

DIVERSIX: Development and systematization of an Active Method for Engineering Teaching

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Abstract

Current society is heavily influenced by science and technology, indicating the need to train generations with critical ability to analyze messages and make responsible decisions in the context in which they act. This is reflected in teaching in general, requiring the university to be a stimulating environment and not merely transmitting knowledge. The teaching-learning process in science education, in particular engineering, can not therefore be restricted to traditional methods. New practices and technologies, with diversified resources and strategies, have been necessary in the improvement of teaching. The present work had the objective of developing an active method for teaching in engineering, at the School of Engineering of Lorena, University of São Paulo. The results show that students crave experiences that develop transversal competences, and that the transmission of theoretical content loses its place for teaching that promotes a process of autonomous construction of knowledge.

Keywords: Transversal Competences; Engineering Teaching; Active Methodologies

1. Introduction

Rapid changes are taking place in society, with a large volume of information in transit, and this is reflected in education in general, requiring the university to be a stimulating environment and not merely a transmitter of knowledge. In this sense, the dynamics of cooperative construction of the school reality brings intentional meaning to education, due to the constant interrelationship between the school environment and the student's daily life, in an interpretative perspective (CARVALHO, 2004).

The teaching-learning process in science education, particularly in engineering by its own varied demands, should not be restricted to traditional methods. It should rather privilege problem solving, scientific thinking, the use of multiple languages and argumentation (SOUZA AND SASSERON, 2012). This implies pedagogical practices that involve, promote and develop intellectual activity, critical thinking and mobilization of cognitive and metacognitive resources (TEIXEIRA, 2013). Such conduct, which can be extended to all levels of education, requires different methodologies than usual, with participatory pedagogical practices, as pointed out by the research by Prsybyciem, Silveira and Sauer (2018).

Based on classroom practice and existing work as a reference, we realize that Higher Education, and the disciplines that make up the undergraduate curriculum in general, and in particular in Engineering, is poorly

adapted to the multiple needs and varied from today's clientele.

Thus, we developed an active methodology for use in higher engineering courses at the Lorena School of Engineering, University of São Paulo.

1.1 Active Methodologies and Technologies

There are currently several reflections on the organization and functions of the school and university. The contents covered are more complex and comprehensive. The construction and development of diverse and specific skills and competences are required by the Ministry of Education and Culture (MEC) itself and by the increasingly demanding labor market. According to David Goldberg (apud BARBOSA, 2013), students in the technology area (where we include Engineering) are not able to ask, name, model, decompose, measure, visualize and communicate, requiring changes in the way we teach for more development. effective in such skills, fundamental in the formation of a complete professional. Moreover, as stated by Anastasiou and Alves (2012), learning does not occur in the same way, nor does it occur at the same time.

It is necessary to reflect on the contextualization of teaching, meaningful learning, the use of intelligent resources, a transformation of ideas into results, thinking, a creation, an innovation, a decision, a problem solving and teaching practices in new methodologies.

Under these conditions, learning should be when the student interacts with the subject and is encouraged to learn the knowledge and not just passively receive it. Involve a student-focused, non-teaching teaching proposal where interaction and knowledge building are present. In this scenario arise the so-called Active Methodologies.

The educational process is part of an education class that stimulates the teaching-learning processes critically, in which the student actively participates and is committed to their own learning (BORDENAVE AND PEREIRA, 2004). Although somewhat publicized, they are not currently their own assumptions. In Brazil, Freire (1996) already defended the 80's and the educator should recreate the knowledge, re-signifying an individual reality.

Examples of active teaching and learning methods are: Case Study, PBL - Problem Based Learning, PjBL - Project Based Learning; Concept Maps, Writing Across the Curriculum, Peer Instruction, Think Pair Share and more.

The objectives of the active methodologies involve an effective teaching strategy, which enables the assimilation of more content, develops confidence in one's own decisions and confidence in what is known, improves oral and written expression, as well as interpersonal relationships, and establishes one's own. interest in solving problems and conducting projects.

Active learning environments are those that involve activities that generate meaningful learning, ie discussions, teamwork, case study, brainstorming, use of concept maps, device modeling, processes and systems, research and research activities.

We emphasize that despite the emphasis on the student figure, the creation of active learning environments never goes without the teacher figure, on the contrary, it is definitive in the success of the enterprise. The use of such methodologies usually requires the following attitudes and posture from the teacher: being a

mentor, co-learner or consultant, coordinating and monitoring teamwork (with students and other teachers), organizing the course around real events, encouraging interdisciplinary work, mediate discussions, stimulate observation, understanding, reasoning, judgment, and practice procedural evaluation. In other words, the teacher starts to have much more complex tasks than those of expository and traditional classes as he guides the student work in a more personalized way, which facilitates their learning (FERRANDIS, FERRANDIS AND LATORRE, 2018).

1.2 Higher Education in Engineering

Applied sciences, among them engineering in general, are usually marked by concrete problems arising from the labor market or the demands of society. With social development, the problems became more diversified and the market became more demanding, and the need for more elaborate solutions that analyze various aspects led to increased complexity and more knowledge is required (RAMOS; FONSECA FILHO; FREIRE ; PERES, 2010).

Traditionally in undergraduate courses, subjects typically form parts of knowledge and are grouped into areas by some similarity. With the emergence of new objects or approaches, other parts are needed, leading to fragmentation and hindering the much needed interaction for the professional's global formation.

With the typical limitations of traditional training, with fixed content menus and focus on content, other ways of promoting interaction between such “parts” are needed. More and more content needs to be taught in the same fixed amount of time. This has made the results less positive today than in previous times.

At the same time, the current professional profile of the engineer is no longer due to an essentially technical background, but much more comprehensive and multidisciplinary. Thus, it is evident that professionals trained for decades had their training appropriate to the time, but nowadays new skills require development. From the year 2000, important congresses about education have been approaching the subject. According to Valente et al (2012), besides traditional skills such as calculation, for example, others related to decision making, social responsibility, sense of ethical responsibility, environmentally conscious attitudes, among others, were included. These are the so-called behavioral skills, increasingly required by the labor market.

1.3 Diversix

At EEL-USP, since 2012, movements have been made to follow the implementation of new teaching methodologies. From this experience came the proposal to develop and systematize the use of an active teaching methodology for engineering, diversified and integrated.

The methodology developed by us was called DIVERSIX for its reference to various pedagogical techniques and for its integration with a skill that is not formally considered in teaching: humor. It enables teamwork, the learning of new teaching-learning methodologies, the development of teaching activities, and the production and use of different learning objects. The term DIVERSIX comes from the junction of the words fun with the definition of the number of resources to be used in the development of didactic activities. It is foreseen the development of competences and diverse skills, such as: creativity, communication, analysis and synthesis, teamwork, leadership, information transmission, writing and others.

The integration of activities by humor is proposed due to the fact that for many years the school, having been considered a place of formal learning that requires seriousness, abolished on almost all levels - except early childhood education - playfulness, which promotes activation. of emotions that facilitate learning. Even today, it is evident the request for silence, a restrained and restricted posture to pay more attention, the very disposition of desks that directs the observation to a single focus (the teacher), the upper platform where the teacher is, shows of a tradition of seriousness and formality required in academic life.

2. Methodology

We opted for action research as a methodological research strategy. It is known that the educational context is considered an interesting niche of this type of research since the mid-70s, where educational intervention goes with the diagnosis of reality and the construction of action strategies (GORI, 2006).

We chose to conduct a reflective practice and investigate it. In this sense, we follow the proposal by Elliot (1994) about the fact that action research is a constantly changing process, in spiral movements of reflection and action. Such movements include diagnosis of a practical problem that seeks to solve, formulation of action strategies, development and evaluation of the efficiency of these strategies, understanding of the new situation and procedure of the same steps in a new practical situation.

As Thiollent (1998) points out in this type of research, researchers and participants representative of the problem are fully involved in a cooperative and participatory way. In it, the researcher equates the problems found, monitors and evaluates the actions. In action research, rather than investigating academic aspects, it is intended to receive and analyze what the people involved have to say and do. This is in line with that proposed by Barbier (2007) which indicates that in action research there is an intentional action to transform reality and to produce knowledge regarding this transformation. In it you work with others and not others. According to Barbier (2007), the issue of change in this type of research, which is not easy to specify, is central. To analyze evidence of it, we chose to apply a questionnaire at the end of the application of the teaching methodology we proposed.

From these considerations, our methodological research option is fully in tune with the action research framework.

Our target audience was formed by students from all undergraduate engineering disciplines and was enrolled in the Organizational and Work Psychology discipline. It was a qualitative research that used the records.

The teaching methodology built was applied in the discipline of Organizational and Work Psychology. Therefore, it was a qualitative research that used daily records of occurrences in class, with students and teacher.

As it is a research concomitant to an applied procedure, all officially enrolled in the discipline were involved, coming from the following courses: Physical Engineering, Materials, Biochemistry, Production, Chemical, Environmental, Industrial Chemical, day and night.

All students were informed on the first day of class about the methodology practice and the use of the requested resources. The rules for the development of the activity and the various competences and skills that would be observed and fostered.

Participants were presented with the rules established for the application of the methodology:

- The classes would take place throughout the semester, with the presentation of themes chosen by the teacher / researcher, based on the syllabus provided by the university.
- Students would be divided into groups in a number conditioned on the total number of students enrolled per class.
- Themes would be drawn between groups
- Each group should use 6 different features, integrated by humor / fun, namely: group dynamics, lecture, videos, article selection, essay building, room evaluation (preparation, application, correction)
- Other resources could be used, at the discretion of the groups, provided that the teacher was consulted in advance for validation of adequacy.

The competencies and skills sought to be fostered throughout the application of the methodology were as follows: creativity, communication, analysis and synthesis skills, teamwork, leadership, information transmission, writing, ethics.

The students' formal assessment also respected what was recorded in the course program, which requires the assignment of grades from zero to ten, with an average of five, considering two formal grades (P1 and P2) from which the arithmetic average is made. P1 consisted of scores from the eight tests, presentation, essay, including test design, application, and correction. The P2 was an evaluation covering all semester content, held on the last day of class.

3. Results

Data collection for systematization purposes of this article occurred in two classes of the Organizational and Work Psychology discipline, with a total of eighty-three students regularly enrolled. The course is semiannual, making fifteen weekly meetings and has an institutionally approved menu, available in the academic system. The menu and the syllabus were fully respected, with modification exclusively in the teaching and evaluation methodology.

On the first day of class the students had an introductory class where the menu, the syllabus and the justification and proposal of the new methodology were presented. It was explained that the intention to adopt such a practice was linked to a research on new possibilities of developing transversal skills important for future engineers. All agreed and some expressed positively about the experience, especially regarding the possibility of bringing humor to the presentations. One student even said, "Can we laugh a little in class? How nice..."

Groups of six to eight students each were established. The choice was free, mostly voluntary and random, as most students did not know each other, as the subject is offered for all seven engineering courses, from the fourth to the twelfth periods. This promotes great heterogeneity in the room, making the groups have components of varied courses and different moments in graduation.

Still on the first day of school, the teaching methodology was explained. This explanation was taken up in the second class, which also presented some basic concepts of Organizational Psychology as introducers of the themes to be presented by the groups. In the second class, the following subjects were drawn: Communication, Groups and Teams, Organizations, Recruitment and Selection, Motivation, Leadership,

Training and Development. Students were asked to create a facebook group to communicate the course and to post the slides. One student from each class volunteered and the groups were created, as shown in figures 1 and 2.

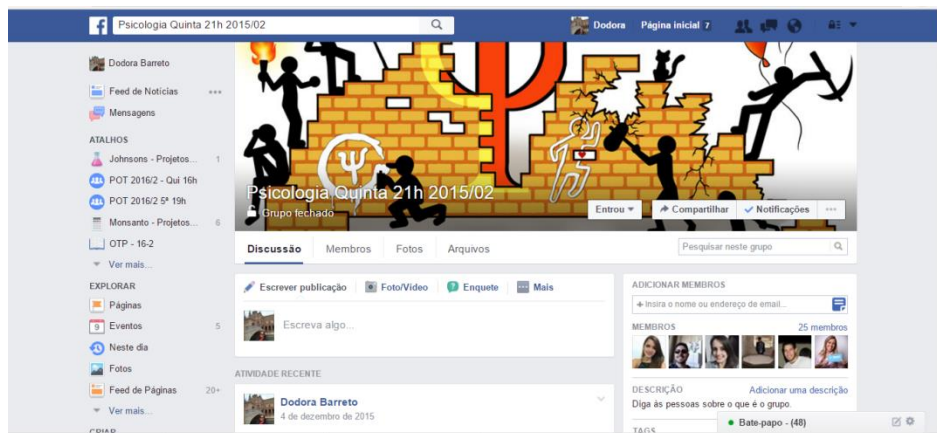


Figure 1. Print screen of the facebook group 1



Figure 2. Print screen of the facebook group 2

Most students joined the groups. Some left at the end of the discipline, others simply failed to access, because there was no more movement of the discipline. We chose not to close the groups, because there is the possibility of sharing files of interest, yet.

From the first presentation the groups became familiar with the methodology which consisted of: each week a group made the presentation containing all the requested resources, delivered the written essay, received feedback from the classroom and the teacher. Three days after the presentation, the group sent 15 questions, with feedback, to the teacher who analyzed and returned the questions that would compose the test 1 day before the application. The following week, the group applied a test on the subject presented throughout the room, corrected it, and returned it. Table 1 below clarifies this system:

Table 1. Group work presentation steps

Phases	Activities	Skills and Abilities
1st step	Oral presentation of the theme Essay delivery (written assignment)	Communication Responsibility Commitment Creativity Team work Analysis and synthesis capacity Writing
2nd step	Preparation and submission of the test to the teacher. on the stipulated date	Responsibility Deadline accomplishments Ethic
3rd step	Test application in class following presentation	Role reversal Ethic
4th step	Test Correction	Attention Responsibility
5th step	Posting Spreadsheets Delivery of corrected tests in class following application	Organization Deadline accomplishments

As already pointed out, at the end of each presentation, the groups were brought together and the teacher was asked to provide feedback to the room with the following instruction: “Each group should highlight three positive aspects of the presentation and three that need to be improved. Feedback is a gift we use or not, it is up to us. But we do not refuse it, so the stance must be open to criticism to improve performance and one should not bounce back. ”

At first the students were inhibited and afraid to criticize their colleagues. From the moment they understood that this would improve everyone's performance, they became more comfortable and feedback effectively contributed. After all the groups made their comments, the teacher also highlighted positive aspects and others that needed to be improved. The same feedback procedure was adopted after each test application.

Throughout the activities, many gains were observed in relation to the two classes, which, due to the objectives of this work, were treated as one. Since at no time was there any intention of comparing them, it was decided to treat them as a population, even to avoid discrimination in the treatment of students. The gains observed could be confirmed by the feedback that, throughout the semester, became increasingly discerning and turned to small details, since there was a significant improvement in the presentations, pointed out by the students. In addition, as the groups introduced themselves, more students came to the teacher for more information on research sources and resources to be used. It is interesting to note that this semester, first of 2016, a student who does another, optional subject, with the same teacher, sought to say that made the choice of the optional subject by the methodology adopted. She has been able to identify

great progress in her development through exposure and feedback and believes that new experience will make her develop further.

At the end of the semester, the researcher applied a questionnaire to evaluate, also qualitative, the teaching methodology. It was requested feedback in the same way as the classes, where students should list positive, negative and suggestions. In addition, a self-assessment was requested so that the observations made could be confronted with the perception they might reveal. For this we list some of the most spoken skills during the semester. To conduct the research, students were asked from the outset to sign an informed consent form.

It is interesting to note that the separation of competences happens exclusively for better understanding. However, in practice they blend and complement each other.

The most worked skills during the semester were: teamwork, cooperation, responsibility, commitment, ethics, communication, ability to analyze and synthesize, creativity, work under pressure and meeting goals and deadlines.

Teamwork refers to the competence to act together. It involves skills such as sociability, planning, organization, empathy, leadership - as a leader or led - prioritization.

Cooperation refers to the competence to assist in the execution of tasks and involves skills such as willingness to serve others, joining efforts, help.

Responsibility refers to the competence to care for what has been requested by both the teacher and colleagues.

Commitment concerns engagement in activities, including prioritizing tasks to meet deadlines.

Ethics is related to the entire course but is made clearer in the design, application and correction of the test for which each group is responsible.

Communication permeates the entire process to a very high degree. All steps require group members to communicate in person or by message and imply objectivity in achieving what is agreed upon.

Analysis and synthesis skills are manifested both in the preparation of the presentation for the room and in the construction of the written essay delivered on the day of the presentation.

Creativity is present mainly in the choice of the dynamics and the videos that make up the presentation.

Despite well-defined initial parameters, there was scope for flexibility and new possibilities for presentation and testing.

Work under pressure manifests itself in respect of deadlines. Perhaps more effective for the first group, which has a shorter lead time. However, it is clear that most do not prioritize planning yet, so the deadlines are tight, causing pressure to not anticipate activities.

Achievement of goals and deadlines refers to meeting what was requested on the requested date: presentation and written work in one day, posting of slides, test questions, with feedback, up to 3 days later, receipt of test questions 1 day before application, test printing, application, correction and delivery to teacher 1 week after.

Separately, for the sake of completeness, as it has already been explained that both classes were considered as one, each presented the results described in figures 3 and 4.

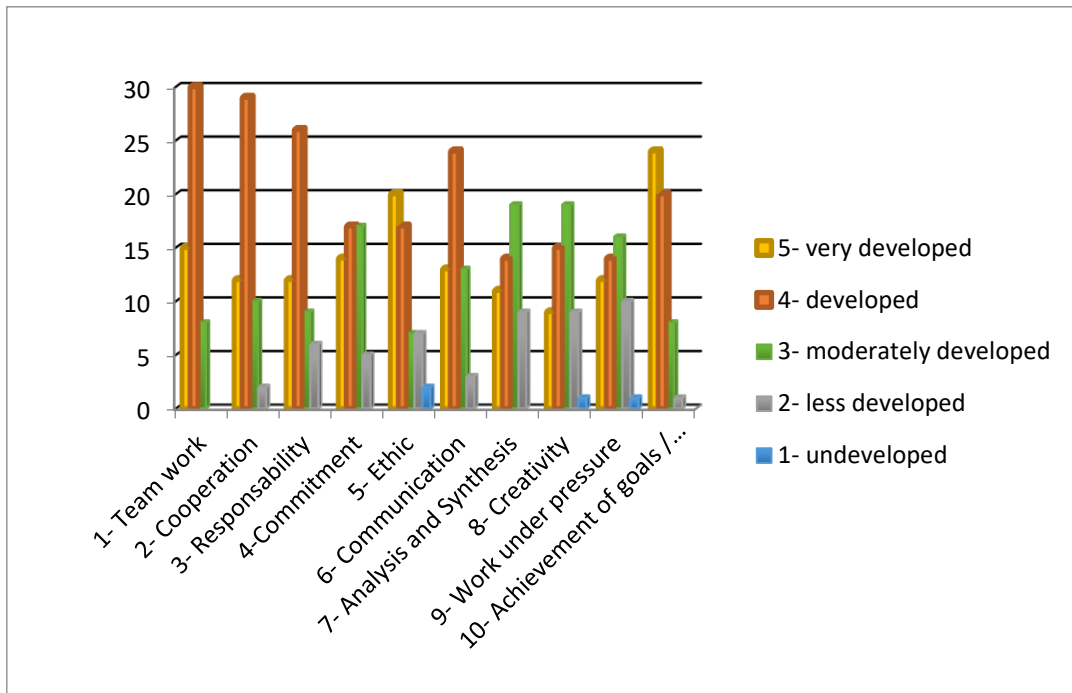


Figure 3. Self-assessment class 1 for skill development

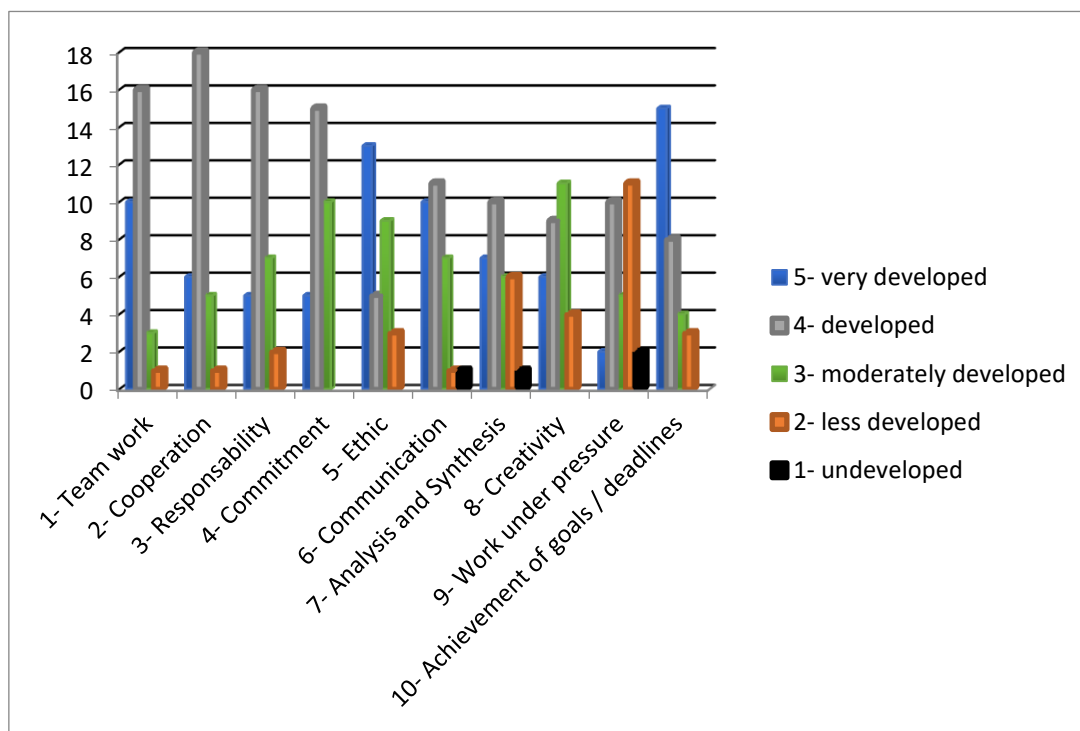


Figure 4. Self-assessment class 2 for skill development

The overall results obtained with the questionnaire were as follows, shown in figure 5.

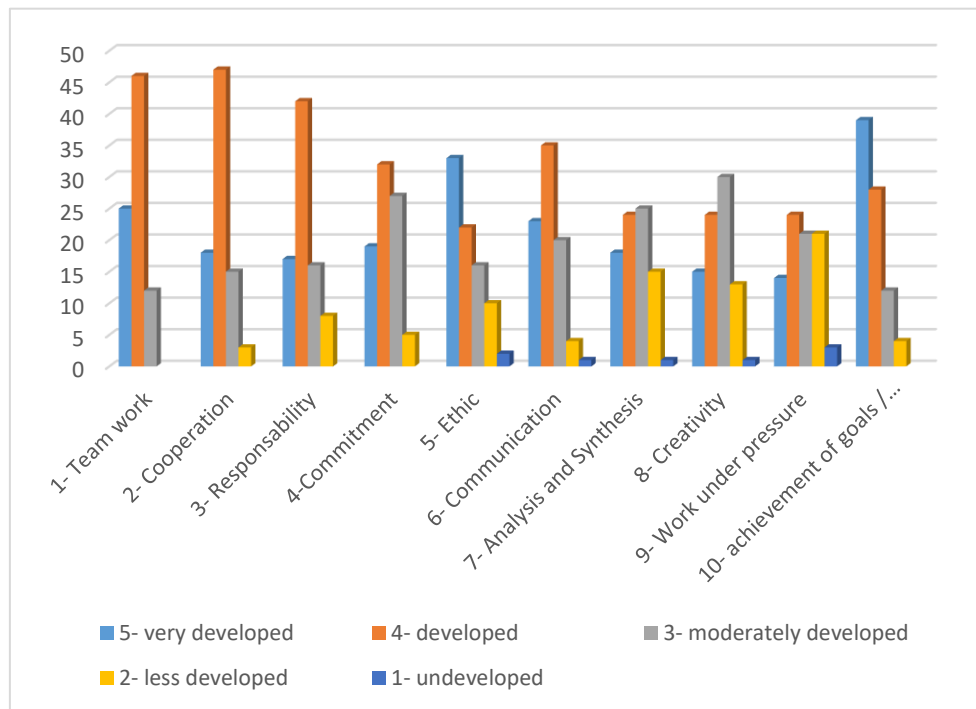


Figure 5. Self-assessment regarding the development of transversal competences

From the answers we identified that the best evaluated competences in the sense of their own development were teamwork, meeting goals / deadlines, cooperation, followed by responsibility and communication. Considering the opinions Very Developed and Developed, they corresponded to 85%, 81%, 79%, 71% and 70%, respectively.

Such answers are in line with what was expected with the establishment of the methodology rules. In order to meet the deadlines, it was necessary for everyone to work in cooperation in the execution of the tasks assigned by members of the groups themselves. In this process, effective communication was fundamental to the fulfillment of the activities, mainly because, as they were students from different courses and periods, if they did not exercise and use skills such as these they could not reach the goal, because there were no specific moments that would find spontaneously.

We emphasize that Teamwork did not have a single unfavorable response, in the fields Little or Not Developed, which corroborates that methodologies like the maid stimulate and reinforce skills of working together with others, essential for the future engineer.

The least developed skills, according to the students' opinion were: work under pressure and analysis / synthesis, followed by creativity. Considering the underdeveloped and underdeveloped opinions, we found 29%, 19% and 17%, respectively, which, although identified as less developed compared to other competencies, do not mean such an unfavorable score. Considering that these skills are measured individually, rather than in groups, and in this case, evaluated according to their own personal impression, according to their own perception that is always loaded with subjective aspects, we hypothesized that they were pointed out as underdeveloped due to some variables. Indeed, only the first group in each class was under pressure to meet deadlines, as it had less time to complete all tasks. As the schedule was released at the beginning of the semester, the groups that organized themselves had time to elaborate the stages, so

supposedly they were not pressured to deliver the activities.

In addition, the ability to analyze and synthesize is most directly used in the preparation of slides and the written essay. With the division of tasks, some people did not really need to intensify their efforts, as another member of the group might have been responsible for the task involving the use of such a skill.

Finally, as there were well-defined parameters as to the resources to be used, creativity could be more exercised in choosing and applying the dynamics and eventually in different resources they wanted to use. Unfortunately, students generally do not exercise such ability. Usually they tend to do what they ask, so there was little scope for creativity, reiterating the idea that traditional actions are still very much present in both teaching and learning.

In order to maintain the standard of evaluation of the practice, which invariably occurred in all classes, we asked them to complete the questionnaire with positive and negative aspects of applying the methodology. They were also asked to make suggestions on the practice experienced during the semester.

We got a total of eighty-three answers. All students responded, even with the clarification that it was a voluntary assessment. This also indicates the commitment to participate in the process. The vast majority strove to participate in all phases of the work.

As positive aspects were raised the following points, highlighted in Table 2, as follows:

Table 2. Positive points of the teaching methodology, according to the students

Strengths
* Dynamic class exposure method facilitating learning (32)
* Student exposure in presentations assists in developing communication and accountability (16)
* Importance of Teamwork (14)
* Greater student involvement and engagement due to new methodology employed and topics covered (14)
* Teacher's domain in relation to content and communication with students - didactics (7)
* Importance of Feedback (7)
* Beacon classes (4)
* Humorous character in presentations facilitates learning and attention in class (4)
* Learning beyond the subject (2)
* Greater absorption of content with tests and varied weekly activities (2)
* Knowledge of the practice of a selection process
* Subject choice and presentation by the group itself
* Well designed P2 assessment with student help

Placed in ascending order of occurrence, we can see that there was great emphasis - thirty-nine statements - on the dynamism of the classes, recognizing that this condition facilitates learning. This meets one of our initial assumptions that the use of diversified activities motivates and enhances learning.

Then the highlight - sixteen statements - was the perception of the development of diverse skills caused by

the exposure of students in the presentations. This perception meets the development of skills that we intended to encourage students as communication and adds to the next highlighted item, teamwork. As the students all needed to present the work, they had to get organized, set priorities, identify and search sources, select material and take responsibility for proper performance.

These obligations, added to the variety of activities and weekly tests were pointed as triggers of students involvement and engagement.

In isolation, with less emphasis, but also with great relevance, since works with individual perception, which varies greatly from student to student, other positive observations added to the already reported. Among them was observed the importance of feedback at each presentation, which guides the next groups and increases the critical capacity of all.

It was also noted the importance of beacon classes, a more “traditional” moment that meets, at least in part, the need for some to maintain old schemes and receive the “final word” from the teacher.

It was also highlighted the presence of humor in the presentations, as a facilitator of learning and attention in class, confirming the research that addresses this possibility (LA TAILLE, 2014).

Interesting the note about learning beyond the subject, which indicates initiative in the gathering of relevant information. Such attitude corroborates the concept of active methodology, which prioritizes the autonomous search for solution to the proposed problems.

In addition to these, other specific considerations such as specific content (recruitment and selection theme), possibility of choices (subject and type of presentation) and evaluation consistent with what was developed, were also observed.

As negative aspects, the following points were raised, highlighted in Table 3:

Table 3. Negative points of the teaching methodology, according to the students

Negative points
* Overwork and weekly assessments (23)
* Time and amount of restricted (beacon) classes, few exclusive teacher classes (22)
* Lack of direct orientation to presentations, lack of script (13)
* Presentations and extensive content (12)
* Poorly performing groups disrupting learning (6)
* Less credibility of the contents of the classes, as they are taught by the students. (4)
* Elaboration of tests and tests made by students (4)
* Delay in note communication (3)
* Seminars in the conventional classroom (3)
* Collective Feedback
* Drafting questions for P2

According to the students' perception, there is overwork and evaluation. Such observation was already expected, since apart from individual perception, students are not used to doing activities constantly in class. As they have a more passive attitude, due to a more traditional teaching, which prevails in most

classes. It is natural for them to find so many activities performed by them not only in their own group presentations, but in the dynamics and feedback in every class that required everyone's participation. Likewise, as tests on the subject took place in virtually every class, which required some prior preparation every week, caused some strangeness in some less accustomed to constant activity. These observations match the following, which call for more lectures from the teacher and more definite scripts for the presentations. Although many have adapted and highlighted the novelty of the methodology as something positive, as seen in the previous points, it is a fact that other students still do not enthusiastically welcome the proposed changes. Although expected, it is a sign that we need to present more frequently the need for student action in the classroom so that they become familiar with methods that develop skills such as those proposed here. Attachment to the practices of lectures, in which often the student does not need to reflect, select, seek, act, is still very present.

It was also pointed out as negative, the low performance of some groups and the low credibility of the contents of the classes, because they are taught by students. It also reiterates the lack of confidence in the performance of the students themselves, even with the guidance and monitoring of the teacher. The teacher still represents a figure of maximum authority of knowledge, who supposedly holds the knowledge. Once again there is a lack of confidence, perhaps due to a lack of practice in finding and revealing information on the topics.

Interestingly, the presentations and contents were extensive, as they never exceeded the predetermined class time and that the groups themselves selected the topics to be presented in each theme. Similarly, although they were free to choose the form of presentation, it was pointed out that they happened in the conventional way. This pattern repetition matches the difficulty that many present in adapting to innovations in teaching methods.

Other specific comments related to the evaluation system. In the proposed model the student was evaluated throughout the process. At each presentation and written assignment, the group received feedback from the class and the teacher, and all students took a test on the subject presented. They all added up to a maximum of 10 points. At the end of the semester a formal evaluation was also applied, on all the content presented in the semester was prepared by the teacher, including suggestions from the class itself, also worth 10 points. Arithmetic average of the two notes was made. In the observations, the autonomy of the groups in elaborating and correcting the tests was pointed out as negative, the delay in the communication of the grades, made only at the end of all tests, and the students' suggestions for the second evaluation. We emphasize that the same aspect was considered positive by some students, which is consistent with the differences in perception. As we talk about changing habits and new practices, this disagreement is natural and does not interfere with the development of the process.

As suggestions, students who spoke noted the following, as shown in Table 4.

Table 4. Suggestions about the teaching methodology used in the semester

Suggestions
* Increase the frequency of beacon classes
* Explanation of the content by the teacher and preparation of a case by the students, each

class
* Orientation and direct monitoring of the teacher regarding the content of the presentations - script
* Organization by the teacher of time in relation to the clues and the dynamics
* Support material for writing the texts
* Decrease the amount of reviews and assignments
* Replace weekly assessments with summaries of each group
* Evaluations with alternatives
* Enter substitute ratings
* Award extra grades to more participating students
* Practical activities focused on the theme: selective processes
* Training and preparation for the labor market
* Feedback only for each group or in discussion form
* Smaller groups to do the work
* Psychology classes at the beginning of the course, as they prepare better
* Discussion of other topics as well
* Continue with humorous presentations
* All subjects use the methodology (ideal world)

It is noticed that many of the suggestions mentioned refer to the traditional teaching model. By requesting more landmark lessons, presenting the content by the teacher, establishing a systematic script, organizing the time done by the teacher rather than the group, they are in fact claiming a model in which they perform what is rigidly defined, in which the teacher is who it sets the steps more rigidly and where freedom of creation is reduced to few possibilities. Here we see the resistance, also by students, to less structured models of knowledge construction. The same happens with the suggestion that they have the indication of support material for the written work. This further indicates that the student waits for the more directed indication of the teacher.

As for the suggestions of practical activities and training, we ran into the same difficulties of workload. It is a theoretical discipline, with a workload of 30h / a, which requires the selection of methods according to the proposed teaching and learning objectives. Thus, the methodology seeks to minimize the distance between theory and practice by using the proposed active tools.

As for evaluations, an even more critical concept when it comes to the joint construction of knowledge and pre-established institutional needs, such as the establishment of a grade, we see that suggestions go in two ways: in the reduction of activities by students and in facilitating and / or expanding possibilities for getting more grades. Once again, the traditional grading model rules over task execution rather than learning itself. An example of this is the suggestion of reducing the number of evaluations and assignments, replacing weekly tests with abstracts, more tests with alternatives, inserting substitutive evaluations, and awarding more grades for participation.

Some suggestions go against institutional determinations, such as smaller groups. As we have a maximum

number of students of sixty and the classes are developed in fifteen weeks, interspersed with the marker classes, we have to distribute the number of students regularly enrolled and in a maximum of eight classes. Although we consider that four students per group would be an almost optimal number, we have not been able to achieve this as long as classrooms have this total number possible. Similarly, the suggestion of discussion of other topics is prevented by the specified number of classes. However, whenever a student mentioned a related subject, it was discussed in the presentations and marker classes.

A specific observation about the methodology refers to the feedback. It was current and determining in the process the weekly feedback given to students about the performance of the groups. Both by peers, by the teacher and by the members of each group. This feedback was pointed out as a positive point (table 2), but in the suggestions came the annoyance of someone because they are public, which makes one think that it is necessary to clarify, especially the reason for not being individual and confidential. Similarly, one of the rules of feedback was that students should not rebut. By suggesting that it be done in the form of debate, they wish to justify any failure. This may be best explained in the practice of classes.

Interesting the suggestion that the classes take place at the beginning of the course, because this meets the full and diverse training of skills and competencies. Very relevant to this research were two observations that came up in the suggestions: to continue inserting humor in the presentations and that all disciplines started to use this methodology. It is evident that this is the personal perception of a student who had his expectations exceeded, but in any case, we have a record of significant experience with the introduction of the methodology.

4. Conclusions

The results show that, even in isolation, that is, in the proposal to change the teaching methodology of a single subject of different undergraduate courses, it is possible to verify and propose new conceptions, besides reformulating relations between teachers and students, to define different directions and emphases for vocational training.

It was possible to provide students from various engineering courses with experiences that they will probably find in their professional future in a short time. As many are in the final stages of the course, participate and will participate in selection processes in various companies. In addition, the importance of knowing how to work in teams is increasingly imminent, which was also provided by the introduction of the methodology. More than that, it facilitated the experience of finding, reflecting and building diverse knowledge more autonomously, which was achieved through research and presentations, as reported by the students themselves.

Based on the results of this work, it is possible to suggest replacing the traditional passive methods with the active ones. The transmission of theoretical content loses place for teaching that promotes a more autonomous process of knowledge construction, which includes practical situations, the reality of each student.

It is interesting to point out the testimony of students who voluntarily enrolled in non-compulsory subject in the semester following the application, which uses the same methodology. Their statements corroborate the search for experiences that develop transversal skills and competences

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