PEDAGOGICAL INNOVATIONS TO SUPPORT LARGE SCALE UNDERGRADUATE INDEPENDENT RESEARCH PROJECTS

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INTRODUCTION

Many undergraduate programs include one or more significant “capstone” experiences, designed to integrate knowledge from across the degree. This paper explores some pedagogical innovations that are currently being applied to a fourth year engineering thesis course, in which students conduct research independently, under the supervision of a faculty member. The thesis course is vital for the development of strong research, critical thinking and problem solving skills, but student experiences in independent study scenarios are extremely uneven, with huge variances in expectations, contact time, and project scopes. In the particular course under study, up to 200 students conduct research with over 100 supervisors across 20 academic departments, and across theoretical, clinical, design and laboratory settings. The key goals of our four pedagogical innovations are: 1) to improve both student and supervisor experience; 2) to improve our ability to meet thesis learning objectives; and 3) to explore new educational possibilities for independent study courses as well as undergraduate research programs.

METHODS

The project is currently in its early stages, with some work completed on initiatives #1 and #2 outlined below (primarily #1); further work will include the full roll-out of four pedagogical innovations and a comprehensive measure of impact of all aspects of the project. More specifically, the pedagogical innovations are:

1. Online support for students, including the development of reusable learning objects (RLOs) as short videos, each outlining a very specific element of the research process. Further details and initial results are provided below.
2. A series of rubrics have been developed to apply some degree of uniformity to the thesis course, and to support the students in meeting a specific set of learning objectives. However, the rubrics have yet to be properly validated or tested for inter-rater reliability or usability. In performing a more formal analysis on the rubrics, using both statistical analysis and user interviews, we hope to further refine and develop the rubrics to make them more usable and functional.
3. A training program will be established for graduate students, focusing on mentorship. Graduate students play a significant role in the undergraduate research experience, often serving as mentors for the undergraduate student. However, graduate students seldom have the opportunity to receive training in research leadership and teaching, and especially training that focuses on mentoring junior researchers. A pilot program will include a weekly discussion group for 10 graduate students. The group will act as a support mechanism for graduate students involved in supervising undergraduate thesis students, and will develop ideas for a more formal mentorship program to be run in the future. The program will involve theory and role play based sessions, along with reflections on real interactions with supervisees.
4. A collaborative learning initiative will be established for students, encouraging peer mentorship and group research practices throughout the school year. Students will share progress, ask questions and provide feedback on problems, accomplishments and approaches, supported by online collaborative and peer feedback tools.

These innovations support two key beliefs about learning in the thesis context: first, that the thesis should support the development of self-regulated learning, that is, learning in which the student is able to identify and generate thoughts, feelings and behaviors that allow them to attain specific learning goals [1]. Through the first and second described pedagogical innovations, we are seeking to determine best practices in assessment and content delivery in independent, self-directed learning experiences. Secondly, learning is social (Social Cognitive Learning Theory [2]); people learn from observing and interacting with others, and by doing so learners acquire knowledge, skills, strategies, beliefs and attitudes. Through training graduate students in mentorship and

supporting student collaborative learning (innovations 3&4), we will test specific strategies designed to enhance the learning that takes place given the relationships between undergraduate students, and between the undergraduate students and the graduate student and faculty members involved in the thesis experience.

In the first year of the project, the focus has been on rolling out the first innovation, the creation of online support and more specifically, the development of RLOs. In the past, a number of full-length lectures have been posted online for students. These lectures, typically 30-45 minutes in length, have failed to take advantage of the possibilities of the medium. Well produced, shorter videos outlining a more specific message allow more flexible, reusable learning units that the student can put together in a way that meets their own needs. The first set of videos produced are geared towards incoming fourth year students, who are in the process of finding a supervisor and developing a set of research goals. Using videotaped interviews with supervisors, 5-8 minute videos were created with “pop-ups” emphasizing important aspects of the faculty member’s response. Each video is themed with a sub-topic, more specifically: 1) Finding and approaching a thesis supervisor; 2) A brief overview of the thesis experience; 3) What to expect from the thesis experience; 4) Final advice and 5) Biggest pitfalls. Given the nature of the thesis course, it was important to create a series of short videos that focus on a very specific element of the process, allowing students to easily access information as they need it and as many times as they need it, encouraging both self-regulated and just-in-time learning. In addition to the new RLOs geared towards incoming students, existing online lectures were reconfigured into shorter (3-8 minutes) RLOs, targeting specific topics. For example, the online lecture on the Literature Review was divided into four videos on purpose, organization, rhetorical strategies and checklist.

RESULTS

Our experience so far in developing RLOs has helped to shape our understanding of the process and constraints involved in delivering effective RLOs. Appropriate preparation of interviewees, the selection of good questions that will elicit information useful to students, considering different platforms for video creation, and identifying and/or “chunking” key information for short videos are all important aspects in creating good RLOs for the undergraduate thesis course. After the RLOs were published in winter 2014, total views, according to Youtube analytics, ranged from 62-187 per video, in a class size of ~160, indicating relatively strong uptake from the students. Future evaluation of the RLOs will include a student survey to measure effectiveness.

DISCUSSION

The thesis experience is an important, but traditionally under-supported learning experience in the undergraduate engineering program. Through a variety of pedagogical innovations, we hope to improve the quality of the experience for both students and supervisors, and encourage all students to meet the stated learning objectives of the independent research experience. At this time, we have started to implement our first innovation, online support for students, with plans in place to implement other initiatives to support the thesis course. It is our hope that once innovations have been piloted and evaluated, they may serve as models for other programs and institutions, and that there may be opportunities for collaboration with other programs offering an undergraduate research experience. Some of the proposed innovations could also be applied to summer research experiences and potentially capstone design courses.

REFERENCES

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