ДИГИТАЛНИ ОБРАЗОВАТЕЛНИ ТЕХНОЛОГИИ
Издание на Великотърновския университет „Св. св. Кирил и Методий“
2/2026

DOI: 10.54664/BKKD4629

Angelina Kirkova-Bogdanova[1], Nikolay Simeonov[2], Elena Stavreva[3], Dimitar Kolev[4], Neshka Manchorova[5]

A MOODLE LESSON FOR PRE-SIMULATION ENDODONTIC TRAINING FOR THIRD-YEAR DENTAL STUDENTS: A PRELIMINARY SATISFACTION STUDY

Abstract: *Simulation-based education plays an increasingly important role in dental curricula, supporting the acquisition of psychomotor and cognitive skills in a controlled, low-risk environment. Learning management systems such as Moodle can further enhance this process by providing structured, interactive learning units that prepare students for hands-on training on high-fidelity simulators. This study describes the development and preliminary evaluation of an interactive Moodle lesson used as pre-simulation preparation in Endodontics for third-year dental students at the Medical University of Plovdiv.*

An interactive learning unit titled "Endodontic Access Cavity Preparation" was developed using the Lesson activity in Moodle. The learning unit included clearly defined objectives, nonlinear navigation paths, and multimodal content (text, images, and short video clips), and embedded formative questions to maintain interactivity. It was implemented in both Bulgarian- and English-taught groups of third-year dental students. Student satisfaction was assessed via an anonymous electronic questionnaire following lesson completion. Data was exported and analyzed quantitatively using IBM SPSS Statistics version 23.

Results indicate high levels of student satisfaction across both language groups. Participants reported that the structure and multimodal presentation made the material interesting and engaging, and the nonlinear pathways supported a sense of personalization and choice in learning. Students also stated that the lesson was suitable for self-directed preparation before working with a high-technology dental simulator and helped them better understand key steps in endodontic access cavity preparation. No significant difference in satisfaction levels was observed between Bulgarian- and English-speaking cohorts

[1] *Angelina Kirkova-Bogdanova (Ангелина ГЕОРГИЕВА КИРКОВА-БОГДАНОВА)* – инженер, дм, старши преподавател към катедра „Медицинска информатика, биостатистика и електронно обучение“, Факултет по обществено здраве, Медицински университет в гр. Пловдив, kirkova@medcollege-plovdiv.org

[2] *Nikolay Simeonov (Николай СИМЕОНОВ)* – главен асистент, дм, към Катедрата по оперативно зъболечение и ендодонтия, факултет „Дентална медицина“, Медицински университет в гр. Пловдив, nikolay.simeonov@mu-plovdiv.bg

[3] *Elena Stavreva (Елена СТАВРЕВА)* – асистент в Катедрата по оперативно зъболечение и ендодонтия, факултет „Дентална медицина“, Медицински университет в гр. Пловдив, elenakstavreva@gmail.com

[4] *Dimitar Kolev (Димитър КОЛЕВ)* – доцент, дм, специалист невролог; преподавател по невропсихология, невролингвистика и приложна психофизиология към ЮЗУ „Неофит Рилски“, Благоевград, d.kolev@swu.bg

[5] *Neshka Manchorova (Нешка МАНЧОРОВА)* – заместник-ректор по международно сътрудничество и студентска интеграция, Медицински университет в гр. Пловдив; професор, дм, към Катедрата по оперативно зъболечение и ендодонтия“, факултет „Дентална медицина“, Медицински университет в гр. Пловдив, Neshka.Manchorova@mu-plovdiv.bg

Integrating interactive Moodle lessons as preparatory tools for simulation-based training in dental education positively influences student engagement and learning satisfaction. The approach supports personalized learning and serves as an effective bridge between theoretical instruction and practical application on high-fidelity simulators.

Keywords: *Moodle, endodontics, simulation-based learning.*

Introduction

Endodontic access cavity preparation is a fundamental component of undergraduate endodontic training because it is a gateway to all subsequent endodontic steps. The quality of access cavity preparation directly determines whether canals can be located and instrumented effectively. A poorly executed access cavity compromises the entire root canal procedure, including cleaning, shaping, and obturation (Almaslamani et al., 2026). This procedure develops core technical and cognitive skills in dental students. The task demands fine motor dexterity, three-dimensional spatial reasoning, and a thorough understanding of pulp chamber anatomy – foundational competencies that underpin all clinical endodontic work. Structured preclinical training has been shown to reduce iatrogenic errors (e.g., gouging, perforation) and improve student performance before patient contact (Slaczka et al., 2024). Mastery of this step is essential for the success of subsequent cleaning, shaping, and obturation procedures, yet it poses substantial challenges for third-year students who are still developing fine motor skills and spatial understanding of internal tooth anatomy.

Traditional endodontic teaching has long depended on didactic lectures, live faculty demonstrations, and hands-on exercises using typodont teeth or phantom-head simulators. Although these methods establish foundational procedural knowledge and basic manual skills, they carry well-documented limitations:

– Limited individualized feedback. High student-to-faculty ratios and time pressures mean that instructors cannot consistently provide targeted, formative feedback to each learner during hands-on sessions. Students may therefore repeat errors without timely correction, slowing skill acquisition (Segura-Egea et al. 2025).

– Restricted pre-practice preparation. Live demonstrations often suffer from poor viewing angles and limited real-time interaction when delivered to large groups, meaning students arrive at practical sessions without adequate conceptual or visual preparation. Typodonts and early simulators also frequently fail to reproduce the three-dimensional anatomy and tactile realism of actual teeth, widening the gap between preclinical training and real patient care (Slaczka et al., 2024).

– Fragmented visual and textual integration. Conventional curricula tend to keep lectures, demonstrations, and practice sessions as separate events, without consistently providing integrated multimedia or pre-class materials that students can revisit. This separation reduces the scaffolding needed for complex psychomotor learning (Segura-Egea et al., 2025).

Emerging solutions – such as e-learning modules, video-assisted instruction, and haptic simulators – have been introduced precisely to address these gaps, suggesting that the traditional model alone is insufficient for comprehensive endodontic skill development.

Haptic and virtual reality simulators, as well as other virtual training tools, have been shown to enhance preparation accuracy, support deliberate practice, and increase students' confidence (Manav et al. 2025), although students often prefer these technologies as part of a blended approach rather than as stand-alone replacements for conventional simulation (Gramatges-Rojas et al., 2025). Within this broader digital ecosystem, structured pre-simulation activities can provide learners with clear objectives, conceptual frameworks, and visual exemplars before they engage in hands-on tasks, potentially reducing anxiety and optimizing the use of limited simulator time (Cox et al., 2017).

Learning management systems such as Moodle are now widely adopted in dental schools as central hubs for course content, assessments, and communication, and they allow the integration of multimedia materials, self-paced learning, and embedded formative assessment (Chang et al., 2017), (El Tantawi, Mourady 2012). Interactive e-learning modules, especially those incorporating clinical scenarios, nonlinear navigation, and immediate feedback on embedded questions, have been associated with

higher engagement, improved understanding, and positive learner perceptions in various areas of dental education, including radiology and prosthodontics (Ostermann et al., 2017). In the context of simulation-based training, elements such as clearly stated objectives, appropriate level of difficulty, feedback, and opportunities for reflection are closely related to student satisfaction and self-confidence, underlining the importance of thoughtful instructional design (Tan et al., 2021).

Although several studies have explored virtual simulators and video-based resources for teaching endodontic access cavity preparation (Sánchez-Herrera et al., 2025), (Choi et al., 2023), (Dabbour et al., 2018), there is comparatively little evidence on the use of Moodle-based, interactive pre-simulation lessons specifically tailored to prepare third-year dental students for subsequent hands-on simulator exercises in this procedure. Addressing this gap, we developed a multimedia, nonlinear Moodle lesson on endodontic access cavity preparation that combines high-quality images, explanatory text, and embedded questions designed to check understanding and guide learners through key decision points. The aim of this preliminary study was to evaluate third-year dental students' satisfaction with this pre-simulation lesson in terms of clarity of objectives, appropriateness of content and volume, quality of images, and perceived interactivity.

Materials and Methods

We conducted a cross-sectional survey among third-year dental students at the Faculty of Dental Medicine, Medical University of Plovdiv, in March 2026. Thirty students were enrolled in the Bulgarian language e-course, and 30 students, taught in English, were enrolled in the English version of the course. Participation was voluntary and anonymous, and the survey was administered as a Google form immediately after completion of the interactive Moodle pre-simulation lesson on endodontic access cavity preparation.

The lesson consisted of 30 pages, of which two pages were true-false questions and two were multiple-choice questions. The lesson started with setting the objectives and ended with a summary. The pages were short, rich in images and explanations. The lesson was non-linear, with students having the opportunity to choose transitions to pages with preparation phases and to pages with different teeth.

Student satisfaction with the lesson was evaluated using a questionnaire comprising seven statements: (1) "The content of the lesson is sufficient to achieve the objectives."; (2) "The content is presented in a comprehensible manner."; (3) "The content is interesting."; (4) "The structure of the lesson is clear and logical."; (5) "The content on the individual pages is sufficient."; (6) "The images are informative."; and (7) "I like the lesson." Each item was rated on a five-point Likert scale, where 1 = "I strongly disagree," 2 = "I tend to disagree," 3 = "I cannot decide," 4 = "I tend to agree," and 5 = "I strongly agree,".

Data were entered and analysed using IBM SPSS Statistics, version 23.0. For each item, we calculated relative frequencies (percentages) of responses in each Likert category and measures of central tendency (mean). The level of statistical significance was set at 0.05.

Results

The Bulgarian cohort consisted of 26 students and 23 were the students trained in English, who participated in the lesson and responded to the survey. Table 1 summarizes the statistics of the lesson.

Table 1. Lesson statistics

	Mean score	High score	Low score	Mean time	High time	Low time
Bulgarian	98.08%	100%	75%	7 min., 49 sec.	20 min., 4 sec.	3 min., 29 sec.
English	100%	100%	100%	5 min., 15 sec.	24 min.	1 min., 15 sec.

Table 2 presents the relative shares of the respondents from each cohort by Likert category in each item and Table 3 presents the mean values and standard deviations of the students' agreements for each item.

Table 2. Students' answers in relative shares by items.

Item	I strongly disagree, %		I tend to disagree, %		I cannot decide, %		I tend to agree, %		I strongly agree, %	
	Bul	Eng	Bul	Eng	Bul	Eng	Bul	Eng	Bul	Eng
1.	0	0	0	8,7	30,8	17,4	38,5	17,4	30,8	56,5
2.	0	0	15,4	13,0	15,4	13,0	30,8	17,4	38,5	56,5
3.	0	0	7,7	8,7	23,1	21,1	30,8	17,4	38,5	52,2
4.	7,7	0	0	4,3	15,4	26,1	38,5	21,7	38,5	47,8
5.	0	0	0	4,3	23,1	26,1	46,2	21,7	30,8	47,8
6.	0	0	0	0	15,4	21,7	30,8	21,7	53,8	56,5
7.	0	0	0	4,3	30,8	34,8	30,8	34,8	38,5	47,8

Table 3. Mean values of the level of agreement with each item

Item	Bulgarian M±STD	English M±STD
1.	4.00±0.800	4.22±1.043
2.	3.92±1.093	4.17±1.114
3.	4.00±0.980	4.13±1.058
4.	4.00±1.131	4.13±0.968
5.	4.08±0.744	4.13±0.968
6.	4.38±0.752	4.35±0.832
7.	4.08±0.845	4.04±1.022

The One-Sample Kolmogorov-Smirnov test showed that the variables associated with the students' agreements differ from the normal distribution, which was a reason to choose the Mann-Whitney nonparametric test for the analysis. We did not find any statistically significant differences in the answers of the students taught in Bulgarian and those taught in English with p-values as follows: 1 – 0.241; 2 – 0.325; 3 – 0.551; 4 – 0.782; 5 – 0.655; 6 – 0.964 and 7 – 1.000.

Some of the students commented:

– I found it helpful as the pictures help you visualise everything.

– The lesson was very informative and direct, but the structure is a bit confusing.

– Images are very helpful, clear and demonstrative. It is a great way of visualising and imagining what actually happens so it's clear and easier to understand when it comes to clinic.

– It is a good lesson, very useful to understand the knowledge.

– It was informative but not in a lot of detail.

Discussion

Students in both the Bulgarian- and English-taught cohorts reported predominantly positive perceptions regarding the sufficiency and comprehensibility of the content, the clarity and logic of the structure, and the informativeness of the images. For all seven items, the majority of respondents selected "tend to agree" or "strongly agree," and only small proportions selecting negative response options. The high proportions of "tend to agree" and "strongly agree" responses across all items indicate that students perceived the lesson as clear, interesting, and visually informative, and that they generally liked the format. These findings suggest that the lesson met its intended objectives of providing a structured, comprehensible, and visually rich introduction to access cavity preparation before simulator-based practice.

The particularly high levels of agreement for the items related to image quality ("The images are informative") and overall appreciation ("I like the lesson") underscore the central role of high-quality visual materials in supporting spatial understanding of complex endodontic anatomy. This aligns with previous reports that multimedia and image-rich e-learning resources enhance visualization, conceptual integration, and learner satisfaction in dental education. Free-text comments such as "the pictures help

you visualise everything" and "images are very helpful, clear and demonstrative" further reinforce the importance of visual scaffolding in preclinical endodontic training.

The absence of statistically significant differences between the Bulgarian and English cohorts suggests that the instructional design of the lesson may be robust across language groups and well-designed digital materials support comparable learning experiences in different teaching languages.

The positive reception of this Moodle-based lesson is consistent with literature reporting favourable student perceptions of interactive e-learning modules and learning management system–supported teaching in dentistry (Fouda et al., 2025). Prior studies in dental radiology and prosthodontics have shown that case-based, interactive, and nonlinear online resources can increase engagement, perceived understanding, and satisfaction compared with traditional text-based materials alone (Chang et al., 2017).

The students gave us more nuanced qualitative feedback, which highlighted areas for refinement. While most students agreed that the content was sufficient, interesting, and clearly structured, small proportions selected "I cannot decide" or mildly disagreeing options, particularly for items related to sufficiency of content and clarity of structure. Comments such as "the structure is a bit confusing" and "it was informative but not in a lot of detail" point to the need for clearer signalling of the learning path and possibly deeper elaboration of certain clinical decision points.

The lesson statistics show that students took between approximately 3.5 and 24 minutes to complete the lesson, with both cohorts achieving high scores. This range suggests that the nonlinear design allowed self-pacing and selective navigation, which can be advantageous for learners with different prior knowledge and reading speeds. Very short completion times in some cases may indicate superficial interaction with some pages, raising questions about how best to encourage more thorough engagement (e.g., via more frequent embedded questions or required checkpoints).

The preliminary findings support the integration of interactive Moodle lessons as standard pre-simulation preparation for endodontic access cavity exercises. By providing clear objectives, concise explanatory text, and carefully curated images, such lessons can help students better prepare for subsequent simulation training. The positive perceptions from both language cohorts also suggest that the same digital resource can effectively support parallel curricula, which is particularly relevant for faculties hosting both national and international programs.

The embedded questions and branching structure offer opportunities for formative assessment and self-regulation, which are central to contemporary competency-based frameworks in dental education. With iterative redesign, the lesson could be expanded into a more comprehensive learning pathway that links pre-simulation preparation, simulator-based tasks, and post-simulation reflection, in line with models that emphasize feedback and deliberate practice for psychomotor skill acquisition.

Limitations and Directions for Future Research

This study has several limitations that should be considered when interpreting the findings. First, the sample size was modest and drawn from a single institution, which limits the generalizability of the results to other curricula and educational contexts. Second, the study evaluated only self-reported satisfaction and perceptions immediately after the lesson, without objective measures of knowledge gain, procedural performance, or long-term retention. Third, the cross-sectional design does not allow causal inferences about the impact of the lesson on simulator performance or clinical outcomes.

Future research should therefore include controlled comparisons between students who complete the pre-simulation lesson and those who receive traditional preparation only, with outcomes such as access cavity quality, error rates, and efficiency on simulators. It would also be valuable to explore how additional features — such as short video clips, annotated 3D models, or adaptive branching based on quiz performance — affect both satisfaction and learning outcomes. Longitudinal studies examining how early exposure to structured digital pre-simulation resources influences students' confidence and performance as they transition from preclinical to clinical endodontics would further clarify the educational value of this approach.

Conclusion

This preliminary study indicates that a multimedia, interactive Moodle-based pre-simulation lesson on endodontic access cavity preparation is a feasible and well-accepted component of third-year

dental training. Students in both the Bulgarian- and English-taught cohorts reported high levels of satisfaction with the clarity, structure, and visual quality of the lesson, and most agreed that it was sufficient to support the stated objectives. The positive perceptions and supportive qualitative comments suggest that such lessons can usefully prepare students for subsequent simulator-based exercises and may help standardize preparation across language streams. Given the single-center design and focus on self-reported satisfaction, further research is needed to examine the impact of this approach on objective performance outcomes and to explore how additional interactive features might enhance both learning and confidence.

Conflict of Interest The authors declare no conflict of interest.

Funding

Contract No BG-RRP-2.004-0007-C01

Strategic Research and Innovation Programme for the Development of the Medical University – Plovdiv (SRIPD-MUP). Pillar 2: Establishment of a network of research universities of the Programme for Accelerating Economic Recovery and Transformation through Science and Innovation of the Innovative Bulgaria component of the National Recovery and Sustainability Plan funded by the European Union – NextGenerationEU.

REFERENCES

Almaslamani et al. 2026: Almaslamani, M., Mahmoud, O., Ali, A. and Abdelmagied, M. (2026), Benefits of Using Magnification in Access Cavity Preparation by Undergraduate Dental Students: A Micro-Computed Tomography Study. *Eur J Dent Educ*, 30: 77–86. https://doi.org/10.1111/eje.13105

Slaczka et al. 2024: Slaczka, D.M., Shah, R., Liu, C., Zou, F. & Karunanayake, G.A. (2024) Endodontic access cavity training using artificial teeth and Simodont® dental trainer: A comparison of student performance and acceptance. *International Endodontic Journal*, 00, 1–9. Available from: https://doi.org/10.1111/iej.14171

Segura-Egea et al. 2025: Segura-Egea, J. J., León-López, M., Cabanillas-Balsera, D. et al. (2025). *Current teaching of endodontics in dental schools around the world: A systematic review.* https://doi.org/10.20944/preprints202502.0574.v1

Manav et al. 2025: Manav, E.Y., Akbiyik, S.Y., Ceylan, A.B. *et al.* Effects of virtual reality and layered tooth model training on manual dexterity in preclinical dental education. *BMC Med Educ* **25**, 1020 (2025). https://doi.org/10.1186/s12909-025-07622-9

Gramatges-Rojas et al. 2025: Gramatges-Rojas A, Sittoni-Pino MF, Flacco N, Musalem-Dominguez O, Spinelli M, Felszeghy S and Arias-Herrera S (2025) Can haptic reinforced VR simulation transform preclinical pulpotomy training? Insights into skill acquisition, student perceptions, and educational impact: randomized controlled trial. Front. Oral Health 6:1677056. https://doi.org/10.3389/froh.2025.1677056

Cox et al. 2017: Cox, M.J., Quinn, B.F., San Diego, J.P., Patel, J., Gawali, K., Woolford, M. (2017). Innovations in Teaching and Learning Strategies to Improve the Effectiveness of Using Haptic Simulators in Higher Education for Dental Students and Other Health Care Disciplines. – In: Tatnall, A., Webb, M. (eds) *Tomorrow's Learning: Involving Everyone. Learning with and about Technologies and Computing.* WCCE 2017. IFIP Advances in Information and Communication Technology, vol 515. Springer, Cham. https://doi.org/10.1007/978-3-319-74310-3_40

Chang et al. 2017: Chang HJ, Symkhampha K, Huh KH, Yi WJ, Heo MS, Lee SS, Choi SC. The development of a learning management system for dental radiology education: A technical report. *Imaging Sci Dent*. 2017 Mar;47(1): 51–55. https://doi.org/10.5624/isd.2017.47.1.51

El Tantawi, Mourady 2012: El Tantawi M., Mourady A. (2012). Using Moodle as an e-learning solution in dental education – a one year experience. *European, Mediterranean & Middle Eastern Conference on Information Systems* 2012 (EMCIS2012), June 7-8, Munich, Germany. Conference proceedings, pp. 695–711.

Ostermann et al. 2017: Ostermann, T., Ihlhoff-Goulioumius, H., Fischer, M. R., Ehlers, J. P. and Zupanic, M. (2017). Implementation and Empirical Evaluation of a Case-based, Interactive e-Learning Module with X-ray Tooth Prognosis. In *Proceedings of the 6th International Conference on Data Science, Technology and Applications – DATA*; SciTePress, pages 277–281. DOI: 10.5220/0006475302770281

Tan et al. 2021: Tan SHX, Ansari A, Ali NMI, Yap AU. Simulation design and students' satisfaction with home-based simulation learning in oral health therapy. *J Dent Educ*. 2021;85:847–855. https://doi.org/10.1002/jdd.12576

Sánchez-Herrera et al. 2025: Sánchez-Herrera G, Deeb O, Alfaro-Ochoa FJ, Pérez-Leal M, Palma-Carrió C and Flacco N (2025) Effect of prior haptic virtual reality simulation on preclinical endodontic access cavity preparation. Front. Oral Health 6:1673147. doi: 10.3389/froh.2025.1673147

Choi et al. 2023: Choi S, Choi J, Peters OA, Peters CI. Design of an interactive system for access cavity assessment: A novel feedback tool for preclinical endodontics. *Eur J Dent Educ*. 2023;27:1031-1039. doi:10.1111/eje.12895

Dabbour et al. 2018: Dabbour H, Liew AKC, Soo E, Abdullah D. Efficacy of Two Different Views of Video Demonstration in Teaching Access Cavity Preparation to Third Year Dental Students. *Iran Endod J.* 2018 Fall;13(4):474-480. doi: 10.22037/iej.v13i4.20275. PMID: 36883030; PMCID: PMC9985672.

Fouda et al. 2025: Fouda, S. M., Madi, M., Ellakany, P., Aly, N. M., Bahgat, H. A., Elembaby, A. E., Virtanen, J. I., & AlHumaid, J. (2025). The perception of dental students and educators about e-learning during COVID − 19 pandemic. *BMC Oral Health*, *25*, 829. https://doi.org/10.1186/s12903-025-06152-6