Work in Progress - Behavioral Aspects of Student Engineering Design Experiences

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Abstract – Problem- and Project-Based Learning courses have come to be popular as underlying pedagogies for Engineering Design classes. Though shown to increase student learning and engagement such active learning approaches also sometimes fall short of addressing student and faculty uneasiness with novel and seemingly unorthodox course designs. Through a planned 2-year qualitative comparison evaluation of two capstone engineering design courses at two different universities, the difficulties and successes of both students and faculty engaged in such courses will be described and characterized on a social plane. Qualitative and projective methods will be utilized to report project development across three dimensions: 1) assignment milestones of design iterations, 2) student and team reflections, and 3) instructor team reports on progress. It is planned that from these affective and social observations, interventions can be constructed and organized into a workshop format for students participating in these Problem- and Project-based Learning Engineering Design courses.

Index Terms – Active Learning, Engineering Design, Problem-Based Learning, Student and Faculty Difficulties

INTRODUCTION

Hands-on doing classes are important to the Mechanical Engineering Design program at Stanford University and Electromechanical Engineering at the Wentworth Institute of Technology. Undergraduate and graduate students of the respective schools are nonetheless mainstreamed into taking many of their core courses in their knowledge domain though deductive scaffolding with traditional lecture and problem-set based means [1], [2]. While the students are socialized out of their inquisitive nature [3] in some cases they have initial difficulties immersing themselves in the hands-on doing engineering design experience. Observer’s note that a student’s initial concern is for immediate summative feedback under the guise of assignment scores and self-calibration to a course grade that sometimes turns into a distracting priority. What if capstone experiences are designed in ways that engage students to inspire and excite within the group process of moving forward from idea to prototype to delivery?

COURSES TO BE INVESTIGATED

The idea that collaboration is central to creative research is the foundation for the proposed investigation. The investigation features participants in two courses: Stanford University’s graduate mechanical engineering 310 (ME 310), and Wentworth Institute of Technology’s electromechanical engineering 5th year capstone class.

Both groups have sponsors. Students enrolling in Stanford University’s ME310 Design Project Experience have extensive global and corporate sponsors, while Wentworth Institute of Technology’s electromechanical engineering Capstone class projects are typically not funded but receive endorsements from both corporate and Harvard Medical area sponsors.

PROBLEM- AND PROJECT-BASED LEARNING

Problem- and Project-Based Learning courses have come to be popular as underlying pedagogies for Engineering Design classes. Active learning has shown to increase student learning and engagement [4] but the inductive approach to learning is oftentimes novel and seemingly unorthodox for the student and faculty in course design.

Problem-Based Learning is differentiated from Project-Based Learning.

Problem-based:
Problem-based learning (PBL) begins when students are confronted with an open-ended, ill-structured, authentic (real-world) problem and work in teams to identify learning needs and develop a viable solution, with instructors acting as facilitators rather than primary sources of information [5].

Project-based:
Project-based learning begins with an assignment to carry out one or more tasks that lead to the production of a final product [5].

An underlying research claim in the study considers similarities with a different set of learning objectives for each course.

Research measures will be developed to consider, characterize and describe project progress. For ME310, the learning objectives are:

- Introduction to the design process for engineering students
- Have an engineered outcome/product/solution
- Contract engineering requirements
• Build teamwork skills
• Develop personal skill development.
For the electromechanical capstone the objectives are:
• To learn and understand the requirements necessary to move from the problem statement to the design solution on paper
• To the prototype, and finally to the actual product.
• To provide training of the mind in innovative problem-solving technologies
• Encourage lifelong decision-making skills, learning strategies and team-working skills.

RESEARCH APPROACH
Through a planned 2-year qualitative comparison evaluation of two capstone engineering design courses at two different universities, a behavioral plane of difficulties and successes for both students and faculty engaged in such courses will be described and characterized. Measures for affective and social responses will be developed and reported. Under investigation are the differences and marked similarities in teaching methods across two courses and campus conditions. Content for analysis pays close attention to the attributes that explain how engineering project groups become teams and examines the relational images that define both student and instructor constructions of project success.

For both year-long courses, the researchers will collect:
• Course assignment milestones of design iterations
• Student and team written reflections
• Reports from Instructors on student team progress
These coupled with qualitative and projective observations of student team internal and external meetings and semi-structured quarterly interviews will form the corpus of data to be analyzed.

NEXT STEPS
It is planned that from these observations, interventions can be constructed and organized into a workshop format for students participating in these Problem- and Project-based Learning Engineering Design courses.

The results from the proposed study will be useful to both industry and the academic community. An emotional and behavioral factors focus from student and instructor reflections on team progress holds promise for implications on engineering education practice and will supplement work on pedagogies of classroom engagement [8], [9] and deepen understanding of the benefits of hands-on doing experiences.

REFERENCES

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