STUDENT'S PERSPECTIVE ON IMPROVEMENTS FOR SECOND YEAR AND OTHER UNDERGRADUATE ENGINEERING DESIGN COURSES

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Abstract -Students and educators should work together on pushing the boundaries of expectation - “expect more to get more” - so that design courses can become increasingly effective and greater potential can be achieved. I encourage instructors and educators to consider the fact that this generation of engineering students enter university with a multitude of experiences and skills in design, decision making and communication that past generations did not have – and taking advantage of that advanced starting point will greatly improve the caliber of the course offerings.

As an engineering undergraduate student at Queen's University, I have been exposed to several engineering design courses. Starting in the 2011-2012 academic year when I was in my second year, a course referred to as APSC 200/293 was introduced. I will be critically discussing my experiences both positive and negative with this design course, as well as the first year design course, and in my opinion how they can be improved. Information and feedback regarding the design courses was obtained from the faculty and compared to my observations. Starting the design courses early on in the students' careers gives them an excellent introduction to the real world of engineering. However, there is great room for improvement in courses of this sort, which can be assisted by utilizing the opinions of willing students. I will further discuss these courses, their downfalls and advantages, and where improvements could be made to promote the success of students.

Keywords: undergraduate design, professional skills, student perspective, course evaluation

1. INTRODUCTION

Queen's University has included a first-year faculty wide engineering design course for many years. In 2009, the faculty undertook a curriculum review process in order to enhance undergraduate engineering education, and to

meet and exceed the new CEAB graduate attribute requirements [1]. This course, developed as a part of a four-year Engineering Design and Practice Sequence (EDPS), has adopted several core requirements for all undergraduate engineering students, including design process methods and tools, problem analysis, creativity, economics and entrepreneurship, engineering communications, professionalism and ethics [1]. The first-year design course, APSC 100, was re-evaluated and improved upon during this review process. Further, a second year design course, APSC 200/293, was developed to improve upon the skills learned in first year, strengthening the students design and professional skills and maximizing the desired learning outcomes. These outcomes were developed by a faculty-wide curriculum committee and are specific to the second year of the four-year EDPS. These outcomes are found in table 1.

Table 1: EDPS learning outcomes for second year [2].

EDPS II Detailed Outcomes (APSC200/293)
<ul style="list-style-type: none">● Demonstrate enthusiasm for engineering and the discipline they have selected● Apply design processes and tools for problem definition, idea generation and decision making● Promote creative processes in open ended problem solving● Apply engineering principles and theories from other disciplinary courses● Solve an open-ended design problem (involving analysis and/or simulation and/or prototyping)● Analyze triple bottom line (financial, environmental, and public interest) to support decision making● Apply relevant engineering regulations/codes/standards in a professional manner● Explain the role of professional/technical associations in engineering and discipline● Apply teaming skills in a group project● Identify all relevant factors and the dominant factors in the system● Apply information search and identification, with proper citations

- Demonstrate a communications strategy that considers the needs and character of the audience
- Compose logical arguments based on supporting evidence
- Compose with the appropriate structure and relationship amongst ideas
- Prepare and deliver a presentation with appropriate language, style, timing and flow
- Demonstrate writing with correct spelling, punctuation and grammar
- Demonstrate conciseness, crispness, precision and clarity of language
- Use appropriate formatting for a memo and a short report

The course involved three separate projects, referred to as P0, P1 and P2: P0, a short, simple project used to engage the students and prepare them to work with their team; P1, a faculty-wide 5-week project which has had a humanitarian theme, and P2, a discipline-oriented project designed to continue the same learning outcomes of P0 and P1 [1]. The three projects are further described later in this report.

In the first year of APSC 200/293, many observations were noted regarding the course and its successes and areas for re-evaluation and improvement [1]. As a student who experienced this course first hand, I have compared my observations of the course with those from the faculty in order to contribute a student perspective and opinion.

2. STUDENT PERSPECTIVE

2.1. Expect More to Get More

Reflecting on my experience with APSC200/293, as well as other undergraduate design courses, I developed the concept of “expect more to get more”. If educators expect more out of their students by beginning at a higher level and pushing the boundaries further, they will get more out of the students and more can be gained overall. I believe that those who chose to pursue engineering have a passion and desire for further learning. Given a chance, students can have a tremendous impact. However, their learning tools need to evolve with the world of engineering. While the basics still need to be taught, students develop into engineers by honing their ability to apply these basics effectively.

From my student’s perspective in APSC 200/293, the concept of the course was to bring together fundamental courses with innovation, design, open-ended questions and critical thinking. This is the type of course that sets an engineering student apart from students in other areas of study; learning and practicing how to learn, how to design and how to integrate different subjects. In comparison

with Dr. Strong and Dr. Frank’s objectives described for the course [1], it appears that my ideas match what the course’s learning outcomes. While I didn’t realize during the course or immediately after how much I had learned, later reflection proved their overall goals to be successful. Nevertheless, there is still large room for improvement, using the “expect more to get more” approach.

2.2 For Educators

I believe a major difficulty with the first offering of this course is that the teaching focus veered from the purpose of the course and the skills targeted for development. It was my perception that the course instructors had a low expectation with the level of student knowledge, targeting too low a level, particularly in the lecture and workshop portions. I encourage instructors and educators to consider the fact that this generation of engineering students enter university with a multitude of experiences and skills in design, decision making and communication. Throughout high school and even before, students are taking the opportunity to get involved in student government, sports teams, part-time jobs and other extra-curricular activities where these skills are necessary. These skills should be polished and directed, rather than re-taught. While these proficiencies may not be present in all entering students, creating a higher standard by expecting and promoting these qualities will facilitate greater student growth and learning.

Reflecting on my experience with the course, students in APSC 200 were often not challenged enough and were taught skills that they already had a range of experience in. For example, evaluation matrices were taught to a great extent in APSC 200, after already been introduced in APSC 100. While repetition can be a useful teaching practice, many students felt that the material was unnecessary and were less likely to give it their full attention. Further, by the time the specific use of an evaluation matrix was taught (in both courses), a great deal of research had already been done, as had primary and even secondary design decisions. Students were making up the numbers in the matrices to fit already-made choices, and misrepresenting their intended function. From my perspective, this generation of engineering students has been practicing critical thinking since a very young age. This includes playing sports where split-second decision making is second nature, or taking on a student leadership role entailing understanding the responsibility that comes with making a choice and the associated consequences. Students know how to look at a problem and suggested solutions, weighing out the pros and cons in a concise and effective manner, without even realizing the skills they are using. They need to be taught to think about why they are making decisions and more about their impact, rather than how to make the decisions

themselves. While the decisions they make may not compare to the ones being made in a design project, they are often multi-faceted and can have significant impact. Comparatively, examples being used in the APSC 200/293 workshops were underwhelming, and by not having enough interest or resonance did not stimulate the students' learning. If, on the other hand, instructors expect that students arrive with a basic tool kit of decision making skills, as well as many other practical skills, they can progress from a higher level rather than starting from the beginning. By improving upon what the students already have, more can be gained and students will leave with greater knowledge and further growth.

2.3 For Students

Continuing with the idea of "expect more to get more", students also need to expect more from themselves, as well as from their own education. In so doing, they will get more from their education and from themselves. Firstly, students need to realize that what they are being taught has practical relevance to their future. As a student of APSC 100 and 200, it was not until after the courses were over, and in reflecting on them with others, that I realized what had been gained. As students, we were so focused on the individual components of the course, particularly the more negative aspects, that we had not taken the time to realize what we had learned and appreciate what could be done with it. If we had realized the full potential of the projects earlier on, we may have put more into them and in the end gotten more out.

In addition, I believe students need to expect more from themselves in order to do their best. This means having more confidence in both their skills and their ability to learn. Students are arriving at university with the knowledge necessary to take their learning to the next level. However, I believe that many students are not confident, nor are they willing to push themselves. It is only by expecting more of themselves, pushing past their perceived boundaries, that they will be able to achieve greater levels of learning. From my observations, many students are afraid to take their learning into their own hands; when a concept is taught that seems beyond the scope of their knowledge they tend to ignore the concept or ask the professor to over-simplify the material. Students need to be prepared to use resources to bring up their own skills, rather than having expectations lowered for them. They need to prepare themselves to research topics on their own and prepare themselves for the material. If students expect themselves to learn on their own, the breadth, depth and quality of their learning will greatly increase.

As engineering is such an innovative and ever-evolving field, engineering education also needs to be continuously changing. Undergraduate design courses such as those

offered at Queen's are extremely important to the modern engineer's education, and as long as a great deal is expected from them, a great deal of knowledge, skill and experience can be obtained. These courses need to be continuously assessed and re-evaluated for continuous development and improvement. This process should not only involve the educators, but the students as well. The educators and developers must be able to look to students for a serious and valuable opinion, while students must feel that their opinion will be taken seriously. Both parties need to value and respect what is expected of and offered by the other, in order for the relationship to be fully reciprocal.

3. COMPARISON TO FEEDBACK

After the APSC 200/293 course ran for a year, the team that developed it took on the task of acquiring and accumulating feedback from all of the stakeholders for the course. This included the students, the teaching assistants, (TAs) who helped run the course, and the instructors. The feedback acquired was compared to my observations and feedback, to note similarities and differences.

3.1 Student Feedback

An online post-course student survey was used in order to assess the course from the perspective of the students. Half of the survey pertained to the overall course - how it met the desired learning objectives and the organization of the course, while the rest of the questions focused on each of the 3 projects [1]. The responses suggested a high level of satisfaction from the students [1]. These results are fairly consistent with my opinion of the course, as well as with the opinions I heard from my peers. During the semester students were often frustrated, particularly by lack of organization. However, after the course was over, in reviewing the specific learning outcomes, students started to realize how successful it had been. A year later, students are continuing to realize what an asset this course has been to their education and are grateful for the experience.

3.2 TA Feedback

The TAs for the course were encouraged to offer comments and suggestions from their point of view. It was noted that both the students and TAs would benefit from a more detailed outline of the schedule and activities for the course, as well as ensuring that students understand the course, team requirements and expectations [1]. This is expected from an innovative first course offering, which is partially still being prepared as the course progresses. However, this is an observation that I note in not only the

design courses, but other courses as well; having detailed and explicit expectations allows the students and educators to ensure that they are on the same level. This feedback matches with the idea of “expect more to get more” from a student perspective: if the students are more aware of what is expected of them, they will be more likely to put in the appropriate effort and achieve greater success. With a course such as APSC 200 which includes a vast range of learning objectives, these need to be reiterated throughout the semester and explained to students in a manner that will excite and motivate their learning. Rather than only using technical terms to describe the learning outcomes, they should also be described in a manner that shows how they can be used beyond this course. A suggestion I believe could work would be having professors from a range of courses and disciplines give their input to students on how they use these skills and learning objectives in the “real world”. Students respond well to instruction that is personalized and when they can see where it will be used.

The TAs also noted that attendance should be taken in lectures and/or workshops to ensure that all students are present to contribute to their teams [1]. Ensuring student attendance is an extremely difficult task, and consequences such as lowered marks can be effective at improving student attendance. However, instructors must be aware of their influence on student motivation and attendance, and attempt to make instructional periods as engaging as possible. Students had low expectations of lectures, and thus did not feel the need to attend. If instructors teach from a higher level, students will have more motivation to attend the courses.

3.3 Instructor Feedback

The instructor feedback pertained mainly to the projects involved in P2, and varied across the disciplines [1]. As the course revolves, the P2 project topics are being refined to improve their effectiveness for students to practice and develop the skills being taught in P0 and P1, and so that the learning outcomes achieved by this final P2 project are more consistent across all 10 disciplines.

4. CONCLUSIONS & RECOMMENDATIONS

Based on both personal observations and a review of the first-offering feedback for APSC 200/293, it is apparent that overall, the course is successful. The feedback obtained from the first round of students who participated in the course was very positive and encouraging. With this course there is definitely room for improvement and continuous yearly evaluation is required to better meet the learning outcomes of the course. The desired learning outcomes that were originally stated in

the introduction of the course were met according to evaluation, and further acknowledged by the students who took the course. These outcomes must be fully explained to both students and TAs throughout the course, to ensure that all parties fully understand what is expected of them.

The concept of “expect more to get more” can be used in the re-evaluation and improvement of the course. This statement pertains to the educators, developers and instructors of the course, as well as the students who are involved.

Instructors and educators must be aware of the knowledge level of students who are taking the course, and should expect more out of these students, pushing them past their perceived boundaries and comfort levels. By doing so, they can teach topics in greater depth and instill higher levels of learning in their students, thus achieving better results. Students arriving at university already have relevant experience and practical skills that can be applied in design courses, and which can be enhanced throughout the course.

Students need to be aware of what is expected from them, and also what they can expect to achieve from the course. They must be willing to realize the importance and relevance of the course material, and to understand that it will benefit them greatly in future courses as well as after they graduate. Additionally, they must expect more from themselves, pushing the boundaries of their learning to do their very best and maximize the desired outcomes.

As a student, I took the initiative to state my opinion regarding my education. I hope to inspire other students to take their education into their own hands, and give critical, constructive feedback regarding their schooling. After previously speaking on this topic, I have been given the opportunity to work with the Engineering and Applied Sciences team at Queen’s University for the summer, in order to help in the further development of APSC 200/293. Using the feedback from both the 2011-2012 and 2012-2013 academic years, the expertise of the faculty and my own perspective and opinions, further evaluation of the course will be performed with the goals of continuing the improvement and success of the course.

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