Objective

Providing a cheap, engaging, and personalized laboratory learning experience is one of several challenges facing effective undergraduate education in STEM disciplines and has been identified as one of 14 Grand Challenges for Engineering in the 21st century by the National Academy of Engineering [1,2].

Overall Objective: Determining the impact that directed hands-on activity with haptic technology will have on engineering education is the ultimate goal of this study. Specifically, we are interested in discovering innovative ways to improve the modeling and design intuition of engineering students in a way that helps them relate theoretical systems seen in the classroom to physical systems found in everyday life, such as a racquet and ball.

Hypothesis: We believe that integrating haptic rendering into the traditional engineering curriculum will provide a learning experience that will help students relate mathematical modeling concepts to real life experience.

We will test this hypothesis using a novel apparatus that provides haptic information to the user to enhance their learning experience and engage their intuition.

Methods

Quantitative assessments (ten minute written quizzes) were administered to students following interventions using take-home assignments that integrated the cigar box (cigar box assignments). Qualitative feedback (in the form of a written survey) was collected at the study’s conclusion.

General Procedure (Fall 2012):
- Class is divided into two groups (Groups A and B)
- with students in each category forming 3-4 person subgroups
- Assessment I is delivered to the class
- Intervention 1: Group A is given the cigar box assignment while Group B is given the complementary written assignment
- Assessment II delivered to the class
- Intervention 2: Group A is now given the written assignment while Group B is given the cigar box assignment
- Assessment III is delivered to the class
- Survey administered

General Procedure (Fall 2013):
- Class is divided into two groups (Groups A and B)
- with students in each category forming 2-3 person subgroups
- Assessment I is delivered to the class
- Intervention 1: Group A is given the “intervention” cigar box assignment while Group B is given a “control” assignment on cigar box
- Assessment II delivered to the class
- Intervention 2: Group A is now given the “control” assignment while Group B is given the “intervention” cigar box assignment
- Assessment III is delivered to the class

Fall 2012 Results

Quantitative Assessment:
- Designed to reinforce concepts that would normally be taught in the course
- Scores derived from quiz performance
- Mean scores increased from Quiz 1 to Quiz 2 but are within error
- Mean scores increased from Quiz 1 to Quiz 2.

Qualitative Assessment:
- Combination of discrete-response and open-ended questions
- Administered at conclusion of study
- Responses to Q4 and Q10 above neutral
- Students thought it was relevant to the course material
- Big jump in mean responses between Q3 (mastery of frequency response before using the Box) and Q4 (mastery after using the Box)

Student Feedback

“I don’t think the ME dept. gives us enough exposure to physical systems so we can work on more real-world (not necessarily ideal) situations. I liked seeing the theory applied to a real thing instead of a vague set of variables.”

“I believe near the end of the semester I learned a great deal b/c I was forced to implement 461 ideas into the code.”

“I think most ME’s in this school have almost no diagnostic skill, this starts to build that experience.”

“Cigar box helped me learn frequency response easily.”

“Cigar box helped me learn frequency response easily.”

“I enjoyed working on the cigar box, it was a good supplement to the HW’s, & lectures. It could be taught in a separate cigar box lab section to supplement what we do in class.”

Conclusions

- More sensitive measures are needed to quantify impact
- Quantitative feedback indicates students largely appreciate hands-on activity
- Further refinement of methods and procedure is needed

Future Work

- Develop new assessments that are more sensitive to impact of cigar box
- Debug and extend software repository for cigar box assignments
- Adapt apparatus for use in other courses

References
