LEARNING EVALUATION OF STATISTICS USING AN INTERNET TEACHING INTERFACE

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ABSTRACT

Aims: This study aimed to evaluate statistical learning using educational material with an online interface.
Materials and methods: For that purpose, this material was developed in order to facilitate the access to the information provided in the lecture for future studies. This study included 98 undergraduate students divided into 2 groups: GI- 50 students who did not have access to this material for studying outside of the classroom, and GII-48 students who did have access to this material for outside studies. The same evaluation was applied for both groups [2 theoretical tests (weight 7) and 6 practical activities (weight 3)], and student learning was measured by determining a weighted mean of both evaluation types and an arithmetic mean of each evaluation type separately. Data from each evaluation type were submitted to repeated measures ANOVA, followed by the Tukey test, and the weighted mean of both groups was compared by a t-test ($p<0.05$).
Results: There were significant differences between the groups, considering the weighted mean and the practical activities; however, there was no difference between groups on theoretical tests.
Conclusion: Considering that, in general, GII showed superior results, the data suggests that such an alternative teaching method can contribute to learning and the improvement of academic performance.

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INTRODUCTION

Current dental practices are based on the principles of evidence-based dentistry, which recommends that all professionals make conscientious, explicit, and judicious use of the current best evidence when making decisions in their daily clinical practices[1-3]. This implies that their professional conduct must be based not only on prior knowledge and clinical experience, but also on the habit of seeking, finding, interpreting, and applying the results of scientific studies to individual problems of their patients[1-3]. In this context, the statistics present an important role for the dental professional, considering that he should be able to accurately read and interpret scientific articles that received statistical treatment[4-8].

In simple terms, statistics is based on mathematical models that describe or make inferences about experimental situations[9,10]. Currently, these concepts are considered essential for professional education in dentistry, but in most cases, its teaching is poorly adapted to the requirements and abilities of their students, particularly those who experienced difficulty in mathematics and, when they made the option to study dentistry, believed that no longer need to work with numbers[6,8,11,12]. Thus, over time, much of this reluctantly assimilated, and poorly

understood, content was forgotten, leaving only a great aversion to statistics[6].

According to Freed et al.[13], the main problems associated with the teaching of statistics are as follows: 1) the great statistics previous knowledge heterogeneity among students; 2) the nature of the discipline, as the student can become frustrated when only searching for answers, rather than when attempting to understand the reasoning and logic of inferential statistics; 3) the reduced working hours available to statistics in the dental curriculum; and, especially, 4) the minimal interest of students because they believe that statistics are not particularly pertinent to clinical practice.

However, despite these difficulties, according to Lu[7], future professionals should demonstrate greater knowledge about statistics than their predecessors; therefore, the educational process in dentistry cannot be like a cafeteria, wherein students can select one dish, but not another. Thus, considering that the academic formation cannot depend exclusively on the popularity of a discipline among students, teachers, on the other hand, should be alerted to identify the difficulties and search for teaching strategies to develop the basic skills necessary for analyzing data, as this practice will encourage students' successes in the biostatistics learning process[9,11,13].

In this context, and also considering that the students' current needs are changing with respect to the past[11,14], the Internet can act as a powerful tool in improving the teaching and learning process in statistics for dental courses; it respects all of the difficult points mentioned above because it motivates the student to study, respecting their possible limitations[11,14-19]. This occurs because the Internet relieves the learning of the time factor, as, contrary to the classroom, when working on the computer, the student has the time that he or she deems necessary to see and review topics until he or she has reach the desired learning level[15,19]. Thus, it was found that there is no provision of websites and tutorials specific to the teaching of statistics in Portuguese.

Thereby, in order to minimize the difficulties of statistical learning, we developed dynamic and interactive teaching material with Internet interface in order to evaluate its effectiveness in students' learning of programmatic statistics content for undergraduate dental students at a Brazilian university.

MATERIALS AND METHODS

Ethical Aspects

This study was approved by the Research and Ethics Committee of the Bauru School of Dentistry, University of São Paulo (CAAE: 21427813.3.0000.5417), and all the students signed informed written consent.

Experimental Design

The 2 study factors of this work were the statistical content assimilation by dental academics, which was evaluated by the final weighted mean of each student, considering the weight of each evaluation type (theoretical tests—TT: weight 7 and practical activities—PA: weight 3) and the average for each evaluation type analyzed separately. Each study factor was assessed in the study at 2 different levels: Groups I and II.

Thus, 98 first-year undergraduate students at the Bauru School of Dentistry (Brazil) were equally into 2 groups:

- GI: 50 students who did not have access to the proposed educational material to allow for studies outside of class (2011's dental students); and
- GII: 48 students who did have access to the proposed educational material to allow for additional studies outside of class (2012's dental students).

Development of Educational Material

For the development of this research, we created an educational material with an Internet interface. This educational material consisted of a proposed offer to the target audience of an online source for queries in statistics.

The visual identity creation and interface design for the Web, programming of the site in Wordpress and Flash, domain registration, hosting, infrastructure setup (dynamic language, database, email, and FTP), publishing content system development, and technical support were all executed by a development company for web pages.

This site offers search tools on specific statistics topics and illustrations that aim to make the explanations more didactic. Furthermore, at this site, the user can also have access to educational materials that are available for download. These materials are often used by the Research Methodology and Statistics discipline of the Bauru School of Dentistry to support students during the course of the discipline.

The site also has the support of an excellent tool for researchers: the statistics tutorial. This tutorial allows the user to identify the statistical analysis type that will be performed with the scientific data obtained in its research. This tutorial was not designed to complete the statistical analysis itself; rather, it serves to focus the researcher on specific methods for analyzing the results, as well as provides information about which test to apply to the scientific data. Therefore, by responding to simple questions, such as "What is your study type?", "Does your data have a normal distribution?", "How many groups do you have?", and "Are your groups paired?", the user will receive the appropriate answer to determine

which test is suggested for the study. When the user receives an answer, he or she will be provided with a summary of responses indicated and can return to any of these points to change the answers if he or she wants. When using the tutorial, the user that does not know which situation applies to his or her work can find detailed explanations about, for example, paired groups, normal distribution, and qualitative variables.

Additionally, the site has been developed to become a method to allow for open communication between the user and the developers, as it allows for direct contact via email and online postings, as an Internet blog.

Learning evaluation

The assessment of learning was done through the evaluations regularly applied during the course of the discipline. This 6-month course has a schedule of 4 hours per week, with a total of 60 hours completed by the end of the course. During the semester, each student performed 2 theoretical tests (weight 7) and 6 practical activities (weight 3). These theoretical tests include essay questions and multiple-choice questions, in addition to practical activities that are exercises applied after certain lectures. After the end of the semester, each student received an arithmetic mean for their 2 theoretical tests and also for 6 practical activities; next, each student received a calculated final weighted mean, which considered the weight of each evaluation type. There was no difference in the evaluation process for students of both groups, as the same questions, tests, and exercises were applied to individuals from both groups. The only difference was in the access to the educational materials.

The discipline program offered to both groups covers the following points about statistics: the role of statistics in the biological sciences, sampling, sampling techniques, sample size determination, table presentation, graphics presentation, elements of tables and graphs, statistical parameter and estimator, central tendency measures, variability measures, probability, probability distribution, binomial distribution, normal distribution, t-distribution, hypothesis testing, confidence intervals, t-tests, paired t-tests, association tests, correlation tests, one-way analysis of variance, two-way analysis variance, differences between parametric and nonparametric statistics, Mann-Whitney, Wilcoxon, Kruskal-Wallis, and Friedman Tests. The proposed Internet courseware also covers the same topics as those offered in the discipline.

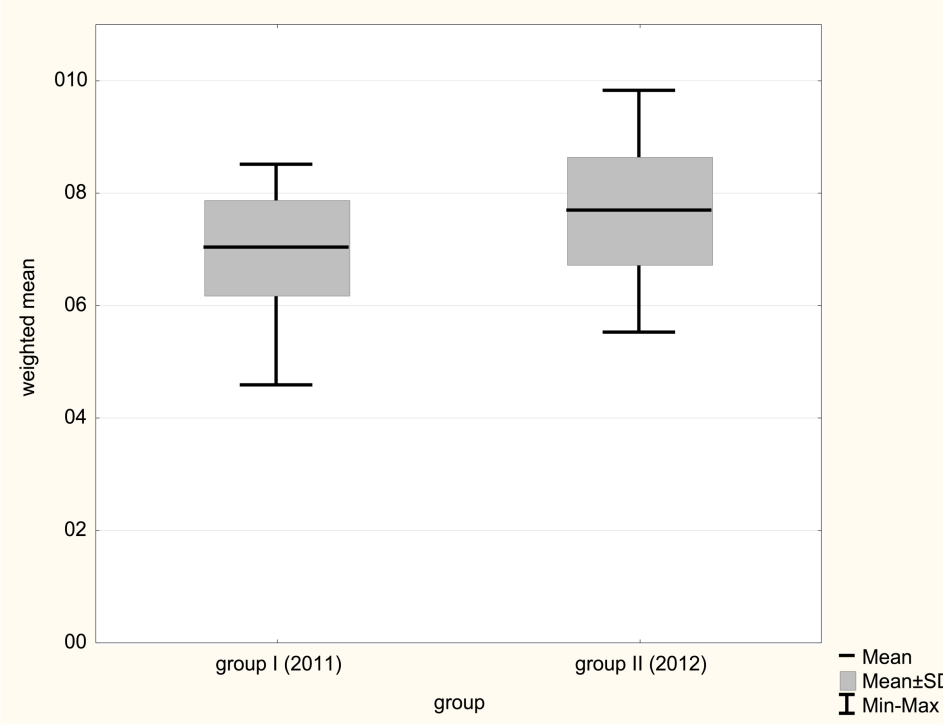

Figure 1. Box-Plot Graph about weighted means of both groups

Statistical Analysis

After data collecting, these were tabulated and statistically analyzed. Data from each evaluation type were submitted to repeated measures ANOVA, followed by the Tukey test, and the weighted means of both groups were compared using the t-test for independent samples, adopting a significance level of 5% (SigmaPlotVersion 11; SYSTAT).

RESULTS

The results and the t-test showed a statistically significant difference between the weighted mean of both groups ($p < 0.01$), as Group II's final mean (7.68 ± 0.96) was significantly higher than Group I's (7.02 ± 0.85) (**Figure 1**).

A repeated measures analysis of variance showed significant differences between the two groups, as well as between the test types when these were evaluated separately, and it also showed interaction between the test type and the groups. After that, the multiple comparison test (Tukey test) showed that there was no difference between the groups when analyzing only the theoretical tests (GI: 6.46 ± 1.16 and GII: 6.83 ± 1.39), but there was a difference between them when analyzing only the practical activities (GI: 8.31 ± 0.70 and GII: 9.64 ± 0.35) (**Figures 2** and **3**).

DISCUSSION

In light of the historical record of several difficulties encountered in statistical teaching to dental students[5-8], the results of this study confirmed previous reports[4,9,12,14,16-18] and also showed that alternative methods may assist in this task, improving the learning levels of students.

Just as in other studies, it was found in this study that the Internet can be an important ally in the teaching of statistics[14,17]. This occurs because the Internet unlinks the learning process from the time factor, and this fact is very important to increase the learning rate[12]. Many times, academic performance is not an adequate representation of a student's learning potential because he or she is required to understand the subject provided in class only during the time available for the lecture. However, because this subject is seen as complex by most students, a large percentage of them do not reach the maximum level of learning during lectures[9]. According to El Tantawi[11], dental educators should direct their attention to students having greater difficulties, and they must also provide the information using different teaching methods, instead of only employing traditional methods. In a study by Hutton, Levy, and Martin[9], 66% of students (1979-80) did not prefer the traditional method of theoretical classes. In this sense, providing dynamic and stimulating learning materials can function as an alternative method that makes these students to study and review the contents offered in the classroom until they are able to fully understand the transmitted subject[9,14,15,17].

Moreover, the larger the students' contact with the discipline, the greater the yield will be. However, while the time allotted for each lecture is limited, the time permitted for self-study by the Internet is limitless, and this fact is extremely conducive to learning[17]. Moreover, according to Pettenson[8], a favorable acceptance of a discipline may not be a necessary condition for cognitive learning to take place, but cognitive learning will probably be best facilitated by this favorable attitude. As the time of contact with the discipline's content is proportional to the student's interest,[8] methods of e-learning can increase interest and, consequently, learning.

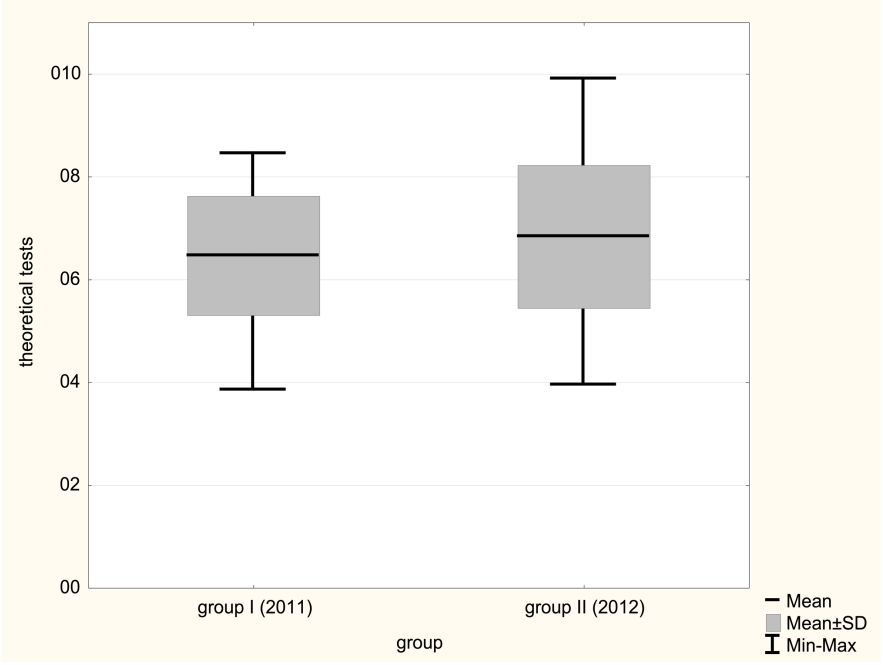

Figure 2. Box-Plot Graph about theoretical tests means of both groups

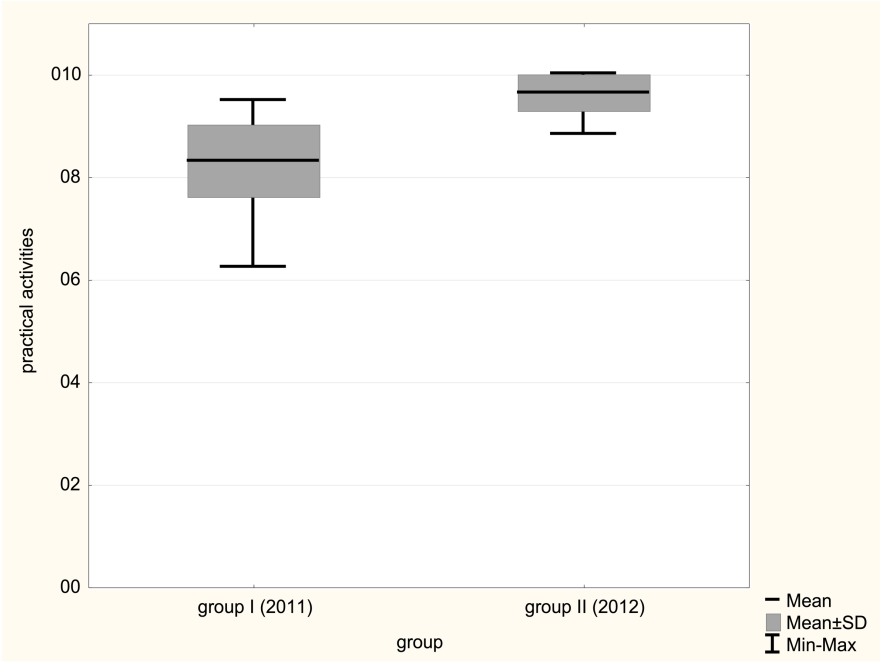

Figure 3. Box-Plot Graph about practical activities means of both groups

In the Statistics department of the Bauru School of Dentistry, students were evaluated through practical and theoretical activities. In order to receive approval at the end of course, they should achieve a 5.0 as a weighted mean (scale: 0-10). The results of this study showed that the group that had access to the material available on the Internet showed a significantly higher weighted mean than the group that did

not have access to the statistical website.

The interactivity between the students and the teacher was also an important factor that may have influenced the improved performance of Group II. The developed website creates a permanent channel of communication between the students with the teacher, and this fact, according to El Tantawi[17], may have positively influenced the students' performance, as this communication often increases levels of learning.

Several Group II students reported using the online content to study before the lectures because then, they would have a better likelihood of receiving good grades in practical activities. Utilizing this approach, they said that because they received better grades in the practical activities that they completed, they could receive lower grades in theoretical evaluations and not have their grades significantly impacted, which was considered a great advantage because they believed that the theoretical evaluations were more difficult than the practical activities. The results showed that this practice has had the expected result, as the Group II practical activities grades were significantly higher than those of the students from Group I.

On the other hand, if only the theoretical grades of the students were analyzed, the website has no statistically significant effect on the comparison between the two groups. This result may be due to two possible reasons: 1) the theoretical evaluations were actually so great in difficulty that they did not allow for differentiating the two groups; and 2) students did not use the courseware aimed at providing means of specific study for theoretical tests, but, rather, they only used the courseware before the classes, seeking practical activities that occurred immediately after the lectures.

Online methods of self-study may be promising and inexpensive, and they can be used in conjunction with traditional teaching methods.6,9 Thus, even though the preliminary results of this study are promising, improvements in dynamics and attractiveness of this online courseware must still be performed. Future studies should also be conducted with these improvements so that the differences between the two groups are also grounded in theoretical evaluations. Furthermore, more complex, and complete assessments of methods of learning should be applied, so that, in the future, online teaching methods even more attractive can be evaluated.

CONCLUSION

The results of this study showed that alternative methods of teaching can make statistic learning less painful and more accessible for students in graduate dental courses. The Internet allows students to study the content before it is administered in the classroom setting, increasing the yield in practical activities, as well as the weighted mean of the course. To this end, the material online must be dynamic and interactive in order to encourage students to study content that tends not to initially arouse their interest.

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