The Student Perspective on a Project Based Learning Course

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Abstract

Courses that use Project Based Learning (PBL) may present specific and unforeseen challenges for both the instructor and students taking the course. This paper discusses a “typical” undergraduate engineering student’s experiences while in such a course, focusing on both the positive and negative aspects which have played important roles in understanding the course material.

Engineering Strategies and Practice II (ESPII) is a PBL course offered at the University of Toronto which requires all first year undergraduate engineering students to participate in a real-world community design project. Student teams develop their own solutions to the issue presented by the client. Each team is responsible for meeting with the client, developing a problem statement, and presenting feasible ideas on how to address the client’s need.

The presenter, an undergraduate engineering student himself, observed that a PBL format allows students to use their own judgement and creativity to a far greater extent than a non-PBL course when solving a problem, and that a group-based strategy aids in developing transferable communication skills. However, a number of negative aspects were also identified. Specifically, the complexity of the design problems was not uniform across the class, which caused some teams to approach their project more diligently than others.

This paper is a result of interviewing former students of the ESPII course in an impromptu setting. The goal was to get broad set of opinions on the course from which to draw some general conclusions about the positive and negative aspects of PBL undergraduate engineering courses.

Background

Engineering Strategies and Practice (ESP) is a series of two engineering design courses offered at the University of Toronto for first year engineering students. Being a core course in all but one stream of engineering offered by the university, ESP’s enrolment numbers have always been high – approximately 950 students per class. Taught in Canada’s largest classroom (1), University of Toronto’s Convocation Hall, the course is directed by a team of instructors and a course-coordinator.

The goal of the two ESP courses is to develop the students’ understanding of design, communication, and teamwork in a real-world environment. The first course introduces concepts, terminology and strategies used in engineering design, and familiarize the student with the processes used to develop a design solution. This culminates in the Conceptual Design
Specification (CDS) report assignment which describes the problem being solved, alternatives that were considered, and the recommended solution. The second course and primary focus of this report – ESP II – places the students in teams of approximately 6, and partners each team with a member of the community (i.e. the ‘client’). Student teams then develop their own solutions to the issue presented by the client. Each team is responsible for meeting with the client, developing a problem statement, and presenting feasible ideas on how to address the client’s need. Throughout this process, each team meets weekly with a ‘project manager’ who is typically a Professor in the Faculty of Applied Science and Engineering, providing each team with advice. Typical issues presented by the client vary from the design of a heat exchanger for a whirlpool at a gym, to developing a complete floor plan of an indoor rowing facility. Each group is expected to approach the project in a professional manner– a portion of their grade depends on the quality of research done in developing their team CDS report.

This paper focuses on the 2005-2006 academic year, and analyzes the second part of the ESP course series, ESP II. In was this particular year ESP was first taught in full-scale, and it was also the year in which the author was a student in the class. The course coordinator and instructors, respectively, for the 2005-2006 year included Prof.’s S. McCahan, P. Anderson, R. Andrews, M. Kortschot, K. Woodhouse, and P.E. Weiss. Enrolment in the 2005-2006 year was approximately 950 students at the beginning of the course.

**Project-Based Learning (PBL) courses**

Engineering Strategies and Practice II is a project-based learning course. The student’s grade is based on their approach to addressing the client’s need, and the level to which they have incorporated their understanding of topics covered in ESP I into their design process, teamwork, and communication. Project-based learning courses, as the name implies, involves students learning through experience.

According to the Buck Institute for Education\(^\text{(2)}\), Project-Based Learning is defined as “an inquiry based process for teaching and learning. In PBL, students focus on a complex question or problem, then answer the question or solve the problem through a collaborative process of investigation over an extended period of time. Projects often are used to investigate authentic issues and topics found outside of school.”

**The Study**

Several of the students enrolled in ESP II during the 2005-2006 academic year were interviewed in a span of two weeks in early September 2007. Since the researcher is a student himself, he was able to perform the interviews in an impromptu setting (e.g. during a game of table tennis). This research methodology was selected in response to the timid nature of many freshmen undergraduate students to receive an honest, unpressured statement from each participant. Test subjects were chosen based on their availability and willingness to answer brief questions pertaining to ESP II, and were not paid for their voluntary participation in the study.

Students were asked about their experiences in ESP II, with particular emphasis placed on how a PBL-based course affected their understanding of the intrinsic course material.

About 90% of the participants found ESP II to be a unique first-year course that allowed each student to learn material based on his/her individual learning style. Since every team requires its
members to perform a certain task integral to the completion of the CDS, and the CDS mark is equal for each member of the team, each student felt compelled to put forth a genuine effort so that the team would receive a particular grade. For students, this provided a driving force for each member of the team to coach one another, improve their transferable communication skills, and develop a sense of ‘teamwork’ that allowed for a successful CDS report.

Some students complained that their team required certain members to be ‘coached’ more than others did. According to the course coordinator, Prof. McCahan, “we tried to create teams which were fair. All students were ranked in order of grade received in ESP I, and were assigned a number from 1 to 160 as we moved up and down the list. This way, we attempted to create ‘average’ groups, which had students from both ends of the academic scale.” (3) Thus, it seems that the students’ concerns were justified – students were expected to coach certain members more than others. To better understand if this was effective or not, participants were asked if they agreed with the Professors’ reasoning. Now, having known that each team included individuals of differing academic standing, there was a surprising reduction in the complaints participants had: the number of complaints fell to 2 from 9, and those individuals who previously complained stated that it’d be more effective if students knew beforehand how the teams were established. There were, however, rebuttals to this argument since one participant explained that if students knew how teams were made, then there was an increased chance that a particular group member would be labeled the “dumb kid” solely based on his/her previous academic performance, and would not be given the ‘coaching’ that he/she deserved.

Approximately 40% of the students interviewed expressed concern that their project was more ‘difficult’ than others. For example, participants compared the “Rowing Club Floor-Plan” project with the “Seniors Home Patio”, and found that the former project was much more difficult. To explain their reasoning, they said that the Rowing Club client expected much more from the design team because it involved designing floor plans for three concurrent floors, whereas the Seniors Home required only one. Further, the demands placed by the Rowing Club client were mostly superficial and were not within the scope of a first year engineering design team. Although all teams are required to produce a CDS, 40% of the participants of this study found that the former design project required a great deal more effort than the latter. The remaining 60%, however, argued that the mix of projects allowed for a ‘heterogeneous design space’ where students were compelled to use distinctive approaches for each differing project, and that the assortment of projects discouraged repetition while increasing interest in one another’s project. Professor McCahan states that, “Projects are not [meant] to be equal, but the central issues are present nonetheless, in different amounts. ESP II strives for the basis that all students are equally likely to get a ‘good’ mark – the course focuses on congruency between topics, not equality, so that while each group may have a different project, they are all within the context of the course.” (3) From this, students believe that there is a ‘fine line’ between having a heterogeneous design space and having equality amongst projects, with most students favoring the current level of project diversity.

To better understand if students were learning what was expected of them, and to assess if the course was on-track with its objectives, the course coordinator referred to R. Felder & R. Brent’s paper, “The ABC’s of Engineering Education” (4) and explained that the cooperative-learning goals of ESP II were in line with the suggestions described in their literature. In general, their paper clarifies how PBL courses are based, and what should be done by the instructors to aid
students in learning the expected material. The table below compares Felder & Brent’s suggestions with the students’ perception of the course.

<table>
<thead>
<tr>
<th>Felder &amp; Brent’s Category</th>
<th>Felder &amp; Brent’s Explanation</th>
<th>What Students Perceived</th>
<th>Percentage of Students who believed that ESPII met Felder &amp; Brent’s goals</th>
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<tbody>
<tr>
<td>Positive Interdependence</td>
<td>Students must complete work as a team for the output to be successful</td>
<td>“Yes, it was imperative that we worked together as a team, that was clear from the lectures I attended”</td>
<td>85%</td>
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<td>“Everyone in the team had to pull their weight for the CDS to have a good mark”</td>
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<td>Individual Accountability</td>
<td>Each team member is accountable for everything in the [report], not just for the sections s/he may have written. If team members hitchhike and do not understand what the team did, they should not get credit for the work.</td>
<td>“I wrote the introduction and conclusion, but I had to know what was in the whole report to do so”</td>
<td>90%</td>
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<td>“Although it was a team mark, we all had to do a specific task as best we could… and make sure that it cohesively fit into the CDS”</td>
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<td>Face-to-face interaction (at least part of the time)</td>
<td>Much of the learning in team projects takes place when the team meets to discuss, debate, and reach consensus on solutions to problems.</td>
<td>“We held team meetings on the same day every week, at a time and place that was suitable for everyone, but sometimes we’d just discuss what we did over the weekend instead of working”</td>
<td>70%</td>
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<td>“We were given ample time to swap contact information beforehand”</td>
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<td>Facilitation of interpersonal skill</td>
<td>Students are not born with the project management, time</td>
<td>“There were times where I felt that I couldn’t solve the problem… and a week”</td>
<td>75%</td>
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</tbody>
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development management, communication, leadership, and conflict resolution skills. The instructor must take steps to help students develop [them].

later, it was explained in class, and I sort of felt jipped”

“The ‘Project Manager’ and TA helped me resolve a problem two of my group members were having…”

Periodic self-assessment of team functioning
At regular intervals, students must be required to reflect on past, present, and future team goals

“The team meetings with the TA helped us focus on upcoming tasks, and helped us distribute tasks accordingly”

90%

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| Table 1.0 – ESP II Cooperative-Learning Goals vs. As Perceived by Students |

Students believe that most of the cooperative-learning objectives set forth by ESP II have been met, with some categories having a higher degree of correlation than others. From the student’s perspective, this means that ESP II has successfully implemented cooperative learning techniques to help aid in better understanding course material.

The students interviewed also provided much positive feedback on ESP II. Even two years after completing the course, 80% of the students interviewed claim to have retained 75% or more of what they learnt in ESP II. Comparing that to a ‘traditional’ engineering course, Fortenberry et al (5) claim that fewer students leave engineering studies when education programs link concepts to real-world practice. In the case of ESP II, all projects are based on real-world issues and some (as in the case of the Rowing Club) are actually resolved because of the approaches outlined in the student CDS reports. Furthermore, since ESP II is a first year course, it also acts to retain as many engineering students due to the nature of the course. Professor McCahan also notes that, “due to these ESP courses, many departments in the faculty have elected to remove upper year design courses… and this is a source of concern.” (3) The students, in fact, echo this opinion as 80% of the participants say that they have few-to-none PBL-based courses in their undergraduate curriculum, except for ESP II. Although this proves that PBL courses are in high demand among many students, having them relate to real-world issues is also very important. “A year after my ESP II course was completed, I passed by the Seniors Home that I worked on for my team CDS. Not only did they remember who I was, but they congratulated my group and I for the unique suggestions we had for their patio building idea,” said one participant.

Nearly all the students interviewed claim that they made new friends, and learnt important networking skills because of working in a problem-based environment with individuals with whom they have never worked with before. A large proportion of these students mentioned that they would enjoy working with the same teams in the future, if given the chance. From a student perspective, it was clear that ESP II was a success – it helped them learn course material in their own way, developed transferable communication and networking skills, and allowed them to iteratively apply what they learnt to develop a team-based real-world project. While some students found the team based environment unfair, they quickly realized that there was much
more to be learned when working on a project as a team; every team member had an important role to play in the CDS report. Furthermore, some students felt that there could have been more equalization among the difficulty of projects, as that would help each team put forth a relatively equal effort. As the facts showed, the students also had an exceptionally high information retention figure, and made long-term relationships with their colleagues thereby strengthening the cooperative-learning environment even more. In general, from interpretation of the student’s perspective of project-based learning courses, the majority of students interviewed believe that this teaching method is unique, useful, and can lead to better retention of information.

References


2. **The Buck Institute for Education and Boise State University, Department of Educational Technology.** Project Based Learning, *Frequently Asked Questions - PBL.* [Online] [Cited: September 16, 2007.] http://pbl-online.org/.

3. **McCahan, Susan.** *Interview with ESP Course Coordinator.* Toronto, 08 29, 2007.


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