A Problem-Project-Practice Based Learning Approach for Transportation Planning Education

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Abstract. *The objective of this study is to evaluate the effectiveness of a problem-project-practice based learning approach in a transportation planning course. The analyses of the following activities provide a good perspective of the approach strengths and limitations: the project itself, the students' assessment, and their evaluation of the course. In the students' evaluation, all individuals had to rank the entire group regarding three aspects: i) the written report, ii) the oral presentation, and iii) important technical contributions to the proposal. In general, the evaluation of the course, which was done anonymously in an online platform, had shown positive outcomes.*

1. Introduction

The recent technological advances, as well as the pressures produced in the social and environmental domains, are demanding changes in the profiles of the professionals now reaching the labor market. Some areas are more sensitive than others to that effect because they naturally involve several dimensions. That is the case of transportation planning, which has strong economic, social and environmental components, currently referred to as mobility planning. The education of professionals in the field is usually done at the graduation level, what implies that the courses can receive professionals with different backgrounds.

The traditional teaching-learning process is based on a broad review of textbooks. They provide the basic concepts in each of the different topics that are important for understanding the central issue. That process is usually complemented by exams to assess the students' capacity for acquiring such a comprehensive knowledge. The time needed for that traditional approach, however, does not leave much room for practical experiences during the courses. Also, it does not stimulate the integration of the students in common activities, what could naturally provide a multidisciplinary view of the studied issues due the different previous educational and even professional experiences.

An alternative to overcome the shortcomings of the traditional approach is to challenge the students with a real problem. That was part of the strategy adopted in the course Urban and Transportation Planning, which was offered to students of Transportation Engineering graduate program at the São Carlos School of Engineering at the University of São Paulo in 2009. The objective of this study is to evaluate the effectiveness of the proposed strategy as a teaching-learning approach.

2. Theoretical Background

The pedagogical strategy described in this paper is based on the concept of PBL as used by Gabb and Stojcevski (2009). Their concept is introduced in this section, immediately after a brief discussion about the usual definition of PBL.

PBL, originally Problem Based Learning, is seen as a complete approach for education, considering both the curriculum and the process (Barrows and Kelson, 1993). The curriculum involves carefully selected and designed problems that demand from the students: the acquisition of critical knowledge, problem solving proficiency, individual learning strategies and communication skills, and teamwork ability. In such a way, the process replicates the systems approach usually applied to solve life problems or to face professional challenges.

One of the characteristics of PBL is that it is centered on the students. That refers to the learning opportunities that are relevant to the apprentices, which have their objectives partially determined by the students themselves. That characteristic does not imply that the professor should give up on his/her responsibility for judging which contents and skills might be important for the students to learn. However, it explicitly transfers to the students part of the responsibility of their learning process. For Powell (1999), Problem Based Learning is, just like Project Led Education, an approach that is somehow the opposite of the classical education model. The classical model, in that case, can be summarized by the conventional arrangement of the lecturer and the students in a classroom, in which several lectures lead to assessments in a similarly traditional format.

Education in Engineering is under a growing pressure for change. The traditional teaching-learning process, which is essentially based on classroom lectures complemented with the resolution of numerical exercises and practical classes in laboratories, implicitly makes lecturers and students to assume that the main goal of the process is to get the ability to pass in exams and tests.

Engineering courses are frequently good enough to produce technically competent professionals, who are able to provide services of quality to the society while facing the responsibilities of the professional life. However, the development of other professional attributes that are relevant for communication and for teamwork are often seen and accepted as an exclusive task of the individuals. Therefore, it depends on the maturity and initiative of each person. Nevertheless, the professional knowledge has grown so much that is nearly impossible for a student to master all available technical contents in a timeframe of four or five years. In addition to that, students are now being criticized for their lack of complementary skills. As a result, professionals and students in different parts of the world are currently trying to strengthen their skills through continuous learning, in some cases trying to go beyond the technical knowledge.

Some universities decided to restructure their courses to meet those expectations and PBL is becoming an attractive way to effectively implement those changes. More than simply applying the original concept, in which the ‘P’ in PBL means just ´Problem´, some researchers have further developed the approach. Gabb and Stojcevski (2009), for example, describe their approach as problem/project/practice based learning or P^3BL.

However, as any other approach, PBL also faces problems and criticisms. Some of them are discussed in the work of Tara Fenwick and Parsons (1997). In addition, although education in engineering can generally benefit from PBL, adaptation problems are also

common, as discussed by Vandebona and Attard (2002) and Güzelis (2006). The case of transportation engineering is not different. Even though, a simple internet search returns several examples of universities applying PBL in their transportation courses. That happens in quite distant places, such as Malaysia, Spain and the United States of America. In contrast, those experiences are not easy to find in Brazil, what makes this study particularly relevant and timely for transportation educators.

3. Methodology

This focus of this study is the teaching-learning strategy adopted in the course Urban and Transportation Planning, which was offered to graduate students at the São Carlos School of Engineering at the University of São Paulo in 2009. The adopted Problem-Project-Practice Based Approach was an attempt to overcome the shortcomings of the traditional approach. In order to do so, the students were challenged to deal with a real problem: the issue of sustainable urban mobility. Given the broad nature of the topic, the students were initially introduced to an indicator set that could provide a good view of the mobility conditions in a city selected as a case study. They were then asked to organize the solutions for the problem in a project that would set the basis for a Mobility Plan. However, that demanded a lot of practical work for getting to know the problem elements and characteristics, and the potential suitable solutions. Interestingly, it also required a substantial amount of theoretical knowledge. It did not come in the form of isolated exercises found in textbooks, but rather as the intricate collection of open problems and distinct solutions usually found in the real world.

The following course activities were analyzed to identify the approach strengths and limitations: the project itself (as a written report and as an oral presentation), the students' assessment, and their evaluation of the course. The students evaluation was carried out in a comprehensive self-assessment activity, in which all individuals had to rank the entire group regarding three aspects: i) the written report, ii) the oral presentation, and iii) important technical contributions to the proposal. The evaluation of the course was also done anonymously in an online platform.

4. Results

The main aspects of the teaching-learning experience are summarized in this section, in the same sequence described in the methodology. While the first subsection brings a summary of the project developed by the students, the subsequent subsections show details of the students' assessment process and of their evaluation of the course.

4.1. The Project

After being introduced to the topic they would have to deal with (i.e., the issue of sustainable urban mobility), the students were asked to prepare a preliminary version of a Mobility Plan. The starting point of the planning process was the calculation of the Index of Sustainable Urban Mobility (I_SUM), which was originally developed by Costa (2008). The index application in the case studied was an important step of the analysis, given it allowed the identification of shortcomings and potentialities of the city regarding mobility. As I_SUM is formed by eighty-seven indicators, those whit the smallest scores and the highest weights were selected to guide the plan propositions. Another concern was the selection of measures for action feasible in the short and medium terms, in order to promote a fast improvement of the city mobility conditions. As a consequence, from the eighty-

seven indicators that form I_SUM, sixteen were selected to be part of the preliminary version of the Mobility Plan developed by the students.

After the identification of the main points for intervention, the students started to work on strategies, measures and procedures to effectively deal with them. That resulted in a natural sequence of precedence, or sometimes dependence, between strategies. In other words, the implementation of some strategies would eventually facilitate the realization of a few other strategies, or it could be an indispensable condition for it. That led to the identification of some general initiatives that could directly interfere in the execution of the other strategies. Consequently, four groups of proposals with common characteristics were generated, as follows:

- *General:* group involving strategies for administrative organization and public participation that directly interfere with the other strategies;
- *Urban Public Transportation*: group that encompasses strategies for the development of motorized modes used for public transportation;
- *Non-motorized Modes*: group of strategies for improving the circulation conditions of pedestrians and cyclists;
- *Transport and Sustainability*: set of strategies aiming at the reduction in the use of the private car. It also considers investments for citizens' education on the issues of mobility and sustainability.

Following the organization of the proposed strategies into groups or categories, the next step was their transformation into guidelines for supporting the development of the definitive municipal Mobility Plan. The process started with the identification of the main problems to be tackled and a list of associated goals. In the sequence, the actions that could lead to the satisfaction of goals were also identified. External and intermediate variables were also listed. External variables were related to the information needed to the implementation of actions, while intermediate variables are related to other external conditions that can be affected in the course of action. The construction process of the preliminary version of the Mobility Plan also involved the development of a plan of actions and investments. Through that plan, the following elements were associated to every action: financing agents, institutional entities responsible for the application and enforcement of measures, indicators for monitoring the progress of the proposals, and cost estimates and execution timeframes.

The process described above resulted in a proposal to guide the city under analysis to mobility conditions that are close to the concept of sustainable urban mobility. That proposal was initially materialized into a written report, which was developed by a team of twelve professionals with different backgrounds (i. e., civil engineering, architecture, technology, geography and economy) and subsequently examined by an expert in the topic of sustainable urban mobility (in that case, the course instructor). Once concluded and reviewed, the resulting proposal was shown to city transportation officials in an open presentation. The objective of the presentation was to get some feedback from the public administrators who could eventually apply the Mobility Plan, about the proposals contained in it.

4.2. The Students Assessment

The fact that the entire class was working on a single project, which was a preliminary version of a Mobility Plan, brought some difficulties for the individual assessment of the students. The work done was seen altogether and the individual contribution of each of the twelve students was nearly invisible to anyone outside the group. That was also the case of the instructor, what was obviously a problem for grading purposes.

In order to assess the individual contributions, a particular assessment method was then designed. Three items were selected for evaluation, and each one of the students was asked to rank the contribution of all colleagues (including himself or herself), as shown in the example of Table 1. In that example, student G was the main contributor to the written report and to the presentation, but he was not the person who gave the best technical contributions (he was actually the second best in that aspect). The best technical contribution was given by student A. The whole set of evaluations provided a clear picture of all students contributions, which were easily translated into conventional grades.

Table 1. Example of an assessment sheet

Elements of Evaluation	STUDENTS											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Written Report	2	3	4	7	5	6	1	8	9	11	10	12
Technical Contribution	1	3	7	6	4	5	2	10	8	11	12	9
Presentation	3	2	4	6	5	8	1	9	7	10	12	11

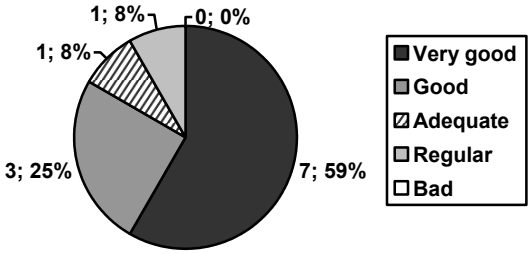
4.3. The Course Evaluation

After the conclusion of all other course activities, the students were asked to fill in an online questionnaire with twenty questions for evaluating the course. A few selected questions concerning the project activities and the teaching learning process are presented in Figures 1 and 2, respectively. A brief analysis of the answers shows, in general, a positive reaction of the students. Apparently one student was not very satisfied with the approach, as shown by a few negative manifestations observed in some of the questions. In addition, some of the questions were not answered by all students.

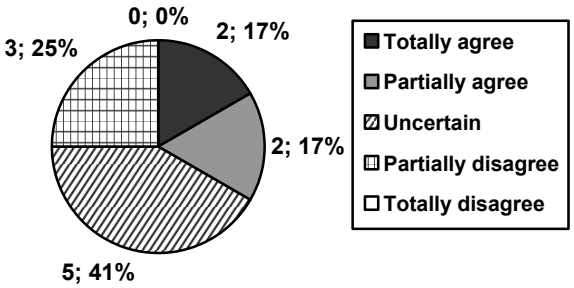
5. Conclusions

The analyses of the following course activities provided a good perspective of the approach strengths and limitations: the project itself (as a written report and as an oral presentation), the students' assessment, and their evaluation of the course. The students evaluation was carried out in a comprehensive self-assessment activity, in which all individuals had to rank the entire group regarding three aspects: i) the written report, ii) the oral presentation, and iii) important technical contributions to the proposal.

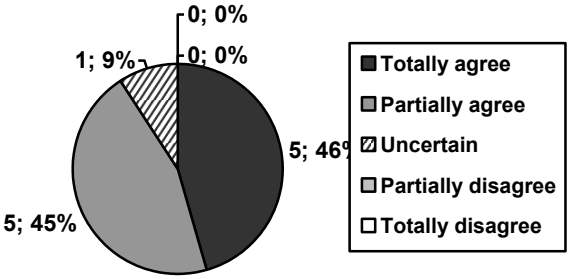
QUESTION:
How do you see the project activities carried out in the course?



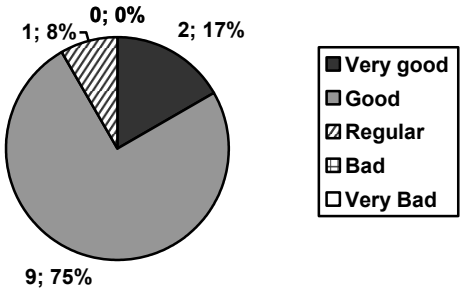
STATEMENT:
The project activities demanded more time than the tasks of other courses.



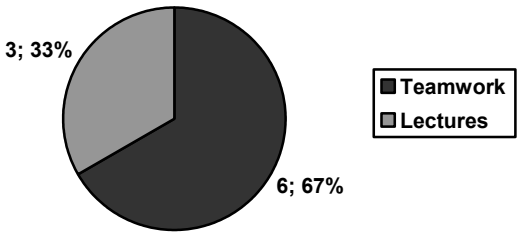
STATEMENT:
The theoretical contents and the project activities were coherent.



QUESTION:
How do you see your performance in the project activities?



QUESTION:
What activities were more effective for you to learn the course contents?



QUESTION:
Did you feel comfortable to interact with the other team members?

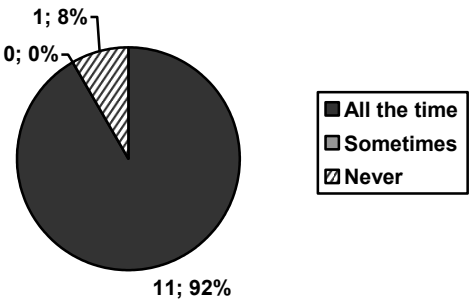
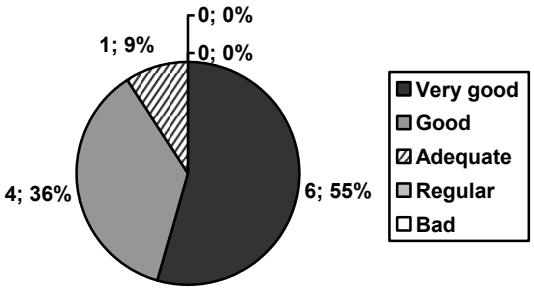
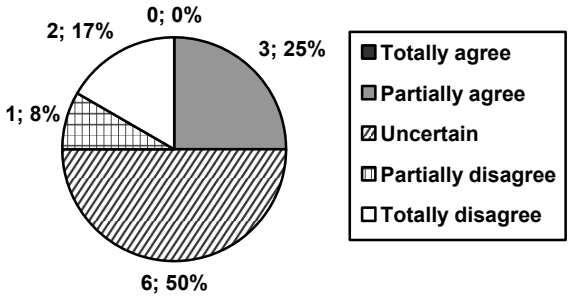


Figure 1. The students' evaluation of the course regarding the project activities

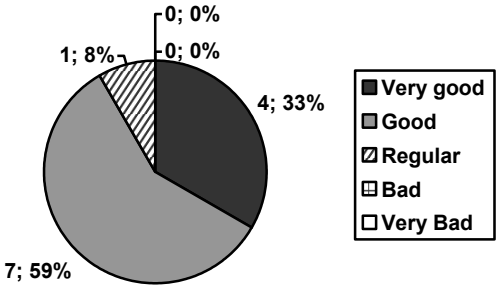
QUESTION:
How do you see the teaching-learning approach adopted in this course?



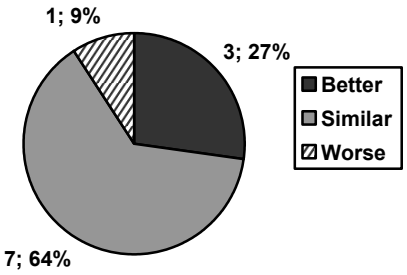
STATEMENT: It is easier to learn the course topics in the traditional way.



QUESTION: How do you see your overall performance in the course?



QUESTION: How do you evaluate the learning process in comparison to a course taught in a traditional way?



QUESTION: What is your overall evaluation of this course?

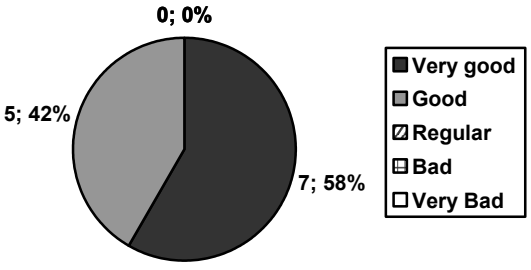


Figure 2. The students' evaluation of the course regarding the teaching-learning approach

The project was a challenge to the students, given that most of them were not familiarized with the issue of sustainable urban mobility at the beginning. However, that was not really a problem for them, because they have compensated their initial

unawareness about the subject with a very intense effort to acquire the necessary knowledge. The role of the instructor was then essentially to provide the required information or to point out sources of reference in the literature. The concrete result of their work was shown in two ways: as a written report and as an oral presentation. In both cases, the outcome was a cooperative production authored by all twelve students. The products presented were clearly seen by the students as part of a professional exercise and not merely as a usual course assignment. That was quite motivating from an educational perspective.

Nevertheless, while the teamwork was very positive from a pedagogical point of view, it became a problem for assessment purposes. Even considering that the products were a result of a collective effort, there were no doubts that the individual contributions varied within the group. So, the instructor introduced an assessment method that took that aspect into account. The self-assessment activity, which was subdivided in three parts, gave a clear picture of the individual involvement regarding the written report, the oral presentation and relevant technical contributions during the entire process. Not surprisingly, the results matched with the subjective impressions of the instructor about the students' involvement and performance.

Finally, the evaluation of the course, which was done anonymously in an online platform, had shown positive outcomes. For example, fifty-eight percent of the students said the course was very good, while the other forty-two percent said it was good. Not a single student marked it as a regular, bad or very bad course. Also, sixty-seven percent of the respondents answered that the project was more effective then the lectures for learning purposes. That may be a sign that the approach is really promising, at least for the sort of subjects considered in that course.

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