Problems and Projects Based Approach For Analog Electronic Circuits' Course

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ABSTRACT

New educational methods and approaches are recently introduced and implemented at several North American and European universities using Problems and Projects Based Approach (PPBA). The PPBA employs a teaching technique based mostly on competences/skills rather than only on knowledge. This method has been implemented and proven by several pedagogical instructors and authors at several educational institutions. This approach is used at different disciplines such as medicine, biology, engineering and many others. It has the advantage to improve the student's skills and the knowledge retention rate, and reflects the 21st century industrial/company needs and demands. Before implementing this approach to a course, a good resources preparation and planning is needed upfront by the responsible or instructor of the course to achieve the course and students related objectives.
This paper presents the preparation, the generated documentation and the implementation of a pilot project utilizing PPBA education for a second year undergraduate electronic course over a complete semester, and for two different class groups (morning and evening groups). The outcome of this project (achieved goals, observed difficulties and lessons learned) is presented based on different tools such as students 'in class' communication and feedback, different course evaluation forms and the professor/instructor feedback.
Resources, challenges, difficulties and recommendations are also assessed and presented. The impact, the effect and the results (during and at the end of the academic fall session) of the PPBA on students and instructor are discussed, validated, managed and communicated to help other instructor in taking appropriate approach decisions with respect to this new educational approach compared to the classical one.

Keywords: Problems and projects based approach, Pedagogical approach, Self learning, Knowledge and competence, New teaching methods and tools, PPBA, Electronic circuit course.

1. INTRODUCTION

In the past decade several institutions opted to change the classical approach to new teaching methods for some specific and non specific strategic reasons. Some used an institutional strategy to transform completely the teaching philosophy using a problem based approach [1]. Other universities implemented this approach for only targeted few courses [2]. With new educational methods, learning theory is based more on the creativity and the use of knowledge [3].
After several real teaching experiences followed by publications [4], [5], [6] and [7] it is shown that the classical approach (static approach) has several questionable differences compared to the modern approach such as PPBA (dynamic approach).
In fact, the PPBA has impacts/benefits on students and instructors. Some student related benefits examples are the followings:

- Updating student knowledge and competences
- Motivation in apprenticeship [8]
- Autonomy creation, and scientific and professional responsibility consolidation
- Better organization and planning.

Some instructor related benefits examples are the followings:

- Teaching satisfaction and motivation with this new efficient model
- Better communication between students and the instructor [9]
- Interesting and motivating teaching tool applied in the class.

Moreover, several advantages with this new approach can be cited:

- The student contributes actively in his apprenticeship [10]
- The student is encouraged for a cooperative and autonomous apprenticeship [11]
- The student is prone to a progressive autonomy development [12]
- The knowledge is transmitted with an active participation of the student as John Dewey said "True learning is based on discovery guided by mentoring rather than the transmission of knowledge."
- The learning skills becomes gradually progressive, coherent and cumulative
- The learning forces will not only be oriented on acquaintances, but also on competences. The PPBA will

bring reasoning competences and problem efficient resolution
- The student will have a higher chance and rate to memorize and retain the information acquired during the learning phase [13].

It is straightforward to mention also the disadvantages of this new method:

- The PPBA would require more upfront preparation time
- The student will have the impression to have less time to devote to other courses
- The PPBA can create a negative attitude and an uncertainty due its new and recent introduction into a classical teaching environment
- The PPBA can present some type of conflict between different member of teams (lack of coordination, lack of planning and different student personality).

It is appropriate before changing any teaching method or approach to define clear and precise objectives. Some of the major objectives of the PPBA can be related:

- To develop student's personal, professional and social qualities
- To facilities and promote higher chances of success and adaptation for changes
- To permit the student to acquire the targeted competences
- To present variety of technical targeted subjects and problems to follow up the rapid evolution and market needs.

The paper is organized as follows: Section 2 describes the pilot project using Problem and Projects Based Approach (PPBA) at École de technologie supérieure- Université du Québec on analog electronic circuits' course. The project resources are given at Section 3. Section 4 defines the implementation of the project followed by the outcome and results at section 5. Finally, the conclusions and the recommendations are presented in section 6.

2. PILOT PROJECT

In fall 2005, the standard weekly laboratories of analog electronic circuits' course were replaced by a Project Based Approach (PBA) [14]. It was the first step to introduce a new vehicular method in the electronic laboratories. Figures 1 and 2 show the transition from standard laboratory sessions to laboratory project based approach. In fall 2007, with the approbation of the department and the faculty of École de technologie supérieure (ÉTS) – Université du Québec, a pilot project of the complete analog electronic circuits' course was planned, organized and implemented to be thought with the Problems and Projects Based Approach. Figure 3 shows the transition from Figure 2 to a complete PPBA method.

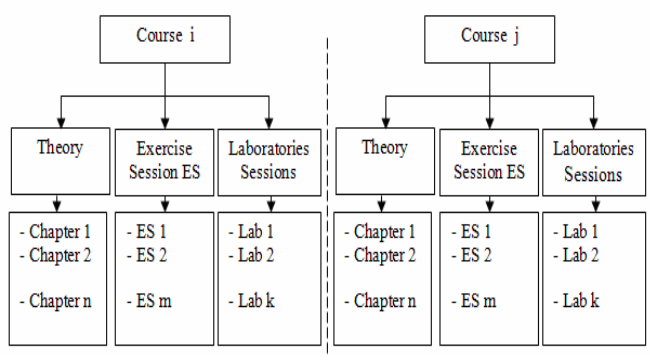

Fig. 1. Bloc diagram of classical teaching approach

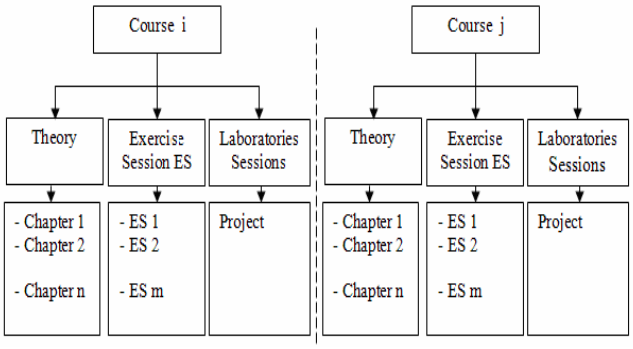

Fig. 2. Bloc diagram of laboratory project based approach (PBA)

3. PROJECT RESOURCES

After the approbation for the pilot project, a good planning was set to organize the following PPBA resources, helping the students and the instructor:

1) PPBA general instructions and directives for students
2) Self learning key words identification and availability
3) Problems description and definition
4) Self test for each problem
5) Theoretical project description and definition
6) Laboratory project description and definition
7) Contract forms (for problems and projects)
8) Evaluation forms for the students and the course.

All the resource information was available to the students through the Web Site of the course

In order to describe and explain the development or the 'in class' unrolling of the project, a document with clear instructions and directives was prepared explicitly for students. All the approach details with the time frames and calendars were set up front. Moreover, the objectives, the advantages, the possible disadvantages and the impact of the approach were also documented. Then the setting of subgroups or teams was planned for each class group (morning and evening).

The major topics of the analog electronic course are the diodes, Operational Amplifiers (Op-Amps), Bipolar Junction Transistors (BJT) and Field Effect Transistors (JFETs and MOSFETs). From the first day of the classes, every student was notified with the fact that the approach requires a self learning effort for the whole session time frame. Hence, students were to contribute actively in their apprenticeship (self learning) and the role of each student in a subgroup was to prepare the content of the lecture using the identified and available keywords that represent the content or the subtopics in the four mentioned major topics. It was also reminded that students within all class subgroups were responsible for their self learning even if they did not have the responsibility, for that certain week, to present the subtopics. In conclusion, every subgroup had the mandate to explain at least one course period containing several subtopics. In fact, the presenter-student acted as the instructor during this lecture period (simplified theory). The professor validated the explanation with adjustments and intervention if necessary.

For each of these 4 subjects a practical/industrial and daily problem was created and documented properly for easy understanding. Similarly a theoretical project including all four topics was described in a short document helping the students to understand the project without reading heavy and lengthy document. Hence in the semester, students were responsible to

complete 4 problems, 1 theoretical project and finally 1 laboratory project.

In another document the responsibility of each student with detailed role of each student was set. Associated contract forms were prepared helping students to be more responsible. The contracts were signed by each member of subgroups helping a fair involvement of all students. In fact each student evaluated the colleague of his subgroup on the contribution and on the implication of the projects and the problems.

Finally, 'how student will be evaluated' was explained to the class. Two evaluation forms were generated for course and instructor evaluations and ratings.

4. IMPLEMENTATION OF THE PROJECT

At the first course class period, the instructor explained how the PPBA approach will be used. The instructions and documentations prepared in section 3 were distributed in class with thorough detailed explanations to make sure that all the required expectations were well understood by the students. The numbers of students in each class being between 35 and 45, four subgroups (between 8 and 12) were formed and clear instructions were given to each member of the subgroups. A fast description of each problem and projects was given with the expected outcomes.

For each subgroup, the following main students' responsibilities were attributed:

- The reporter
- The animator
- The scribe.

The role of the reporter was to gather all the keywords signification understood by each member of the subgroup. The animator was responsible to lecture and explain the signification of the keywords prepared and understood by the colleagues of his subgroup, and to make sure that the lecture was well communicated within the allowed time frame. Finally the scribe took notes with a computer all the validated definitions of the keywords or the subtopics. The professor intervened when keywords were not well explained or not well understood by the presenter or the class. This intervention was very important in order to avoid the misunderstanding or misinterpretation of significance of keywords understood by all students in the classroom.

After the explanation of all the subtopics, each subgroup had the responsibility to understand and solve the 4 problems associated with each major topic (diodes, Op-Amps, BJTs and JFETs/MOSFETs). The theoretical and laboratory projects were assessed and solved within all the semester time frame (starting from the beginning of the semester till the end).

5. OUTCOME OF THE PROJECT

The approach was implemented with the following schedule:

- Problem 1 (Weeks 1, 2 and 3) - Diodes
- Problem 2 (Weeks 4, 5 and 6) - Op-Amps
- Mid term exam/evaluation (Week 7) on diodes and Op-Amps
- Problem 3 (Weeks 8, 9, 10 and 11) - BJTs
- Problem 4 (Weeks 12 and 13) - JFETs/MOSFETs
- Theoretical project (Week 1 to 13)
- Laboratory project (Week 1 to 13)
- Final term exam/evaluation on BJTs and JFETs/MOSFETs.

Several difficulties were observed during the semester. The students found the lecturing difficult since they felt less mature to transfer the content and the signification of subtopics to other students in the classroom. This was the major drawback of the approach; nevertheless, the performance of students with time (after the 4^{th} week) was improved with the experience gained on the first problem.

The reunion or gathering of subgroups with 8 to 12 members was quiet challenging and difficult due to the availability of each member. The lack of motivation of some students with this new approach affected also the communication between members. This was reflected through the contract forms filled in by each member of the subgroup.

The instructor role was completely different than the classical lecturing. This approach required a multidisciplinary and broad vision of the instructor in order to intervene properly and validate all presented materials by students. The instructor found this approach very dynamic since it needed an active behavior in the class showing respect to the presenters and helping or supporting them when needed.

For the assessment of the course by the instructor, several meetings had taken place with the pedagogical development agent. In fact with the advance of the project several adjustments to the approach was implemented to satisfy the need of the classroom. Two course evaluation forms were prepared by the instructor and the faculty to evaluate the course. The students were requested to fill the 2 evaluation forms (7^{th} week and 11^{th} week). The overall approach evaluation investigated by the instructor and the student's evaluation results presented several conclusions with respect to advantages and drawbacks:

Advantages:

- The approach helped the improvement of communications skills of the students
- The information retention or memorization turned out to be higher than the classical approach
- The approach created a synergy for the implication of team work within several problems and projects identical to a real world industrial situation
- The students and instructor were dynamic rather than static as with the classical approach.

Drawbacks:

- The approach was received with a lot of hesitations by the students since it was only applied to one course within several classical approach courses in the engineering faculty
- Since the approach was new, it was perceived negatively by the students
- The approach was very demanding and students were consecrating more time than the classical courses
- The students felt uncomfortable and ridicule in transferring the knowledge to other students
- With this new approach, students felt unsure about the nature and results of the exams or evaluations.

6. CONCLUSIONS AND RECOMMENDATIONS

The classical teaching experience shows a static learning with reduced autonomy and communications, lack of efficient organization and planning, less motivation and creativity. To overcome these learning drawbacks, a new approach (PPBA) was implemented as a pilot project for analog electronic circuits' course. The approach was not only oriented on acquaintances, but also on competences.

The pilot project was implemented to 2 groups over one semester. Student exam results showed similar outcome as for the classical approach. Nevertheless, the communication skills and the learning motivation were increased. Unfortunately, the rate of students' satisfaction was low since the approach required more time for preparation and more challenge to explain the signification of the keywords of different subtopics. Since the approach was used only for one course within the faculty, it was perceived negatively by student, and some student psychological rejection was observed from the beginning of the semester.

For the implementation of PPBA for future courses, it is recommended first the implication of several courses and not only one (either through departments or faculty). In this way the psychological students' fear can be consumed. Secondly, it is imperative to evaluate the overall profile of students to see if they can absorb this approach or not by evaluating the part time remunerated working hours outside the university. Part time working and assisting more than 3 courses per semester would not allow enough time and energy to consecrate on PPBA. In fact, only the presenter subgroup came to the class with a good preparation. 'Listener' students came to the class without any preparation and were completely lost while the presenter addressed the subtopics in the class. Finally but not least, the success or failure of a pilot project can not be assessed on one time essay, it needs to be repeated with the required and recommended adjustments to evaluate the statistical results over several trials.

The following recommendations were suggested and implemented for the winter session:

- Reduce the subgroup number to 3
- Eliminate the self learning (at least for the basic subtopics and use the classical approach (classical lecture duration of 8 weeks in a semester of 13 weeks)
- Eliminate the task of presenting the keyword significations by students
- Keep the 4 problems within the semester (4 weeks)
- Assess the performance of the class with respect to the retention and competence skills (verifying exam results and answering the questionnaire prepared explicitly for the needed purpose).

7. ACKNOWLEDGMENT

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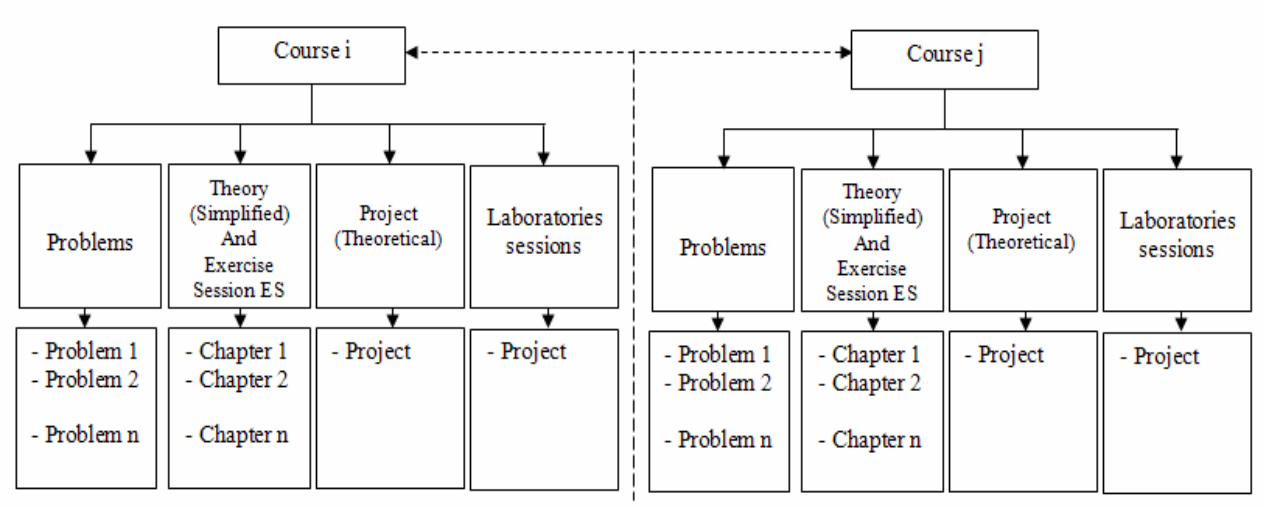

Fig. 3. Bloc diagram of problems and projects based approach (PPBA)