

Objective criteria for assessment of the quality of dental restorations improve student's critics towards the treatment assignment: a randomized controlled trial

Critérios objetivos para avaliar a qualidade de restaurações dentárias aumentam a crítica de estudantes acerca do tratamento designado: um ensaio randomizado controlado

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Resumo

Introdução: Parâmetros objetivos podem auxiliar a decisão de como lidar com restaurações existentes em pacientes. **Objetivo:** Este estudo testou as hipóteses que seguem: i) o ensino de critérios objetivos a estudantes de odontologia melhora sua crítica acerca da indicação para substituição de restaurações; e ii) uma abordagem prática complementar aumenta a proporção de tratamentos indicados corretamente comparada com uma abordagem estritamente teórica. **Método:** Este ensaio randomizado em bloco controlado envolveu estudantes de odontologia de uma universidade brasileira que foram randomizados para um grupo que recebeu uma aula teórica (A, controle) ou uma aula teórica seguida por um treinamento prático (grupo B); ambas as intervenções foram aplicadas em um ambiente moodle. A proporção de restaurações indicadas corretamente antes e depois do ensino dos critérios foi comparada com o teste U de Mann-Whitney ($p < 0,05$), e a comparação entre as intervenções foi estabelecida com o teste de Wilcoxon ($p < 0,05$). **Resultado:** A proporção de indicações corretas aumentou significativamente após as intervenções para ambos os grupos ($p = 0,02$), sem diferença significativa entre as intervenções ($p = 0,871$). **Conclusão:** O treinamento online proposto aumentou a proporção de indicações corretas às restaurações, confirmando a primeira hipótese do estudo. A segunda hipótese foi rejeitada visto que as diferenças entre as intervenções não tiveram efeito na proporção de respostas corretas. O foco no ensino de parâmetros objetivos para avaliação da qualidade das restaurações pode aumentar a habilidade dos estudantes de tratá-las corretamente.

Descritores: Restauração dentária permanente; estudante de odontologia; critério; ensaio randomizado controlado; tomada de decisão clínica.

Abstract

Introduction: Objective parameters may help the decision of how to manage existing dental restorations in patients. **Objective:** This study tested the following hypotheses: i) teaching objective criteria to dental students enhances their criticism toward the indication for replacement of dental restorations; and ii) a complementary practical approach enhances the proportion of correctly indicated treatments compared with a strictly theoretical approach. **Method:** This block-randomized controlled trial involved dental students from a Brazilian university who were randomized to either a didactic/theoretical class group (A, control) or a didactic/theoretical class followed by practical training (group B); both conditions were applied in a moodle-based environment. The proportion of correctly indicated interventions before and after teaching the criteria was compared with using Mann-Whitney U-test ($p < 0.05$), and a comparison between the approaches was established with Wilcoxon test ($p < 0.05$). **Result:** The baseline proportion of correct assignments significantly increased after interventions for both groups ($p = 0.02$), with no significant difference between the interventions ($p = 0.871$). **Conclusion:** The proposed online training enhanced the proportion of correct assignments to restorations, confirming the first study hypothesis. The second hypothesis was rejected because differences between the strategies had no effect on the proportion of correct answers. Focusing on teaching objective criteria for assessment of the quality of restorations would enhance students' ability to correctly treat them.

Descriptors: Dental restoration; dental student; criteria; randomized controlled trial; clinical decision-making.



INTRODUCTION

Dental restorations aid in restoring the anatomic form, function, and aesthetics lost mainly by caries¹. When a restoration with marginal discrepancies or recurrent caries is replaced, the cavity size is significantly increased compared with the original restoration². This is particularly true for composite restorations whose limits, as related to the dental structure, are more hardly identified because of the resemblance with the dental tissues³. Therefore, determination of restoration replacement should be based on solid criteria under the risk of leading to unnecessary pulpal compromise and progressive destruction of the tooth.

To the best of our knowledge, there is no objective parameter for the ideal longevity time for direct restorations. Still, anterior restorations presented an annual failure rate of $\leq 4\%$, caused mainly by bulk fracture of the material or tooth, loss of retention, and esthetic properties^{4,5}. Also, a comparison between the survival of amalgam and composite restorations revealed a higher survival rate for amalgam restorations, with a lower failure rate caused by secondary caries^{1,6}. Other studies have identified endodontic complications as the main cause of failure in the first year and caries and fracture of the restoration in the later years^{7,8}.

Failure of restorations is a natural consequence of their in-service time in a hostile environment. However, the scenario presented by books and lecturers does not address aged and failed restorations, leaving the decision of how to deal with them to the clinician⁹. It is common for a clinician to decide the replacement of the restoration when he or she recognizes it as deviating from the ideal. For instance, the replacement of restorations is by far the most common restorative procedure and is driven mainly by the clinical diagnosis of caries³, despite the clinical judgment of the presence of caries being reported as highly inconsistent among dentists¹⁰.

Alternatives to the total replacement of a restoration have been suggested as converging to minimally invasive concepts, such as refurbishing and repair of the restoration¹¹. However, the decision process should take into account a standardized, well-recognized, and evidence-based diagnosis based on solid criteria rather than on personal opinion.

Published in 2007 and revised in 2010, the FDI World Dental Federation clinical criteria for evaluation of direct and indirect restorations attempted to replace the USPHS criteria^{12,13}. Under the assumption that awareness of the FDI criteria would contribute more objective elements for the assessment of dental restorations, the authors believe that these criteria should be taught on a daily basis to dental students, reinforcing their criticism toward the indications for interventions in existing restorations. However, to the best of our knowledge, the best teaching approach for these criteria remains unknown. Therefore, this study tested the following hypotheses: i) teaching the FDI criteria to dental students enhance their criticism toward the indication for replacement of dental restorations and ii) a complementary practical exercise increases the proportion of correctly indicated treatments.

METHOD

Trial Design

This randomized controlled parallel trial designed according to the Consolidated Standards of Reporting Trials of 2010¹⁴ and approved by the institutional Ethics Committee under protocol no. 1.371.665 was conducted in accordance with the World Medical Association Declaration of Helsinki. A block design based on the course semester, during which the dental students would operate in dental clinics, was adopted. Such grouping attempted to control potential confounders introduced by different levels of operatory experience.

Participants

The population from which participants were selected represents dental students of the third and fourth years of a community university located in Southern Brazil. Dental students from the fifth to the eighth semesters enrolled in the dental clinics of the School of Dentistry were considered as eligible participants.

Sample Size

The sample size was calculated using G*Power 3.1 (Universität Düsseldorf, Germany), considering the following parameters: one tail, α error probability of 0.05, β error probability of 0.10, and difference of 0.3 between proportions of correct answers. A total of 94 subjects participated in the study which extended to 104 (10%) considering the odds of dropout.

Randomization

Approximately 40 students enroll each clinical semester. The student list was obtained, and a first randomization was made through simple raffle. Overall, 26 students were selected in each semester. The students were informed about the aims of the study and were invited to enroll in the study. The students signed consent forms and provided their email information. They also were randomized through a second raffle to groups A or B and were informed that all data collection and training would occur through an online moodle platform (Figure 1).

Measuring Instruments

The online training tool consisted of a questionnaire containing questions about contact during graduation and experience with decision making related to assessment of dental restorations. The second instrument involved assessment of 30 images of dental restorations (10 anterior composite restorations, 10 posterior composite restorations, and 10 amalgam restorations) and their conduct decision, which could involve maintaining, repolishing/refurbishing, repairing, or replacing the restoration. The correct answers were previously established by the group of authors in discussion sessions based on the FDI criteria¹³. When the decision was for repairing or replacing the restoration, the participant was asked to indicate the reason.

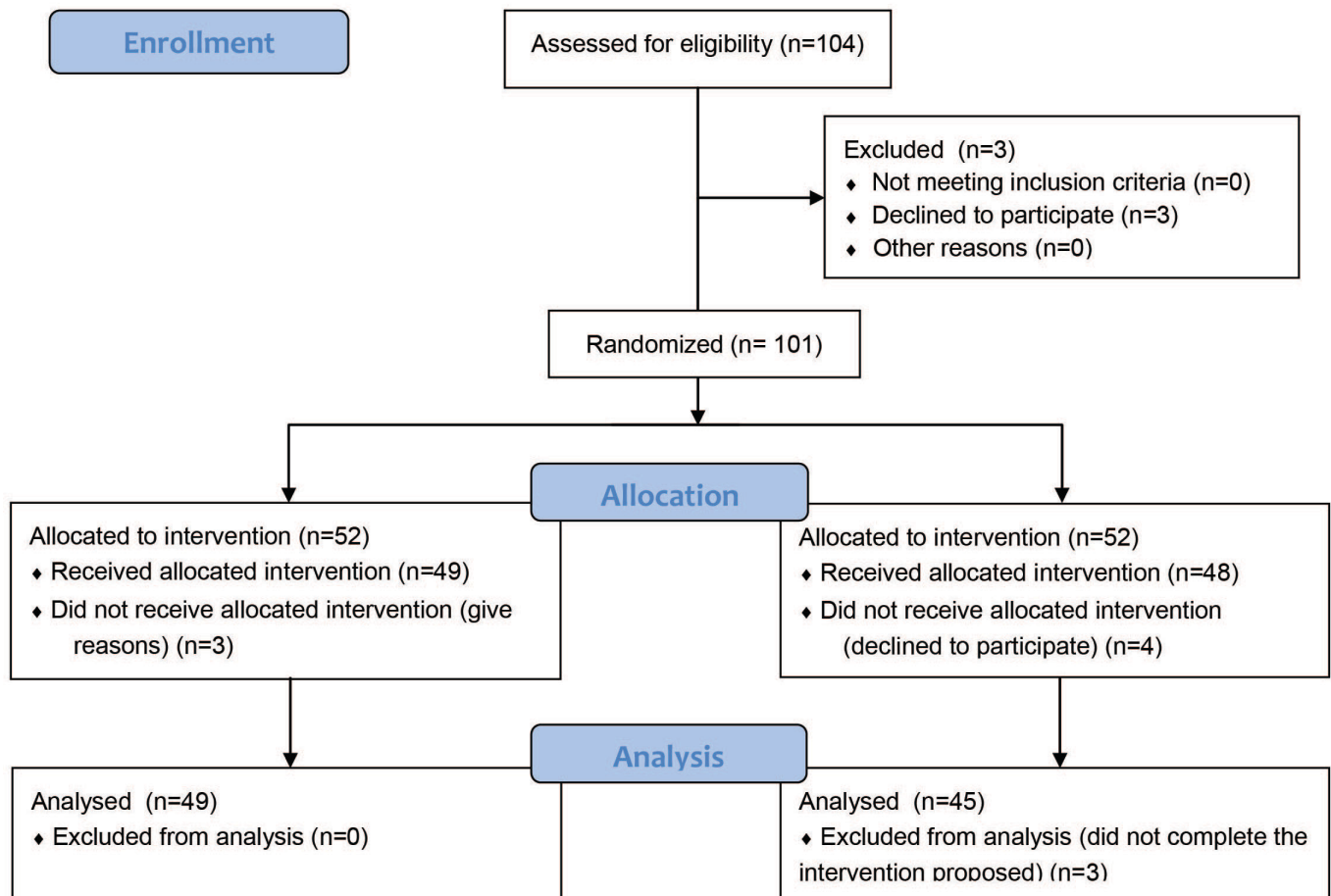


Figure 1. Fluxogram of the study.

Interventions

Training for participants in group A involved a video class with approximate duration of 1 hour that briefly addressed the history of assessment of the quality of restorations along with the FDI criteria¹², reviewed and exemplified with images provided by Hickel et al.¹³. The final minutes of the video showed the rationale used for assessing the three different types of restorations, considering the parameters assessable through images¹³. Group B participants were trained with the same video class and a complementary practical quiz that involved determining the scores of 20 restorations for each of the parameters involved. These participants had feedback of a quiz immediately after each assessment. Participants of both groups were allocated a one-month period to answer the pre-training questionnaires and another one-month period for training and post-training reassessment of the same restorations images. Data were collected from June to August 2016. Differences between interventions of groups A and B were probably acknowledged by the research participants because there was no way to prevent communication among participants.

Outcomes

The primary outcomes were the proportion of correct assignments to the restorations and the proportion of more invasive treatments assigned by either participants of group A or B. Primary data were collected before and after teaching the FDI criteria for assessment

of restorations. Secondary outcomes included information about contact with the issue during classes or lectures.

Statistical Methods

The reasons for the indication of repair or replacement of the restoration were categorized and expressed as frequencies. The proportion of correctly indicated interventions and more invasive interventions before and after teaching the FDI criteria were compared using Wilcoxon test, and comparison between the teaching approaches was established using Mann-Whitney U-test ($p < 0.05$). Statistical analysis was performed using Statistical Package for Social Sciences software 20.0.

RESULT

Overall, 94 participants answered the baseline questionnaire. Table 1 presents the results of experience and perception about the decision-making process regarding the maintenance of restorations.

The baseline proportions of correct assignments to the restorations were 30.3% in group A and 30.7% in group B ($p = 0.918$). 60% and 59% of the restorations were assigned for more invasive treatments by participants of groups A and B, respectively. In both groups, the proportions of correctly assigned restorations significantly increased after the educational interventions (34.8% in group A and 36.1% in group B; $p = 0.02$). No significant difference was

Table 1. Experience and perception about the decision-taking process regarding the maintenance of dental restorations

Question	n	%	95%CI
During your undergraduate dental course have you been taught about how to assess the quality of the restorations?			
Yes	85	90.4	84.4-96.4
No	9	9.6	3.6-15.6
What was the nature of the information you received? (n=87)			
Theoretical in pre-clinical discipline	66	70.2	60.6-79.8
Practical in pre-clinical discipline	0	0.0	0.0-0.0
Theoretical in clinical discipline	20	21.3	12.7-29.9
Practical in clinical discipline	1	1.1	-1.1-3.3
Based on your experience in the previous semester, what was the frequency you had to decide whether the restoration should be preserved or not (approximate number of patients/semester)?			
1 to 3	67	71.3	62.2-80.4
4 to 6	21	22.3	13.9-30.7
7 to 10	5	5.3	0.8-9.8
> 10	1	1.1	-1.0-3.2
You feel confident to decide whether the restoration should be maintained			
Always	5	5.0	0.6-9.4
Almost always	28	27.7	18.7-36.7
Sometimes	56	55.4	45.4-65.4
Almost never	12	11.9	5.4-18.4
Never	0	0.0	0.0-0.0

n= number of answers; 95%CI= 95% confidence interval.

found between the educational interventions ($p = 0.871$). After the interventions, the proportion of more invasive assignments decreased to 55.4% in group A ($p = 0.008$) and 48.9% in group B ($p = 0.0001$). No significant difference was found between the groups ($p = 0.379$). Posterior composite restorations presented the lowest proportion of correct assignments regardless of group (Figure 2). Figure 3 presents the frequency of categorized reasons for indicating repair or replacement of the restoration in groups A and B before and after the educational interventions.

DISCUSSION

The actual model of health care recommends that health professionals, including dentists, should take decisions based on the best evidence available, aiding at providing patients with the best treatment possible¹⁵. Based on this, when it comes to assessing the quality of dental restorations, the FDI criteria should be broadcasted and adopted. These criteria have resulted from a comprehensive revision of the USPHS criteria and from 40 years of systematic assessment of restorations¹². These criteria are widely acknowledged by clinical researchers; however, it remains unclear whether dental students and dental clinicians are aware of the existence of such parameters for the clinical assessment of dental restorations.

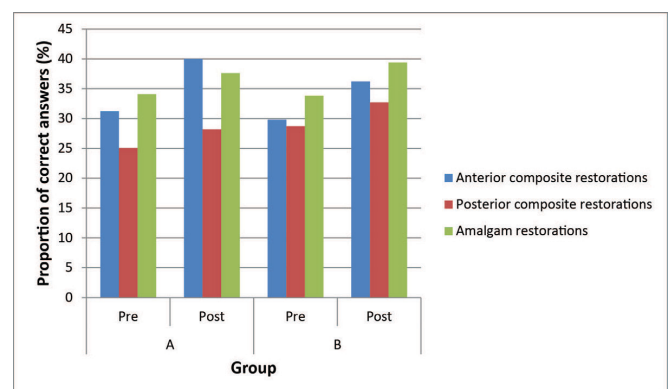


Figure 2. Proportion of correct assignments to each type of restoration.

Misdiagnosis of the clinical condition of a dental restoration inevitably leads to overtreatment by unnecessary replacement of the restoration or to undertreatment, missing the opportunity of less invasive treatments for early caries¹⁶. In fact, our results revealed a clear trend toward assigning more invasive treatments to the restorations when the diagnosis of the restoration condition was incorrect. According to Gordan et al.¹⁷, the lack of standards to determine restorative failure may lead dentists to favor the decision for more invasive surgical interventions when facing

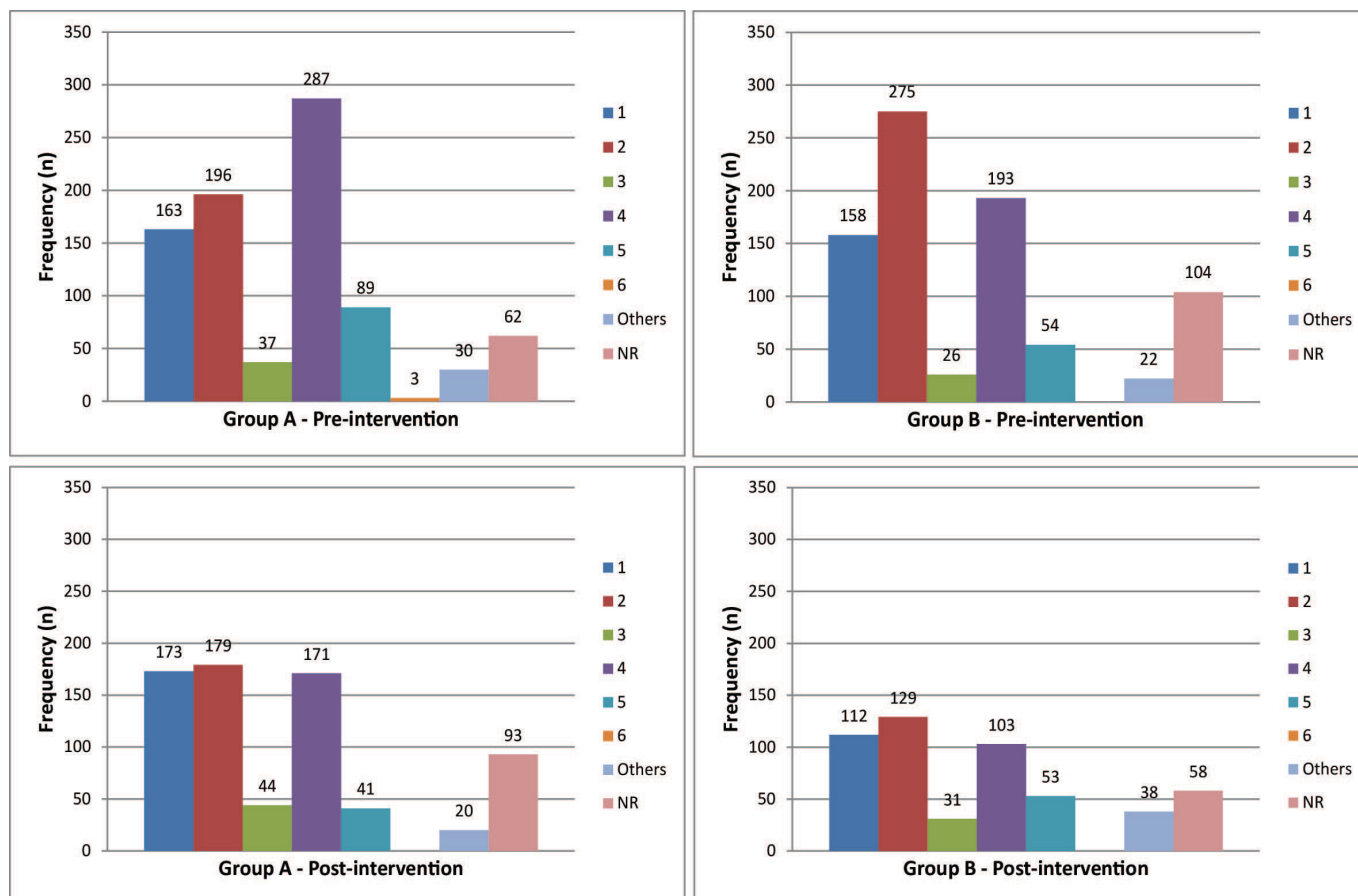


Figure 3. Reasons for assigning repair or replacement of the restoration by participants of groups A and B, before and after the educational interventions. Each participant could have assigned more than one reason. The numbers express the categorized reasons, as follows: (1) color match and translucency, surface gloss, marginal or surface staining; (2) esthetic anatomic form, contact point, excess or insufficient material; (3) crack or fracture of the material, retention, steps; (4) marginal adaptation, marginal gap; (5) caries, tooth integrity; (6) tooth erosion or abfraction; NR: not reported.

uncertainty with respect to diagnostic threshold. Another prior study showed that training dentists to use objective criteria for assessment of restorations reduces the assignment of replacement to the restorations as well as the time taken to examine restorations¹⁸. In this sense, the training tool developed and assessed in the study successfully reduced the proportion of incorrectly diagnosed and assigned restorations as well as the proportion of more invasive assignments, regardless of the training strategy used.

Discrepancy was observed between self-confidence in assessing the quality of restorations and the number of correct assignments. Most participants claimed that they were taught how to assess the quality of a restoration and felt confident to decide on the maintenance of the restoration “almost always” or “sometimes.” Still, the baseline percentage of correct assignments of 30% revealed the lack of familiarity with systematic criteria. Other studies have highlighted the disparity in dentists’ decisions with respect to their diagnostic measures¹⁷ and restorative treatment decisions^{10,19}. Regardless, most students had to decide whether to maintain a dental restoration at least once a month in their practice routine. Therefore, teaching evidence-based state-of-the-art protocols on caries diagnosis, assessment of restorations and restorative options should be emphasized.

Analyzing images of restorations does not allow assessment of all relevant criteria to determine the quality of restoration¹³. Still, eight of 16 criteria could be assessed, with an emphasis on the esthetic criteria. Given that the esthetic aspect of anterior restorations in determining patients’ wish to have their restorations replaced and that this is the second cause of failure in these restorations^{5,20}, dental students should be adequately trained in this assessment. Images seem to play an important role in this matter. Also, functional and biological criteria could be adequately assessed through images, such as the presence of primary or recurrent carious lesion, marginal adaptation, fracture of the tooth, and restoration¹³. Restoration fracture is one of the main causes of failure in both anterior and posterior restorations⁵. It also has been shown to be influenced by parafunctional habits, such as bruxism²⁰. Although this risk factor is not easily determined, the presence of hairline cracks and fractures in the restoration is fairly detected in pictures.

The proportion of correctly assigned treatments was higher for amalgam restorations and anterior composite restorations (Figure 2). As for amalgam, the authors wondered whether the color contrast between amalgam and the natural tooth enhances visual aid capacity in detecting failures, especially at the tooth–restoration margins. Anterior restorations rely on esthetic properties and demands⁵, which are much more straightforward when it comes to deciding

on maintenance of the restoration. Conversely, the same esthetic properties play a different role in posterior composite restorations, increasing the range of interpretations and decisions.

The correct diagnosis of a restoration's condition is paramount for the restorative decision-making process. Therefore, the FDI criteria, besides providing objective elements to the correct diagnosis of the restoration's clinical condition, suggests two intermediate treatment alternatives to "just monitoring-no treatment" (for clinically excellent or very good restorations) and to "replacing the restoration" (clinically poor restorations)¹². This represented an obvious improvement toward more rational and minimally invasive dentistry compared with the USPHS criteria or with no criteria.

Treatment decisions are somewhat subjective and influenced by several factors, such as practice setting, gender, source of income, and prior caries risk assessment. Those who decide for the replacement of the entire restoration work solo or in small private groups are men, have a high percentage of "self-paying" patients, and do not assess caries risk¹⁷.

The main drawback of replacing the entire restoration is enlargement of the cavity by inevitable removal of sound tooth tissue^{9,20}. Minimally invasive alternatives to replacement include refurbishment, which involves recontouring, repolishing, and application of glaze or adhesives on the surface, and is mostly associated with a score of 3 (clinically sufficient or satisfactory) in the FDI criteria¹³. The threshold to determine the clinical failure of the restoration is the difference between scores of 3 and 4 (clinically unsatisfactory). The latter indicates the need for repair, which implies the addition of restorative material in a small and accessible defect¹³.

Clinical evidence on the potential of repair to increase longevity of restorations is limited by the lack of randomized controlled trials⁹. Still, promising results have been shown in prospective cohort studies^{21,22}, revealing the long-term clinical success of such procedures in maintaining the restorations in service with similar or lower long-term failure rates than untreated defective restorations^{21,22}. When considering operational aspects, repairing requires lesser time and effort than replacing the restoration and is often performed with no anesthesia²³. With respect to cost-effectiveness, a recent study revealed that repairing was less costly and more effective in retaining the tooth compared with replacement, especially for composite restorations. Still, based on German healthcare system standards, repair of amalgam restorations was more expensive than its replacement²⁴.

Diagnosing a clinical situation, such as the quality of a dental restoration, involves specific mental operations, which should be considered when defining educational objectives. Two essential mental operations involved in diagnosis are analysis and classification.

Hierarchically, one must analyze the restoration in order to classify it. Analyzing represents the mental ability of fragmenting a whole object or reality in basic elements or components aiding at comprehending it²⁵. For instance, when a dental restoration is analyzed for its quality, clinical aspects, such as color match, marginal adaptation, presence of fracture or adjacent caries, are determined and classified according to their appropriateness. This generates a classification of the restoration as a whole that includes distributing it into groups based on a reference or system, allowing the clinical decision for maintaining it, repairing it, or replacing it. The online tool proposed was idealized considering the development of the mental operations related to the clinical diagnosis and subsequently with the clinical decision-making process. Although no significant improvement in assignments to dental restorations was observed using a complementary practical quiz, this strategy could complement training for the decision-making process as part of a problem-based learning proposal because it has no additional cost.

Limitations of this study involved the possible awareness of each participant about the other group of participants, regardless of the concealment during the allocation process. Further, the common intervention for both groups involved a video class, which could be accessed at the convenience of the participants and checked by the authors. However, the level of commitment in watching the video could not be verified. Therefore, special attention should be given to producing an interesting educational technology, which is paramount for success of this intervention model.

In conclusion, dental students claimed being taught the assessment of the quality of dental restorations in preclinical and clinical disciplines. Still, they assigned correctly only 30% of the restorations. The online training proposed enhanced the proportion of correct assignments to the restorations, confirming the first study hypothesis. The second hypothesis was rejected because differences in teaching strategies had no significant effect on the proportion of correct answers. Dental schools should focus on teaching objective criteria for the assessment of the quality of restorations to dental students, and also address the issue in continuing education for graduated professionals. Future studies should develop training alternatives that increase training time for assessment of restorations, and should also include a clinical component.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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