between students using technology within the scope of learning and students following conventional education methods. Contrary to these findings, Hsu (2004) finds that the use of technology bears positive impacts on the ability of students to undertake scientific research and to collaborate with each other. This study involved 40 students attending geology courses in Northeastern Taiwan and concluded that the use of technology yields positive effects on the students' learning outcomes. Similar conclusions are reached in Retson, Williams, & Symons (1996), which was conducted in Canada and concerned the teaching of physics courses. The results of this study showed that the students who use computers tend to outperform the students who do not, with regard to the final tests. Moreover, the study by Russel (1999) shows that students, tend to be satisfied with the lessons that incorporate multimedia, and consider the interaction between themselves as a positive aspect which benefits the overall learning process.

The scientific discipline of statistics has two important attributes, namely, it educates people to think in a detailed and structured way and it provides a conception on how the economic and social world actually works. Ormerod (2003) argues that despite these advantages, students normally show limited interest in statistics which is attributed to the dogmatic teaching approaches usually followed. In addition, Nelson (1997) notes that statistics should be taught as a way of thinking about the world with the help of the analysis of theoretical models, in order to simplify reality and therefore, more easily comprehend economic, social and business issues. Moreover, it has been argued that increasing effectiveness in the teaching of statistics courses, necessitates educators to change their pedagogical approach and place more emphasis in exercises that promote active learning as well as collaboration between students. Hence, students are expected to assume wider responsibilities in the learning process, which in return creates more interesting teaching sessions (Simkins, 1999).

In this context, one should point out the evident necessity of the students to embrace the notion that statistics courses go well beyond the rules of memorizing financial concepts, adopting the appropriate terminology and editing graphs. Students are expected to cultivate their skills in critical thinking combined with the appreciation of the significance of the concepts and the ideas taught. Thereby, students need to develop the appropriate theoretical background but also, be familiar with various economic and statistical models. Furthermore, the paper by Ping (2003) argues for the need one to understand and clarify to students that any particular model does not fit perfectly in all statistics, since it involves the bias of the creators, that is, their subjective element.

Moreover, we note the need to bring into perspective economic notions. The studies by Cukier (1997) and Jung & Rha (2000) agree that there is consensus regarding the economic benefits of distance education. Furthermore, the study by Whalen & Wright (1999) argues that web-based training is more cost-effective than conventional training, which has been shown from the early stages of online education. On the other hand, the learning outcomes of online education are still investigated and thus, the mix between online and classroom education in hybrid models, is still being explored.

Finally, as noted in Ormerod (2003), the teaching of statistics should draw from contemporary issues for analysis purposes, provide insight in the essential theoretical models, ensure that students have sufficient knowledge and understanding of the latest developments in the area of statistics as well as their importance for contemporary economics and institutions, and finally, take advantage of the up to date computer technology, in order to facilitate the use of interactive models, where possible.

3. Learning challenges during the COVID-19 pandemic

The survey conducted within the scope of this study comprises questionnaires addressing (a) the changes that the Covid-19 pandemic crisis has brought in the teaching of statistics, (b) the ways that the students are

experiencing this crisis, (c) suggestions on behalf of the students regarding distance teaching as well as the delivery of the relevant academic curricula.

The curricula of statistics courses, customarily, encompass a myriad of concepts, elements and methods, which may be seen as discouraging by the prospective students. More specifically, the Department of Statistics and Insurance Science of the University of Piraeus is well known to offer very intensive introductory courses in statistics, involving diversified concepts and extensive teaching materials, often to the discouragement of the students. Hence, educators find themselves in need of more appealing —or even potentially radical— teaching approaches, which facilitate the learning process and seek to maximize the learning outcomes without straining the students.

The discipline of statistics is conceptually different from the discipline of mathematics. In its early stages, individuals perceived statistics as the citation of usually large tables of data accompanied by diagrams seeking to describe diverse phenomena within the economic, demographic, political and social life. However, this state of affairs has changed rapidly during the last decades with the enormous expansion of statistical data describing all areas of human activity. This expansion has emerged hand in hand with the rapid development of appropriate statistical methodologies as well as empirical applications of various statistical and economic frameworks.

It is well accepted that statistical sciences have matured considerably in the course of the last four decades. Therefore, it has become essential that both students and prospective educators of statistics be able to communicate effectively their views and ideas regarding the statistic subjects as well as their teaching, in light of the contemporary educational needs. Furthermore, conventional teaching has been replaced by online courses across the Greek educational institutions. This switch found the various stakeholders, namely, the Directorates, the Secretaries and the schools, largely unprepared for the online education challenges.

The COVID-19 pandemic has led to a crisis that seems to persist and thus teachers are expected to re-enter and reshape the distance learning processes in order to facilitate learning and meet the corresponding challenges. In this

context, we ask for the involvement of the students in the process. Their view concerning the structure, the outline and the contents of the online courses; as well as the changes deemed essential to facilitate the understanding of statistical concepts and methods on their behalf, are important issues for our research. The questionnaire involved in this study entails two parts. The first part considers the social characteristics of the participants while the second part addresses the views of the students regarding the distance teaching practices and aspects of the respective course.

4. Research

In this context, we conducted a survey using online questionnaires, in the Department of Statistics and Insurance Science of the University of Piraeus during the spring semester of the academic year 2019-2020. The COVID-19 pandemic hit most of Europe, including Greece, in the beginning of 2020. The survey took place in the second quarter of 2020, making the results as recent as possible. We collected the answers of students, who contributed to the present study with their views and experiences, and thus allowed us to gain insight into their preferences and draw conclusions regarding the effects of the structural change that took place with regards to the educational methods, during the pandemic crisis. Our survey included three groups of students amounting to 88 participants in total (46 males and 42 females), aged between 18 and 23. The questionnaires were delivered exclusively to students of the department, which makes our sample homogeneous in terms of education level, academic background and age.

The main questions included in the questionnaire considered the degree of satisfaction regarding online education as compared to the lifelong statistics courses, the course adjustments under the pandemic crisis, the skills development during the course and the level of participation of the respondents. Subsequently, we present the main questions of the questionnaire.

1. In relation to lifelong statistics courses you think that online education is:
2. Regarding the psychological pressure during the days of Covid-19, you feel that the adjustment to the normal course contents and obligations is:

3. Do you think that internet-based learning in the statistics course has helped you develop knowledge and skills in statistical software, such as SPSS?
4. Is active participation in the online course the same as in the live course?

5. Questionnaire results

The first question addressed the views of the students, regarding the online education as opposed to the lifelong statistics courses. We summarize the results of the first question in Chart 1.

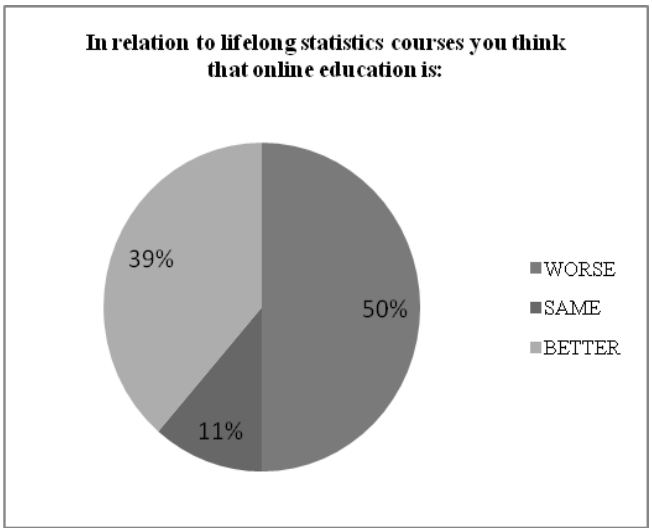

Chart 1: Online educations vs. lifelong courses in statistics.

It is worth noting that half the survey participants consider the online courses worse than their lifelong counterparts.

The second question considered the psychological pressure resulting from the COVID-19 pandemic and the extent that the course contents and requirements have been adjusted. The responses of the second question are summarized in Chart 2.

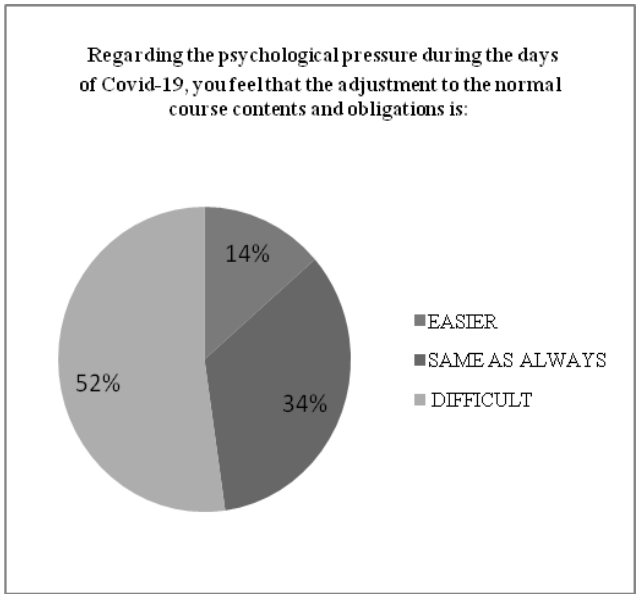

Chart 2: Adjustment of the course contents and requirements during the COVID-19 pandemic.

Regarding this question more than half of the participants (i.e. 52 per cent) considered that the readjustments of the course contents and requirements resulted in an increased level of difficulty.

The next question addressed the students' views on skills development relating to the use of statistical software (e.g., SPSS, RATS, R, etc.), within the framework of the internet-based statistics courses. The results of the third question are presented in Chart 3.

Here it can be noted that the majority of the survey participants (more than 77 per cent) claim moderate to high-degree effects of the internet-based statistics courses as regards their skills development in the use of statistical software.

The final question refers to the level of active participation of the students in the online course. These results are displayed in Chart 4.

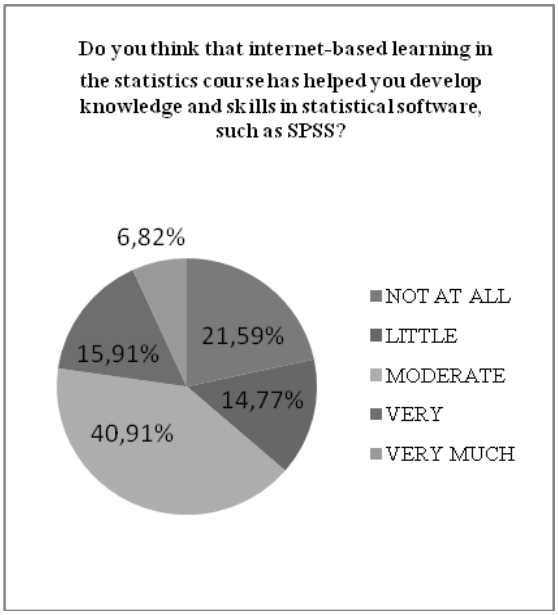

Chart 3: Software skills development within the framework of internet-based statistics courses.

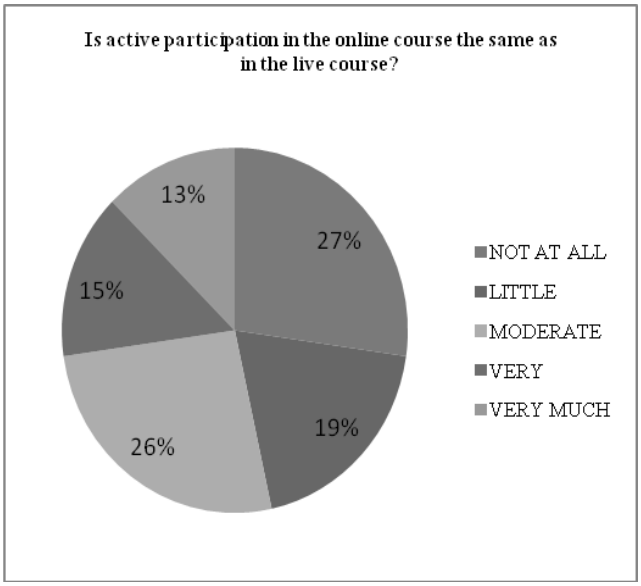

Chart 4: Level of participation in the online course.

The answers to the aforementioned question highlight that the majority of the respondents (i.e., 54 per cent) had zero to moderate active participation in the online course as opposed to the conventional course in statistics.

6. Concluding remarks

The questionnaire undertaken within the scope of this survey was posted on the webpage of the Department of Statistics and Insurance Science of the University of Piraeus, and resulted in a total of 88 responses.

Combining teaching with games and computers is shown to be more effective in regard to the learning objectives although probably more costly than conventional teaching approaches (Tsami, 2009). Study systems that are based on computers seem to have better results than games and simulations, especially concerning the low-achieving students. Furthermore, academic curricula are found to be cost-effective since they can bring students to a certain level of qualification adequacy in less time and are, in general, preferred by the students. Students enjoy being taught at their personal pace, which allows them to increase their performance and maximize their potential. Moreover, students seem to prefer the relevant courses which are very versatile, instead of the conventional ones. Thus, it is acknowledged that self-paced courses are favoured by the students, since they allow the students to develop conveniently the skill-set needed in order to meet the exam requirements. Nevertheless, the debate is still ongoing within the educational communities with educators raising concerns as to the lack of challenge that may be concealed in the specific education mode and the limited understanding of subject that may be incurred to the students. The findings of this paper are aligned with established research outcomes, which have been obtained from diverse academic sources worldwide.

It is well accepted that computer science has brought tremendous impacts on education, providing new tools which assist the teaching process and facilitate learning at all levels, but also cultivating a new dimension of educational technology. As a result, the academic community has acknowledged the importance of the use of computers within the scopes of teaching both for the students and for the educators. More specifically, computers are understood to enhance the understanding capability of the students, while at the same time, they provide a means of making the teaching process more appealing and thus, allowing the educators to be more contagious. Due to these advantages of technology, we argue that the

educators, besides striving to get acquainted with updated computer tools, they should also focus on creating software systems suitable for educational purposes.

In addition, it has been observed that students find no interest in analyzing statistical theory, which is attributed to the static and often difficult manner that the corresponding teaching is conducted, even though such courses have direct practical applications. Nevertheless, as educators, we are provided with the option of integrating computers in our teaching methods, in order to facilitate learning of the various statistics contents. Finally, Tsami (2009) notes that computer science has invaded into all aspects of contemporary life and thus, its application with regards to the educational processes in the future is deemed certain. Our study used questionnaires to obtain data which provide statistical evidence that students do not notice any major difference concerning their interaction with the teachers, in the context of the online courses as compared to conventional courses.

7. Acknowledgements

This research was supported by University of Piraeus Research Center in Piraeus – Greece.

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