

The Effects of iPad Use on Student Attitude and Course Grades

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We integrated iPads into some regular laboratory activities in an introductory, non-majors biology course during the fall 2013 and spring 2014 semesters. Students used iPad apps to compile and present information, build concept maps, and review cell division. Using surveys, we measured attitudes towards iPad use in biology education and then correlated those with laboratory and course grades. Data indicated that there was no significant relationship between attitude about iPad usage and course or lab grades. Student self-assessments about proficiency with iPads and usefulness for biology significantly decreased between the start and the end of the semester.

Keywords: iPad, Classroom Technology, Student Attitude, Presentation Skills

Introduction

The hands-on, collaborative, and investigative nature of the biology lab makes it an ideal setting for students to learn course material and develop critical thinking skills. Since traditional undergraduate students entering our universities are digital natives, biology teaching laboratories should integrate technologies that are already foundational to the students' lives and interactions (Prensky, 2010; Tessier, 2013). From a cognitive psychology standpoint, this integration should allow students to more readily connect the new biology information that they are learning to pre-existing information and contexts, allowing for easier recall and deeper learning.

We sought several uses for iPads in an introductory biology laboratory, but we were unable to find many high-quality apps designed specifically for introductory biology classes at the college level. Instead, we taught students to use the more generic presentation and concept mapping apps and integrated them into several lab activities. Students also used the camera, web browser, and two biology-specific apps focused on cell division.

We hypothesized that students entering the course with positive attitudes about using iPads in biology lab would end up with higher lab grades than those with more negative attitudes. We also thought that their experience using the iPads during lab would improve their attitudes about the usefulness of iPads in an educational setting. We conducted before-and-after surveys to assess student attitudes about the use of iPads in our non-majors biology lab at the University of Oklahoma (Appendix A). We ran these analyses with paired-sample t-tests between pre- and post-responses for each student on the questions about student comfort with iPads, perceived usefulness in academics, perceived helpfulness in learning biology content, and the average of the three questions. To assess correlation between attitude and grade, we performed an ANOVA with each attitude category by lab grade, then by course grade.

Student Outline

Actual student lab activities that we presented during this workshop are parts of labs contained in student lab manuals, which are copyrighted by a publishing company. So, in Appendix B we offer the self-made handouts that students are given to help them use the iPad apps during these activities.

A synopsis of the activities being presented during which we used iPads is listed below under the instructor notes.

Materials

For a Class of 25 students:

- Twelve iPads with the following apps loaded, and a connected email account: Explain Everything (\$2.99), Mental (free) or other concept mapping app (e.g. Inspiration, free to \$9.99), and Carolina Biological Plant Histology (free to \$4.99) and Animal Histology (free to \$4.99) apps.
- One stylus per iPad to assist with drawing graphs and making lab group presentations on the iPad
- Apple TV (\$99) or AirServer software (\$15) for wirelessly displaying students' iPad screens (may require certain wireless network security exceptions); or a dock or lightning port to VGA or HDMI adapter for displaying students' iPad screens directly.
- About 100-125 condoms of multiple brands and subtypes (e.g., lubed vs. non-lubed, ribbed vs. non-ribbed, latex vs. lambskin, etc.)
- An assortment of graduated cylinders, beakers, and pipets
- 15 rulers and one or more yardsticks
- At least 5 pairs of scissors
- 5 balances
- 200 marbles, 100 large metal ball bearings, or other small, heavy, uniformly sized objects that can be placed into condoms to test strength
- Trays to catch marbles/ball bearings if the condoms break
- Non-latex gloves for students who are allergic to latex

Notes for the Instructor

We used iPads in the following labs during the fall 2013 and spring 2014 semesters; labs that we presented at ABLE 2014 are marked with a "*" below.

Group Introductions (Week 1)*:

Groups of three students used the *Explain Everything* app to introduce themselves to the class. The objectives were to help the TAs start learning student names and personalities, help students meet each other, and to give students practice with *Explain Everything* in advance of week 2's lab. Required elements of the presentations were:

- Title slide with text on it (student first names/group name)
- Any hand-drawn image or rough sketch (map of where they are from, their hobbies, majors, etc.)
- One or more photos of themselves (individually or the whole group), taken with the iPad
- A video in which each group member says something that (a) makes him or her uncool or (b) he or she already

knows about biology, wants to know, and has learned so far

- Fun fact about each group member

Groups used the iPad's AirPlay functionality along with AirServer software to display their final product on a projector screen to the rest of the class and emailed a PDF of the presentation to the TA.

Process of Scientific Inquiry (Week 2)*:

The overall objective of this lab was to introduce students to the tools of science (metric units of length, volume, and mass) and the fundamentals of experimental design. They were given access to multiple brands of condoms and carried out their own experiments in which they measured condom strength using the technique(s) of their choosing (Poli, 2011). They then used the *Explain Everything* app to create presentations describing their experiments to the class. Required elements of the presentations were:

- Title slide
- The question they were trying to answer
- The hypothesis being tested, **and their prediction** stated in a formal IF ... AND ... THEN format
- A list of experimental variables
- Methods (including photos and/or videos)
- Results, including at least one graph
- Conclusions

As in the previous week, each group used AirPlay to show their final product to the rest of the class and emailed a PDF of the presentation to the TA.

Genetics and Inheritance (Week 8)*:

This lab combines practice with protein synthesis, mitosis, meiosis, and inheritance. We used the iPads for two different activities. First, students used the microscopes to tally the stages of mitosis in onion root tips, but we supplemented this exercise with two Carolina Biological apps (*Plant Histology* and *Animal Histology*). Both apps provide high-quality photos of individual cells in each stage of mitosis, along with a quizzing feature that helps students learn to recognize the stages.

Second, each group used the *Mental* app to create a concept map using the following terms: cell division, mitosis, meiosis, exact cell copies, gametes, fertilization, zygote, DNA, proteins, transcription, translation. The objective was to give students practice articulating the interrelationships and the "big picture."

Instructor note: We discovered that students could eas-

ily connect the molecular-scale terms to one another and the cell division terms to one another, but many had trouble seeing the relationship between those two groups. This insight helped guide our subsequent teaching of meiosis and inheritance.

Molecular Phylogeny of Plants (Week 9):

In this lab, students examined a variety of flowering and nonflowering plants and used their observations to propose an evolutionary tree incorporating all of the species they observed. They then used DNA sequences for the *rbcl* gene to test their hypotheses.

We began by giving students some practice constructing phylogenetic trees, using a variety of screws and bolts as the “taxa.” Students then used the *Explain Everything* iPad app to create their hypothesized trees for the plants, which they emailed to themselves. After generating the DNA-based phylogenetic tree, they turned in homework containing images of both trees, plus a paragraph comparing and contrasting them.

Instructor note: We did not use the iPads for the screw and bolt part of this activity, but future students could easily use iPads to photograph their work to share and discuss with the rest of the class.

Animal Diversity (Week 12):

This lab is a traditional march through six phyla (sponges, cnidarians, flatworms, nematodes, annelids, and mollusks). At the end of the lab, students used the *Mental* app to do a word sort/concept mapping activity using the following terms: animals, annelids, aquatic, asymmetry, bilateral symmetry, clam, cnidarians, collar cells, complete digestive tract, earthworm, flat body, flatworms, hydra, incomplete digestive tract, leech, mollusks, nematodes, no digestive tract, phyla, planaria, polyp or medusa body form, porous body, radial symmetry, segmented body, snail, spicules, sponges, squid, stinging cells, terrestrial. To keep students from getting too overwhelmed by the number of terms, they were told to first make groupings of the most-inclusive to least-inclusive terms, then start connecting them from the top down. The objective of this iPad activity was to have students wrap up what they had learned in lab by organizing the most important terms.

Animal Behavior (Week 13):

In this lab, students learned to quantify the behavior of terrestrial isopods (“roly polies”) and male betta fish. Each group then designed and carried out its own experiment on either species. Students used the *Explain Everything* app to create and deliver their in-class presentations about their experiments. Required elements were similar to those from week 2 of the semester.

Research Results:

Data indicate that there was no significant relationship between students’ attitudes about iPad usage and their course [$r(65) = 0.07$, $p = 0.58$] or lab grades [$r(65) = 0.05$, $p = 0.68$].

Student self-assessments about their proficiency with iPads, and about the usefulness of iPads in learning biology content, significantly decreased [$t(83) = 8.5$, $p < 0.001$] from the start (mean = 3.1, $SD = 0.46$) to the end of the semester (mean = 2.6, $SD = 0.62$). Comments from students surveyed indicated that they were frustrated with technical problems that arose during class, and that many of them expected that more biology-specific apps would be available.

These results highlight the need for well-trained GTAs or instructors who have a positive attitude about the use of iPads in the learning process. Also, these comments drive us to continue searching for, or requesting that companies release, more college-level, biology-specific apps. Finally, results show that undergraduate students may overestimate their proficiency with using technology like iPads, especially for academic pursuits.

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About the Authors

Mark Walvoord received his Bachelor’s degree in Biology from Oklahoma Baptist University and his Master’s degree in Zoology from the University of Oklahoma. He is currently the assistant of the Student Transformative Learning Record at the University of Central Oklahoma and an adjunct biology instructor at the University of Oklahoma. At the time of the presentation, he was the director of the Student Learning Center at the University of Oklahoma.

Mariëlle Hoefnagels has worked at the University of Oklahoma since 1997, the same year she earned her PhD in Botany and Plant Pathology at Oregon State University. She is now an associate professor in Biology and in Microbiology/Plant Biology. Her primary responsibility at OU is to teach non-majors biology, but she regularly teaches courses in mycology and scientific writing as well. She is also the author of two general biology textbooks published by McGraw-Hill.

Appendix A Student Surveys

Survey: BIOL 1005 iPad Use in Lab

Note: Survey responses will not be viewed or compiled until after course grades are finalized.

Biology iPad Use Pre-Survey

- What is your name? _____
- What is your 9-digit OU ID number? _____
- What is your major? _____
- What is your classification?
 - a. Freshman
 - b. Sophomore
 - c. Junior
 - d. Senior
 - e. Other

- How comfortable are you using a tablet (like an iPad or other device)?
 - not at all comfortable
 - a little uncomfortable
 - comfortable
 - very comfortable

- Have you ever used a tablet (like an iPad) in an academic setting?
 - a. Yes
 - b. NoIf yes, please describe:

- How useful do you think tablets (like iPads) are in academic settings?
 - not at all useful
 - a little useful
 - pretty useful
 - very useful

- How helpful do you think an iPad would be in learning Biology course material?
 - not at all helpful
 - a little helpful
 - pretty helpful
 - very helpful

- What is the lowest grade that you would be *satisfied* earning in BIOL 1005 this semester?
A B C D F
- Do you have any comments about the use of iPads in Biology lab?

Biology iPad Use Post-Survey

- What is your name? _____
- What is your 9-digit OU ID number? _____
- What is your major? _____
- How comfortable are you using a tablet (like an iPad or other device)?
 - not at all comfortable
 - a little uncomfortable
 - comfortable
 - very comfortable
- How useful do you think tablets (like iPads) are in academic settings?
 - not at all useful
 - a little useful
 - pretty useful
 - very useful
- How helpful were iPads in learning Biology course material?
 - not at all helpful
 - a little helpful
 - pretty helpful
 - very helpful
- How else could iPads have been used in Biology lab to help you understand and learn the course material?
- Do you have any comments about the use of iPads in Biology lab?

Appendix B

Student Handouts for Specific Apps

iPads for the Biology Lab: *Explain Everything* app

To use the iPad:

- Turn on the screen by clicking the round button at the middle, bottom of the iPad
- Swipe your finger across the screen from right to left to go to subsequent pages of apps
- Tap an app icon once to open the app
- To close out of an app click on the button at the bottom of the iPad
- To open an app already open in the background, double click the home button to see open apps, then tap on the one you want to re-open
- You can rotate the iPad and the picture will adjust to portrait or landscape view (note: some apps only work in one view)

Explain Everything

This app is a versatile whiteboard tool that lets you create presentations using slides you create, plus photos and videos you import from other apps. You will use this app to share your experimental procedures and results with your classmates.

- Tap the *Explain Everything* app on the iPad screen.
- To create a new presentation:
 - Tap the “+” button in the upper left.
 - Choose one of the four color templates for your slide.
 - A workspace will open.
- To create a text slide (say, a title slide with the list of student names):
 - Tap the letter “A” (fifth icon from the top along the left side of the workspace)
 - Tap the workspace and begin typing
- To add a new slide (say, a second text slide to list the objectives of your experiment):
 - Tap the little “+” sign in the slide counter at the lower left corner of the screen
 - A new slide will appear. In the lower left, it should say “Slide 2 of 2”. You can now use the right and left arrows to move from slide to slide in your presentation.
- Draw an image (say, a graph of your results):
 - Add a new slide
 - Select the pencil tool (second icon from the top along the left side of the workspace)
 - Use your finger or a stylus to draw the axes of a graph. Label the axes completely and sketch in your data.
- Take a photo from inside *Explain Everything*:
 - Add a new slide
 - Tap the “insert an object” tool (sixth icon from the top along the left side of the workspace)
 - Tap “New Picture”
 - The iPad’s camera app will open.
 - Take the picture.
 - Tap “Use Photo” if you like it, or “Retake” if you don’t.
 - You may crop, rotate, or select a portion of the image to use if you’d like, or just tap Done.
 - Use the pencil tool (if desired) to point out features of the photo.

- Import an existing photo from the iPad’s camera roll:
 - Add a new slide
 - Tap the “insert an object” tool (sixth icon from the top along the left side of the workspace)
 - Tap “Existing photo/video”
 - Select the desired photo source
 - Select the desired photo. You may crop, rotate, or select a portion of the image to use if you’d like, or just tap Done.
 - Use the pencil tool (if desired) to point out features of the photo.
- Take a video from inside *Explain Everything*:
 - Add a new slide
 - Tap the “insert an object” tool (sixth icon from the top along the left side of the workspace)
 - Tap “New Video”
 - A video camera will open. Follow the instructions to record your video. Note that file size grows rapidly with every second of video.
- Import an existing video from the iPad’s camera roll:
 - Add a new slide
 - Tap the “insert an object” tool (sixth icon from the top along the left side of the workspace)
 - Tap “Existing photo/video”
 - Select the desired video source
 - Select the desired video.
- Delete a slide:
 - Tap the slide counter on the lower left side of the screen to see a full list of slides
 - Touch and hold the slide you wish to delete
 - Tap the red “X” to delete the slide
- Rearrange your slides:
 - Tap the slide counter on the lower left side of the screen
 - Touch and hold the slide you wish to move
 - Drag the slide to its new location in the presentation
- Save your work:
 - Tap the Save icon in the lower right of the screen; it’s the second icon from the right and it looks like a little file folder.
 - Enter or select the name of the presentation and tap Save
 - Email your presentation to all group members and your TA (note that this will export images only, not video; you can only export video if you “screencast” your presentation, which we won’t do in this class):
 - Tap the Export movie icon in the lower right of the screen; it’s the third icon from the right and looks like a little movie strip
 - Select “More...”
 - Select PDF near the top of the screen
 - Select MORE mail (scroll to the very bottom of the MORE list).

- Type the name of the PDF
- Type the names of the recipients (your group members and TA, for example). The email containing the presentation will come from [insert the shared iPad/icloud email address], so do not reply to the email.

Using AirPlay to Present Your Work to the Class:

- The AirServer app should be launched on the lab's MacBook.
- Swipe the iPad screen from bottom to top to reveal a control panel.
- Tap the AirPlay logo:
- Select the Computer's Name from the AirPlay menu.
- Make sure mirroring is switched on.
- Once the iPad's screen is being projected to the class, tap the screen to return to the app you wish to display, and present your little heart out.
- When finished, turn off your iPad or switch off mirroring to stop displaying your iPad's screen.

***Troubleshooting: If the Computer's Name doesn't show up, try turning the WiFi off, then back on, from that same swipe-up control panel.*

iPads for the Biology Lab: Mental app

To Use the iPad

- Turn on the screen by clicking the round home button at the middle, bottom of the iPad
- Swipe your finger across the screen from right to left to go to subsequent pages of apps
- Tap an app icon once to open the app
- To close out of an app click on the home button at the bottom of the iPad
- To open an app already open in the background, double click the home button to see open apps, then tap on the one you want to re-open
- You can rotate the iPad and the picture will adjust to portrait or landscape view (note: some apps only work in one view)

Mental

This app is a concept mapping tool. Concept maps organize knowledge as terms ("concepts") enclosed in boxes, linked to other terms with connecting phrases that define the relationships between the terms. In a finished map, each box must be connected to one or more other boxes in the map; the more connections you make, the better.

- Tap the "Tools" icon in the upper right corner before you begin. Tap "App settings," then make sure "Movement Without Selection" is checked. This setting simplifies dragging the terms around on your concept map. While you're at it, you might also want to turn "Autocapitalization" off.
- Your instructor will provide the terms you must include in your concept map.
 - Find out whether they are available as a "pre-map" that was emailed to the iPad in advance. If so, all you have to do is tap Mail, open the appropriate email message, tap on the file with the ".mental" extension, and select "Open in Mental."
 - If they are not available as a "pre-map" you'll have to type them in yourself, as described below.
 - Tap the Mental app on the iPad screen.
 - Tap "Maps" button.
 - To create a new map, tap the "+" at the top of the list of existing maps (if any)
 - To add a new term to the map, tap the + button in the row of icons at the upper right. A keyboard will pop up.

- Type in a term. When you're done, tap a blank space on the map.
- Tap the term once and wait for its outline to turn green. Move it out of the way by dragging it with your finger or the stylus.
- Tap the + button again, and type in a second term. Repeat as often as needed to get your desired terms/concepts into the map.
- Drag the terms wherever you want them in the Map space. To select multiple terms, tap them sequentially, then drag. To deselect all terms, tap any blank space on the map.
- To connect a term to another one, tap it once. It will be surrounded by a green line, and you will be offered three choices: Edit, Connect, or Delete.
 - **Edit** lets you edit what's in the term (double-clicking a term has the same effect).
 - When you tap **Connect**, the line around the term changes color. Tap another term you want to connect to. When you do so, an arrow will lead from the first term to the second one; edit the connecting phrase associated with the arrow. You may need to move the terms farther apart to make the connecting phrase legible.
 - **Delete** lets you delete the entire term.
- If you want to resize your map (to make room for more terms, for example), move one or more terms toward the edge of the map space, then "pinch" the map smaller.
- You can continue to move the terms and connecting phrases around; the boxes will remain connected with each other.
- If you want to make a branched arrow, or edit the connecting phrase, or delete both the arrow and the connecting phrase, click on the phrase. Again, you will get three choices: Edit, Connect, and Delete.
 - **Edit** lets you edit what's in the connecting phrase.
 - When you tap **Connect**, the line around the connecting phrase changes color. Tap another term you want to connect to. When you do so, an arrow will lead from the connecting phrase to the term.
 - **Delete** lets you delete the entire arrow and its connecting phrase.
- When you are finished, rename the map by double-clicking the title bar on top. Use this format: "Week 8 lab [Names of students in your group]"
- Now you're ready to send the map to your TA. The export button at the upper right corner of the screen offers two export options: Mental file or PDF file. Choose PDF file. You can then email the map to everyone in your group and to your TA. The email containing the presentation will come from [insert the shared iPad/icloud email address], so do not reply to the email.

Using AirPlay to Present Your Work to the Class:

- The AirServer app should be launched on the lab's MacBook.
- Swipe the iPad screen from bottom to top to reveal a control panel.
- Tap the AirPlay logo:
- Select Computer's Name from the AirPlay menu.
- Make sure mirroring is switched on.
- Once the iPad's screen is being projected to the class, tap the screen to return to the app you wish to display, and present your little heart out.
- When finished, turn off your iPad or switch off mirroring to stop displaying your iPad's screen.

***Troubleshooting: If Computer's Name doesn't show up, try turning the WiFi off, then back on, from that same swipe-up control panel.*

iPads for the Biology Lab: Animal and Plant Histology (Mitosis/Meiosis and Histology) apps

To Use the iPad

- Turn on the screen by clicking the round home button at the middle, bottom of the iPad
- Swipe your finger across the screen from right to left to go to subsequent pages of apps
- Tap an app icon once to open the app
- To close out of an app click on the home button at the bottom of the iPad
- To open an app already open in the background, double click the home button to see open apps, then tap on the one you want to re-open
- You can rotate the iPad and the picture will adjust to portrait or landscape view (note: some apps only work in one view)

Carolina Biological Plant Histology and Animal Histology

Both of these apps are simple to use. They teach the stages of mitosis and offer an opportunity to practice identifying the stages of mitosis by sight.

- Tap the Plant Histology app (or the Animal Histology app) on the iPad screen.
- Tap the hexagon labeled “Mitosis.”
- Tap the hexagon labeled “Study” for a series of descriptions and photos of the stages of mitosis. The descriptions are the same for both the plant and animal apps, but the photos are different. When you reach the end of the descriptions, tap the Menu button.
- Tap the hexagon labeled “Practice” for a series of 6 or 7 questions in which you practice identifying the stage of mitosis by looking at cells. The Plant app uses plant cells; the Animals app uses animal cells. It is a good idea to be familiar with both.

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