

# Active methodologies for competency development in primary teeth endodontics among dentistry students: a pilot study

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**Abstract** This pilot study aimed to evaluate active teaching-learning methodologies used for developing dental students' competency in pulpal therapy in primary teeth. The study included 24 students enrolled in a Pediatric Dentistry course at Cruzeiro do Sul University. Initially, a dialogical lecture was conducted, followed by reinforcement by gamification using Kahoot!, an online quiz platform (eight multiple-choice questions), and a step-by-step video of the endodontic technique. Subsequently, a simulation laboratory with primary teeth and artificial pulp was conducted. Each student performed the treatment on an upper central incisor. Two radiographs (initial and final) were evaluated by a trained examiner using qualitative criteria. Descriptive and inferential statistical analyses were performed using Pearson's Chi-square and Fisher's Exact tests ( $\alpha=5\%$ ). The results showed 53.8% accuracy for the eight Kahoot! questions. The poorest student performance was in the area of "pulpal diagnosis" (28.0%), while the best performance was "endodontic technique in primary teeth" (72.0%). Adequate performance was demonstrated during the simulation lab, with student competency at 79.2% for the "preparation form" stage, 75.0% for the "apical limit," and 66.7% for "obturation", with statistically significant values for all evaluated criteria, except for the "obturation" stage. Our findings indicated that active methodologies were relevant for competency development among dental students. In particular, the understanding of pulpal therapy in primary teeth was evaluated through the identification and recording of explicit competencies.

**Descriptors:** Teaching Materials. Education, Dental. Pediatric Dentistry. Endodontics. Primary Tooth.

## Metodologías activas para el desarrollo de competencias de estudiantes de Odontología aplicadas a la endodoncia de dientes deciduos: estudio piloto

**Resumen** El objetivo de este estudio piloto fue evaluar el uso de metodologías activas de enseñanza-aprendizaje para el desarrollo de competencias relacionadas con la terapia pulpar en dientes deciduos por parte de estudiantes de Odontología. La muestra estuvo compuesta por 24 estudiantes matriculados en la Asignatura de Odontopediatria de la Universidad Cruzeiro do Sul. Inicialmente, se utilizó una clase expositiva dialogada, gamificación con cuestionario en línea en la plataforma Kahoot! (8 preguntas de opción múltiple) y un video con el paso a paso de la técnica endodóntica. Posteriormente, se llevó a cabo un laboratorio de simulación con dientes deciduos con pulpa artificial. Cada estudiante realizó el tratamiento en un incisivo central superior, obteniendo dos radiografías (inicial y final) evaluadas por un examinador capacitado mediante criterios cualitativos. Se realizaron análisis estadísticos descriptivos e inferenciales mediante las pruebas Chi-cuadrado de Pearson y Exacta de Fisher ( $\alpha=5\%$ ). Los resultados mostraron un 53,8% de aciertos en las 8 preguntas presentadas en el juego de Kahoot!, con el peor desempeño de los estudiantes en la competencia de "diagnóstico pulpar" (28,0%) y el mejor desempeño en la competencia de "técnica endodóntica en dientes deciduos" (72,0%). En cuanto al laboratorio de simulación, el desempeño adecuado de los estudiantes fue del 79,2% en la etapa de "forma de preparación", 75,0% en "límite apical" y 66,7% en "obturación", con valores estadísticamente significativos en todos los criterios evaluados, excepto en la etapa de "obturación". Se concluye que las metodologías activas utilizadas en la terapia pulpar de dientes deciduos permitieron evaluar el desempeño de los estudiantes mediante la identificación y registro de competencias.

**Descritores:** Materiales de Enseñanza. Educación en Odontología. Odontopediatria. Endodoncia. Diente Deciduo.

### **Metodologias ativas para o desenvolvimento de competências de estudantes de Odontologia aplicadas à endodontia de dentes decíduos: estudo piloto**

**Resumo** O objetivo deste estudo piloto foi avaliar o uso de metodologias ativas de ensino- aprendizagem para o desenvolvimento de competências relacionadas à terapia pulpar em dentes decíduos por estudantes de Odontologia. A amostra foi composta por 24 alunos matriculados na Disciplina de Odontopediatria da Universidade Cruzeiro do Sul. Inicialmente, empregou-se aula expositiva dialogada, gamificação com quiz online na plataforma Kahoot! (8 questões de múltipla escolha) e vídeo de passo a passo da técnica endodôntica. Em seguida, realizou-se o laboratório de simulação com dentes decíduos com polpa artificial. Cada aluno realizou o tratamento em um incisivo central superior, com aquisição de duas radiografias (inicial e final) avaliadas por examinador treinado por meio de critérios qualitativos. Foram realizadas análises estatísticas descritiva e inferencial por meio dos testes Qui-quadrado de Pearson e Exato de Fisher ( $\alpha=5\%$ ). Os resultados mostraram 53,8% de acertos das 8 questões apresentadas no game Kahoot!, com pior desempenho dos alunos na competência "diagnóstico pulpar" (28,0%) e melhor desempenho na competência "técnica endodôntica em dentes decíduos" (72,0%). Em relação ao laboratório de simulação, o desempenho adequado do aluno foi de 79,2% para a etapa "forma de preparo", 75,0% para "limite apical" e 66,7% para "obturaçãõ", com valores estatisticamente significativos para todos os critérios avaliados, com exceção da etapa "obturaçãõ". Conclui-se que as metodologias ativas utilizadas na terapia pulpar de dentes decíduos permitiram a avaliação do desempenho dos discentes por meio da identificação e registro da competência.

**Descritores:** Materiais de Ensino. Educação em Odontologia. Odontopediatria. Endodontia. Dente Decíduo.

## INTRODUCTION

The teaching-learning process for healthcare professionals has traditionally been based on methodologies in which the teacher transmits content and the student participates as a passive observer<sup>1,2</sup>. Currently, a student-centered approach aimed at developing active professionals who are motivated to "learn how to learn" has attracted increasing attention<sup>3,4</sup>.

Active methodologies are based on autonomy, with the students responsible for their own education and the teacher acting as the facilitator. In this way, educational institutions aim to train professionals who are not only technically competent but also possess critical skills for decision-making through dynamic engagement and interactive processes<sup>5-7</sup>.

Different active methodologies, such as gamification, are available to assist teachers in the teaching-learning process. For example, Kahoot! is a free online educational platform that gamifies quizzes. Using Kahoot!, teachers can encourage students to engage with information in an active and enjoyable manner. The pursuit of victory motivates students, leading to greater knowledge acquisition<sup>7,8</sup>.

According to Freeman *et al.* (2014)<sup>9</sup>, students who participate in active learning methodologies exhibit better content retention than those who engage only in traditional lectures. There is a scarcity of scientific research on the use of active methodologies in dentistry, with existing studies focusing mainly on Radiology and Surgery, suggesting that studies in various specialties should be encouraged<sup>6</sup>.

Given the lack of research addressing this topic in Pediatric Dentistry, this pilot study aimed to evaluate the use of active teaching-learning methodologies for the competency development of dental students in pulpal therapy in primary teeth.

## METHOD

This pilot study was approved by the Ethics Committee of Cruzeiro do Sul University (CAAE: 36559620.0.0000.8084) and was conducted from March to May 2021. This was an observational study with a cross-sectional design, involving 24 students enrolled in the Dentistry Undergraduate Program who regularly attended the Pediatric Dentistry course at Cruzeiro do Sul University. The methodology was divided into four stages: (1) a dialogical lecture, (2) gamification via a Kahoot! quiz, (3) a step-by-step video of the endodontic technique in primary teeth; and (4) a simulation lab of the endodontic technique using primary teeth with an artificial pulp.

### *Dialogical Lecture*

Initially, an online dialogical lecture (3 hours) was delivered on the topic, "Pulp Therapy in Primary Teeth," by a professor with expertise in the subject. During the lecture, clinical cases were discussed and student questions were addressed. Moreover, students were provided with supplementary articles on the topic via a Virtual Learning Environment (BlackBoard).

### *Gamification with an Online Quiz via the Kahoot! Platform*

In the second stage, students were engaged in gamification via an online Kahoot! quiz, featuring 8 multiple-choice questions, three related to "pulp diagnosis," three about "endodontic technique in primary teeth," and two on "radiographic technique". Prior to starting the quiz, the students were informed about the game rules, the use of Internet-connected electronic devices, and the time allocated to the activity. Each question had a time limit of 60 s to answer, and the winner was automatically determined by the Kahoot! platform based on the number of correct answers and the response speed. Each question was reviewed and discussed with the students afterward, and a performance report was generated at the end of the quiz.

### *Step-by-Step Video of the Endodontic Technique in Primary Teeth*

After the quiz and discussion, a video demonstrating the step-by-step process of the endodontic technique in artificial primary teeth was presented. This video is available on the YouTube channel of the Graduate Program in Dentistry at Cruzeiro do Sul University, titled "Endodontics in Primary Teeth" (<https://www.youtube.com/watch?v=3RTy1O2NVZE&t=20s>).

### *Simulation Lab of the Endodontic Technique*

After 7 days, students attended a simulation lab, in which the endodontic technique was applied to anterior primary teeth with an artificial pulp (Denarte, São Paulo/SP, Brazil). Each student performed the endodontic technique on an upper central incisor, with the acquisition of an initial diagnostic radiograph for odontometry using a millimeter ruler. The procedure involved coronal access surgery, manual instrumentation with three Kerr files, irrigation with Dakin's solution (Rioquímica, São José do Rio Preto, SP, Brazil), and an endo-PTC lubricant gel (Fórmula e Ação, São Paulo, SP, Brazil). The professor in charge of the activity (ROG) individually evaluated each step of the procedure, guiding the correct execution. Following final irrigation and drying of the canal with paper cones, obturation was performed manually using the intermediate file and Guedes-Pinto paste<sup>10</sup>: composed of camphorated parachlorophenol (Biodinâmica, Ibioporã-PR, Brazil), iodoform (Biodinâmica, Ibioporã/PR, Brazil), and manipulated rifocort (Laboratório Buenos Ayres, São Paulo/SP, Brazil), followed by restoration with high-viscosity glass ionomer cement (Riva Self Cure - SDI, Victoria, Australia).

A new radiograph was acquired at the end of each activity. The initial and final radiographs were collected and analyzed by a trained and experienced examiner (ROG) using the qualitative criteria described by Kamaura *et al.* (2003)<sup>11</sup>. To classify the apical limit as adequate or inadequate, radiographs were analyzed at their original size on a millimeter scale. Limits between 1.0 and 2.0 mm from the radiographic apex were considered adequate, and those situated beyond or any limit exceeding the radiographic apex were considered inadequate. To assess the obturation step, the presence/absence of porosities caused by the lack of obturation paste was evaluated. The presence/absence of extrusion of any obturation paste beyond the apical foramen was also assessed. Additionally, the preparation form was evaluated

and classified as adequate or inadequate based on the presence of a conical shape towards the apex. The radiographs were also assessed for deviations and/or perforations from the conical shape.

### Statistical Analysis

The collected data were tabulated in Excel for Windows and analyzed using descriptive statistics with absolute frequency (count) and relative frequency (percentage). SPSS® Statistics software (version 23.0, IBM, Armonk, NY, USA) was used for statistical analysis. To compare the frequencies of the qualitative criteria evaluated in the simulation lab, non-parametric tests were applied (Pearson's Chi-square and Fisher's exact tests) with a significance level set at 5%.

## RESULTS

The results showed a 53.8% accuracy rate for the eight questions presented in Kahoot! quiz. The poorest student performance was related to "pulp diagnosis" (28.0%), while the best performance in the "endodontic technique in primary teeth" (72.0%). The global percentages of correct and incorrect answers based on competency are presented in Table 1. The questions involving clinical case simulations related to the "pulp diagnosis" competency showed an accuracy rate ranging from 15.0% to 38.0%. Regarding correct answers related to the "endodontic technique in primary teeth" competency, a 62.0% accuracy rate was observed for the question addressing the composition of the obturation material used, 69.0% for the question on the shape of the access surgery, and 85.0% for the topic of irrigating solutions during the chemo-mechanical preparation. The questions addressing the "radiographic technique" competency showed an accuracy rate ranging from 38.0% to 92.0%.

**Table 1.** Global percentage of correct and incorrect answers according to the competencies presented in the Kahoot! quiz

Competencies assessed in the Kahoot! quiz	Assessed questions	Global percentage of correct answers by competency	Global percentage of errors by competencies
Pulp diagnosis	1, 6 and 7	28.0%	72.0%
Radiographic technique	2 and 4	65.0%	35.0%
Endodontic technique for deciduous teeth	3, 5 and 8	72.0%	28.0%

Table 2 presents the frequency and percentage from the qualitative assessment, relating to the simulation lab. Student performance was assessed based on pre-determined criteria relating to endodontic treatment performed on primary teeth with an artificial pulp. For the "preparation method" and "apical limit" aspects, 79.2% and 75.0% of the treatment conducted were deemed appropriate ( $p < 0.05$ ). Regarding the criteria for "extrusion" and "accidents," absence was noted in 87.5% of the procedures ( $p < 0.05$ ). However, no significant difference was found in the "obturation" stage ( $p > 0.05$ ).

**Table 2.** Frequency (n) and percentage (%) of the criteria used in the qualitative assessments of endodontic treatment on anterior teeth performed by students during the simulation laboratory on primary anterior teeth with artificial pulp.

Criteria	Qualitative assessment % (n)		p-value
	Adequate	Inadequate	
Apical limit	75.0% (18)	25.0% (6)	0.014*
Obturation	66.7% (16)	33.3% (8)	0.102
Preparation method	79.2% (19)	20.8% (5)	0.004*
	Absent	Present	
Extravasation	87.5% (21)	12.5% (3)	0.000*
Accidents	87.5% (21)	12.5% (3)	0.000*

Pearson's Chi-square test or Fisher's exact test. \* $p < 0.05$ : statistically significant.

## DISCUSSION

For many years, knowledge construction was based on the traditional teaching model, in which knowledge is passively transferred between the teacher and the students, and often limited to lecture-based teaching. Given that the teaching-learning process is dynamic, this traditional model tends to stagnate as the usual content transfer is not capable of generating learning<sup>12</sup>. Currently, educational institutions aim to develop student learning using active methodologies that provide students with autonomy in acquiring knowledge and a comprehensive view of Dentistry through problem-solving<sup>13-15</sup>.

This pilot study aimed to assess the use of active teaching and learning methodologies to develop competencies among dental students related to pulp therapy in primary teeth, encouraging the improvement of specific difficulties encountered in the proposed learning. It is worth noting that, to date, studies evaluating active methodologies in the field of endodontics in primary teeth have not been reported.

The literature has highlighted the increasing use of interactive materials that combine theoretical content from books with technological products, such as apps, games, or videos. A combination of theoretical content and technology promotes the pursuit of concepts and allows knowledge acquisition to be applied in practice<sup>13,15</sup>. In this study, the theoretical content of the lecture was reinforced using gamification through the Kahoot! platform, and a demonstration of the endodontic technique via video prior to practical application in the simulation lab. These contributed to identifying areas of difficulties experienced by students. For example, our results showed poorer performance in the "pulp diagnosis" competency. Mapping student performance also encourages teachers to improve the teaching-learning process.

Pedagogical games provide knowledge construction through a playful approach for learning complex content. The gamification process promotes the consolidation of the learned content. It is important to highlight that the use of digital resources should be supervised to prevent distraction<sup>13,16</sup>. In this study, Kahoot! was used by the responsible teacher, controlling time and motivating student participation in the classroom. Students showed good acceptance and involvement during this activity, corroborating the findings of Matos *et al.* (2019)<sup>17</sup>, who demonstrated a positive response from students when using active methodologies.

The use of videos in classrooms expands the limits of teaching and aims to illustrate the content being taught. Its application synthesizes learning. Moreover, as a resource, it can serve to reinforce learning<sup>18,19</sup>. In this study, digital media were used as an auxiliary method, presented before the practical activity, with the aim of encouraging autonomous and distance knowledge acquisition. This facilitated a greater understanding of the practical steps that needed to be applied during the simulation lab.

Practical dentistry activities are commonly developed in simulation laboratories to acquire manual skills prior to clinical patient care. For teaching pulp therapy to primary teeth, the use of teeth with artificial pulp is common. Students performance is evaluated through the clinical observation of the teacher during each step of the procedure, combined with the evaluation of the final radiographic image, which is considered a subjective method<sup>11,20</sup>.

To improve the evaluation of student performance in endodontic practice, previously standardized evaluation criteria were employed<sup>11</sup>. This allowed the identification of the stage of endodontic treatment that presented the greatest difficulty for the student and reduced subjectivity in the evaluation process. In this study, the best performance was observed in the "preparation method" (79.2%) and apical limit (75.0%) stages, which were performed adequately by the students. Regarding the "extravasation" and "accidents" criteria, most of the treatments performed by the students showed absence ( $p < 0.05$ ). It is important to note that only the "obturation" stage did not show a statistically significant difference in its qualitative evaluation ( $p > 0.05$ ), indicating a greater need for student training in this aspect, as errors in this stage can result in failure of pulp therapy in primary teeth in future clinical care. Understanding the difficulties of students who exhibit different skill levels throughout their training favors the evaluation process by making it more objective and clearer, facilitating students' understanding of their competencies. Furthermore, it allows for the reorganization of the teaching plan proposed by the discipline.

This study highlights issues with using conventional radiographs for evaluating this practical activity without standardization of the processing pattern to ensure radiographic quality. For a more accurate evaluation, the use of digital radiographs could be an alternative. Reapplying gamification after the laboratory practice could also benefit teachers' evaluations of content consolidation, and this practice is recommended. Additionally, further studies involving active methodologies with a larger number of participants in different study topics within Pediatric Dentistry should be conducted to better understand competencies and the teaching-learning process.

## CONCLUSION

The active methodologies used for the proposed topic allowed the evaluation of student performance through the identification and recording of assessed competencies.

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