



## Abstract

Incorporation of mobile technology into the post-secondary classroom is becoming increasingly common as universities seek to facilitate active, student-centered learning through rapid access to information, connect students with course content through social media, and evaluate digital alternatives to conventional instructor-student interaction. The m-Learning Scholars Program at Boise State University was initiated during the 2010 – 2011 academic year, and provides a venue for exploring the potential of mobile technology to enhance student learning in the geosciences. Through this program, 38 students in an introductory Earth History course for non-geoscience majors each purchased a subsidized handheld device (iPod touch) that they used in the lecture and laboratory portions of this Spring 2011 course. Largely in response to the results of that exploratory initiative, 14 tablet devices (iPad 2) will be integrated into the lab curriculum for two introductory courses (Fundamentals of Geology; Global Environmental Science; ca. 550 students total) during the Fall 2011 semester.

Preliminary results indicate that mobile devices provide students access to dynamic course content and are a valuable tool for active learning, but the devices (especially handheld) are limited in comparison to more expensive traditional computers. Basic spreadsheet, statistical, and graphing applications provide much of the same functionality as a desktop spreadsheet program although data must be exchanged between multiple applications. In the classroom, handheld devices were a versatile alternative to audience response hardware ("clickers"), but their small screen size was a severe limitation to browser-based in-class activities. The portability of the mobile devices made them very useful for field-based lab activities in which students assessed and modified experimental design in response to their real-time analysis of new data. Most applications were best suited for classroom use with access to a wireless network (e.g., *Blackboard™*, *Google Earth™*, *Measure Map™*, *EarthObserver™*), but some allowed data and/or maps to be downloaded in advance for use in any setting (e.g., *Topo Maps™*, *Geology ID™*). Other applications were useful as alternatives to traditional field tools (e.g., *Tiltmeter™*, *iGeoLog™*).



Earth History students simulating changes in allele frequency in a lab on natural selection.

Students used a statistics app (Statistical™) on handheld devices to generate histograms and calculate mean and variance before and after "selection events" in order to explore directional, stabilizing, and disruptive selection.



Before "selection"

After "selection"

## Mobile devices as an alternative to traditional computers in a laboratory setting

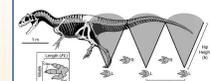
### Advantages

- Students can modify experimental design in response to real-time analysis of new data, especially in the field
- Many apps have basic functionality of desktop software:
  - Spreadsheet (e.g., *Numbers™*, *Office™*, *Documents 2™*)
  - Graphing (e.g., *Numbers™*, *123 Charts™*, *Graph™*)
  - Statistics (e.g., *Numbers™*, *Statistical™*)
- Many discipline-specific apps exist:
  - Satellite imagery (e.g., *Google Earth™*, *Measure Map™*, *KMZ Loader™*)
  - Remote sensing data (e.g., *EarthObserver™*)
  - Topographic Maps (e.g., *Topo Maps™*, *Google Maps™*)
  - Geologic Maps (e.g., *EarthObserver™*, *Geology ID™*, *Geology MT™*, etc.)
  - Stratigraphy (e.g., *iGeoLog™*, *Tiltmeter™*)
  - Seismology (e.g., *iSeismo™*)
- Datasets for some activities can be delivered to students via apps for course management systems (e.g., *Blackboard™*)

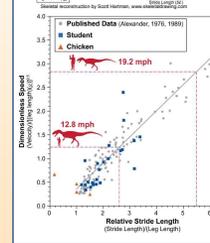
### Limitations

- File management for some datasets may require each device to be associated with a unique email address
- Need to adapt to a different user interface
- Handheld device are severely limited by their small screen size

Earth History students measuring velocity and stride length of chickens in order to test the hypothesis that modern organisms can be used along with measurements of fossil trackways to calculate the velocity of extinct organisms such as (non-avian) dinosaurs.

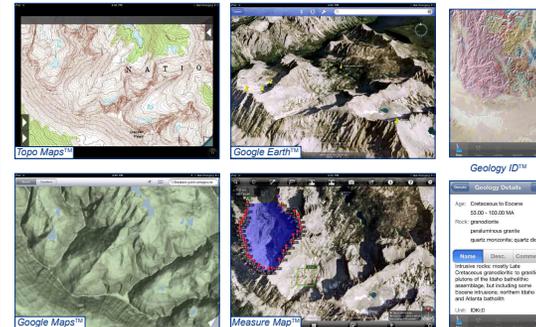


Students used handheld devices to record video of the experiments and to perform linear regression analyses on new data while still in the field.



Student view of handheld device using Statistical™

Students in Fundamentals of Geology will use tablet devices to explore the geology and glacial geomorphology of the Sawtooth Range in central Idaho. The devices will also be used to introduce topographic maps.



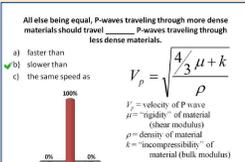
## Engaging students in large lectures through mobile technology

### Advantages

- Students have immediate access to information that can stimulate discussion in class
- Students have anytime access to lecture capture (vodcast, podcast, etc.) outside of class
- Apps are an affordable alternative to clickers (e.g., \$17 per year or \$35 per 4 years versus \$60+ for clicker)
- Students can send messages with their clicker responses, providing structured metacognition opportunities
- Apps are web-based, and can be used for distance learning
- Some apps for tablet devices (e.g., *Docer™*) have potential to mirror images projected on lecture hall screen, making lectures more accessible to low-vision students

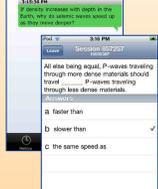
### Limitations

- Requires robust wireless internet connection in the classroom
- Extra setup logistics at the beginning of each lecture



Example clicker slide from Fundamentals of Geology

Student question sent with response to clicker slide



Student view on handheld device using ResponseWare™

## Formative and summative in-class assessment with mobile technology

### Advantages

- In lecture setting, students can participate in structured metacognitive activities via short-answer quizzes on apps for course management systems (e.g., *Blackboard™*)
- In lab setting, students can complete online post-lab quizzes to receive immediate feedback regarding their understanding of important concepts before they leave the classroom
  - Stimulus for student-instructor dialogue
  - Can relieve grading load on lab instructor(s)
- Assessment results can be used to compare across lecture and/or lab sections

### Limitations

- Handheld devices limited by screen size for browser-based quizzes



Student view on handheld device using Blackboard Mobile Learn™



Example post-lab quiz question from Fundamentals of Geology