THE PROFESSORS' TEACHING PRACTICE IN ENGINEERING COURSES: STUDENTS' AND TEACHERS' CONSIDERATIONS

A PRÁTICA DOCENTE DOS PROFESSORES DE ENGENHARIA: CONSIDERAÇÕES DE ALUNOS E PROFESSORES

LA PRÁCTICA DE ENSEÑANZA DE LOS PROFESORES DE INGENIERÍA: CONSIDERACIONES DE LOS ESTUDIANTES Y LOS PROFESORES

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ABSTRACT: This article originates from research funded whose main objective was to understand the teaching practice in the classroom of engineering courses to transform it. The instrument for data collection that was used as basis for the discussions in this text was the printed questionnaire answered by the students and the online questionnaire answered by the professors. A total of one hundred people agreed to participate in this research stage, of which seventy-two were students and twenty-eight professors. For both professors and students, the main positive points in the professors' pedagogical practice of the engineering courses were methodologies and techniques adopted, professors' knowledge and professor-student relationship. This investigation highlights the importance of the methodologies and techniques adopted for the pedagogical practice and, also, highlights the need for its transformation to effectively contribute to the development of the necessary students' skills.

KEYWORDS: Engineering education. Teaching practice. Engineers' skills.

RESUMO: *Este artigo tem origem em uma pesquisa intitulada qualitativa, cujo objetivo principal foi compreender a prática docente na sala de aula dos cursos de engenharia para transformá-la. Assim, o instrumento utilizado para a produção e coleta de dados que serviu de base para as discussões neste texto foi o questionário impresso respondido pelos alunos e o questionário online respondido pelos professores. Concordaram em participar nesta etapa da pesquisa um total de cem pessoas, sendo que destas, setenta e dois eram alunos e vinte e oito eram professores. Tanto para os professores quanto para os alunos, os principais pontos positivos na prática pedagógica dos professores dos referentes cursos foram: metodologias e técnicas de ensino utilizadas, conhecimento dos professores e relação professor-aluno. Esta investigação evidencia a importância das metodologias e técnicas de ensino utilizadas para o desenvolvimento da prática pedagógica, e destaca, ainda, a necessidade de se implementar*

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uma prática docente coerente com o objetivo dos cursos, qual seja: contribuir para o desenvolvimento das competências necessárias à atuação do engenheiro.

***PALAVRAS-CHAVE**: Ensino de engenharia. Prática docente. Competências do engenheiro.*

***RESUMEN**: Este artículo hace parte de una investigación cualitativa cuyo objetivo principal fue comprender la práctica docente en las clases de ingeniería para transformarla. El instrumento utilizado para la recopilación de datos que sirvió de base para las discusiones en este texto fue el cuestionario impreso respondido por los estudiantes y el cuestionario en línea respondido por los maestros. Un total de cien personas acordaron participar en esta etapa de la investigación, de las cuales setenta y dos eran estudiantes y veintiocho maestros. Tanto para los maestros como para los alumnos, los principales puntos positivos en la práctica pedagógica de los docentes de los cursos de ingeniería fueron: metodologías y técnicas adoptadas, conocimiento de los docentes y relación maestro-alumno. Esta investigación destaca la importancia de las metodologías y técnicas adoptadas para la práctica pedagógica y, también, destaca la necesidad de su transformación para contribuir efectivamente al desarrollo de las habilidades necesarias.*

***PALABRAS CLAVE**: Enseñanza de ingeniería. Práctica docente. Competencias del ingeniero.*

Introduction

A few years ago, mastery of technical knowledge and professional experience were considered as primary requirements for the exercise of teaching practice. Thus, the vast majority of engineering course professors were invited by Higher Education Institutions (HEI) to lecture subjects in these courses because they were good students and because they were considered successful engineers, with great experience in the market in which they operated. Thus, it was believed that to achieve success in teaching practice, it would be enough for professionals to expose their experiences in the market in the classroom. According to Masetto (2012), the perception of this practice and the economic crisis installed in Brazil in the 1980s led to a large migration of engineers, established in industry, to the university. These liberal professionals, although mastering the technical content, did not have knowledge attested by the teaching courses or by the discipline Didactics/Methodology of higher education, about pedagogical practices.

Resolution CNE/CES 2/2019 (BRASIL, 2019) institutes the National Curriculum Guidelines (DCN) for engineering courses, establishing in its article 3 the desired profile for this professional, considering the formation necessary "[...] humanist, critical and reflective, capable of absorbing and developing new technologies, stimulating their critical and creative

performance in identifying and solving problems, considering their political, economic, social, environmental and cultural aspects, with an ethical and humanistic vision, in compliance with demands of society" (our translation).

Amidst so many discussions about the quality of engineering education, in 2018 the Brazilian Association of Engineering Education (ABENGE), together with Business Mobilization for Innovation and the National Confederation of Industry (MEI/CNI), presented a proposal for Guidelines National Curriculum (ABENGE; MEI/CNI, 2018) for undergraduate courses in engineering with the aim of promoting innovation in education through the construction of a program that would engender improvements in the formation of engineers.

This proposal has been discussed since 2016 by a working group formed by members of government, industry, engineering professionals and academia. As a result of these discussions, the new National Curriculum Guidelines for the Undergraduate Course in Engineering were ratified by the Ministry of Education (MEC) in April 2019. The ratified document proposes a series of reforms, including the establishment of a competency-based curriculum to be developed through contextualized activities that involve the necessary technical content.

Thus, it is expected that graduates from engineering courses develop a profile of humanistic, critical, reflective, creative, cooperative, ethical engineer, able to research, develop and adapt, capable of implementing an innovative and entrepreneurial performance. It can be highlighted in the new National Curriculum Guidelines for Undergraduate Engineering Courses the emphasis on a different education from the traditional one, which is considered here as content. There are references to formation that fosters the development of inter and intrapersonal skills to better meet society's needs, not only providing adequate and innovative services and products, but also actively participating in the development of local or regional society, preserving the environment and maintaining its professional ethics (ABENGE; MEI/CNI, 2018).

Given the obvious need to rethink the teaching-learning process in engineering courses in Brazil, a survey was carried out - entitled Understanding work to transform it: teaching practice in the classroom of engineering courses with funding from the Fund for Incentive to Research-FIP – among three engineering courses at the Polytechnic Institute of a private university in Minas Gerais. The main objective of this research was to understand the teaching practice carried out in the on-site engineering courses of this institute, with the aim of transforming it, if necessary. Three instruments were used for data collection: questionnaires for students and teachers, observation of classes by some teachers who answered the

questionnaires, and formation of a Group of Work Meetings (GET) [3]. This article presents the results obtained through the questionnaire that was the first instrument used for data collection. At this stage, the objectives were: (a) to know the teaching practice from the perspective of the student; (b) knowing the teaching practice from the perspective of the teacher; (c) compare the views of students and teachers on teaching practice and (d) reflect on the most common practices, considering some of the categories of pedagogical theories or teaching approaches that stand out most in the practices of Brazilian teachers, according to Mizukami (1986). This author characterizes five teaching approaches, named as Traditional, Technicist, Humanist, Cognitivist and Socio-Cultural. This characterization is based on the following categories: conception of man, conception of the world, conception of society-culture, conception of education, conception of school. Regarding the didactic elements that make up the teaching-learning process, Mizukami considers: the objectives, the content/knowledge, the teacher-student relationship-method and the assessment.

These teaching approaches made it possible to characterize and identify the pedagogical practices of the professors of engineering courses where the research was carried out. Then it was possible to identify what needs to be transformed, regarding teaching practice, so that the objectives of the courses are achieved.

Pedagogical Practice in Engineering Courses

Changing the curriculum of engineering courses considering a new approach focused on the development of skills and competences by the student requires the involvement of professors, in the sense of reviewing their pedagogical practices. But the need to equally promote a movement of students towards positioning themselves as active subjects in the knowledge construction process, based on skills and competences, cannot be ignored. As stated by Freire (1996), “There is no teaching without a student”, and he asserts that “Teaching is not transferring knowledge” because “Teaching is a human specificity”.

In this sense, the professional teacher is invited to participate in the process of discussion and construction of the Pedagogical Project of the Engineering courses where the research was carried out, even committing themselves to the improvement of their teacher formation. There

[3] Grupos de Encontros do Trabalho-GET é um dispositivo dinâmico de três polos, desenvolvido pela Ergologia, que toma por base o diálogo socrático de sentido duplo para produção de saberes baseado na intervenção e na pesquisa. Os grupos encontros do trabalho se reúnem regularmente para discutir uma situação problema, com base em um referencial teórico, e produzir respostas, ainda que provisórias, para um problema do trabalho real. Para outras informações ver Trinquet (2010).

are several initiatives, national and international, in order to promote the improvement of techniques and methodologies adopted in higher education in engineering with the purpose of leading the professor to implement a practice capable of leading to the development of skills and competences. For example, Cruz (2019) reinforces the importance of popular engineering (PE), whose emphasis is the development of social responsibility, critical thinking, problem-solving capacity and creativity. The PE involves three perspectives that complement each other: the solidarity economy, social technology and university extension. Some factors highlighted by the author that favor the formation of engineers focused on PE are: the involvement of the student in projects and extension work, offer of subjects with a focus on Science, Technology and Society and the requirement of an experience curricular internship.

For the implementation of activities and subjects considering the factors highlighted by Cruz (2019), it is necessary to change the curricular structure of the courses. Keller-Franco and Masetto (2018) draw attention to the curriculum structure based on work projects. It is a way of working that they consider very suitable for engineering courses. A project-based pedagogical structure presupposes a strong relationship between theory and practice, in addition to demanding that work be carried out based on interdisciplinarity. It also implies the implementation of the concept of formative assessment, multiple domains of spaces, times and technologies, valuing the construction of knowledge by the student during the process, promoting an openness to society as an environment for problematization and learning and, finally, partnership relationship between teacher and student in a horizontal relationship between learners. In this context, the development and enhancement of skills such as critical capacity, the ability to solve problems, creativity, collaboration and mastery of sources for the search for information stand out, as a characteristic of a researcher, among other skills.

Other authors emphasize critical pedagogy (PANIAGUA *et al*., 2018), where the student is recognized as an agent of social change. It is the capacity built by a subject who appropriates his social contexts and realities, is autonomous and capable of criticizing and arguing based on theoretical and practical concepts for the creation of initiatives that will converge in alternatives for social transformations. Pereira and Hayashi (2019) investigated the reasoning ability of engineering students. The authors proposed an activity based on Toulmin's argument pattern (TAP) and noticed, in addition to the weakness of argumentation, the students' difficulty in arguing against their own convictions. In a proposal for a collaborative activity mediated by social media and applied in three classes with a total participation of 127 students, Mello (2016) also highlights the fragility of the capacity for collaboration and cooperation of civil engineering students.

In addition to the skills mentioned above, many others are considered necessary for the professional performance of the 21st century engineer (BRASIL, 2002; NATIONAL RESEARCH COUNCIL, 2012; THE ROYAL ACADEMY OF ENGINEERING, 2007), such as: ability to interpret texts in various supports, for decision making, for mastering technologies, for establishing oral and written communication, for active listening, for cultural awareness, for the appreciation of diversity, for adapting to new situations, for acting with ethics, integrity and citizenship, for conflict resolution, negotiation and leadership. These are some highlighted skills that deserve attention.

Some understand competence as a personal characteristic that is exercised in a specific context based on the relationships that human beings establish with the environment (MACHADO, 2002). It can be associated with the manifestation of knowledge to meet complex demands, requiring the mobilization of psychosocial resources, including skills and attitudes, in a specific context (MACHADO, 2002). Considering the human work activity, ergology presents a broader concept of competence, that of industrious competence. The industrious competence involves not only the knowledge appropriated by the subjects, but also the historical dimensions apprehended in the daily work and the values incorporated by them in the relationships established at work (BRITO, 2008; SCHWARTZ, 1998). The industrious being not only mobilizes the knowledge necessary to carry out the prescribed tasks, but also acts by transforming the environment in which he finds himself (BRITO, 2008; SCHWARTZ, 1998).

Methodological Path

Teachers and students from three courses at the Polytechnic Institute of a private university in Minas Gerais were invited to answer a questionnaire on the pedagogical practice commonly adopted in these courses. Students were asked to answer the questionnaire thinking about the class/pedagogical practice adopted by the teachers in the current semester. The same guidelines were presented to teachers who agreed to participate in this research.

Students completed a printed questionnaire that was distributed in the classroom and collected at the beginning of the subsequent class. The students' questionnaire was divided into three blocks of questions, namely: personal information to characterize the group of students (5 multiple-choice questions), lecture/pedagogical practice of teachers (11 multiple-choice questions on a Likert scale and one question discursive) and self-assessment (6 multiple-choice questions on a Likert scale).

Teachers answered an online questionnaire available on the Google Forms platform. The teachers' questionnaire was divided into two blocks: personal information to characterize the group of respondents (7 multiple-choice questions) and teachers' classroom/pedagogical practice (11 multiple-choice questions on a Likert scale and one discursive question). The questions related to the class/pedagogical practice are the same in both questionnaires, however, there was some verbal, pronominal etc. adaptation to the teachers' questionnaire. In the discursive question, both students and teachers were asked to expose, in relation to the teaching practice currently adopted, the positive aspects and those that could be improved.

Table 1 shows the questions of the class/pedagogical practice block of the teachers that are related to the resources and techniques used by the teachers. For these questions, a Likert scale with the five options was adopted: never, at least 1 time, more than 1 time, more than 5 times, more than 10 times. In Table 2 are the questions related to the conduct of classes, and for these the Likert scale adopted with four options was: always, almost always, sometimes, never.

A quantitative analysis was carried out through descriptive statistical analysis with the data collected for the answers to the multiple-choice questions on a Likert scale. A quantitative analysis of the answers to the discursive question was also carried out, based on the categories: conception of man, conception of society, conception of knowledge, teacher-student relationship, methodology-technique and evaluation, as defined by Mizukami (1986) when characterizing the approaches to the teaching-learning process.

Results

One hundred people answered the questionnaires, of which seventy-two were students and twenty-eight were teachers. Frames 1 and 2 present the data produced through the questionnaires answered by students and teachers, respectively, in the block of questions referring to personal information. These data were used to proceed with the characterization of the subjects participating in the research.

Frame 1 – Likert scale questions regarding the resources and techniques used

2.1 The resources mentioned below, for the presentation or discussion of the contents of the disciplines, were used with what frequency						
Whiteboard (blackboard)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Rear projector	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Data Show	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Videos and movies	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Social networks	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
2.2 How often did teachers use the following teaching techniques?						
Lectures (AE)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Exercise solving (RE)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Group work (TG)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Paper presentations (AP)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Workshops (O)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Laboratories (L)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
External visits (VE)	Nunca	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Debates (D)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Case Studies (EC)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Problem solving (RP) based on real situations	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR
Development of prototypes and products (EP)	Never	at least 1 time	More than 1 time	more than 5 times	more than 10 times	NR

Source: Devised by the authors

Frame 2 – Likert scale questions regarding the conduct of classes and student self-assessment

Questionnaire	Question
Student and teacher	2.3 I am free to express myself or not during classes.
	2..4 In my interactions with the course professors, I feel respected and considered in my condition (social, physical and intellectual origin, gender, race, among others).
	2.5 In the classroom I am motivated to interact and cooperate with my peers.
	2.6 The teachers of my course seek to inform themselves about my previous knowledge and consider them to develop the class.
	2.7 Teachers are more concerned with my learning than with teaching the entire content.
	2.8 Teachers create situations that bring theory and practice closer in order to bring real situations into the classroom.
	2.9 Teachers organize the physical space of the classroom according to the proposed activities.

	2.10 Teachers indicate adequate materials for the development of the proposed activities.
	2.11 Teachers assess the results obtained in the classroom and reorganize activities if they were not satisfactory.
Student	2.12 I participate in activities and work developed individually and in groups, with commitment and responsibility.
	2.13 I look for other support references (internet research, library, videos, films, etc.) to deepen the contents worked on in class.
	2.14 With regard to meeting deadlines for delivering work, I consider myself a punctual student.
	2.15 My relationship with teachers is based on cordiality, respect and ethics.
	2.16 My relationship with colleagues is based on cordiality, respect and ethics.
	2.17 I participate/participate in extra-class activities such as monitoring, research activities, readings and complementary studies, among others.

Source: Devised by the authors

As can be seen, most of the student respondents belong to the Metallurgical Engineering course, are male, are in the 10th period, study in the night shift and are involved in some professional activity.

For the responding teachers, see Table 2, most belong to the Energy Engineering course, the predominant gender is male, most are over 50 years of age and more than 50% of this group is dedicated only to teaching. Most professors have experience in higher education, surpassing fifteen years of experience. Among the participating teachers, 60.7% said they had attended some discipline related to higher education methodology or didactics.

Table 1 – Characterization of the 72 responding students

Personal information		**(%)**
Course	Civil Engineering	29.0
	Energy Engineering	20.0
	Metallurgical Engineering	51.0
Gender	Male	51.0
	Female	46.0
	Did not answer	3.0
Current Period	10	51.4
	9	38.9
	8	9.7
Shift	Morning	22.2
	Afternoon	0.0
	Night	75.0
	Did not answer	2.8
They work (internship, monitoring, employment relationship, etc.)	Yes	63.9
	No	31.9
	Did not answer	4.2

Source: Devised by the authors

Table 2 – Characterization of the 28 responding teachers

Personal information		**(%)**
Course	Civil Engineering	39.3
	Energy Engineering	42.8
	Metallurgical Engineering	17.9
Gender	Male	60.7
	Female	39.3
	Did not answer	0.0
Age group	25-30	3.6
	31-35	3.6
	36-40	21.4
	41-45	7.1
	46-50	10.7
	51-55	10.7
	56-60	10.7
	Acima de 60	32.2
Another professional occupation besides teaching	Yes	42.9
	No	57.1
	Did not answer	0.0
Title	Specialist	0.0
	Master	64.3
	Doctor	28.6
	Post-Doctor	7.1
Experience in higher education (years)	0-5	21.4
	6-10	17.9
	11-15	3.6
	Acima de 15	57.1
Attended higher education methodology or didactics	Yes	60.7
	No	39.3

Source: Devised by the authors

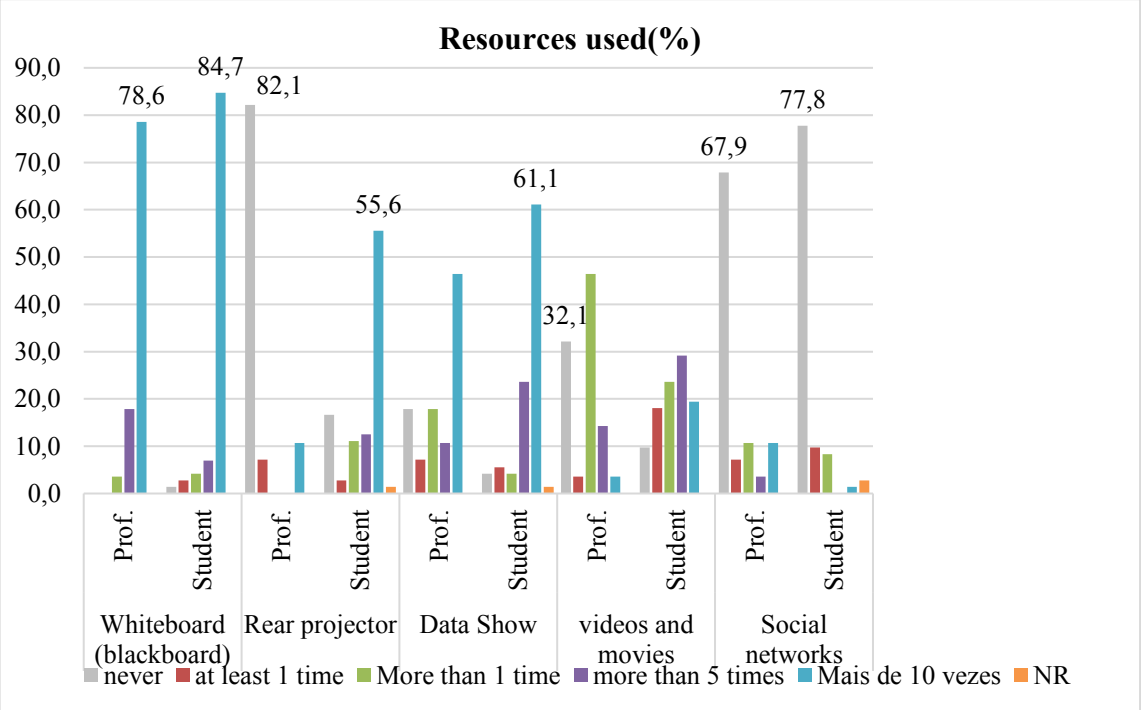
In relation to the resources and teaching techniques present in teaching practices

Graph 1 shows the percentage of occurrences of each item in the Likert scale adopted for question 2.1, presented in Table 1, for both teachers and students. Both teachers and students stated that the most used resource during classes was the whiteboard (blackboard) and, secondly, the slide projection. Although almost all teachers say they do not use the rear projector, practically half of the student respondents said that the overhead projector is still widely used. Most of both groups agree that social networks are not used as educational resources. Those items that were not answered are computed in the NR group in Graphs 1 and 2.

In Graph 2, it can be seen that, according to the teachers' answers, the four techniques most used by them are: lecture, problem solving, problem solving based on real situations and group work. As can be seen in Graph 3, students confirm that the most used techniques are: group work and lectures, presentation of work and laboratory practices.

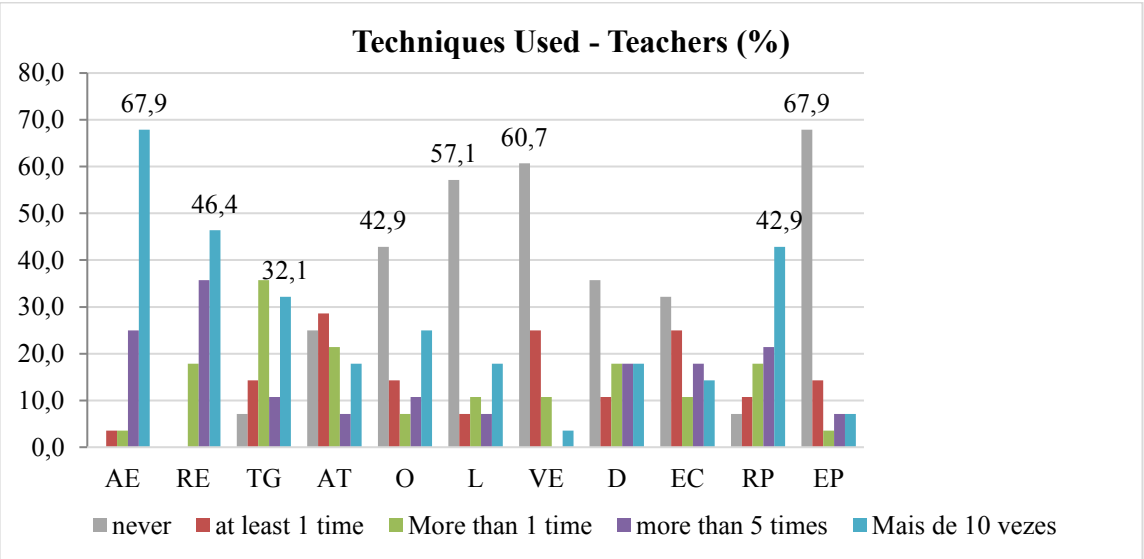
Teachers report that they never use teaching techniques such as prototyping, external visit (technical), laboratory and workshop, as can be seen in Graph 2. Students, in turn, confirm what the teachers reveal. As described in Graph 3, students declare that teachers have never used teaching techniques such as prototyping, debates, workshops and case studies.

Graph 1 – Resources used according to the responses of teachers and students



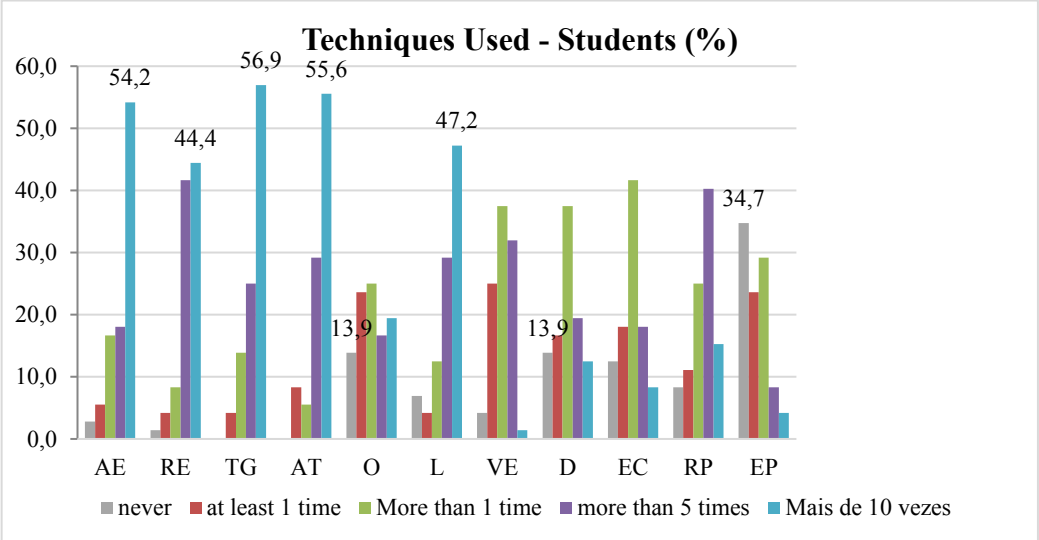
Source: Devised by the authors

Graph 2 – Técnicas utilizadas segundo as respostas dos professores



Source: Devised by the authors

Graph 3 – Techniques used according to student responses



Source: Devised by the authors

The complex teaching work: classroom management

The research reveals that there is a certain consensus among professors that the teaching work is not limited to the transmission and apprehension of contents. As shown in Table 3, more than half of the teachers reported that they always seek information about the students' prior knowledge (question 2.6) and that they are more concerned with student learning than with the presentation of content (question 2.7).

Teachers seek to take a stance that approaches the perspective of approaches that go beyond the traditional stance. Thus, they create situations that bring theory and practice closer (question 2.8), and evaluate the results obtained in the classroom to reorganize the activities if the results are not satisfactory (question 2.11). This finding is also verified by the students, as regarding the same previous questions, most answered almost always or sometimes. Thus, it is clear that technical formation is also a priority, but at the same time there is another priority that cannot be neglected. The student who is learning the engineering profession has the right and the need to learn as best as possible. But he is equally entitled to know the reason for the technical procedure itself. The student must also be able to know the historical origins of technology, or if he wants to, take it as an object of study that aroused his curiosity and also reflect on the indisputable advance it entails without denying the risks to which it exposes us (POSTMAN, 1992).

Most teachers believe that they **always** motivate students to interact and cooperate with their peers (question 2.5), and most students believe that this happens **always** or **almost always**.

The sciences that study human behavior with a focus on motivation claim that there is a mismatch between what research reveals and what teachers at different levels of education do in classrooms and even in the world of work. Therefore, the dynamics of extrinsic motivators are in opposition to science. What is proposed for the 21st century is that teaching practices promote the construction of autonomy. The research reveals that teachers are aware that the classroom must promote the building of cooperation capacity and not competition. However, it is also necessary to consider that it is not possible to train engineers without an understanding of oneself as a historical, political, social and cultural subject. Just as they cannot earn an engineering degree without an understanding of how society works. Such knowledge, supposedly only technical, does not make it possible to build.

Most teachers believe that they **always** motivate students to interact and cooperate with their peers (question 2.5), and most students believe that this happens **always** or **almost always**. The sciences that study human behavior with a focus on motivation claim that there is a mismatch between what research reveals and what teachers at different levels of education do in classrooms and even in the world of work. Therefore, the dynamics of extrinsic motivators are in opposition to science. What is proposed for the 21st century is that teaching practices promote the construction of autonomy. The research reveals that teachers are aware that the classroom must promote the building of cooperation capacity and not competition. However, it is also necessary to consider that it is not possible the formation of engineers without an understanding of oneself as a historical, political, social and cultural subject. Just as they cannot earn an engineering degree without an understanding of how society works. Such knowledge, supposedly only technical, does not make it possible to build.

All teachers stated that they indicate adequate materials for the development of the proposed tasks (question 2.10). This is confirmed when it is verified that 75.0% of students agreed with the teachers. However, it can be asked if students carry out research beyond the materials indicated to carry out the proposed tasks? If the answer is no, it can be concluded that such practices, both student and teacher, are traditional. Such teaching is intended to bring the student into contact with the great achievements of humanity, such as fully elaborated reasoning and demonstrations, and emphasis is placed on models. With teacher-centered teaching, the student is a mere executor of the prescriptions set by the teacher. Therefore, this teaching does not promote the construction of skills and competences provided for in the guidelines of engineering courses.

The teachers, as a whole, stated that they respect the conditions of each student (question 2.4). This statement is confirmed by 86.1% of the students, who agreed with the teachers, reporting that they feel respected in their particular conditions.

Table 4 shows the percentage occurrence of the Likert scale items for students' self-assessment. Almost all students stated that: they participate in the proposed tasks and assignments with commitment and responsibility (2.12); meets deadlines for work deliveries (2.14); relate cordially and respectfully with teachers (2.15) and peers (2.16). Most students stated that they always or almost always look for other references to deepen the contents (2.13). And 51.4% always or almost always participate in extracurricular work.

Table 3 – Answers from teachers and students to questions about conducting classes

Question	Answering	Answers (%)				
		Always	Almost always	Sometimes	Never	NR
2.3	Professor	**96.4**	0.0	3.6	0.0	0.0
	Student	31.9	**47.2**	20.8	0.0	0.0
2.4	Professor	**89.3**	10.7	0.0	0.0	0.0
	Student	**54.2**	31.9	11.1	0.0	2.8
2.5	Professor	**78.6**	17.9	3.6	0.0	0.0
	Student	36.1	**38.9**	20.8	4.2	0.0
2.6	Professor	**57.1**	28.6	14.3	0.0	0.0
	Student	8.3	34.7	**43.1**	13.9	0.0
2.7	Professor	**60.7**	35.7	3.6	0.0	0.0
	Student	5.6	38.9	**43.1**	11.1	1.4
2.8	Professor	**64.3**	28.6	3.6	3.6	0.0
	Student	6.9	37.5	**54.2**	1.4	0.0
2.9	Professor	**39.3**	28.6	28.6	3.6	0.0
	Student	12.5	27.8	**45.8**	12.5	1.4
2.10	Professor	**78.6**	21.4	0.0	0.0	0.0
	Student	22.2	**52.8**	22.2	2.8	0.0
2.11	Professor	**60.7**	28.6	10.7	0.0	0.0
	Student	8.3	30.6	**36.1**	25.0	0.0

Source: Devised by the authors

Table 4 – Student responses to self-assessment questions

Question	Answers (%)				
	Always	Almost always	Sometimes	Never	NR
2.12	47.2	44.4	6.9	0.0	1.4
2.13	41.7	37.5	20.8	0.0	0.0
2.14	58.3	36.1	2.8	1.4	1.4
2.15	81.9	16.7	1.4	0.0	0.0
2.16	69.4	26.4	4.2	0.0	0.0

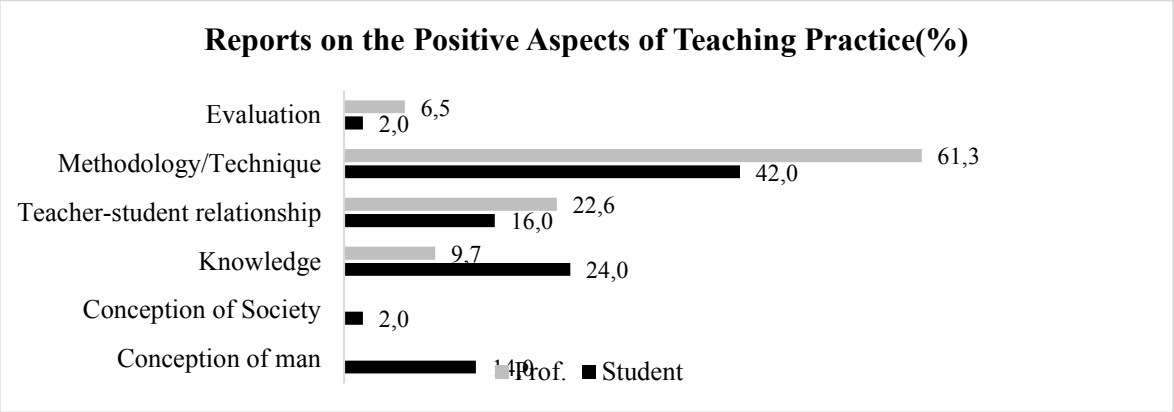
2.17	15.3	36.1	33.3	15.3	0.0

Source: Devised by the authors

In Graph 4, it can be seen that, for professors, the three main positive aspects of teaching practice in engineering courses at the institution where the research was carried out are related to the following categories: methodology/technique, professor-student relationship and knowledge. For students, the main positive aspects reported are also related to the same categories: methodology/technique, knowledge and teacher-student relationship.

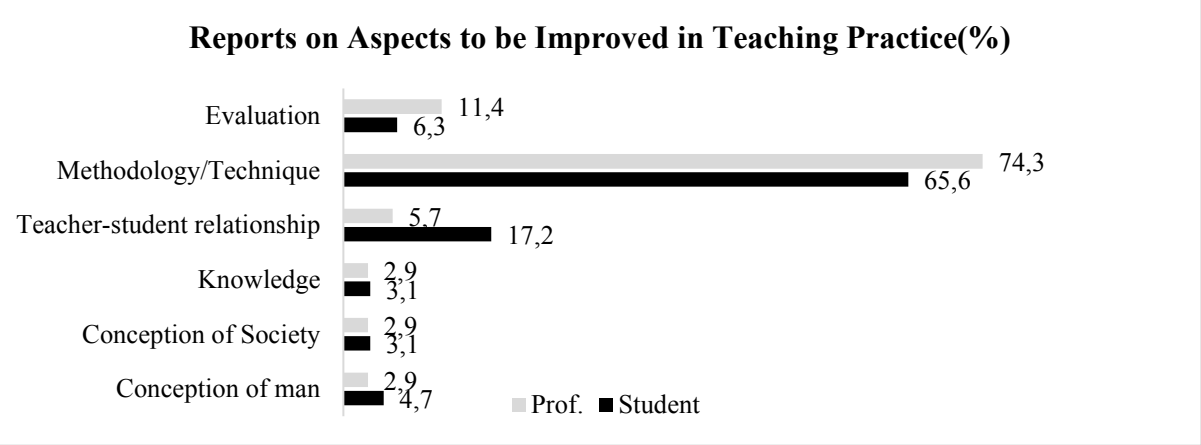
Regarding the aspects to be improved, represented in Graph 5, teachers reported that the three main ones are related to the following categories: methodology/technique, evaluation and teacher-student relationship. From the students' point of view, what needs to be improved is related to: methodology/technique, teacher-student relationship and knowledge. It appears that the methodology/technique and the teacher-student relationship are elements of teaching practice that the two groups participating in the research, that is, both teachers and students, consider that they need to improve.

Graph 4 – Reports from professors and students to the positive aspects of teaching practice



Source: Devised by the authors

Graph 5 – Reports from professors and students for aspects to be improved in teaching practice



Source: Devised by the authors

The data allow us to conclude that to improve the teacher-student relationship, it is necessary to understand the teaching work as complex and closely related to student work, which is equally complex. In this sense, a dialogical relationship makes it possible to understand the work of teachers and students in order to transform it in what direction, if not towards liberation. It is necessary to understand that an authoritarian and verticalized practice, both of the teacher and the student, does not promote the construction of knowledge or emancipation and autonomy. If the teacher-student relationship needs to be improved, and both teachers and students recognize this need, this improvement will become possible as the subjects of this relationship, engaged in a transformative practice, seek to demystify their places of origin. Thus, teachers and students problematize the dominant culture, scientific knowledge, in order to value language, culture and knowledge as historically situated products. Teachers and students create conditions for the naive conscience to be transformed into critical conscience, capable of perceiving social contradictions. Classroom relationships will be based on dialogue that provides opportunities for cooperation, learning management and the solution of real problems. They will become relationships in which decisions are made based on honest and frank dialogue and choices do not prioritize the interests of some over others. This transformation requires a change in the understanding of the teacher's role, but especially of the student as an active, critical and autonomous subject.

Final considerations

Regarding the resources and techniques used by engineering professors at the researched institution, almost all of the students' responses coincide with those of professors, having only different weights. According to the professors and students who participated in the survey, it can be said that the most used resources are still the most traditional, such as the blackboard and the slide projector. As teaching techniques, the expository class with exercise resolution still predominates, although there is also the carrying out of group work and presentation of work. In a few instances, teachers propose activities such as workshops, laboratories, debates, external visits and case studies or work with projects. During the period when the research was carried out, social networks were not yet used as pedagogical resources, nor were proposals made for the development of prototypes. On the other hand, with respect to the conduct of classes, teachers and students disagree in their opinions; except for only one question (2.4), where students agree with teachers considering themselves respected considering their particular conditions (social, physical and intellectual origin, gender, race, among others). Although they think they are conducting classes in a certain way, students interpret this conduct differently. The most discrepant results were for questions 2.7, 2.8, 2.9 and 2.11 (see Table 2). Students believe that teachers are still more concerned with content than learning; teachers do not always bring their contents closer to or contextualize the realities experienced by the students; the classroom is not organized according to the work performed; and no formative evaluation takes place.

Thus, the research reveals that the pedagogical practice of teachers is predominantly based on expository classes, with a tendency for students to reproduce content through the resolution of exercises.

There is an emphasis on classroom situations and great concern with meeting the menu and teaching the contents. The teacher's main objective is the transmission of previously defined, ready and finished content that appears in books and texts. There are also few actions that promote the construction of knowledge and critical reflection on the part of the student. In this context, the student is a taxable person, with minimal participation in classes. With these characteristics, the hypothesis that the predominant teaching approach in the engineering courses of the investigated institution is the traditional one is confirmed (MIZUKAMI, 1986). However, the traditional teaching approach contributes little to the development of skills related to the three domains of competences that are widely recommended for 21st century engineers: (1) cognitive (critical thinking, problem-solving ability, analysis, argumentation, creativity etc.)

; (2) intrapersonal (social responsibility, appreciation of culture and diversity, professionalism, ethics, integrity, citizenship etc.); and (3) interpersonal (communication, collaboration, conflict resolution, leadership etc.) (NATIONAL RESEARCH COUNCIL, 2012).

For Kubo and Botomé (2001), in a teaching and learning process it is essential that there is interaction between the actions of teaching and learning. In this case, teaching refers to what a teacher does and learning about what happens to the student as a result of the teacher's actions and the student's activity. The authors emphasize the importance of teacher behavior when planning and carrying out the teaching process, so that learning can take place. They suggest a series of questions that the teacher must consider when planning and carrying out teaching tasks (KUBO; BOTOMÉ, 2001) (Frame 10). The starting point is the question “which situations will the apprentice need to deal with after graduating?”.

When both teachers and students are asked what are the positive aspects and which can be improved in the pedagogical practice of teachers, there is an emphasis on the adopted methodology/technique and the teacher-student relationship. Due to its importance, it was indicated as the main positive aspect and also as the main one to be improved in this context of the teaching and learning process. In this sense, only with the evaluation of the first data collection instrument, the questionnaires for professors and students, it is concluded that the teaching and learning process in the engineering courses of the researched institution can be improved with the transformation of the teaching practice of its teachers. Initially, it is considered important the care of teachers when planning and carrying out teaching actions, so that these actions provide a more active participation of the student. There is a need to rethink the methodologies and techniques adopted in order to promote the participation of students in projects engaged with the needs, not only of society as a whole, but also of the environment in which they live and will work. Thus, it is important that not only teachers, but the entire academic community are involved in the process, promoting opportunities and encouraging student participation in contextualized extension projects and practices committed to social development.

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