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Personalizing the Educational Experience in Engineering via Technology

1. INTRODUCTION

Over the past decade there has been an explosion in the number of undergraduate students entering or desiring to enter engineering programs across the country. While some institutions have implemented various enrollment management methods to limit their student numbers, many other land-grant institutions feel that limiting the enrollment would be in conflict with their mission. As a result faculty at these engineering institutions are faced with growing student numbers while not being provided the resources needed to maintain quality. One of the biggest challenges when dealing with large class sizes is providing accurate assessment and feedback of student learning. Therefore, I am seeking to DEVELOP and VALIDATE computer based tools to improve student learning assessment and student feedback on their understanding via the following objectives.

- ❑ **Objective #1: Personalize student homework experience.**
- ❑ **Objective #2: Develop interactive exams.**
- ❑ **Objective #3: Extend the platform to include assessment of laboratory/hands-on learning activities.**

Initial Target Courses:
1. **Basic circuits courses at sophomore level in Electrical Engineering.**
2. **Circuits/Motors courses for non-Electrical Engineering majors.**
3. **General measurement and instrumentation courses in Mechanical Engineering.**

2. HISTORY

In the Fall of 2011, I was teaching a course of 185 students, and my TA was struggling to keep up with the grading. Instead of grading every problem, as I had instructed, the TA was only grading one or two of the problems and then giving full credit for the others without even looking at the final answers provided by the students. I quickly realized that without the feedback, students would assume that their work was correct and not really learn the material when they were in error. Therefore, new use of technology was needed to maintain the quality of student learning. **Specifically, I used the Blackboard assessment tool (Blackboard Inc., Washington, DC) to allow students to immediately enter the answers to the homework problems and obtain immediate feedback**. They were even allowed multiple attempts to help them learn the material. The students would still turn in a paper copy of the homework where one of the problems was randomly selected for grading, but the bulk of the feedback was provided by the online homework submission systems. **As a result, the students were able to determine deficiencies in their knowledge base immediately without needing to wait until homework was returned.**

3. METHODS

❑ **Objective #1: Personalize student home work experience.**
- ▶ Develop the tool using MATLAB (MathWorks Inc, Natick, MA) to reduce student cost and maximize efficient use of faculty time.
- ▶ Vary problem parameters between the students so that while the steps would be the same for every student, the final answer would be different.

❑ **Objective #2: Develop interactive exams.**
- ▶ Develop the tool to interactively assess a student's understanding to replace a traditional written exam.
- ▶ The software would formulate a question for the student that would require a series of steps to obtain the solution. If the student successfully answered the question, then they would be given the next question in the test or quiz. If not, they would have a subset of the possible points deducted and they would be given a new question based on a subset of the problem steps.
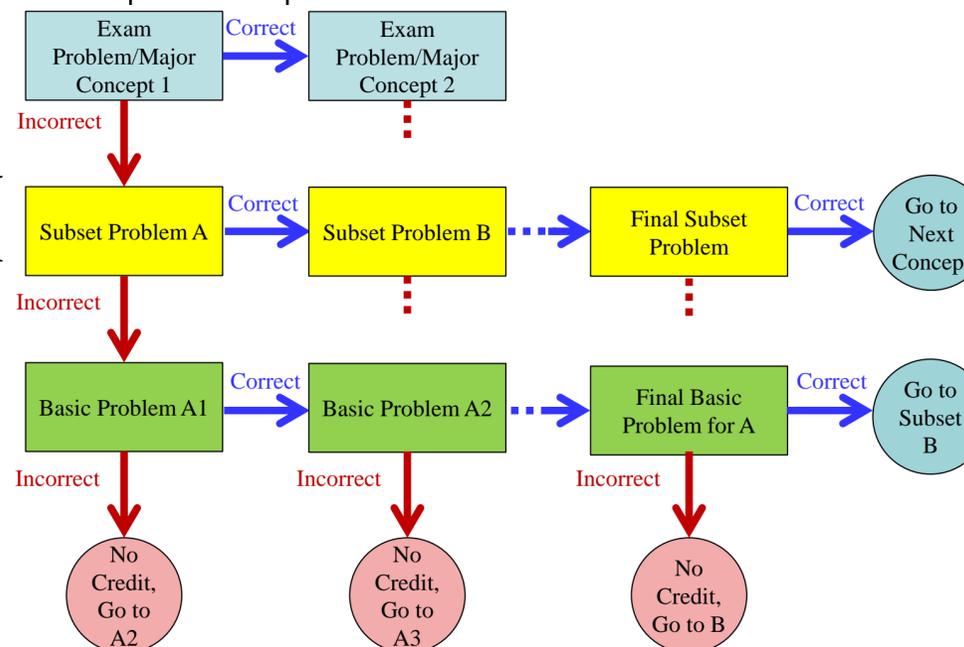
❑ **Objective #3: Extend the platform to include assessment of laboratory/hands-on learning activities.**
- ▶ The students will be asked to design various circuits using an oscilloscope and function generator. The software will then read the measured waveforms from the scope and compare it to the specified design constraints. If the design specifications are not satisfied, the student will be asked to design a simpler circuit.

4. ISSUES/CONCERNS

❑ **Find collaborators with expertise in assessing teaching and learning with technology in engineering.**
- ▶ In the past, I have relied on qualitative measures such as direct student feedback obtained through discussion during office hours or by positive comments passed on to me by the deans office or student advising. However, there is a science behind assessing improvements to student learning. **I want to build a research team to formally assess my proposed improvements and publish the results in peer reviewed journals so that others might benefit.**

❑ **Formalize the study in terms of understanding Human/Computer interactions in the learning environment.**
- ▶ Iowa State University offers a PhD program in Human/Computer interaction. Given the importance of the proposed topic, I would like to recruit a graduate student in this research area to carefully evaluate and develop the type of tool that I have described.

5. DISCUSSION

The long-term goal is to develop software tools that could interactively assess and develop a student's understanding. **To accomplish this goal, I hope to build a research team to write and submit an NSF proposal to develop and evaluate the proposed tool.** Once developed, the tool will reduce the time spent by instructors on grading providing more time for office hours, development of in-class demonstrations, and improved lab experiences. At the same time, the students will obtain an individualized learning experience which should challenge the students to perform to the best of their ability. At present, the students that don't test well on a traditional exam receive the same grade as the students that simply copy the answers from their classmates on the homework and labs. This is not fair to the students and does not give the companies recruiting our students an accurate assessment of the students' true abilities.