

Computer Based Modeling for Engineering

Overall research question(s)

1. What are student approaches to modeling and problem solving and how do they change over time as students move into upper division courses and use programming and computational tools to model and solve discipline specific problems?

Instrumentation: See below – student outcomes section

2. What characteristics (e.g. gender, GPA, surface/deep approach to learning, self-efficacy) do the learners bring to problem solving processes that assist or hinder their success as modelers and problem solvers?

Instrumentation: UPA data (GPA, gender, etc.), student surveys, e.g. the Revised Study Process Questionnaire (see below – Appendix 1), and a self-efficacy & beliefs about the course survey (latter still to be developed). These data will be related to data on student problem solving, student performance in courses and other student surveys.

3. Does student performance in the discipline improve with the new approaches to teaching modeling and problem solving?

Instrumentation: (a) Course specific GPA comparisons to a matched sample of students in previous years, (b) comparison of performance on a problem solving task administered to junior level students who have not had the benefit of the new courses (fall 2007) to students who have been through a series of the new courses (fall 2008) (possibly in ISE), (c) focus group interviews with students in each group, and (d) interview faculty teaching courses about student abilities in the two groups. (e) We will also work with the professors in the upper division courses that will be revised to identify some test questions or projects for which we can gather data of students who have not taken the sequence of courses (fall 2007) and those who have (fall 2008).

4. How do the various faculty involved in the project use technology inside and outside of the class to enhance student learning?

Instrumentation: (a) Baseline and follow-up faculty surveys (see below – Appendix 2), (b) modified ClassTech Classroom Observation Rubric, and (c) faculty interviews.

Specific, measurable, student outcomes

Because of the project, students across a range of engineering disciplines will be able to:

1. Use various software programs to enhance visualization of engineering problems and their solutions,
2. Use programming (irrespective of programming language/syntax) and computational tools for modeling of complex engineering problems,
3. Use programming and computational tools to solve engineering problems relevant to specific engineering disciplines,
4. Use advanced features of Excel (e.g. functions, Goalseek™, Solver™, pivot tables, lists, named ranges, etc.) to model and solve problems,
5. Use advanced features of VBA (e.g. recording macros, write functions and subroutines, create loops, write event handlers, develop decision support systems) to model and solve problems,
6. Use advanced features of other relevant software programs, such as Matlab and Access, to model and solve problems,
7. Analyze problem solutions through decision support,

8. Articulate problem solving strategies and processes.

NOTE: Several of these outcomes (i.e. 2 – 6) are course specific and will therefore change for each course that is developed.

Means of measuring, collecting data on each outcome

Instrumentation for outcome 1: (a) Common questions across student course surveys completed at the end of the semester, and (b) student focus group questions.

Instrumentation for outcomes 2-6: (a) Baseline student survey for selected courses (to include self-efficacy items), (b) Student course surveys assessing confidence in specific course outcomes e.g. IE 110 survey completed at the end of the semester – see below Appendix 3 (c) samples of student work related to specific course outcomes, (d) correlate student confidence (what they say they learned) with actual classroom data on specific student learning course outcomes, (e) Graduating Senior Survey data (Q55e, Q56f, Q57b) to compare responses of students prior to the introduction of the courses to those after the introduction of the courses.

Instrumentation for outcomes 7-8: (a) Questions about modeling and problem solving on student course surveys, (b) specially developed problem solving tasks, (c) student reflections about in-class problem solving tasks (see Reflection Tool for Problem Solving Tasks, and Rubric – appendix 4), and (d) related samples of student work.

We are planning to develop a set of similar problem solving tasks students would be required to complete at the start of the introductory course (pre-test) and at the end of the course (post-test). They will accomplish this by completing a paper-and-pencil task and then reflecting on and articulating how they undertook the task alongside the problem they are solving. The student work will be graded using a rubric we will develop for each problem. We will then examine students' descriptions of their problem solving strategies using qualitative methods, to see how their approach to solving problems changes over time.

We intend to track the changes in modeling and problem solving abilities, as well as in their cognitive processing, as they gain more experience in working with technology as a problem solving tool. All students in ISE/TE 110, CBE 225 and the new courses created in other departments will complete these tasks. For comparative purposes we will select a matched sample of engineering students taking CSC 116 who will also complete these problem solving tasks. In the case of CBE 225, it may be possible to compare sections taking the new course with some sections taking the old version.

As stated earlier, we also plan to compare performance on a problem solving task administered to junior level students who have not had the benefit of the new courses (fall 2007) and later to students who have been through a series of the new courses (fall 2008), and to compare performance of these two groups on selected course test items and assignments.

We will have students complete a reflective tool (containing predetermined prompts - see Reflection Tool for Problem Solving Tasks, and Rubric below), at the end of selected problem solving tasks and homework assignments during the course work, to elicit personal reflection on their level of engagement with the task, approach to problem solving, and approach to modeling and conception of being a modeler. These individual reflections will be examined for emerging themes and trends, and also scored using a rubric based on the SOLO taxonomy (see Reflection Tool for Problem Solving Tasks, and Rubric below).

Data analysis methods

Qualitatively and quantitatively as appropriate.