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Performance of dental students after the implementation of a remote and asynchronous course on Evidence-Based Dentistry

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Abstract The aim was to report dental students' performance, attendance, as well as to assess changes in their knowledge, attitudes, access, and confidence in performing practices related to Evidence-Based Dentistry (EBD). This is a non-controlled longitudinal case series. The participants were nineteen undergraduate students who took part in a remote and asynchronous course on EBD. Academic performance and attendance on classes were recorded. Eighteen students were also assessed for knowledge, attitude, access, and confidence in EBD-related practices using the KACE questionnaire (Knowledge, Attitude, Access and Confidence Evaluation), which was applied before (T0), immediately after (T1), as well as one year after the end of the course (T2). Among the eighteen students, twelve achieved mean scores above 6.0, and most of them preferred to attend to the modules in the asynchronous format. The results for the "knowledge" domain showed a significant increase from 3.86 (T0) to 6.86 (T1) ($p<0.001$), which remained relatively higher at T2 (6.00, $p=0.001$). The "attitude" domain mean score increased from 38.71 (T0) to 40.93 (T1) and decreased to 35.43 at T2 ($p<0.001$). Still, it remained relatively higher than the baseline score ($p<0.001$). "Access" increased from 24.64 (T0) to 28.29 (T1) ($p=0.027$), with no significant difference observed at T2. "Confidence" increased from 12.57 (T0) to 21.07 (T1) ($p<0.001$) and decreased to 18.50 at T2. Nevertheless, it still remained relatively higher than at T0 ($p<0.001$). A remote and asynchronous course on EBD can be considered viable, demonstrating positive and stable results in terms of knowledge acquisition, access to evidence, and confidence in performing practices related to EBD.
Descriptors: Evidence-based Dentistry. Education, Dental. Education, Distance.

Desempeño de estudiantes de Odontología tras la implementación de un curso remoto y asincrónico sobre Odontología Basada en Evidencia

Resumen El objetivo fue reportar el desempeño académico de los estudiantes, su asistencia escolar y evaluar los cambios observados en la adquisición de conocimiento, actitud, acceso y confianza en el desempeño de prácticas relacionadas con la Odontología Basada en Evidencias (OBE). Se trata de una serie de casos, no controlada, de seguimiento longitudinal. Los participantes de esta investigación son 18 estudiantes de pregrado que participaron en una Disciplina remota y asincrónica sobre OBE. Se evaluó el desempeño académico de los participantes y su asistencia escolar. Dieciséis estudiantes fueron evaluados en cuanto a conocimiento, actitud, acceso y confianza en Práctica Basada en Evidencias mediante el cuestionario KACE (*Knowledge, Attitude, Access and Confidence Evaluation*), aplicado a los estudiantes inmediatamente antes (T0), inmediatamente después (T1) y un año después de la finalización de la Disciplina (T2). Se observó que de los 18 estudiantes, 12 obtuvieron una media superior a 6,0 puntos. Gran parte de los estudiantes asistió a los módulos en formato asincrónico. Al analizar los momentos inmediatamente antes y después de la aplicación de la asignatura, se observó un aumento significativo en las puntuaciones de "conocimiento", "acceso" y "confianza"; en la escala "actitud" no hubo cambio significativo. Después de un año de finalización del curso, las dimensiones "conocimiento", "acceso" y "confianza" no presentaron una caída significativa, mientras que la dimensión "actitud" mostró una reducción significativa. Considerando las limitaciones de este estudio, la Disciplina remota y asincrónica puede considerarse una modalidad de enseñanza viable, con resultados positivos y estables en relación con la adquisición de conocimiento, acceso a evidencias y confianza en el desempeño de las prácticas relacionadas con OBE.
Descriptores: Evidence-based Dentistry. Education, Dental. Education, Distance.

Desempenho de graduandos em Odontologia após aplicação de uma disciplina remota e assíncrona sobre Odontologia Baseada em Evidências

Resumo O objetivo foi reportar o desempenho de alunos, sua frequência escolar e avaliar as mudanças observadas na aquisição de conhecimento, atitude, acesso e confiança no desempenho de práticas relacionadas à Odontologia Baseada em Evidências (OBE). Trata-se de uma série de casos, não controlada de seguimento longitudinal. Os participantes desta pesquisa são dezoitos alunos de graduação, que participaram de uma disciplina remota e assíncrona sobre OBE. Avaliou-se o desempenho acadêmico e sua frequência escolar. Dezeseis alunos foram avaliados quanto ao conhecimento, atitude, acesso e confiança em Prática Baseada em Evidências pelo questionário KACE (*Knowledge, Attitude, Access and Confidence Evaluation*), aplicado imediatamente antes (T0), imediatamente posterior (T1) e um ano após a conclusão da disciplina (T2). Observou-se que dos dezoito alunos, doze obtiveram a média maior do que 6,0 pontos e grande parte assistiram aos módulos no formato assíncrono. O resultado relacionado ao tópico "conhecimento" aumentou significativamente de 3,86 em T0 para 6,86 em T1 ($p<0,001$) e se manteve elevado em T2 (6,00, $p=0,001$). O tópico "atitude" aumentou de 38,71 em T0 para 40,93 em T1 e reduziu para 35,43 em T2 ($p<0,001$), mantendo-se maior que T0 ($p<0,001$). O "acesso" aumentou de 24,64 em T0 para 28,29 em T1 ($p=0,027$) e não houve mudança significativa em T2. Já o tópico "confiança" aumentou de 12,57 em T0 para 21,07 em T1 ($p<0,001$) e reduziu para 18,50 em T2, mantendo-se maior que em T0 ($p<0,001$). A disciplina remota e assíncrona pode ser considerada viável, com resultados positivos e estáveis em relação à aquisição de conhecimento, acesso a evidências e confiança no desempenho das práticas relacionadas à OBE.
Descritores: Odontologia Baseada em Evidências. Educação em Odontologia. Educação a Distância.

INTRODUCTION

Evidence-Based Practice (EBP) is defined as the application of the best available evidence, combined with professional expertise and patient preferences[1]. This might be considered as an essential approach for clinical decision-making, enabling professionals to formulate relevant questions, search for appropriate sources, critically appraise the evidence, and implement it within their specific work environment[2,3]. Originally conceived in the medical knowledge field, the EBP movement has expanded to others, including Dentistry, giving rise to Evidence-Based Dentistry (EBD)[4].

The adoption of EBD-related practices can potentially result in several benefits, including increased confidence in clinical decision-making and a higher likelihood of delivering safe and effective treatments[5]. Despite the significant barriers that might hinder the implementation of EBD-related practices[6], several studies indicate that most dental students or professionals declare interest in practicing or learning about EBD[4,7-17].

Currently, major regulatory committees in dental education recommend training in EBD[18,19,20], reflecting a clear educational global trend[21-26]. Although there seems to be no similar guidelines in Brazil to date, other studies have already identified the need to improve practicing professionals' EBD competencies[10], highlighting a gap in dental education in this specific knowledge field. Despite the challenges of incorporating EBD into curricula, educational interventions are expected to be also tested among Brazilian undergraduate dental students, following successful international examples[27,28].

In another aspect of the context addressed by this research, the COVID-19 pandemic led to the replacement of in-person classes by remote learning formats[29]. In response, School of Dentistry of Ribeirão Preto, University of São Paulo (FORP/USP), developed a remote and asynchronous course entitled *"Evidence-Based Dentistry: How to Translate Scientific Knowledge into Clinical Practice"*, which offers theoretical foundations and practical training based on EBP. Online education generally provides benefits such as cost reduction, time savings, in addition to a more student-centered learning model. Based on the recent impact of the public health context on education, it is relevant to explore non-traditional teaching formats for delivering EBD-related knowledge[30,31].

The aim of this study was to analyze student academic performance and class attendance, as well as to evaluate changes in knowledge acquisition, attitudes, access, and confidence in EBD-related practices following the implementation of a

remote and asynchronous course.

METHODS

Study design and ethical considerations

This is a non-controlled longitudinal case series study conducted over a period of 18 months, 12 of which followed the completion of the course. The present research study was approved by the FORP/USP Research Ethics Committee.

Course description

This has been offered annually as an elective course since the second semester of 2019. The edition addressed in this study took place in the second semester of 2021 and was delivered remotely and asynchronously. The course was designed to cover the set of EBP competencies envisioned for Health professionals[32] and to meet the most recent recommendations for teaching this subject within the field of Dentistry[3,33].

The course has a total workload of 45 hours, consisting of 15 modules that are exclusively theoretical, practical, or mixed. All lectures were recorded and made available weekly. Individual or group assignments were given for most modules, with a submission deadline of seven days. These assignments were later graded (on a scale from 0.0 to 10.0 points) and followed by feedback.

If a student received a score lower than 6.0 on any of the assignments, or failed to submit the assignment by the established deadline (resulting in a score of 0.0), they were given the opportunity to submit it after the deadline. However, in such cases, the maximum possible score ranged from 0.0 to 7.0 points.
In addition, twice a week throughout the entire period in which the course was taken, remote office hours were offered via Google Meet, each lasting one hour.

Participants

The participants were students from FORP/USP, who had been previously enrolled and completed the course during the second semester of 2021, regardless of class attendance or academic performance. The total number of individuals was nineteen students. However, for the one-year follow-up report, only eighteen students responded to the questionnaire.

Assessment Methods

Academic Performance

The academic performance of the research participants was quantified through the scores (ranging from 0.0 to 10.0 points) obtained in each graded assignment, regularly applied throughout the course. Mean scores and their respective standard deviations were calculated. Additionally, for scores below 6.0 points or in cases of non-submission, the percentage of recovered grades (i.e., scores of 6.0 or higher) following a second opportunity to submit the assignment was also calculated.

Class Attendance

The percentage of attendance was calculated for each student, considering both synchronous and/or asynchronous video lectures.

Knowledge, Attitudes, Access, and Confidence in EBP

The KACE[34] assessment tool is a self-administered instrument consisting of 35 items, divided into 4 scales, which evaluates different dimensions of Evidence-Based Practice (EBP): knowledge of EBP principles, attitudes toward EBP, behavior in accessing evidence, and confidence in critically appraising it. This questionnaire is designed to measure the outcomes of EBP training within the context of Dentistry. The knowledge and attitude scales each include 10 items, while the access scale includes 9 items and the confidence scale contains 6 items.

Statistical Analysis

Descriptive statistics were used for quantitative variables, including the calculation of means and standard deviations for the scores in the four dimensions. A repeated measures ANOVA test was applied to compare means across three time points (T0, T1, and T2), followed by Tukey's post-hoc parametric test. Assumptions for ANOVA were checked using the Shapiro-Wilk normality test, supported by visual inspections through QQ plots, histograms, and box plots. All inferential analyses were conducted at a 5% level of statistical significance, using two-tailed tests, with the software Jamovi (The Jamovi Project, Sydney, Australia) (version 1.8).

RESULTS

Academic Performance

Among the activities for which grades were assigned, the average scores ranged from 5.4 to 7.7 points. When analyzing each student individually, it was observed that out of the 18 students, 12 achieved an average score above 6.0 points. The highest individual average was 9.4 points, while the lowest was 2.6. The percentage of recovered grades (scores of 6.0 or higher) through a second opportunity for assignment submission was 8.08%.

Class Attendance

Most students attended the course modules (ranging from 89.47% to 100.00%), with asynchronous participation being the preferred format (between 89.47% and 94.74%). The synchronous mode had low engagement: eight modules had no viewers (0.0%), and only two modules recorded participation rates higher than 10%.

Knowledge, Attitudes, Access, and Confidence in EBP

Table 1 presents the descriptive and inferential analysis of participant responses across the domains of knowledge, attitudes, access, and confidence, as assessed by the KACE[34] instrument. Comparisons were performed between three time points, namely before (T0) immediately after the course (T1), and one year after the completion of the course (T2). A statistically significant increase was observed in the "knowledge," "access," and "confidence" scales, indicating improvement in these areas. However, no significant change was found in the "attitudes" scale.

Table 1. Comparison of scores on the KACE34 instrument scales before (T0), immediately after (T1), and one year after the course (T2).

KACE scale	Assessment Time (mean/SD)			T0 - T1	T1 - T2	T0 - T2
	T0	T1	T2	(p-value)	(p-value)	(p-value)
Knowledge	3.86 ± 1.61	6.86 ± 1.79	6.00 ± 1.36	p<0.001	p=0.211	p=0.001
Attitude	38.71 ± 2.67	40.93 ± 3.73	35.43 ± 2.82	p=0.223	p<0.001	p<0.001
Access	24.64 ± 4.65	28.29 ± 9.50	26.50 ± 4.24	p=0.027	p=0.200	p=0.178
Confidence	12.57 ± 3.69	21.07 ± 3.29	18.50 ± 3.13	p<0.001	p=0.080	p<0.001

SD: standard deviation.

One year after the completion of the course, the "knowledge" dimension did not show a significant decrease, maintaining significantly higher values than those observed at baseline. Regarding the "attitudes" dimension, a significant decrease was observed one year after the course, reaching significantly lower levels than those recorded before the course. As for the "access" dimension, no significant changes were observed one year after course completion, with values remaining like both baseline and immediate post-course assessments. For the "confidence" dimension, the scores measured one year after the course did not significantly change and remained significantly higher than the initial scores.

DISCUSSION

This study aimed to report students' academic performance and attendance, as well as to evaluate the changes observed in knowledge acquisition, and in attitudes, access, and confidence related to EBP, one year after course completion. To the best of our knowledge, this is the first attempt to assess the effects of EBD teaching in a fully remote and asynchronous format over a 12-month follow-up period.

The delivery of EBP-related content to undergraduate dental students, in various formats, appears to be frequently associated with a positive learning experience for students[23,35-39]. Students who had some experience with instructional processes that included EBP reported perceived knowledge acquisition[8,23,36—38,40,41]. In line with our findings, a significant increase in knowledge acquisition was observed among the participants. This result reinforces previous reports of learning gains[34,40-45], whether stemming from courses focused exclusively on EBP education[40,41,44] or from other educational interventions incorporating EBP teachings into regular courses[43], journal clubs[45], or study design courses[42]. However, the results differ from a previous study that evaluated the effects of a vocational training program delivered to students after graduation[46]. That study suggests that once students enter professional practice, they may be negatively influenced in their ability to retain the knowledge acquired. Another study supports this finding[47]. It is inferred that this decline over time may be attributed to the insufficient integration of EBP principles into undergraduate training and the real-life clinical practice, particularly regarding the lack of direct application of theoretical knowledge and practical examples to each student's individual work context. Although there was a statistically significant increase in students' knowledge levels, their average academic performance did not reach 70%. This highlights the need to improve the remote and asynchronous course model in order to optimize academic outcomes. Nevertheless, after 12 months, students' knowledge levels remained stable, corroborating previous research[45] and suggesting that learning the theoretical foundations of EBP may produce stable improvements (12 months) under the educational model tested.

Immediately following pedagogical interventions in EBP courses, students typically demonstrate a positive attitude[38,41,43], along with high expectations regarding its implementation in professional practice[36,37]. However, in the present study, no significant change in attitude was observed following the course, corroborating previous findings[43,45]. On the other hand, other studies have reported meaningful increases in attitude scores[34,40,41,42]. The lack of substantial improvement after course completion may be attributed to the apparently high baseline scores observed before the course. This positive attitude is considered to be critical for the real-world implementation of EBP in healthcare settings[48,49]. Nonetheless, a substantial decline in scores was recorded 12 months after the course, confirming previous findings[45]. This result may reflect a decreased belief in the practical applicability of EBP in the often-demanding daily lives of students or recent graduates. Such a finding highlights the apparent need to integrate EBP education more closely with other clinical courses, emphasizing the practical application of theoretical content and using real clinical scenarios to illustrate key principles.

Access scores increased significantly following the course, aligning with most available studies on this topic[34,40,42,44-46]. Despite one divergent study[43], it is worth noting that evidence searching was a particularly emphasized skill throughout the course, which may explain the sustained improvement observed after 12 months, as previously documented[45].

Following the course, students also showed significant improvements in their confidence to critically appraise evidence, in agreement with prior research[34,40,41,43-46]. The discrepancy with one specific study[42] may be due to the differing instructional focus of that course, which did not prioritize this skill. The confidence-related outcomes remained stable over one year, reflecting the course's instructional emphasis, consistent with earlier findings[45].

Although, to the best of our knowledge, this is the first attempt to evaluate the effects of an asynchronous and remote EBP course delivered to undergraduate students, we acknowledge the inherent limitation of the study design, which lacks a control group—ideally composed of students at the same academic level who would receive the course in an exclusively in-person format. Moreover, although the primary aim of this study was to present a pedagogical experience in a specific context, it must be recognized that the limited sample size may compromise the generalizability of the data and conclusions presented here. Therefore, we propose further studies with longer follow-up periods and broader evaluation scopes, as recommended by the so-called "Sicily Statement"[50].

Despite these limitations, the positive and significant results observed in the domains of knowledge, access, and confidence highlight the relevance of this research, suggesting that the findings are important for education. Furthermore, the study contributes to the existing literature by emphasizing the effectiveness of remote instruction, which may be applicable to similar contexts. Finally, it should be noted that the sustained improvements observed in the "knowledge," "access," and "confidence" dimensions may also have been influenced by the contribution of other clinically focused courses and/or related extracurricular activities.

CONCLUSION

Considering the limitations and limited external validity of this research, the study suggests the feasibility of delivering a remote and asynchronous EBP course. Furthermore, it is inferred that this approach was followed by positive and stable outcomes in terms of knowledge acquisition, access to evidence, and confidence in performing EBP-related practices - indicating a lasting positive impact (12 months) under the tested educational model.

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