

Effect of software facilitated teaching on final grades of dental students in a dental morphology course

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ABSTRACT

الأهداف: تقييم الفرق في أداء الطلاب في مادة تشريح الأسنان بعد إدخال برنامج حاسوبي ثلاثي الأبعاد.

الطريقة: عملت هذه الدراسة بأثر رجعي في كلية طب الأسنان، جامعة الدمام، الدمام المملكة العربية السعودية، بين أغسطس 2013 ويناير 2016. وشملت الدراسة 3 مجموعات من الطلاب الدارسين للمادة في 3 سنوات دراسية مختلفة: مجموعة (1)، 2013-14 (مجموعة المراقبة)؛ المجموعة (2)، 2014-2015، والمجموعة (3)، 2015-2016، وبلغ حجم العينة 294 (مجموعة 1 = 94؛ المجموعة 2 = 100، والمجموعة 3 = 100). الطلاب لا يتلقون التعليم باستخدام البرنامج الحاسوبي الميسر للتعليم في حين تم تزويد الطلاب لمجموعات 2 و 3 مع الأقراص المدمجة من هذا البرنامج. تم تحليل درجات الامتحانات النهائية للطلاب إحصائياً بأثر رجعي.

النتائج: أظهرت النتائج أن الطلاب الذين حصلوا على البرنامج الميسر للتعليم (مجموعة 2 و 3) لديهم أداء أفضل من الطلاب الذين لم يحصلوا عليه (المجموعة 1). في نفس العام للمجموعات 2 و 3، وكان عدد الطلاب الذين حققوا درجات جيدة (> 80%) أعلى بكثير من الطلاب الذين حققوا درجات متوسطة (> 79%)، وقيمة $p = 0.012$ للمجموعة 2 و 0.009 للمجموعة 3.

الخلاصة: أظهرت نتائج هذه الدراسة وجود علاقة إيجابية بين استخدام برنامج حاسوبي لتعليم الطلاب وأدائهم في الامتحانات النهائية والذي بالإمكان أن يعزز من تعليم الطلبة.

Objectives: To evaluate differences in students' performance in a dental morphology course after the introduction of a 3D software-teaching program.

Methods: This retrospective study took place at the College of Dentistry, University of Dammam, Dammam, Kingdom of Saudi Arabia, from Augst 2013 to January 2016. The study included 3 groups of students taking the course during 3 different academic years: group 1, 2013-14 control; group 2, 2014-

2015; and group 3, 2015-2016. The total sample size was 294 (n = 294; group 1 = 94; group 2 = 100; and group 3 = 100). Group 1 = students did not receive teaching facilitated by a software program, but groups 2 and 3 students were provided with the program's CDs. The final examination grades of the students were statistically analyzed, retrospectively

Results: The results demonstrated that the students who received software-facilitated teaching (groups 2 and 3) performed better than the students who did not receive it (group 1). Within the same year for groups 2 and 3, the number of students achieving good grades (>80%) was significantly higher than the students who achieved average grades (<79%), with p -values of 0.012 for group 2 and 0.009 for group 3.

Conclusion: There is a positive correlation between the use of a teaching software program for students and their performance in final examinations. The addition of computer-based learning, as one of the teaching methods, could demonstrably boost students' learning.

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The use of digital technology is an essential component of teaching modern dentistry concepts and techniques to dental students. Computer-aided learning programs in dentistry are attractive, easily accessible anytime from anywhere, and they improve learning outcomes. These programs have changed the traditional way of delivering content to learners.¹ Moreover, they provide self-assessment features that help the students to prepare for their upcoming exams. These programs are easy to use and offer the additional advantage of repeated practice.² Students learn from these electronic educational programs through various sources, including CDs, DVDs, website downloads, and installation programs. One useful program is the interactive dental education software, 3D Tooth Atlas (eHuman, Fermont, CA, USA) version 7.0.4,³ which was designed primarily for dental morphology education. This program contains an extensive database of dental anatomy, including supporting bone, for the primary and secondary dentitions within 3 dimensional (3D) models. In addition, the software comprises a series of photographs, radiographs, micro-computerized tomography (micro-CT) scans that can be viewed in both vertical and horizontal cross-sections. Practical quizzes are also presented in this program, which allow for self-assessment procedures, when dental students can review their correct and incorrect answers. The implementation of the Interactive Tooth 3D Atlas software program in dental education, and its effects on dental students' performance has not been investigated previously in the literature. Therefore, this study evaluated the differences in students' performance, after the introduction of the 3D software program, through the final examination grades within the dental morphology course, over the past 3 academic years.

Methods. The study received ethical approval from the Scientific Research Unit of the College of Dentistry at University of Dammam (CDUD), Dammam, Kingdom of Saudi Arabia (KSA), and the study was designed according to the principles of the Helsinki Declaration. This study took place in CDUD, Dammam, KSA from August 2013 to January 2016. A written informed consent was taken from all the participants; they were informed that their final grades for the morphology course would be accessed, but their individual identities would be kept confidential. Dental students in their second year of dental school were part of the study, and this was the only inclusion criterion, there were no specific exclusion criteria for this study. The tooth morphology course is taught to second-year dental students at the CDUD in the first semester of the academic year. To provide the optimal learning

environment for the students, various teaching aids, such as the use of multimedia and videos, are used in conjunction with conventional didactic lectures. The decision to introduce an intervention using any new teaching method is made by the course director after consulting all the teaching faculty members. Before the introduction of an intervention, the additional material or method must be proven useful and helpful in students' successful completion of learning outcomes for a course.

The present study included 3 groups of students taking the tooth morphology course during 3 different academic years: group 1, 2013-2014 (control); group 2, 2014-2015; and group 3, 2015-2016. The total sample size was 294 (n=294; group 1 = 94; group 2 = 100; and group 3 = 100). Group 1 students did not receive teaching facilitated by the Interactive 3D Tooth Atlas software program, but students in groups 2 and 3 were provided with CDs of this program for the duration of the course, during the academic year in which the students took the tooth morphology course. The grading system utilized by the College of Dentistry is as follows: A+ = 95-100; A = 90-94; B+ = 85-89; B = 80-84; C+ = 75-79; C = 70-74; D+ = 65-69; D = 60-64. For the convenience of analyzing the results of this study, A+, A, B+, and B were considered good grades, and C+, C, D+, and D were considered average grades.

There was no way to find out whether the students in groups 2 and 3 used this software at home for self-learning, but their exposure time to the software was intentionally increased during their designated lecture times. To ensure the maximum calibration of lecture content and delivery methods, the same instructors were chosen for all 3 student groups. The examination for all the 3 groups was created after departmental discussions, to ensure that the questions did not favor the contents within the digital format. The course topics that were assessed, and the examination questions' ratio of multiple-choice to short essay questions was also intentionally kept the same for all 3 groups. In addition, learning variables consisted of different levels of software instruction: for some students, parts of the conventional lectures were removed and completely replaced by the software; and for others, software teaching was added to the conventional lectures. The final grades of students from the 3 groups were analyzed, retrospectively. The Google Scholar search engine was used to locate related research. Data were collected and analyzed statistically using the Statistical Package for the Social Sciences (IBM Corp., Armonk, NY, USA) version 19. A Chi-square test was applied after summarizing the data in 2-way contingency table to examine the differences

Table 1 - The comparison between the grades and gender of the students made by utilizing Chi-square test (p -value obtained after comparison of female and male students who achieved good grades within the same year group).

Grades	Gender		Total	P -value
	Male	Female		
2015-2016				0.00001*
Good	12	52	64	
Average	30	6	36	
2014-2015				0.00001*
Good	20	43	63	
Average	35	2	37	
2013-2014				0.00001*
Good	12	40	52	
Average	33	9	42	

*Chi-square test, statistically significant at $p < 0.05$

in the grades achieved among students in groups 1, 2, and 3. A $p < 0.05$ was considered statistically significant.

Results. The evaluation of students' grades in the tooth morphology course over the 3 academic years revealed that the students who were taught using the new software program performed better than those who did not receive software-facilitated teaching. For group 2 (2014-2015) 63% of the students achieved good grades, and in group 3 (2015-2016) 64% of the students achieved good grades. The number of students receiving good grades within each year was significantly higher than the numbers of students who achieved average grades, with p -values of 0.012 for group 2, and 0.009 for group 3. For both years with the software intervention, the percentage of students' scoring good grades was higher than those of students who scored good grades during 2013-2014 (group 1, the control group), where only 52% achieved good grades. The comparison between good and average grades for group 1 did not reveal any statistical significance. Although the comparison of groups 1, 2, and 3 revealed no statistical significance, a gradual increase in the number of students scoring good grades was clearly seen over the years.

In all 3 groups, the female students performed significantly better than the male students. The proportion of female students who secured good grades was significantly higher than the males for each year, and the p -values for each of the years were also statistically significant (Table 1). The year-wise performance of the male and female dental students was also analyzed separately. Female students achieved a significantly higher number of good grades in 2015-2016 compared with the grades achieved by female students in 2013-2014 ($p = 0.043$). Similarly, the female students

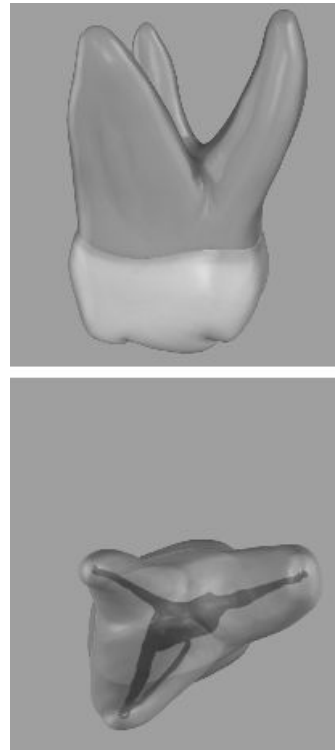


Figure 1 - Screenshots of 3 dimensional views of maxillary first molars from the software program 3D Tooth Atlas (eHuman, Fermont, CA, USA) Version 7.0.4

again performed significantly better in year 2014-2015 when compared with 2013-2014 ($p = 0.036$). The comparison of male students' performance between the different yearly groups did not reveal any statistical significance.

Discussion. Access to modern teaching technologies is easier than ever before.⁴ A wide variety of new teaching methodologies are available, and both the instructors and students should benefit from these tools.⁵ The use of the term Net Gen (net generation) is commonly used to describe the generation of people who are digitally knowledgeable, socially connected, and interactive.⁶ It is logical to expect that people from this Net Gen would prefer a teaching strategy that involves the use of digital technology.⁷ One modern teaching approach is to include a software program as one of the teaching tools. The 3D Interactive Tooth Atlas program³ contains concise and relevant information related to the morphology of teeth; it is well designed, the content is of high quality, and the program is also easy to navigate (Figure 1). Therefore, considering the benefits, the division of tooth morphology in the CDUD decided to introduce a software component to the students' tooth morphology course and to analyze the effect of this intervention on the final grades of the students in the

course. The results of our study clearly demonstrated that students who received software-facilitated teaching performed better than the students who did not receive it. Many other factors, such as differences in the learning abilities of different students and their individual preparations for the examinations, could have affected the results. Every attempt was made to standardize these factors; for example, the same instructors and the same subject matter was used to examine the students. The only factor that was purposely altered was the introduction of software-facilitated teaching for groups 2 and 3. Therefore, the achievement of better grades within groups 2 and 3 was the result of the positive impact of software-facilitated teaching.

An extensive search of the literature (PubMed-indexed journals only) for comparable studies that tested the use of a software programs to teach dental morphology courses yielded no results. However, in our previous 2-year retrospective study, we analyzed the effect of “video triggering” on the performance of students in an oral biology course and concluded that video triggering was useful in enhancing students’ learning.⁸ In that study, we used video triggering as an intervention, which was comparable to the introduction of a software program in this study. A similar clinical study reported that the use of computer-based treatment planning software resulted in improved clinical decision-making skills among dental students.⁹ The results of our study were in agreement with those results: a positive association between the use of the software program and improved students’ performance was established from our study.

The customary use of didactic lectures has various disadvantages that include inactivity of students and one-way communication.¹⁰ On the other hand, the use of a software program not only provided students with a 3-D view of the anatomy of teeth, but also allowed them to interact with the program resources at their own pace and at a convenient time. Other advantages of using a computer-based program for teaching included cost effectiveness (less time and money spent by learners to travel and attend lectures) and flexibility in learning (accommodation for different learning styles).¹¹ During the course of the study, the faculty members noted that their teaching time and energy was also saved when they used the software for teaching. This is another significant advantage of software-facilitated teaching, because instructors typically have a grueling teaching schedule, and any time or resources saved can help the instructors to focus more on their remaining teaching, including individual students, during a particular day. Though the results of this study noticeably established the increased performance of students after using

software-based instruction, they should not be considered conclusive. Many other factors, such as the small sample size, individual students’ preparations for the examinations, and sharing of the examination experience by group 1 students with groups 2 and 3, could have affected the results and should be considered limitations of the present study. Future studies, involving a greater number of students and other dental courses, could help to establish a clearer picture regarding the use of software programs to enhance students’ performance.

In Conclusion, The results of our study showed a positive correlation between the use of a software program for teaching students and their performance in final examinations. The inclusion of such computer-based learning programs could help to improve students’ learning abilities.

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