Application of The Flipped Classroom, Jigsaw Classroom and PBL Methodologies in An Electrical Engineering Course

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Abstract: This paper intends to demonstrate an application of three learning methodologies – Problem Based Learning (PBL), The Jigsaw Classroom and Flipped Classroom – in an Electrical Materials I class, present in the fourth semester curriculum of the Electrical Engineering Course at the Universidade Federal do Pará (UFPA). Such an application was considered innovative because, besides stimulating proactivity, it was able to intercalate several methodologies that show to the students, in a practical way, how to apply the theoretical knowledge acquired in class in common problems and projects find in Engineering. During the course, each evaluation (in a total of four) involved unique characteristics of the used methodologies, but traditional tests, about the course content, were still being applied by the teacher. Another measure adopted was the choice to use a main object of study, this being the transformer, extremely used and necessary equipment in electrical power systems, an electrical Engineering actuation field. Thus, during this work elaboration, a
bibliographical research was done about these methodologies, besides a study about how the discipline in question was previously taught and the differences between his content at UFPA and other universities. After the last evaluation and the dissemination of the grades obtained by the students, an opinion survey was conducted (using the Likert scale) as a way to obtain a return about the level of acceptance regarding the way in which the discipline was presented. In addition, discursive questions were asked so that the students could give their opinion in a critical way, which would be considered for a better implementation in the subsequent classes. Finally, it is worth emphasize that the technique used during the course culminated in the production of articles written by the class, in order to exercise the scientific writing of the students. The set of these attributes contributed to the development and improvement of necessary skills that must be worked in an engineer’s formation at the present time.

*Keywords:* Active Learning, Electrical Engineering, Flipped Classroom, Jigsaw Classroom, Project Based Learning.

### 26.1 Background

The learning quality of university students can be optimized through the use of teaching techniques that deviate from the traditional model (with the
students being the passive agents in the teaching-learning dynamics). The scientific literature shows several cases in which methodologies that focus on proactivity have provided good results, such as: group skills development, the realization of projects which show practical applications of the subjects in question and a better content assimilation, according to what students report\textsuperscript{1-3}.

This work is a case study of the Electrical Materials I module, taught in the second semester of 2016. The group had 39 students from the Electrical Engineering course present in the Universidade Federal do Pará. The teacher in charge of the classes aimed to merge three types of methodology, these being: Project-Based Learning (PBL), Flipped Classroom and Jigsaw Learning. These methodologies will be described during this work.

### 26.2 Purpose/Hypothesis

The objective of this work is to describe the application and results of the PBL, Flipped Classroom and Jigsaw Classroom methodologies, since the practice was considered innovative when it merged several teaching techniques into a discipline that, within the UFPA Electrical Engineering course, was always taught in the traditional way.

During the semester, it was attempted to show the students practical appli-
26.3 Design/Method

On the first day, the teacher asked the class to divide into groups and explained how would be their evaluation, which was divided into two tests, a seminar and a project (about which they should write an article and do an oral presentation). In the project, the students should, in some way, model the object of study chosen, taking into account, mainly, the electrical properties of the materials that compose the transformer.

After the division of groups, each student was also responsible for a specific theme, which resulted in the assembly of new groups (secondary groups) with students who had the same theme in common. After the study of these subjects, which related to the types of materials from the electromagnetic point of
view (diamagnetic materials, conductors, dielectrics, among others), the main
groups were built once again, each member being considered “specialist” in
a given theme, which proved to be important for the final work, encouraging
teamwork. This technique is called the Jigsaw Classroom\(^2\).

With the seminars, the students did researches and presentations about
the module’s content before the teacher’s lesson, causing the class to have
a previous understanding about the topics of the module, besides the more
active role students acquired at the classroom. This approach is known as
Flipped Classroom\(^3\).

In order to focus the student as the active agent in learning process, the
PBL method was also used during Electrical Materials I module. This method-
ology uses a project approach, where the teacher and/or a tutor guide the
students using the necessary didactic resources for each situation. With the
proposal made for the final evaluation, students were motivated to look for
more information on transformers, so that they could find efficient project
design solutions, with each team elaborating their solution\(^1\).

### 26.4 Results

The studies’ results were analyzed using an opinion survey in a Likert scale
of five alternatives, which shows the degree of acceptance of the respondents
about any proposed statement. The survey was divided into four parts: one about the Jigsaw methodology (questions 1 to 5); one about the PBL (6 to 10); one about the Flipped Classroom methodology (11 to 15) and one with general questions (16 to 20). Before the first three parts, there was a text explaining briefly each of the methodologies. The survey involved general questions (whether the students had identified the use of methodologies or not, whether their application was valid in the subject, if there was an improvement on the class dynamics, among others), with the last two questions (19 and 21) being discursive, so that the students could express their opinion about the module (pros and cons) and to report if they had any previous experience of this kind at some earlier point at UFPA's Electrical Engineering course. 14 out of 39 students decided to answer the survey.

After the survey analysis, it was possible to imply that the used techniques were quite adequate and well accepted by the students, who reported that few modules during their graduation were taught differently of the traditional way. According to the undergraduates, classroom performance was better, as was the assimilation of content and the development of skills essential to an engineer, such as problem solving, teamwork and proactivity. Some students also reported that they would like to have had more expository classes and more exercise resolutions, but even so, they recognized that the methodologies cited have yielded advantageous experiences. Finally, it was observed that the
application of these methodologies instigated the students to produce their own elaborated scientific knowledge among their competences, promoting benefits for their academic life.

26.5 Opinion Survey

1) Do you identify the use of this methodology in the Electrical Materials I module?; 2) It is valid the use of this methodology in the Electrical Materials I module; 3) It is possible to work more independently in the Jigsaw Classroom format than in the traditional methodology; 4) The Jigsaw Classroom leaves the work very dependent on the performance of the other members of the group; 5) The distribution of roles among the participants of the base groups facilitated the realization of the final project requested by the teacher; 6) Do you identify the use of this methodology in the Electrical Materials I module?; 8) The application of the PBL methodology can positively influence learning; 9) Project design assists student pro-activity; 10) This methodology provides a practical overview an Engineering project development; 11) Do you identify the use of this methodology in the Electrical Materials I module?; 12) It is valid the use of this methodology in the Electrical Materials I module; 13) This methodology improves the class dynamics, since the students, after making the presentations, already have a theoretical background and doubts about the
topics to be taught; 14) The student acquires more autonomy in the learning process from the Inverted Classroom methodology; 15) It is possible, using this methodology, to perceive which students really have some difficulty in the subjects, being able to draw the profile of each student and give more attention to the one that really needs; 16) The timetable of the course was adequate for the presentation of all the works, projects and lessons; 17) The evaluations were considered appropriate for this module; 18) The use of different teaching methodologies provided a more complete experience in relation to knowledge production; 19) Among the modules you have studied so far, have you identified the use of these methodologies? Which (modules and methodologies)?; 20) How was your experience during the Electric Materials I module (with the methodologies used) and what need to change?

Bibliography


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