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Active Teaching-Learning Methodologies Applied in Implant Dentistry

Metodologias Ativas de Ensino-Aprendizagem Aplicadas na Implantodontia

Poliana Sandes da Silva[a]; Alena Ribeiro Alves Peixoto Medrado[b]; Juliana Borges de Lima Dantas[a]; Atson Carlos de Souza Fernandes[a]; Illa Oliveira Bitencourt Farias[a]

[a]Escola Bahiana de Medicina e Saúde Pública. BA, Brazil
[b]Universidade Federal da Bahia. BA, Brazil.
E -mail: julianadantas@bahiana.edu.br

Abstract

The teaching and learning methodologies in implant dentistry have been the subject of ongoing discussion due to the challenges students face in developing the skills necessary to perform both the planning and surgical-prosthetic stages of implant-supported rehabilitation. To address this, a literature review was conducted to describe the various active teaching methodologies applied in implant dentistry. An electronic search was carried out in the PubMed, Google Scholar, and SciELO databases between January 2023 and August 2024, targeting publications from 2018 to 2024 in English and Portuguese. A total of 5,650 articles were identified. Following title and abstract screening, nine studies were selected for full-text review, of which four met the established inclusion and exclusion criteria. The reviewed literature described active methodologies such as Active Learning, the Flipped Classroom model, Augmented Reality, Realistic Simulation, as well as Sensory and Hybrid Reality approaches for teaching implant dentistry. According to the findings, the integration of innovative teaching and learning methodologies in implant dentistry enhances the opportunity for practice-based learning experiences that closely replicate real-world scenarios. However, the results also highlight a persistent need for the incorporation of these active methodologies into both undergraduate and postgraduate curricula. Such implementation would improve the students' and professionals' training in the planning and execution of implant-supported rehabilitations, ultimately fostering greater clinical competence and readiness.

Keywords: Dental Implants. Educational Measurement. Training Support. Active Learning. Systematic Review.

Resumo

As metodologias de ensino e aprendizagem na Implantodontia têm sido discutidas em virtude da dificuldade dos discentes em desenvolver habilidades para a execução do planejamento e das etapas cirúrgico-protéticas da reabilitação implantossuportada. Nesse sentido, foi desenvolvida uma revisão de literatura para descrever as diversas metodologias ativas de ensino aplicadas na Implantodontia, a partir de pesquisa eletrônica na base de dados PubMed, Google Scholar e SciELO, realizada no período de Janeiro 2023 a Agosto 2024, em busca de publicações entre os anos de 2018 e 2024 em idiomas inglês e português. De um total de 5650 artigos publicados, foram escolhidos 9 estudos para leitura e análise dos títulos e resumos. Apenas 4 publicações foram selecionadas contemplando os critérios de inclusão e exclusão. Foram descritas metodologias ativas a exemplo de Aprendizado Ativo, Sala de Aula Invertida, Realidade Aumentada, Simulação Realística, além de Realidade Sensorial e Híbrida voltadas para o ensino da Implantodontia. Segundo a literatura pesquisada, a aplicação de novas metodologias de ensino e aprendizagem na Implantodontia oportuniza a implementação de uma aprendizagem com experiências práticas que englobam a realidade. Contudo, observou-se a necessidade da inserção de metodologias ativas de ensino e aprendizagem aplicadas na Implantodontia nos cursos de graduação e pós-graduação para melhor capacitação de discentes e profissionais no que diz respeito ao planejamento e execução de reabilitações implantossuportadas.

Palavras-chaves: *Implantes Dentários. Avaliação Educacional. Apoio ao Desenvolvimento de Recursos Humanos. Aprendizado Ativo. Revisão Sistemática.*

1 Introduction

In the digital dentistry scenario, pre-surgical planning for implant rehabilitation procedures using complementary technologies has become increasingly common[1]. Innovative teaching methodologies have thus emerged, combined with everyday professional practice to improve teaching at undergraduate and postgraduate levels, based on the implementation of new technologies, to contribute to the students' training [1]

It is possible to see the importance of implementing new teaching strategies in academic institutions in the health area, to promote appropriate professional training, capable of transforming theoretical and practical knowledge into an important contribution to the care needed for the patients' health[2]. This is a skill that can be acquired through the application of active learning methodologies during undergraduate and postgraduate courses, which enables the development of skills beyond the cognitive domain[3,4].

In the scenario of educational development, the performance of undergraduate students should be integrated

with the application of an incremental line of learning for better use of curricular components, based on theoretical classes associated with laboratory practices and clinical care[5]. However, despite the recognition of the skills and abilities of dental professionals, it is necessary to offer individualized care for each patient, considering social, clinical and physiological aspects[5].

For a long time, traditional teaching advocated that students should only be recipients of information[6]. However, in one of his works on "Banking Education", Paulo Freire emphasizes the metaphor of the bank to compare students to empty containers that need the deposits of knowledge from the teacher. Such education aims to accommodate and adapt students to the world, as well as sowing the seeds of their creativity[6].

And according to the National Curriculum Guidelines for Undergraduate Dentistry Education, education in higher education should be centered on the student as subject and the teacher as mediator/facilitator[7]. In this sense, it is important to implement active methodologies in Dentistry, especially in Implant Dentistry, such as the *Blended Learning* method ("*Blended Learning* - BL"), combining online and face-to-face methodologies, in which the student becomes responsible for their own knowledge[8,9]. We can also consider the use of Active Learning and Virtual Reality as learning material aimed at training students' practical and cognitive skills[8].

In this context, the application of theoretical-practical teaching to implant dentistry has been highlighted due to the difficulty students have in developing skills to carry out the planning, surgical and prosthetic stages of rehabilitation with dental implants. In addition, the introduction of digital technologies has enabled undergraduate students to develop their theoretical and practical skills in innovative and modern environments.

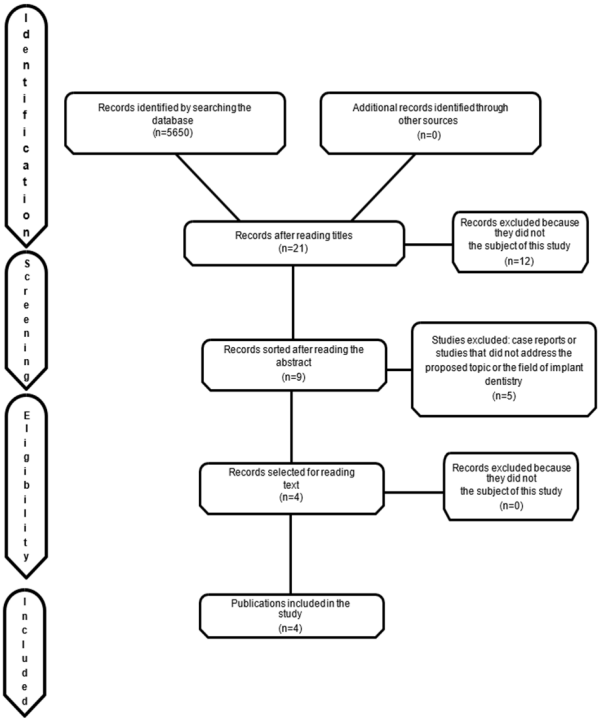
The aim of this study was to develop a literature review to describe the various active teaching and learning methodologies applied in implant dentistry.

2 Material and Methods

This study consists of a discussed literature review, carried out from January 2023 to August 2024, through an electronic search in the PubMed, Google Scholar and SciELO databases for publications between 2018 and 2024 with the keywords "*Dental Implants", "Educational Measurement", "Training Support", "Active Learning" and "Systematic Review",* combined using the Boolean expression AND. To select the articles, the titles and abstracts were read and analyzed. The inclusion criteria for the references used were literature review, type of study design (cohort, cross-sectional, prospective and longitudinal); language (English or Portuguese); approach to active teaching methodologies in implant dentistry and the availability of free full text.

Of a total of 5,650 results, 9 publications were chosen (Figure 1). Of these, only 4 publications were selected and are summarized in Table 1, covering the inclusion and exclusion criteria. These publications were supplemented by other references that were relevant to the work because of the need for concepts not described in the previously selected articles that were important for supplementing and discussing the content, as well as adding other references cited in the articles referenced by manual search. Articles published in languages other than English and Portuguese were excluded, as case report studies were or those not focused on the field of implant dentistry.

Figure 1 - Prisma® flowchart of the study based. EBMSP, 2024



Source: research data.

Table 1 - Description of the results found between January 2023 and August 2024 of the papers used in the study. EBMSP, 2024

Author	Type of Study	Methodology	Final Considerations
Ferro et al.[8]	Narrative Review	Active Learning, Inverted Classroom, Augmented Reality, Artificial Intelligence, Sensory Reality and Hybrid Reality methodologies were analyzed.	The application of new teaching and learning methodologies in implant dentistry provides the opportunity to implement learning with practical experiences that encompass reality.
Wu et al.[9]	Observational study	This is a comparative study of student learning in practical dental implant installation classes between a flipped classroom cohort and a traditional classroom cohort, involving 80 volunteer undergraduate students.	The application of the flipped classroom method in implant dentistry developed a significant level of student's learning when compared to the traditional approach in limited class time. Despite the additional study load and greater demands, the previously recorded lessons were relevant to the students' involvement in the subject.
Nagpal et al.[12]	Systematic Review	A detailed search was carried out in the electronic databases Medline (OVID), EMBASE, ERIC and Web of Science	In view of the increase in reported complications resulting from the installation of implants by general practitioners, the need for training aimed at this surgical therapy for postgraduate students was observed. To conclude, it is essential that implant dentistry teaching is based on case selection, diagnosis and a predictable treatment plan.
Monaghesh et al.[19]	Systematic Review	Studies reporting the applications of virtual reality technology in dental implants were analyzed in the PubMed, Web of Science and Scopus databases.	The use of virtual reality in dental implant training had a significant effect on manual skills and the acquisition of theoretical knowledge, which helps to develop important skills for planning clinical cases for students and professionals.

Source: research data.

3 Results and Discussion

The traditional methodology that centers the educator as the sole holder of knowledge, making the student a mere spectator, a receiver of information, has been widely questioned due to the new curricular standards[9,10]. Thus, according to the National Curriculum Guidelines for Undergraduate Dentistry Education, education in higher education institutions should be centered on the student as the subject and supported by the professor as a facilitator and mediator of the learning process, in order to ensure adequate student training encompassing teaching, research and extension[7,11].

There has been a growing increase in complications due to the inappropriate placement of dental implants by professionals with deficits in cognitive skills and critical analysis construction[12]. Thus, studies on the importance of applying practice-based teaching to postgraduate dental students related to the surgical therapy of dental implants are necessary[12]. And to reduce implant placement failures, it takes time and determination on the part of the educators involved in teaching implant dentistry[13].

Active teaching-learning methodologies have been increasingly applied in the health education process[14]. In this sense, Problem-Based Learning (PBL) has been used in order to increase the cognitive ability to apply knowledge in clinical practice and to build critical thinking skills in dental students[15,16]. However, there is no scientific evidence about the application of

PBL in implant dentistry[17].

In addition, the *Blended Learning* (BL) methodology has presented itself as an opportunity to guide and develop different possibilities for each student, according to the need, using methods such as the inverted classroom, individualized or not, with *online* transmission and simulated experiences, for example, which allows knowledge and skills to be shared, ensuring application and problem-solving for competent clinical care[8]. However, the association of two groups (video class + practical workshop and traditional class + practical workshop) on the ideal position of dental implants installed by students in study models, allowed the analysis of learning efficiency with the use of the inverted class in the practical course of Implant Dentistry when compared to the traditional approach[9].

Although the flipped classroom teaching approach has its limitations due to the significant demands made on logistical planning and video production when compared to traditional classes, as well as the fact that it requires more willingness on the part of the students due to the need to watch the videos before the synchronous class, the application of the method has proven to be effective in implant dentistry[9]. In this teaching model, it is possible to provide students with problem-solving skills and cultivate critical thinking through the opportunity to be more involved with the content of the recorded classes and practical exercises, which has an impact on the quality of concentration time and knowledge retained, when compared to traditional classes[9].

It was also possible to find non-traditional methodologies that have been scientifically validated, and which give educators the opportunity to broaden students' learning possibilities, enabling them to practice clinical excellence[8]. Among the methodologies highlighted in this study, concepts such as Active and Combined Learning related to Realistic Simulation (RS) were reported, which are predisposing factors for a significant change in the educational methodology of implant dentistry[8].

Other studies have analyzed evidence on the implementation of practical exercises as a possibility for teaching based on interactive activities, which enables professionals to be trained for intervention in a simulated environment[18]. That is, the application of practices using models, whether plastic, digital, printed or cadaver, in which it is possible to manipulate soft and hard tissues, providing real clinical situations, making it an excellent way to simulate rehabilitation with implants[8].

The literature describes the implementation of technological innovations with gradual advances in computing power, which characterized the introduction of Artificial Intelligence (AI) as the basis for the development of computer systems aimed at augmented reality (AR)[8]. This technology is an impacting factor in the educational process due to its ability to enable sensory perception experiences, from the superimposition of virtual images obtained by computer on real structures or virtual reality (VR), encompassing technologies that allow users to interact with a fictitious virtual environment[8].

VR offers simulation in a virtual environment and allows the evaluation of different anatomical areas of the body, as well as aiding in the planning of procedures and surgical training with dental implants[19]. In addition, the importance of this technology has been recognized by dental professionals and has played a crucial role in the development of dental education geared towards the modern clinical reality of Digital Dentistry[19,20].

In addition, the use of VR in dentistry makes it possible to improve the function and processes of implants and, despite the technology limitations, the method can improve the students' and professionals' performance, as well as the planning of rehabilitation with dental implants[19]. It is believed that the fusion of these technologies in Digital Dentistry is inevitable, since the use of digital resources for planning surgical therapies has become increasingly common[8].

Although there are high success rates in implant dentistry, failures are the main reason for implementing educational resources to improve conventional methods[21]. Among the failure factors, it is possible to highlight inappropriate planning and clinical inexperience due to the application of inefficient teaching methodologies in implant dentistry, which directly interferes with the professionals' training [21].

Implant dentistry is a complex science that requires professional training to exercise cognitive and practical skills to perform a safe and efficient procedure[21]. However, it is notorious that there are different levels of academic training among students on implant dentistry courses due to the different types of teaching applied in higher education institutions[21].

New graduates need to recognize the level of complexity of clinical cases, based on planning that is coherent with the proposed treatment, which can have a positive influence on reducing the number of clinical failures related to dental implants[12]. It is believed that implant dentistry can provide efforts to adequately share the principles and fundamentals of clinical and laboratory practice with implants, raising the level of students' basic competence[12].

Many undergraduates wishing to enter the field of implant dentistry are taught using traditional teaching-learning methodologies, rather than being directly involved in applying skills to prevent clinical complications[8]. In this sense, knowledge, when shared through active methodologies, brings significant results for the student's professional training and allows for the development of competencies, skills and attitudes, as well as facilitating the resolution of real problems in clinical practice and reducing failures in cases of implant-supported rehabilitation[8].

In parallel with the skills developed by Virtual and Augmented Reality, there is also a need to include new technologies which, despite their limited cost, would help develop skills in students and professionals[19]. In other words, the development of teaching aimed at continuous training to

improve skills in implant placement, with the aim of increasing students' tactile ability[19].

A limitation of this literature review was the scarcity of publications that met the established inclusion and exclusion criteria, which allowed only four studies to be included.

4 Conclusion

This study looked at various active methodologies applied to the teaching of implant dentistry, including the inverted classroom, realistic simulation, virtual reality and augmented reality. The findings highlight the importance of incorporating innovative pedagogical approaches into undergraduate and postgraduate courses to enhance the teaching-learning process. However, it is recommended that future research be carried out with expanded inclusion criteria, to include other active methodologies not explored in this research.

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