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RESEARCH ARTICLE

Teaching basic statistic concepts to student classes with diverse mathematical background using specialized applets

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Abstract: This study examines whether the use of specialized software applications can have an effective role in understanding and clarifying concepts of the basic measures of central tendency and dispersion, so that the advantages over traditional teaching are clear. Higher education students need to have a deep understanding of the concepts of theory of probability, descriptive statistics measures and statistical conclusions in order to be able to be used in their studies and in their work. For this purpose during an introductory course in Statistics at a University of Applied Sciences, two separate groups of students consisting of randomly selected members were given the same worksheet. One of these groups was additionally given specialized application software developed to visualize these concepts in order to answer the questions on the worksheet. The investigated case is whether the appropriate use of specialized software can help to effectively understand and interpret basic descriptive statistic concepts in a realistic application. The main conclusion is that appropriate specialized software applications can lead to the deepening of statistic concepts by students and in general promote the statistical literacy to a much greater extent than traditional teaching.

Keywords: statistics in higher education, statistics education, statistic literacy

1 Introduction

The evolution of Information and Communication Technologies (ICT) gives potential for serious changes in the approach to teaching the concepts of Statistics (Rowell, 2004) in terms of the methods and the availability of hardware infrastructure used. As a rule, ICT defines new pedagogical models. The use of ICT as tools for creative expression and problem solving can be effective in the creative potential of students and teachers (Fesakis, 2019). Modern teaching approaches should aim to understand and consolidate statistical concepts using active learning strategies and real data (Gialamas, et al., 2006). Previous studies show that teaching statistical concepts with widgets can improve learning outcomes (Chance & Rossman, 2006; Doi et al., 2016; Lee, 2018). Specialized software applications can be used as tools for visualizing concepts in statistics and probability theory.

Teaching statistics courses need careful handling, especially when the class consists of students with different backgrounds (Garfield, 1995). In the classes of business school students in statistics and probability courses, due to different mathematical backgrounds, more hands-on activities and simulations should be addressed in lectures. In these classrooms, there are also a number of students with low abilities who do better in interactive learning than in traditional learning (Mills, 2002).

It is referenced, that the use of interactive tools simulation methods in a course of statistics, can help students enhance understanding of statistics concepts (Mills, 2002; Mills, 2004; Dinov et al., 2008). Specialized software applications and applets can be used for statistics and probability theory courses. The interactive interface of an applet enhances user control for dynamic inputs and outputs (Yuanting, 2022). These specialized applets can be tools for surveys, simulations and data visualization and can contain instructions for activities driven by a worksheet. Furthermore installation is not needed and can run in tablets and smartphones just like computer (Yuanting, 2022). These applications can enchance statistic teaching, because they have the ability of representation and visualization of statistic concepts, as well as the ability of experimentation (Schneiter, 2008).

The aim of this work is to demonstrate that the use of specialized software applications, can help substantially in the understanding and deepening of concepts of Statistics by students in Higher Education and especially in classes where there are many different mathematical backgrounds that make difficult to teach basic concepts such as classes with students of Economic and Business Administration studies.

The objective of this study is to compare the learning outcomes of teaching with the help of specialized software oriented to specific statistical concepts and the traditional teaching of the same concepts using a computer with general software, but without specialized software and statistical applets.

To achieve this goal, during an introductory statistics course at a University of Applied science, two equivalent groups of students were used. The teaching of the concepts of the basic measures of central tendency and dispersion in one group was with the traditional method in the laboratory using computers with generic software (control group) and the teaching of the same concepts to the other group was with the help of specialized software models, created for this purpose (experimental group).

The hypotheses of this research are:

Members of the experimental group had the same degree of understanding of the concepts of the basic measures of central tendency and dispersion in a realistic application, compared to the control group, before the teaching intervention.

Members of the experimental group will have a significantly higher understanding of the concepts of the basic measures of central tendency and dispersion and its use in a realistic application compared to the control group.

2 Research methodology and approach

The survey was conducted during the teaching of an introductory statistics course at a university of applied sciences and involved 98 students who were randomly selected so that the sample would be representative. From this number 63 had graduated from general high schools (GEL) of various orientation groups (46 technological, 17 theoretical) and 35 had graduated from vocational high schools (EPAL). These students had achieved different grades on a twenty-point scale, in the nationally tested Mathematics subject for their admission to Tertiary Education.

The sample was split into two groups consisting of 49 students each. The students were randomly selected and assigned to one or the other group based on the criterion that the overall average level of both groups should be approximately the same in terms of basic mathematical and statistical literacy. The survey was carried out in three phases for both groups. Specifically, in the first phase, a test consisting of a worksheet was designed which measured the basic statistical knowledge of the students. Well designed worksheets can be used for assessment (Lee, 2014) and testing of learning level (Sasmaz-Oren & Ormanci, 2012).

In the second phase, the teachings were held in parallel. One of these groups (experimental) was instructed to use appropriate specialized software and applets created for this purpose. Students from each group worked in pairs to answer the questions on the worksheet. The researched hypothesis is whether the appropriate use of specialized software applications and applets can help in the essential understanding and deepening of statistical concepts of the basic descriptive statistical measures of position and dispersion in realistic applications.

For the Experimental Group the teaching intervention was drawn with the help of specialized software made for this reason, while for the Control Group the teaching intervention was held with the traditional method and the possibility of using a computer with general software. Both groups were given the same exercises involving understanding basic descriptive statistic measures of central tendency and dispersion. The exercises included applications from the daily life of an enterprise and in some of them 'extreme' situations were examined in which simple measures such as the arithmetic mean, the median, the mode and the variance coincided for different populations.

In the third phase, the knowledge was reviewed with the worksheet given in the first phase and a comparison was made between the scores of the two groups which succeeded in the second phase. The hypotheses were tested to see if there was a statistically significant difference in the responses of the two (independent) groups, so as to examine whether the claim, that the use of specialized software applications and applets can significantly assist in the understanding and comprehension of statistics concepts, can be accepted. A significance level of 5% was used for the test.

3 Results

For the experimental group, the results of paired samples test (Zumbo & Jennings, 2002) are shown in Table 1 and 2.

It is clear that there is a clear differentiation (improvement) for the experimental group after the teaching intervention, in the answers to the questions measuring basic statistical concepts for the students of the experimental group.

Table 1 Paired samples statistics

	Mean	N	Standard Deviation	Standard Error Mean
Score After Intervention	7.7952	48	2.41793	0.34900
Score Before Intervention	5.6417	48	2.36683	0.34162

Table 2 Paired samples test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Standard Deviation	Standard Error Mean	95% CI				
				Lower	Upper			
Score After lntervention - Score Before lntervention	2.15354	2.01055	0.29020	1.56974	2.73735	7.421	47	0.000

For the control group, a very small improvement was observed in the answers to the questions measuring basic statistical knowledge of the students after the teaching intervention as shown in Table 3.

Table 3 Paired samples statistics

	Mean	N	Standard Deviation	Standard Error Mean
Score After Intervention	5.9752	48	1.85394	0.26759
Score Before Intervention	5.5838	48	1.82210	0.26300

A comparison was also made between the answers given by the two groups. The comparison between the two groups after the intervention gives the results shown in Table 4 and 5.

Table 4 Group statistics

	Group	N	Mean	Standard Deviation	Standard Error Mean
Score After Intervention	Experimental	48	7.7952	2.41793	0.34900
	Control Group	48	5.9752	1.85394	0.26759

Table 5 Independent samples test

		Levene's Test for Equality of Variances		t-test for Equa lity of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI	
									Lower	Upper
Score After Intervention	Equal variances assumed	3.539	0.063	4.138	94	0.000	1.82000	0.43978	0.94681	2.69319
	Equal variances not assumed			4.138	88	0.000	1.82000	0.43978	0.94604	2.69396

Hypothesis testing at a significance level of 5% for the average scores of the two groups (experimental group and control group) considered as independent groups shows that after such a teaching intervention there is a clear advantage in the understanding of basic concepts of statistics for the experimental group.

4 Conclusion

The group that was given appropriate specialized software along with the worksheet responded more quickly, clearly and more completely to the exercises. The group that did not use specialized software took longer overall and did not fully answer all questions. The results obtained from the statistical analysis of the research verified the research hypotheses of the work and can be applied accordingly in addition to the specific sample and to samples that have the same characteristics as the one used for the research. The use of specialized software applications and widgets can, if used appropriately, solve comprehension problems and problems due to the different backgrounds/origins of students and ultimately have significant reinforcing effects on the teaching of Statistics. A key conclusion of the research is also that appropriate software applications (specialized software, applets and modeling software) can lead to the

discovery and deepening of statistical concepts by students and generally promote statistical literacy.

The findings from this work are according to findings from other researchers who have found that students learn better through interaction (Mill, 2004). Moreover, research to date has shown that interactive software aids the learning process.

Conflicts of interest

The author declares that they have no conflict of interest.

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