Using Mobile Devices to Teach Structural Dynamics and Structural Health Monitoring

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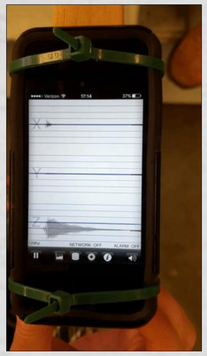
Research Questions

- Do mobile devices in the classroom foster enthusiasm for the topic?
- If devices are used by a group of students, does this have an impact on learning?
- Does the hands-on nature of the laboratory matter? Or, is data analysis and calculation sufficient? Is direct instruction even necessary?

$$\omega_n = \sqrt{\frac{k}{m}}$$

ω_n = natural frequency
m = mass
k = stiffness

Can you identify damage by observing changes in frequency response?



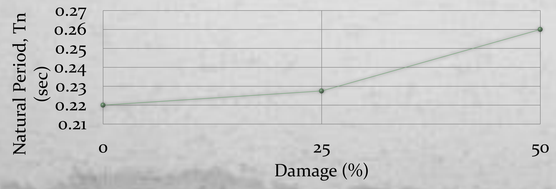
Lab Conduct

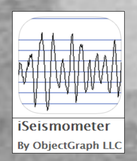
Three lab sections

1. No experiment (n=7)
2. Experiment (n=7)
3. No lab (n=3)

- Cantilevered 48” long 2x4 beam
- 20-lb mass
- Progressive section loss in three tests

- Damage measured with iSeismometer app at each level of damage
- Data analyzed and compared for each interval





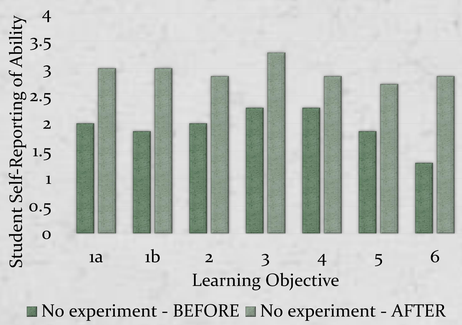
Results

- Self reported learning gains (4-point scale)
- Written comments to examine effectiveness of mobile devices and
- Positive learning gains, but small sample size (n=17) yields poor confidence in results

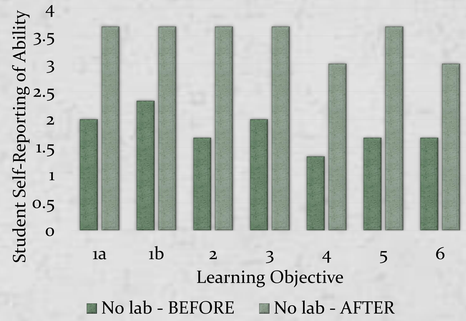
Student Perception of Learning Gains

Learning Objectives

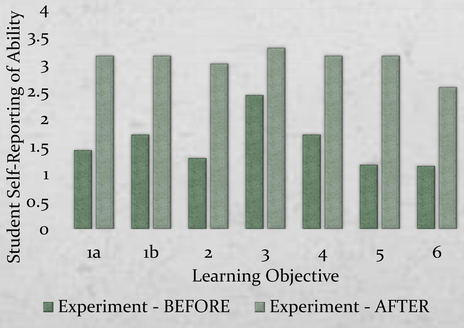
1. Identify the natural frequency and period of a freely vibrating single degree-of-freedom (SDF) system using
   a. Measurement of free vibration with an initial displacement
   b. Calculation with system stiffness and mass parameters
2. Identify the damping ratio of a freely vibrating SDF system by supplying an initial displacement and analyzing the log decrement of the measured response
3. Describe the effect of mass and stiffness on the natural frequency and natural period of a SDF system
4. Describe the parameters that affect the damping ratio of a structure
5. Analyze dynamic response data to determine the natural period and damping ratio of a structure
6. Evaluate the ability of multiple dynamic evaluations to identify damage in a structure



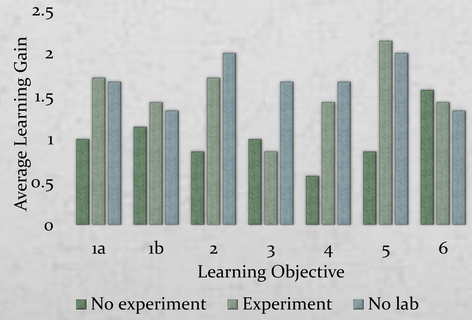
“No Experiment” before and after



“No lab” before and after



“Experiment” before and after



Learning gains (after – before) for each laboratory section

Student Comments

Most Effective Aspects of Experience

Experiment	No Experiment	No Lab
• Damage detection • Data collection • Better understanding • Good supplement for verbal • Using the iSeismometer application	• Easy to visualize • Unique • Explanation of theory • Applying the equations	• Preparing a spreadsheet • Comparison of results with theory • Real time data collection

Suggestions for Future Work

Experiment	No Experiment	No Lab
• Apply an initial, controlled displacement to the beam • Increase lab length to allow for higher quality of testing • Analyze other structural members	• Pictures and definitions for vocab • Focus on bridge evaluation context • Slowing down on spreadsheets/formula development • Complete the experiment (easier to follow/visualize)	• Attend and participate in the laboratory • Decrease class sizes for higher quality learning • Provide a recording of the lab to increase understanding

Conclusions

- Participating in the laboratory appears to be tied to increased learning gains
- Positive but statistically insignificant connection observed between active learning and performance
- Although not statistically significant due to a small sample size, student comments were perhaps more valuable than demonstrated learning
- Engineering students prefer hands-on experiments based on physical versus theoretical experiences
- Based on student feedback, mobile devices in the classroom seem to foster enthusiasm for the topic and a desire to learn more
- Provides basis for further laboratory development and mobile device use in civil engineering courses