Peer Review as an Active Learning Strategy in a Large First Year Course

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Abstract – Peer-review of writing is an instructional strategy used to develop students' critical thinking skills, writing competence and as a way of engaging students as active agents in their learning process [1,3,4]. In the Fall 2013 semester, two peer-review assignments were introduced in a compulsory first year engineering course, Introduction to the Engineering Profession, taken by nearly 500 students (in two sections). The objectives of the peer-review assignments were two-fold: (1) to help improve students' writing by providing them with constructive criticism and feedback and (2) to develop students' critical thinking and editing skills. Using a rubric provided by the instructor, students were asked to evaluate their peers' written assignments in three categories: overall presentation, clarity and coherence (organization), and justification/explanation of the topic being discussed/analyzed. One assignment addressed the inter-disciplinary nature of the engineering profession while the second focused on making ethical decisions. Evaluators were required to justify the score given in each category, as well as to provide a short written comment on the paper as a whole. At the end of term, a class survey was conducted where students reflected on the peer review assignment from a learning perspective. This study presents the results of an analysis of those reflections. Overall, students and the instructor valued this instructional approach. Implications of this type of instructional strategy for undergraduate engineering education are also discussed.

Keywords: Peer Review, Critical Thinking, Writing Competences, Constructive Criticism and Feedback, Editing Skills

1. INTRODUCTION

The objective of this paper is to summarize our experience of using peer review of writing assignments given in a first-year engineering course. The principles used to design the instructional strategy were based on Topping's [6] definition of peer-assessment where "learners consider and specify the level, value, or quality of a product or performance of other equal-status learners (...) Peer assessment can be summative or formative". In this specific engineering experience, peer-assessment was used for summative evaluation purposes. Lessons learned during the pilot project suggest the use of the strategy not only for summative but also formative evaluation methods.

The motivations behind the use of this strategy were two-fold: (1) to help improve students' writing by providing them with constructive criticism and feedback and (2) to develop students' critical thinking and editing skills. However, the use of this strategy can have other benefits that, even though not planned, occurred during the experience.

Some benefits that researchers [1,3,4,5] have found when using peer-review as a teaching and learning strategy include the following:

- Reflection on one's own thinking and learning,
- Awareness of one's biases and how they affect review processes,
- Ability to evaluate following standards (e.g., rubrics) and not personal or affective judgments, and
- Development of skills to provide constructive feedback as well as how to receive/accept it.

However, concerns have also been raised in the use of peer-review as an assessment strategy [1,3,4,5]. These concerns can be summarized as follows:

- Lack of honesty on comments to avoid hurting peers' feelings,
- Humiliation throughout the feedback process,

- Increased anxiety among students, and
- Bias in feedback.

These benefits and concerns are in line with those expressed by students as well as by the instructor in this exercise. These benefits will be introduced and discussed in the following sections. Lessons learned and recommendations for designing and implementing this type of strategy in an undergraduate engineering course will also be provided.

2. COURSE DETAILS

FACC 100 Introduction to the Engineering Profession is the first of two compulsory courses taken by all students in the Faculty of Engineering at McGill University. The course provides students with a general overview of the engineering profession as well as exposes them to different engineering disciplines. The course is normally taken during the first year. It is followed by FACC 400 Engineering Professional Practice, which deals with issues (e.g., codes, legislation) related to professional engineering practices (e.g., liability, project organization and management, client relations).

The following topics are covered in FACC 100: introduction to engineering practice; rights and code of conduct for students; professional conduct and ethics; engineer's duty to society and the environment; sustainable development; and occupational health and safety. By the end of the course, students should be able to do the following:

- Formulate an opinion on the necessary skills and competencies to be successful as an engineer,
- Understand engineering professional values and ethics; apply knowledge of these values to address issues in professional practice,
- Explain how the field of engineering is inter-disciplinary,
- Assess critical issues in engineering using concepts related to sustainability and global engineering,
- Apply design and management processes to engineering projects, and
- Understand basic technical concepts from various engineering disciplines.

In terms of graduating student attributes, FACC 100 covers *Professionalism*, *Impact of Engineering on Society*, and *Ethics and Equity*. In most cases, students were introduced to the topics and corresponding issues, though some of the course activities (referred to below) provided students with opportunities to develop and apply competencies associated with these attributes.

FACC 100 is offered twice per year (i.e., in both the Fall and Winter semesters) and is taken typically by more than 800 students: there are approximately 450 students, mostly out-of-province (designated as U0 students), in the

Fall semester while 350 students, mostly from Quebec (i.e., the CEGEP system), take the course in the Winter semester.

Creating course activities that are interesting and that engage the students in the learning process is challenging, especially given the class size. Over the years, assignments and activities have included the following: (1) the use of a student response system (clickers), (2) an organized debate between teams of students on specified topics (only some of the students can participate in these), and (3) a written assignment involving some form of peer review.

3. PEER REVIEW ASSIGNMENTS

During the Fall 2013 semester, there were two peer review assignments.

The first assignment was a reflective exercise to increase students' appreciation of the inter-disciplinary nature of the engineering profession. Students were asked to choose three branches of engineering and provide one example of an engineering project in which engineers from these three disciplines need to work collaboratively. They had to justify their response and could make use of references, figures, tables, etc. The second assignment focused on making ethical decisions. Students had to pick one of two given scenarios and describe possible actions that they would take. They had to justify their actions, making use of ethical theories, the 6-step approach to addressing complex ethical issues introduced in class, and/or the 3-tests for an ethical decision.

The length of each assignment was constrained to a maximum of one page. In both cases, while students needed to justify their response in a clear and organized manner, there was no *right* nor *wrong* answer. We believe that this type of open-ended question is more suited to peer review as students cannot evaluate 'incorrectly'. A reviewer did not need to agree with an author's point of view; rather, they had to judge whether or not the author was clear in providing their response.

Grades for each assignment were determined as follows: 50% of the mark was based on the average score given by a maximum of 3 peer reviews and the remaining 50% was based on a student's participation in the peer review process. The peer review process was double-blind. The instructors and TAs did not review the papers; however, they reviewed the peer reviews to assess the quality of the feedback provided. If scores were assigned without appropriate justification and feedback, students did not receive maximum marks.

To assist the students in grading the papers, a rubric was provided. The papers were evaluated according to the categories and rubrics provided in Table 1 and 2 for the first and second peer review assignments, respectively.

Table 1: Categories and rubrics for grading peer review assignment 1.

Category	Rubric
The paper describes the topic in a clear manner, i.e., the choice of three engineering disciplines and engineering project	<i>Fully satisfied:</i> 2.5 <i>Mostly satisfied:</i> 2 <i>Partially satisfied:</i> 1.5 <i>Not satisfied:</i> 0
The need for engineers from the three disciplines to work collaboratively on the project is clearly justified and the discussion is well-organized (i.e., the arguments as well as their flow is clear)	<i>Fully satisfied:</i> 6 <i>Mostly satisfied:</i> 4 <i>Partially satisfied:</i> 2 <i>Not satisfied:</i> 0
The overall presentation is professional (free of spelling mistakes, high quality of writing, etc.)	<i>Fully satisfied:</i> 1.5 <i>Mostly satisfied:</i> 1 <i>Partially satisfied:</i> 0.5 <i>Not satisfied:</i> 0

Table 2: Categories and rubrics for grading peer review assignment 2.

Category	Rubric
The paper describes clearly the actions that will be taken in view of the situation	<i>Fully satisfied:</i> 3 <i>Mostly satisfied:</i> 2 <i>Partially satisfied:</i> 1 <i>Not satisfied:</i> 0
The actions taken are justified with reference to appropriate ethical theories, the 6-step process to dealing with ethical issues, and/or the 3-tests for an ethical decision	<i>Fully satisfied:</i> 5 <i>Mostly satisfied:</i> 4 <i>Partially satisfied:</i> 2 <i>Not satisfied:</i> 0
The overall presentation is professional (free of spelling mistakes, high quality of writing, etc.)	<i>Fully satisfied:</i> 2 <i>Mostly satisfied:</i> 1.5 <i>Partially satisfied:</i> 1 <i>Not satisfied:</i> 0

4. FEEDBACK OBTAINED

At the end of the semester, students were asked during class time to respond to the following questions and comment on the following:

1. Did you enjoy reading other students' papers?
2. Did knowing that your paper would undergo peer review change the way that you approached your writing?
3. Is this a useful exercise?
4. Ways to improve?

A total of 314 students responded and submitted this paper-and-pencil survey. Due to the nature of the data, 35% of these responses were selected and analyzed using a random sampling procedure. In relation to the first

question, 82% of the sample responded positively to the strategy; 6% did not enjoy the exercise; 7% were indifferent to it; and 5% did not answer the question. From the sample analyzed, 50% of participants changed their approach to writing when knowing that they were being peer reviewed; 39% of the sample expressed that they did not change their writing style; 2% reported changing their writing style somehow; and, 9% did not respond the question. A total of 77% of the sample found this exercise useful while 9% of the respondents did not.

Answers to the questions were classified using a grounded theory approach [2], in the following categories: (a) bias in peer's grading, (b) acquisition of new skills, (c) grading scheme, (d) rubrics, (e) roles of the TAs and course instructor, and (f) quality of writing.

Bias in peer's grading refer to those comments where students perceived that their peers (graders) did not follow the use of the rubric to assess their work but were mainly driven by personal preferences or affective appeals. Some students mentioned that because grades and grade points averages (GPA)s are competitive, they thought their peers had the option of acting maliciously.

Acquisition of new skills refer mainly to metacognitive skills that students reported they started to develop. By reviewing others' papers, they had the opportunity to reflect on their own writing process. Also, students reported using peers' comments and feedback from the first assignment as a way of improving their writing in the second assignment. This category refers also to comments raised by students on how they were able to reflect on new ideas and learn new concepts by reading other's papers.

Responses in the grading scheme category are defined as comments that concern the fairness of grades given by peers, insecurity on their ability and expertise to determine peer's grades, and the need of more reviewers in the process. A suggestion mentioned by a large number of students was not having their peers give the final grade. Most student's valued and appreciated peer's feedback, but preferred not to be graded by them.

In relation to the category rubrics, most comments addressed having more numerical options as well as providing more details on the grading scheme. Such comments are important in view of the fact that these are first year students who are not likely familiar with this instructional strategy.

Comments in the category on the roles of TAs and the course instructor focus largely on having the TAs or course instructor being responsible for giving the final grade. Students also suggest receiving feedback to their written assignment by TAs or the instructor. Another comment highlighted was having the TAs or the instructor review the comments provided by the grader in the peer-review form and deciding on the fairness and accuracy of the grade assigned (as described in Section 3, this was done).

The category quality of writing encompasses interesting comments that evidenced dynamics present in this type of educational setting. Even though a large number of students reported not changing their writing style despite their paper being reviewed by their peers, those who were more careful in their writing described doing so because of social pressure. As mentioned before, anonymity was an important feature in the process, but even so, this type of assignment allows for social comparison among peers (i.e., comparing one's own writing to that of their peers). Comments where written style changed due to the peer review process tended to described how students were more careful about writing and not the other way around. Finally, a large number of students reported improving their writing for the current assignments by using the rubrics as useful guidelines.

5. LESSONS LEARNED

Based on the feedback obtained from the student survey, as well as our personal experience, we plan to continue including peer review exercises in the future. While the overall experience was positive, there are several changes that should be considered to improve the exercise and process further.

First, there should be a better communication of the objectives and outcomes of the exercise. While the general objectives and intended outcomes of the peer-review exercises are stated on the assignments, these were generally written from the perspective of the student's role as a reviewer, i.e., to develop the ability for critical assessment and providing constructive feedback. On the other hand, the outcomes from the student's role as an author are perhaps less clear. Indeed, one obvious outcome is that a student should be able to use the feedback to help improve writing in the future. However, an equally important outcome is that a student (in the role of an author) be able to accept feedback—whether positive or negative. In particular, negative comments should not be treated as an 'attack' on one's work and trigger a sense of defence and an immediate criticism or complaint on the process (which did occur in a few isolated incidences). Rather, the author should be able to review their paper in light of the negative comments and then decide whether or not any are relevant and applicable, before finally deciding if this will impact future work.

Second, while students received feedback on their paper, they were not able to incorporate comments to improve their writing in the specific exercise, though they were able to apply some general guidance to improve their second written assignment. In this context, it would be more useful to provide the students with an opportunity to revise their paper according to the feedback, and then resubmit (of course, students can still exercise their right

not to implement any changes or make use of the feedback provided).

Third, a few students raised issues with regards to grading. There was concern that the grading could be too subjective (e.g., biased by a student's on writing) and the TA/course instructor should play a greater role in the actual grading process. Others indicated a desire to have increased flexibility in assigning grades. With regards to the roles of the TA/course instructor, we believe that in ensuring the peer reviews are fair, providing useful/thoughtful feedback is as important as reviewing the paper itself. It is important to note that only half the weight of an assignment was based on the grades from peers while the other half was based on the participation in the peer review process (which was reviewed by the TA/course instructor). In terms of increased flexibility with grading, an improvement in the rubrics can be made; however, the rubrics should not allow for such fine grading resolution (e.g., 0.5 marks). Nevertheless, the rubrics can be improved to provide more explicit descriptions of what is expected in each assessment category.

In view of the above, a future peer review exercise might involve the following processes:

1. The student writes a paper.
2. The paper is peer reviewed with feedback and comments being provided; no grade is given at this time.
3. The paper is returned to the student along with the peer reviews.
4. The student can revise her/his paper, taking into account the comments/feedback provided.
5. The paper is peer reviewed again, by the same reviewers. Feedback and comments are provided, along with a grade (i.e., the grade must be justified as in the past).
6. As before, a student's mark on the assignment is determined by the average grade obtained from the peer reviews and by their participation in the peer-review process (the TA/course instructor will continue to monitor the peer review process).
7. The number of peer reviewers should increase from three to five. The lowest and highest grades can be disregarded, and the average of the 3 remaining grades will be used.

Given the increase in scope of the peer-review assignment, we would only conduct one such exercise in the class. Moreover, we would reduce number of exercises from two to one.

Finally, it is extremely important to mention that a suitable online system is necessary to handle such a double-blind peer review process.

6. CONCLUSIONS

Overall, students and the instructor valued this instructional approach. The assignments allowed students to reflect on their writing and communication skills. Even though students valued their peers' feedback, they preferred receiving a mark from the TA or instructor. The main difficulty perceived with this type of pedagogical approach was having an appropriate suitable online system that allows a double-blinded peer review process. Taking together, this was a positive experience that we plan to include in the future.

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