

# Flipped classroom for the teaching of access cavity preparation in Endodontics

Paulo Maurício Reis de Melo Júnior\*; Sandra Maria Alves Sayão Maia\*; Rodolfo Scavuzzi Carneiro da Cunha\*\*; Edval Espíndola Júnior\*\*; Valdes Roberto Bollela\*\*\*

\* Universidade de Pernambuco

\*\* Faculdade de Odontologia do Recife

\*\*\* Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo (FMRP-USP)

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## ABSTRACT

The objective of this study was to evaluate the flipped classroom as a teaching-learning strategy for endodontic cavity access. Individualized study material for students was made available online through desktop and mobile application software with demonstrative texts, images, and videos. In the face-to-face classes, the knowledge acquired in the previous study was evaluated by an individual test and individual responses were discussed in groups monitored by the teacher who conducted the conference and critical reflection of the answers. Next, a problem case was presented accompanied by questions to be solved by the students in a group. There was a discussion of the answers until the understanding and solution of the presented problem. Videos with the sequence of procedures for “endodontic access cavity preparation” in simulated teeth were watched before and during the execution of the laboratory practice. Among the students, 92.8% agreed that the flipped classroom is a good teaching-learning method, and all believed that it was adequate for learning “endodontic access cavity”, even though the majority (64.2%) recognized that they would have difficulties in mastering the content. After the laboratory activity, all the students were satisfied and confirmed that the method contributed to their learning. In addition, 92.8% agreed that the teaching strategy exceeded expectations and were motivated for other experiences. The data of the retrospective pre–post self-assessment skills showed that there was significant learning by the students and all were considered qualified after the DOPS (Direct Observation of Procedural Skills) by the teacher. It was concluded that the flipped classroom was adequate for “endodontic access cavity” study.

**Descriptors:** Education. Teaching. Learning. Peer-Learning. Endodontics.

## 1 INTRODUCTION

Higher education is facing great challenges specifically regarding the classroom, with the need for renewal of the pedagogic approach used and its structure. This requires changes in the teaching and learning process as well as a critical reflection about the teacher/student/peer interaction, group activities, instant feedback, material-dialogic approach to pedagogy, the use of information and communication technologies, virtual learning environments, video classes, social networks, and other relationship and interaction possibilities<sup>1</sup>.

The student must play the role as a subject of his own learning, recognizing the importance of mastering the contents of the course for an expanded understanding of reality, and the teacher must be a constant mediator between the elaborated knowledge and the difficulties of the students, rather than just offering presentations of the content of his discipline<sup>2</sup>.

According to the assumptions of the National Curricular Directives for the Dentistry courses<sup>3</sup>, a priority is the use of new active strategies and methodologies which should be described in the pedagogic projects of the courses as teaching-learning strategies, with the need to execute interventive projects for the development of educational experiences.

The “flipped classroom” represents an alternative educational model consisting of the inversion of the dynamics of the traditional classroom, whereby the theoretical content is made available by means of reading material, images or videos from apps or from the web. This content is to be accessed by the students in flexible scenarios such as their own home or any other environment they prefer, whereas in the classroom the time is devoted to exercises, the elaboration of projects, open discussions or tests of the skills of application of relevant knowledge for learning<sup>4</sup>.

This strategy intends to develop critical-reflexive and analytical thinking, self-learning and student interaction and is a good alternative for the integration of information and communication technologies applied to education. The teacher acts as a consultant, encouraging the students to engage in investigation and in collective and collaborative work<sup>5</sup>.

Within this context, the objective of the present study was to assess the implementation of a flipped classroom for the teaching of the access cavity preparation content in Endodontics.

## 2 METHODOLOGY

The present study is characterized as an educational research-action<sup>6</sup> for the improvement of Endodontics teaching and the consequent student learning.

The “access cavity preparation” content of the curricular component Basic Oral Health Care II, of the Dentistry Course of the University of Pernambuco, Arcoverde Campus, was selected for adequacy to the “flipped classroom” teaching strategy, divided into three class phases as follows: incisor and canine access cavity (class 1), premolar access cavity (class 2), and molar access cavity (class 3).

The new methodology was first presented to the students with the recommendation of previous individual study using the teaching material made available online by means of a desktop app software and mobile devices (smartphones or tablets) with texts, images and demonstrative videos developed by the professors teaching the curricular component entitled “ENDO UPE – access cavity App”, using the platform online for the creation of apps denoted “app factory” (<https://fabricadeaplicativos.com.br/>).

In the face-to-face classes, the learning

objective was the application of theoretical content to access cavity preparation in simulated teeth in the laboratory (preclinical) environment. The knowledge acquired by the students by previous study was assessed with an individual test consisting of ten fundamental multiple-choice questions of essential basic content for the development of practical activity.

Next, the students were divided into five groups for the discussion of individual responses in an attempt to reach group consensus. With the teacher as a monitor, the responses were checked and submitted to critical reflection for the construction of a single validated template. After the teacher ascertained that the students had obtained significant gains in conceptual understanding, a problem case was presented for clinical contextualization of the content, accompanied by questions to be resolved by the students in groups.

The videos previously provided to the students with the sequence of procedures for access cavity preparation in simulated teeth were projected, so that the teacher could clarify possible doubts. During laboratory practice, the students used the software/app as a support in order to review the operatory steps (<https://www.youtube.com/channel/UC-Iju3V3mfA3MVMqLt6NRw>).

The objectives of laboratory practice learning consisted of the training and execution of access cavity preparation in three simulated anterior upper or lower teeth (incisors and canines), two upper and lower premolars, and two upper and lower molars. The instrument used for evaluation was the Direct Observation of Procedural Skills (DOPS), with the attribution of zero to 10 points after a checklist of seven different items<sup>7</sup>.

Student satisfaction with the method was assessed with questionnaires applied before (expectation) and after the experience and their

perception of the acquisition of competence was determined by a self-assessment (retrospective Pre-Post) questionnaire. The data collected were tabulated and analyzed statistically.

The study was approved by the Research Ethics Committee of the University of Pernambuco (CAAE 56214016.0.0000.5207).

### 3 RESULTS

Fourteen matriculated students participated in the teaching strategy and responded to the questionnaires after giving written informed consent to participate in the study.

The results of the questionnaire regarding expectations about the “flipped classroom” applied before starting the new strategy revealed that 92.8% of the subjects agreed that this was a good teaching-learning method that would be appropriate for learning access cavity preparation, although most of the students (64.2%) admitted that they would have difficulties in mastering the procedure since this was their first practical experience with the execution of endodontic procedures.

After the laboratory activity, the students responded to a questionnaire for the assessment of pre- and post-experience and confirmed that the method contributed to their learning. In addition, 92.8% agreed that the teaching strategy exceeded their expectations and motivated them towards further experiences, with 85.71% stating that they did not prefer traditional methods such as lectures and that they would like to see this model adopted by other curricular components.

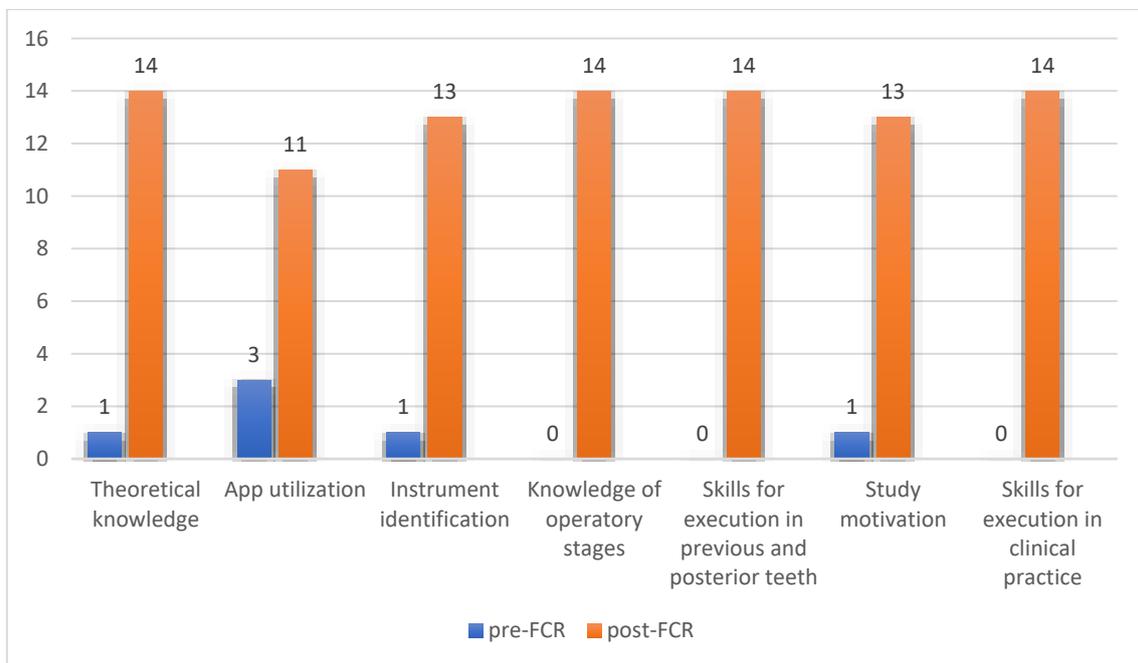
All subjects agreed that the presence of the teacher in the classroom facilitated learning and pointed out that the presentation of content in texts online was favorable, together with images and videos of the procedures available in the educational app.

The students also recognized that this method develops autonomous study and praised

the classroom time devoted to exercises for the assessment of previous learning and to a group discussion with peers and teacher for the solution of doubts.

The data of the self-assessment questionnaire regarding the acquisition of competence applied before and after the flipped classroom confirmed that there was significant learning, as shown in graph 1.

The DOPS scores obtained at the end of the classes revealed that all the students (n=14) showed skill in access cavity preparation after the following items were checked by the teachers: ability to identify the instruments needed for access cavity preparation; the surgical steps; the identification of the point of choice; the skill in trepanation of the pulp chamber, and preparation of the contour and convenience shape.



Graph 1. Acquisition of competence before (pre) and after (post) the flipped classroom (FCR)

#### 4 DISCUSSION

Flipped classroom study associated with the use of educational multimedia apps for the teaching of access cavity preparation showed highly promising results. Indeed, habitually the teachers used face-to-face time with the students in the classroom in order to give a lecture about this topic, recommended its study to the students

and, in the following week, the students performed practical activities related to the content in a simulated laboratory environment. However, normally the teachers did not observe mastery of the operatory steps in most of the students and consequently no safety for their execution. This required a review of theory and programming of the workload expected for

practical activity and for the time to be spent by the teachers in mediation and evaluation, causing disorganization of the pedagogic planning.

Favorable results were also reported in 2015, by Park and Howell<sup>9</sup> in a study at the Harvard School of Dental Medicine in which the students used web resources in order to learn about dental anatomy before a meeting in the classroom and used class time for discussion. The questionnaires applied in order to assess the method revealed increased student participation in the classroom and approval of the model by most of them, mainly due to the collaborative and interactive aspects of this strategy.

In another Dental course at Tokushima University, a study was conducted to compare two active methodologies, team-based learning and flipped classroom, both of them producing similar results regarding the learning of dental prostheses and better results compared to the group that learned this discipline in the traditional manner<sup>10</sup>.

The use of the flipped classroom, like any other active learning methodology, involves changes in the attitude of the students, who must become the protagonists of their own learning<sup>11</sup>. Among the difficulties met by the students to carry out the preparatory activities are the lack of time and the strong cultural belief that the only form of learning consists of lectures proffered face-to-face by the teacher. This was also observed in a student who suggested a complementary lecture even though he was satisfied with his participation in this new experience<sup>12</sup>.

The choice of the use of web course management tools was based on the proposal by Baker at the 11th Conference on College Teaching and Learning held in Florida in 2000<sup>13</sup>, for the first flipped classroom. In this first study, the multimedia material was constructed and made available online for the study of theoretical

content and of the operatory stages that would be executed in laboratory practice. Since it was observed that this type of material was not available on the web, the teachers decided to photograph and record the execution of these procedures before the class. Similarly, Jonathan Bergmann and Aaron Sams, professors of chemistry in Colorado, USA, in 2006 recorded their lectures and posted them for students/athletes who needed to leave regular classes for long periods of time because of training and games<sup>14</sup>. However, in the flipped classroom it is possible to create or use materials already available on the web, although their quality should be evaluated in order to determine whether they are appropriate for the purposes of the course and the learning objectives.

An additional option of the cited study was the creation of an app using the “app factory” platform online, which permits anybody to create his own apps and publish them rapidly and easily with smartphones without programming. Moffett (2015)<sup>15</sup> suggested that teachers who are not familiar with the production of video classes should use videos already existing on the web (YouTube or Vimeo) or record their voice on a slide presentation. In addition, they could use blogs in order to provide material for the students in combination with a space where they could add their notes, as well as Google Drive, Skype, podcasts, video presentations in Microsoft PowerPoint or Keynote. However, the production of video lectures has been the strategy most commonly recommended by the literature regarding the pre-class time<sup>16</sup>, proving to be superior to the reading of textbooks in the flipped classroom<sup>17</sup> or to the use of videos, permitting the students to integrate with the virtual environment such as Moodle or EdModo<sup>18</sup>.

The growing purchase of smartphones by the Brazilian and the world population and the easy access to them as mobile devices have also

contributed to the decision of providing educational material with an app developed by the teachers themselves from the curricular component with student collaboration. This has rendered the study environment more favorable and attractive, facilitating student involvement in the teaching and learning process. Another advantage is that this material can also be accessed through a link with the web in any electronic device without the need to download the app, to be used during the class or later as an auxiliary instructional resource. This often replaced the repetition of the step-by-step demonstration of the operatory stages by the teacher during the laboratory activities.

However, once the teacher decides to experiment with the flipped classroom proposal, he will also have to think how he could stimulate and succeed with his students during the preparatory phase of the face-to-face class. For this reason, the material or previous study was offered with variety using short texts, images, and videos inserted in the multimedia resource to reach out to the students with different learning styles<sup>19</sup>. Thus, more “visual and listening” students should better adapt to the proposal of video classes, while more kinesthetic students may prefer other types of activities, such as practical ones<sup>20</sup>.

When new technologies are properly used they motivate and excite students born in the digital era to use the web, computers, tablets, and smartphones<sup>21,22</sup>. Although some students reported difficulties in access to the internet, the lack of infrastructure of the informatics laboratory and their poor skill in handling apps in some cases, at the end all of them reported that they had learned to use this tool.

The material was offered 15 days before the first face-to-face class and 7 days before the next ones in order to favor study according to the particular rhythm of each student. The students

were also asked if all of them would have easy and unlimited access to the material for consultation as often as needed, as proposed by Sharma *et al.* (2015)<sup>16</sup>. The involvement of more senior students as monitors (peer-instruction) may also be a strategy that permits a more collaborative online time<sup>23</sup>.

The first activity in the face-to-face class was a multiple-choice test with questions about the content of the material previously offered to be responded by the students in order to guarantee the execution of pre-class tasks before the face-to-face meeting and to permit a diagnosis of student knowledge. Indeed, obtaining the engagement and commitment of the students is one of the great challenges of the flipped classroom<sup>24</sup>, and for this reason, the multiplatform app was used by being a multimedia tool of daily access, which was already handled with expertise by most of the students investigated (78.57%).

Again, in order to facilitate learning, mastering of the content and motivation for laboratory activity, the teacher provided feedback and the students discussed in groups the solution of a problem/case which stimulated the memorization and required the understanding, analysis and synthesis of the content to be learned. In addition, the teacher clarified aspects that were not fully clear for the students<sup>25</sup>. Indeed, it is often difficult to identify the correlation between theory and its relevance for professional practice<sup>4</sup>.

Basic notions about techniques that facilitate group work, although representing no exceptional skill, are essential for the teacher, who must also favor student interaction. Before answering a question, he should check with other students whether they can make any contribution and he should monitor the activities of each group, providing clarification and helping the students with the solution of the proposed task,

and offering feedback whenever necessary<sup>24</sup>.

This proposal of the inverted classroom permits a new organization of teaching time and space which, in the present case, was easily integrated into the curricular organization as a new Dental course of the University of Pernambuco. However, the way is open to the revision of teaching strategies to render them more appropriate for the purposes of the course and more effective in order to generate student competence<sup>24</sup>.

The present study dealt with the four central pillars of the flipped classroom strategy, i.e., *flexibility*, with the establishment of activities that would favor interaction and reflection on the part of the students, observation and continuous monitoring with the offer of different opportunities of learning the content; *learning*, with the student having the opportunity of being in the center of his own learning, engaging in relevant and significant activities which provided more in-depth meaning of what was being learned; *intentional teaching actions*, i.e., the proposed activities were based on the learning objectives and differentiated teaching material was provided that would guarantee learning of the content; *professional educator*, i.e., the teacher was available to the students by evaluating them and providing regular feedback, which in turn reflected on his own teaching practice<sup>25</sup>.

It was observed that the students already had positive expectations about the flipped classroom, as confirmed by the results of the satisfaction questionnaire after the intervention. The study of the data obtained with the questionnaires before and after gaining competence revealed a gain of competence in theoretical knowledge, the identification of the instruments needed and the operative stages for access cavity preparation, as well as skills for their practical application to all dental groups and

sufficient training for their use in dental clinic patients. In other studies, the use of a flipped classroom in Medical courses also potentiated learning in the humanities<sup>26</sup>, surgery<sup>27</sup>, emergency medicine<sup>28</sup> and in clinical skills for the management and resuscitation of trauma victims<sup>29</sup>.

The students reported other factors that might have contributed to the positive result of the intervention, including the innovative teaching material and greater interaction with peers and instructors, since their active presence favored learning, possibly because the teacher, by being free from giving lectures, became more available to resolve doubts, to provide guidance and to evaluate. Similarly, a cohort study on public health students<sup>30</sup> also revealed greater motivation for, and engagement with the study, as previously seen with students of a Nursing course<sup>31</sup>.

In a Pharmacy course, student evaluation by the teachers using the DOPS revealed improved achievement<sup>32</sup>, as observed for student performance in access cavity preparation in simulated teeth of all dental groups.

Within this context, the teacher acts much more like the person who plans and implements the teaching activity (clearly stating which learning objectives are to be reached) and acts in face-to-face meetings as a facilitator of learning, guaranteeing by strategies of formative and summative evaluation that the expected results are actually achieved. Although the flipped classroom idea is simple, it can be a flawed method if the technique is not mastered by the instructor and understood by the student as a method motivating him to learn<sup>2-33</sup>.

As can be seen, the flipped classroom is an alternative for teachers who wish to diversify their way of teaching, representing an efficient active teaching-learning methodology with the differential characteristic of permitting the

simultaneous practice of various concepts and pedagogic resources that are essential for the training of dental surgeons. Examples are: collaborative learning; the development of student autonomy and learning at his own pace (learning to learn); peer instruction; significant learning with application of the acquired knowledge; hybrid study (face-to-face and distance education); e-learning using technology and the web, and greater availability of the teacher for the detection of gaps and weaknesses of the student, in addition to access to a prompt feedback.

As limitations of the strategy used in the study, the students reported interferences for access to the web, little experience with the use of the educational app, and lack of infrastructure in the laboratory for practical simulations and in the informatics center of the course. And one student suggested the use of a lecture before the practical activity.

## 5 CONCLUSIONS

The flipped classroom strategy was appropriate for the study of access cavity preparation. The students showed greater motivation for the study of Endodontics and satisfaction with the method and felt more competent for the execution of endodontic procedures.

## RESUMO

### **Sala de aula invertida para o ensino do conteúdo abertura coronária em Endodontia**

O objetivo deste estudo foi avaliar a sala de aula invertida como estratégia de ensino-aprendizagem para o conteúdo abertura coronária. O material didático para estudo prévio individual pelos estudantes foi disponibilizado *online* por meio de um *software*/aplicativo para *desktop* e dispositivos móveis contendo textos, imagens e vídeos demonstrativos. Nas aulas presenciais, o estudo

prévio foi avaliado por um teste individual e em grupos houve discussão das respostas individuais monitorada pelo professor. Em seguida, foi apresentado um caso-problema, acompanhado de questões a serem resolvidas. Houve discussão das respostas até o entendimento e solução do problema apresentado. Vídeos com a sequência dos procedimentos para abertura coronária de elementos dentários simulados foram projetados antes e durante a execução da prática laboratorial. Por meio das respostas dos questionários de expectativa e de avaliação do método, 92,8% concordaram ser um método adequado para o aprendizado do tema proposto, apesar da maioria (64,2%) reconhecer que teriam dificuldades para o domínio do conteúdo. Após a atividade laboratorial, 100% dos estudantes estavam satisfeitos e confirmaram que o método contribuiu para o seu aprendizado. Além disso, 92,8% concordaram que a estratégia de ensino superou as expectativas e que estavam motivados para outras experiências. Os dados da autoavaliação de aquisição de competências pré e pós sala de aula invertida comprovaram que houve aprendizado significativo pelos estudantes e todos foram considerados habilitados baseados nos dados após a observação das habilidades pelo professor. Concluiu-se que a estratégia da sala de aula invertida foi adequada para o estudo do conteúdo abertura coronária.

**Descritores:** Educação. Ensino. Aprendizagem por Associação de Pares. Endodontia.

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Correspondência para:  
Paulo Maurício Reis de Melo Júnior  
e-mail: [paulo.reis@upe.br](mailto:paulo.reis@upe.br)  
Rua Quarenta e oito, 895 Encruzilhada  
52.050-380 Recife/PE Brasil