Circuits Virtual Community of Practice

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Session 8:
Simulation and Hands-on Learning
&
Assessing Impact
May 9th, 2013

Agenda

- Welcome and Learning Objectives ~ 5 mins
- Three Models of Hands-on Learning ~ 20 mins
- Breakout Discussion: Assessing What Works ~ 25 mins
- Report Out: Convincing Evidence ~ 20 mins
- Wrap-up & Plans for Session 9 ~ 5 mins

Session 8: TBD

In preparation for Session 8 (May 9th) & Session 9 (May 16th):

1. Possible topics
   1. Adoption: Commonly available resources & barriers
   2. Student Assessment
   3. Revisiting Topics – Teams, Learning Objectives, Motivation, Taxonomies
   4. Cool/Fun ideas we never got to talk about
   5. Continued VCP Collaboration
      1. Sharing content and ideas
      2. Collaborative projects/research
2. Definite topics
   1. Reflection
   2. Meeting in Atlanta in June – Report back to VCP
   3. VCP Meeting in August

Session 8 Learning Objectives

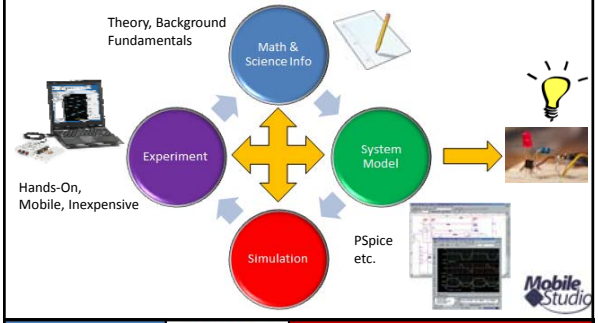
- Describe key characteristics and differences between several models of problem solving.
- Articulate some of the challenges in assessing the impact of a new instructional approach on student learning.
- Identify possible tools and techniques that can be used to measure the impact of new instructional techniques on student learning.
- Evaluate strengths and weaknesses of various measures of impact.

Models of Problem Solving

- Mobile Studio in Intro Circuits Course
  – Paper & pencil, simulation, experiments
  – Mid-Term Quiz Problem Assessment
- TESSAL (Ga Tech) Bonnie Ferri
- Lab-in-a-Box (Va Tech) Kathleen Meehan

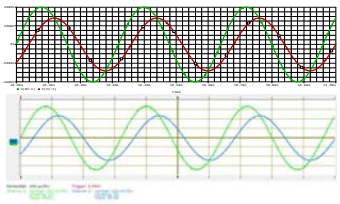
Mobile Hands-On STEM

Models of Problem Solving



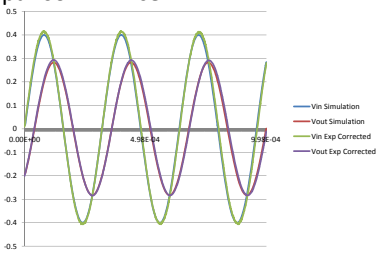
Models of Problem Solving

- Simple RC Filter
- PSpice
- Mobile Studio



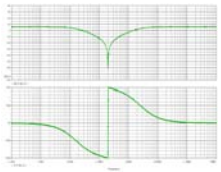
Models of Problem Solving

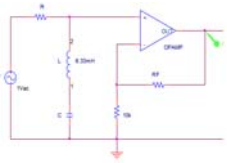
- Comparison in Excel



Mid-Term Circuits Exam Problem 5

Given these graphs:





Find:

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http://mobilestudioproject.com/

Results

Exam Median: 74 (vs. low 60s in prior terms)

Student performance assessed with two problems

- 2nd order systems – damping, system response and circuit elements
- Filter circuits – cutoff frequency, phase shift, and output

Grades went up an average of 10 pts/prob (out of 20 pts/prob)

Prob #5 had concepts that were taught using in/out-of class Mobile Studio-based activities

Prob #5 synthesized a number of concepts: *frequency response, op-amp gain, resonance & filtering*

Students were asked to design from a written spec and to determine the transfer function of their circuit

Results

Students performed much better than expected on problem #5, especially in comparison to prior years

Even students with low overall scores performed well on this problem

Conclusion: **The scaffolding of frequency response, filters and resonance concepts with the paper/pencil, in-class hardware problem analysis and out-of-class project was very beneficial.**

Problem	1	2	3	4	5	6	7	Total
Median Scores	23/30	10/20	13/20	15/20	17/20	14/20	14/20	105/150
%	77	50	65	80	85	70	70	70

TESSAL

Teaching Enhancement using Small-Scale Affordable Labs

- Improve undergraduate learning with experiments in ECE courses without labs
- To maximize benefits, the lab module should excite students & support or demonstrate a fundamental principle that is hard to understand from theory alone.
- Concepts should appear in standard course evaluation methods such as in-class exams.
- Modules contain supplemental material - tutorial for students on fundamental concepts & online quiz with representative questions that might be found on a standard exam.

TESSAL Center

http://www.ece.gatech.edu/research/tessal/index.html

TESSAL

- Designed for faculty with no resources for high-end experiments, nor time to develop, build or maintain experiments.
- Should be robust & portable.
- Easy for students to use without the need for a lengthy learning period.

TESSAL Center

TESSAL

RC Circuits

Labs	Concepts	Goals &Description
Resistive and RC Circuits 	Resistive networks, first and second-order circuits, step response, time constant	The goal is to introduce physical RC components and explore how they behave in circuits. Students use myDAQ boards connected to their laptops.
Frequency Response 	Frequency response, resonance, filtering	Students explore steady-state sinusoidal responses of first and second-order circuits at difference frequencies. They take measurements to plot the Bode Plot using myDAQ boards.

TESSAL Center

Lab-in-a-Box

- 625 Undergrads in Circuits
- 48 Lab Seats & 3Hr Sections!
- Set of hands-on exercises in which students design, build, and test at home circuits using an inexpensive electronics kit, digital multi-meter, and a USB oscilloscope
- Does not require the same resources as a traditional experimental lab class

Lab-in-a-Box

http://www.lab-in-a-box.net/

Lab-in-a-Box

- Phase II:
  - Laboratory lectures (face-to-face in the 1st lab course and then offered online the 2nd)
  - Excel report templates
  - Supplemental learning materials for each experiment
  - Multimedia tutorials on measurement techniques, PSpice simulations, and calculations using MATLAB
  - Automated reporting & grading

Lab-in-a-Box

Lab-in-a-Box

- Circuit validation: students demonstrate to GTAs
  - their circuits function
  - they understand the required measurements
  - they know the fundamental concepts that are demonstrated experimentally.
- Management: a great deal of infrastructure development to assure software & hardware work.

Lab-in-a-Box

Models of Problem Solving: Discussion, Q&A

Mobile Hands-On STEM

TESSAL Center

Mobile Studio

Lab-in-a-Box

The Challenge of Assessment: How do you know if it works?

- Good ideas and implementation derived from:
  - Research-based Principles of Learning
  - Learning Objectives
  - Learning Taxonomies (e.g., Bloom's)
  - Student Motivation
  - Tools & Techniques:
    - Team-based learning
    - Active Learning

How can the impact on student learning be measured?

- Some tools and techniques used to assess impact:
  - Qualitative student feedback (e.g., attitude / motivation surveys, self-evaluation of learning objectives, ABET outcomes)
  - Conceptual questions on exams
  - Pre- and post- concept inventory exams
  - Asking the same/modified question each semester
  - Analysis of exam performance
  - Grade comparisons across semesters
  - Peer assessment
  - Trained observers

Convincing Evidence?

- Problems defining what is being studied*
  - Focus on a core element of a given instructional method
- Problems measuring what "works"*
  - Look at a broad range of learning outcomes
  - Interpret data carefully
  - Quantify the magnitude of any reported improvement
  - Have some idea of what constitutes "significant" improvement
- "Hawthorne effect" – improvement because there is a change, regardless of what actually changed

*Prince, "Does Active Learning Work? …", JEE (2004)

Activity: Breakout Discussion

- Question 1
  - What evidence would convince you that a particular instructional technique or approach had a positive impact on student learning?
    - How does this differ if you are the instructor implementing the new method vs. considering the adoption of someone else's idea vs. trying to convince a colleague to adopt the idea?
- Question 2
  - What are some tools and techniques (including those mentioned previously) that you could use to collect evidence of impact?
    - What are the pros and cons of various approaches? What are appropriate uses of the various tools and approaches?
    - How can understanding of research-based learning principles, learning objectives, etc. be used to develop meaningful assessment?
    - What are some of the challenges you face in assessing impact and how can they be addressed?

Suggestion: Use the earlier discussion of problem solving models as concrete context for this discussion of assessment.

Group Report / Discussion

Each group will report (~ 5 minutes each)

- What evidence is "convincing"?
  - Are there key characteristics that emerged during the discussion?
- How can you collect this evidence?
  - What tools / techniques are appealing?
  - Challenges and solutions?

Session 9: Great Ideas (that *almost* changed your classroom)

In preparation for Session 9 (May 16th):

- Come prepared to share a challenge you have encountered and let the group brainstorm some solutions!
- We will also be reflecting on the Spring VCP session and planning for the Summer / Fall.