Journal of Modern Education Review, ISSN 2155-7993, USA
February 2015, Volume 5, No. 2, pp. 195–203
Doi: 10.15341/jmer(2155-7993)/02.05.2015/009

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Biomembranes Transformation: Instructor Led to iPad-Based Student Led

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Abstract: In the spring of 2013, our graduate-level biochemistry course underwent a radical transformation from a traditionally taught graduate level science class to an iPad-based, student-led class. The overall objective of the course was to provide a platform for developing presentation skills for graduate-level science students, in addition to typical biochemistry course goals. While designing the course, the instructor predicted that students would have little difficulty with this new technology and use it to explore uncharted territory. Initially, some students flourished while others were hesitant to leave their comfort zone. At the end of the course, however, many of the students felt that the use of the iPads had enhanced their learning and their overall knowledge of biochemistry, presentation skills, and technology. The major challenge for the instructor was finding a balance between encouraging free thought and maintaining course structure and integrity. Overall, the consensus was that the iPads were an excellent instructional tool that encouraged sustained active student engagement, resource sharing and innovative presentation strategies. However, in this type of open-ended learning environment, it becomes more important to have clearly outlined course expectations and grading rubrics. The authors discuss many aspects of the transformation that may be useful to other instructors interested in incorporating student-led learning and tablets into graduate education.

Key words: biochemistry, iPad, tablets, graduate-level instruction, student-led instruction

1. Purpose

Traditional graduate-level science courses utilize “tried-and-true” teaching methods: whiteboard and computer-delivered lectures received passively by students dominate the classroom and professor-student

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discussions in class happen occasionally. Thus, the majority of graduate student learning occurs independently, outside of lecture, searching through books, magazines, and utilizing online resources. Typically, students prepare for lectures by reading through the textbook material, where the professor uses lecture time to solidify the important concepts covered from the literature. However, while widely used, these methods may not best promote student learning because of their passive nature. The incorporation of active student learning into science classrooms is known to enhance learning (Handelsman et al., 2006) and recent technologies, such as the Apple iPad, provide an opportunity for active learning.

Previous discussions of the use of the iPad in higher education have had mixed conclusions, although most reflect students' excitement to use the technology. Early discussions on the use of the iPad, from across the globe (Australia, Canada, and USA), found that students were positive, and appreciated the flexibility of using the iPads, but did not feel that their learning was enhanced (Kinash et al., 2011; Hall & Smith 2011; Jalali et al., 2011). Another group discussed the use of the iPad by an instructor to develop in-person and distance lectures and activities for students, which were overwhelmingly positively received (Manuguerra & Petocz, 2011). More recently, many examples can be found of using iPads and other tablets in various levels of higher education from medical school (Lobo et al., 2013) to undergraduate business management (Franklin et al., 2013) with more successful learning gains than when iPads were first released in 2010. This increase in student learning while using mobile technology may be due to the continued development of applications and programs to use in class, increased student awareness of these technologies, and increased instructor flexibility for changing pedagogical methods.

The purpose of this manuscript is to discuss the benefits and pitfalls of transforming a traditional graduate level biochemistry lecture course (*Membranes Biochemistry and Biophysics*) to an iPad-based, student-led classroom in the spring of 2013. In addition to standard biochemistry graduate level course goals, a major goal of the course was to increase student teaching and presentation ability through the extensive use of iPads, both within, and outside of class time.

2. Design

2.1 University Owned iPad Access

Our university Office of Information Technology Training & Development group provides technology support and training for faculty and staff on the UAF campus. One of their educational technologists initiated this journey through a short faculty course on the instructional use of iPads at the university level. Upon completion, participants were offered the opportunity to submit a proposal outlining the potential loan of up to 10 iPads for use in the instructor's class. The awarded proposal for this course, written by a biochemistry professor, had two main objectives for the use of the iPads: (1) in-class group "lecture" presentations and (2) to develop students' "quintessential" research slide. The Spring 2013 graduate level course, Membranes Biochemistry and Biophysics, had seven students enrolled: two second-year Masters of Science students and five Ph.D. students at varying stages of their degree. All of the graduate students were associated with the authors' university Chemistry Department or the Biology and Wildlife Department.

2.2 Course Goals and Design

The following were the course goals listed in the syllabus: develop an understanding of the basic biophysical processes that are involved in membrane-mediated events; develop an understanding of the different families of

proteins classified as membrane proteins; use basic concepts to formulate hypotheses, select pertinent literature, interpret experimental data and propose meaningful experimental approaches to solving current questions in membrane biochemistry; strengthen and develop resource sharing and individual and group presentation skills.

In addition to the traditional biochemistry-related learning goals, one main goal of the course was for students to explore iPad applications, share resources, and integrate new and existing tools to make both unfamiliar material and their own research more accessible to a larger audience. At this stage of the student's education, the students are highly independent; they are not only working within a research group, but also leading a research project of their own. One critical aspect of being a scientist, often not fully developed, is the dissemination and presentation of information, including discerning relevant information and targeting a specific audience. Since graduate programs in science are often so focused on research, teaching opportunities outside of the directed laboratory teaching assistant, are few and far between. Thus, the intended use of the university owned iPads was for weekly preparation and delivery of short lectures and presentations. The instructor provided an Apple TV so that students could wirelessly project onto the classroom screen. Students were encouraged to explore various iOS applications, such as Prezi, Explain Everything, Idea Flight, and Near Pod as well as outline textbook chapters using mind-mapping applications, such as Mindomo and iThoughtsHD.

The textbook used was *Membrane Structural Biology* by Mary Luckey. Each week, the class met for 1.5 hours on Tuesdays and Thursdays. During the Tuesday sessions, students were expected to come prepared having read the assigned textbook chapter and completed a "mind map" or outline on their iPads of the chapter. They then worked in groups or individually on unique, creative presentations of their section of that week's chapter. The students, with assistance from the instructor, determined appropriate division and assignment of chapter sections. During the Thursday sessions, students presented their presentations to their classmates. Students did not have to present in a traditional manner; for example, students sometimes prepared a quiz for the students to participate in on their iPads, created a comic of their section, or presented a video. In addition to weekly chapter presentations, each student selected a textbook chapter topic to lead a primary literature discussion on a current scientific article.

The culminating project for the course was to describe a fundamental cellular signaling pathway or experimental method in the students' specific area of research, with the intention that the project would be useful for the students' overall thesis research projects. Students were encouraged to use animation, illustrations, or videos of the pathway to describe this quintessential aspect of their research. This assignment was intended to encourage brainstorming with peers and to provide time to develop a unique and informative presentation tool students could use in other scenarios for the rest of their graduate career, if not beyond. Students used iOS applications such as, Educreation, Keynote, Prezi, Grafio and other photo editing tools.

Participation points were given for homework (chapter mind maps/outlines), preparing presentations, and for the presentation itself. Points were as follows: 0 points for no participation, 1 point for subpar or incomplete work and 2 points for full credit. The final project was graded with equal weight on the following criteria: background/setup, clarity and timing, difficulty level and depth, the use of appropriate tools, and creativity. Lastly, for the final exam, each student wrote several exam questions with the iOS application NearPod. The instructor selected questions from their pool and the final exam was administered in class via the iPads.

2.3 Post-course Surveys

Following the completion of the course, students were provided with and voluntarily completed an anonymous survey and an essay survey to reflect on their experience in the course. Completion of the survey had no influence on the final grade in the course, but those students that chose to thoughtfully complete the essay survey were offered

joint authorship on this manuscript. Questions on both surveys included reflection on the influence of iPad use on learning within the course, improvement in teaching and communication skills, and overall feelings and suggestions for the course (Table 1). Out of 7 students in the course, 6 students submitted answers to the anonymous survey and 5 submitted essay responses. We visualized student responses to the anonymous survey using pie charts, where 100% represents the 6 student responses (Figure 1). Student essay responses were carefully read and reported in the student reflections section of the findings, below.

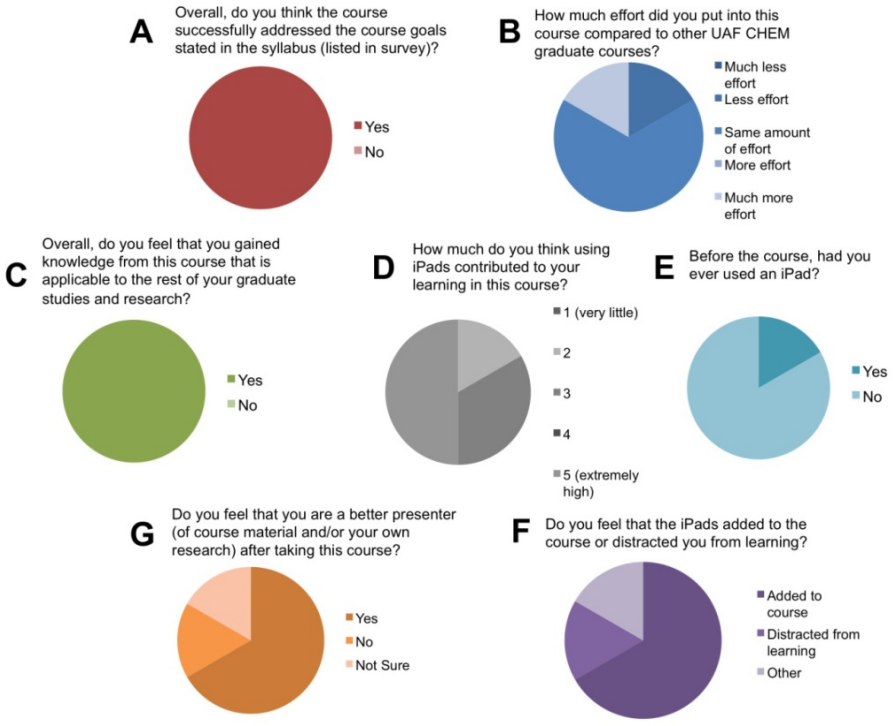

Figure 1 Student Responses to Anonymous Post-Course Survey. 100% of Each Chart Represents the 6 Student Responses (Out of 7 Students in the Course).

Table 1 List of Questions Asked in the Essay Survey and Average Word Count of Student Responses

Open-ended Question	Average Word Count of Response
Compare and contrast this course to "traditional" graduate-level science courses you have taken. Things to think about include group work, required study time, types of assessments, use of class time.	187
How did you feel about the learning required to successfully present your section of the chapter to the class each week? Did using an iPad to study and create your presentations aid your learning or distract you?	102
What skills, if any, did you gain from taking this course that will apply to your graduate work in general and your future career that were unique to using an iPad?	73
Any thoughts about incorporating technology into other graduate level courses? Perhaps to improve graduate student presentation skills, teaching ability (because we are generally required to teach undergraduates), communication with other graduate students, being aware about what technology is out there...	93
What were your favorite applications used in the course and why? Do you continue to use these apps to present your work since the course has ended?	170
What would you change about the course if you had a say (which, if you answer this, you do have a say!)? What would you keep the same?	126
How did you like the freedom of choosing how to present your chapter to the course? Would you prefer assigned applications for each week? Why?	59
Do you have any other thoughts that could be relevant to include in this manuscript?	111

3. Findings

3.1 Instructor Reflection

The shift towards a student-centric atmosphere took a bit of adjustment for both the instructor and the students. The major challenge, from the instructor's perspective, was finding the balance between encouraging free thought and a sense of ownership with maintaining course structure and integrity. This challenge may be addressed in future course offerings by providing more clear rubrics for the weekly presentations and the culminating semester project.

Throughout the semester, we experienced the inevitable technological glitches with individual iPads and with presenting and the associated distractions and frustration. These glitches will most certainly happen and especially at the beginning of the course. Not all classrooms are set up for the use of this technology and this should be addressed before the beginning of the course. Our university Office of Information Technology was very helpful in the beginning stages of this course, finding a suitable room and making sure the class was set up appropriately as well as registering all the devices on a wireless network. The only way to handle this is to be patient; by the second week, there were very few technological glitches that could not be handled in a timely manner. Most often, the iOS Airplay feature of the iPads (for wirelessly projecting the presentations) was finicky, and when problems occurred we would usually directly connect the iPads with the appropriate cord or email the presentations to ourselves and open it on the computer at the front of the class. Having other options is key for the success of mobile technology in the classroom.

3.2 Student Reflections

3.2.1 Comparison to Traditional Graduate Level Science Courses

Compared to traditional graduate level science courses that are nearly completely lecture by the professor, the overall consensus of students was that this course was different because of the focus on student group work in the classroom and student presentations to the class. All of the students acknowledged that most science graduate courses require mostly learning information from a lecture delivered by a professor and a small amount of primary literature discussion and, often, one large presentation on a topic per semester. Although the course was different in structure, 100% the students felt like they learned the biochemistry-related course goals stated in the syllabus (Figure 1A). One student, in an essay response, stated that she appreciated the opportunity to tackle and then present to her classmates the new content without being lead through by the professor. Another student felt that the increased in-class group work allowed for open-ended discussions, aiding in critical thinking and comprehension of the material. Yet another student was not quite able to adapt to the new environment and commented that because the environment was so open-ended, the student felt that they did not learn as much scientific information as in other graduate courses. However, all students agreed that the significant change in learning structure was a challenge and many felt that the challenge was beneficial to their overall learning.

Another important difference noted in this student-based course was the increased preparation time required for beginning a new chapter. The expectation that each Tuesday students would begin working on a presentation in class increased the motivation of students to actually read the chapter before coming to class, whereas in lecture-based courses students rarely have the motivation to read a chapter before coming to lecture. One student stated, "we weren't able to come to class partly prepared and lean back to simply listen to the instructor; we were forced to actively be involved in discussions and sharing our gained knowledge through presenting or helping

others present." This change in the use of time meant that students were able to do most of the learning during class time, rather than being introduced to information in a lecture setting and then actually digesting the information and learning outside of class. While students felt there was a change in preparation time required for the course, most students reported that the overall effort required for the course was the same as other UAF Chemistry courses, with only one student reporting more effort and one reporting less effort was required (Figure 1B).

3.2.2 Skills Applicable to Graduate Work and Future Careers Gained from the Course and iPad Use

All students who responded to the anonymous survey reported that they felt the knowledge gained from this course was applicable to the rest of their graduate studies (Figure 1C). Students were also surveyed for perceived skills gained from participating in the course and using iPads that are valuable to them as graduate students outside of the specific biochemistry course in essay format. In addition to learning how to use specific iPad applications and using the iPad as a learning tool, most students expressed that they felt their communication skills were greatly improved (Figure 1D). Students wrote that this increase in communication skills was due to weekly practice of giving a short presentation to the class. The knowledge that the students were presenting to an audience of motivated peers who would ask questions to better their understanding of the material also improved the quality of communication. Along these same lines, many students felt that their confidence in their ability and their actual ability to interpret, organize thoughts, and teach new scientific information improved by participating in the course.

Students also reported feeling encouraged and more comfortable solving problems relating to technology and to explore and learn new technology and applications without guidance. This feeling was fostered by being required to figure out how to use the iPads at the beginning of the course, finding new presentation tools to make creative presentations, and helping fellow students explore applications on the iPads. The atmosphere and nature of the course also lead to students feeling more comfortable using creativity in science communication, which is not a common skill emphasized in most traditional science lectures or even scientific conferences. The encouragement and the ability to be creative led some students to think critically about the best method to deliver or teach a specific subject (i.e., screencast versus labeled diagram). Please see Table 2 for the students' favorite iPad applications and their application to graduate student education.

Table 2 List of Students' Favorite Apps and Their Applications to Graduate Coursework

Application Name	Function	Application to Graduate Coursework
Grafio	Flow-chart creation	Ability to make cellular signaling pathways
Keynote	Presentation maker	Similar to PowerPoint
Prezi	Presentation maker	Flexible presentations
Dropbox, Google Drive	File storage in the cloud	Allows for accessing files on computers and tablets
Penultimate, EverNote, Notabilty, Remarks, Good Notes	Note-taking	Annotate PDF manuscripts and course notes, many sync with Dropbox
Educreation, Explain Everything	Whiteboard screencasting	Draw and talk your way through a process for your audience
Mindomo, iThoughts	Mind-mapping	Note-taking while reading literature
Idea Flight	Interactive presentations	

3.2.3 Influence of iPads on Learning

Overall, students reported that the iPads contributed a mediocre amount to the learning gained in the course (Figure 1E). This was surprising to the instructors, given the large amount of time students worked with the iPads. However, this survey did not measure learning in an unbiased manner, and a comparison of learning gained with

and without iPads in a course with the same design would be difficult given how central iPad use and presentations were to the course. However, these lower than expected self-assessed learning gains might be associated with student frustrations in using the new technology. Only one of the six students reported using an iPad before taking this course (Figure 1F). In the essay responses, a few students admitted that use of the iPads in the first few weeks was quite distracting and a few students were intimidated by the new technology itself. This kind of distraction and intimidation occasionally lead to dull presentations in which the peers of the presenters learned very little, especially at the beginning of the semester. One student admits another type of distraction from the use of the iPads in class — easy access to the Internet. However, that same student felt that through the exploration of new iPad applications, that the iPad ended up aiding her learning for the same reason it had originally distracted her — easy access to scientific information on the internet and ease of creating presentations. By the end of the course, all students felt that their presentation skills had improved (Figure 1D). A few students expressed concern that few of their peers were using similar presentation skills and styles to lecture-based professors, rather than being creative and fostering group discussion. Even with these distractions and intimidation and reluctance to master a new technology, most students reported that the use of the iPads did positively contribute to their learning (Figure 1G), though not in an extreme manner (Figure 1E)

The largest influence the iPads had on the course was the transformation of the course from uni-directional to bi-directional pedagogy, allowing students to significantly participate and influence the learning that takes place in the course. This change in focus of the course also ended up requiring that students have the ability to speak about and teach new information to their peers, rather than just being required to write responses to tests and quizzes. One student wrote in their essay response, “the real understanding of the concepts was generated while we played with iPad tools to create presentations or trying to make things decipherable to others in class.” This weekly interpretation and presentation experience is one that none of the graduate students experienced in other science graduate courses at the university.

Interestingly, although students did not quantitatively report that the iPads highly contributed to the learning in the course, they found other values to the iPad use in their education. Three students stated that they continue to use iPads in their graduate research and coursework, including two who did not use iPads before. All three of these students stated that they continue to enjoy exploring creative, effective presentation methods with their iPads and also use them to manage other aspects of graduate school (i.e., file sharing, note management). Two additional students have since stated that they continue to use new presentation and file sharing tools (e.g., Prezi and Dropbox) on their computers.

3.3 Suggested Course Improvements

The students and the instructor agree that there should have been more clear learning outcomes and expectations for assignments at the beginning of the course. Some students suggested the required use of specific applications to move students out of their comfort zone. Improvements such as these would help to provide more structure and motivation for students who are nervous when transitioning into a new learning environment, while still fostering creativity. These changes would also aid in the amount of overall learning gained from the course, as students would know what was expected and thus, could focus on learning the new information.

Since the majority of the students had never experienced iPads before the course (Figure 1F), allowing the students to check out the iPads before the course so that they could learn the basic functions (i.e., email, internet, application downloading) without the stress of knowing a grade is attached to their performance might improve

performance with the iPads. Providing information and encouragement to participate in university sponsored events and workshops focused on Internet technology (e.g., Dropbox, the Cloud) and iPad use available for free to students throughout to year would also be beneficial to increasing student ability to master a new technology. Even a complete, separate course on using technology in education for graduate students (and faculty) would be valuable. Along these same lines, education about student curation of knowledge and presentations would have been useful for students to learn how to organize information they find online (or on their electronic textbook) and ways to share files and presentations so that the work done during the course might be useful in the future. All of the above would be useful resources and tools for students to be aware of, but realistically probably cannot be included in a chemistry course design that also needs to meet traditional, science-related chemistry course goals. Perhaps future students will either arrive at the course with more knowledge and comfort with this technology and/or the ability to teach themselves when provided with tutorials or by attending campus-wide technology workshops.

4. Practical Implications

Transforming the course from a traditional lecture course towards a student-centric atmosphere required some adjustment for both the instructor and students. Even with this extreme course transformation, students reported that the course met its learning goals (Figure 1A) and that skills applicable to the chemistry graduate experience were gained (Figure 1C). The major challenge for the instructor was finding a balance between encouraging free thought and a sense of ownership for the students while maintaining course structure and integrity. Overall, the student consensus was that the iPads were an excellent instructional tool (Figure 1G) that enhanced sustained active student engagement, resource sharing and innovative strategies. The use of iPads and weekly presentations also increased student communication skills (Figure 1D) and ability to use technology to present and curate information (Table 2). However, in this type of innovative learning environment, more clearly outlined course expectations and grading rubrics were desired by both the instructor and students. The students felt that the iPads did not greatly contribute to their learning in the course (Figure 1E), agreeing with previous studies on the effectiveness of iPad use in the classroom (Kinash et al., 2011; Hall & Smith 2011; Jalali et al., 2011). This conundrum of gaining relevant skills but not improving learning with iPad use are likely due to frustrations with learning and incorporating new technology into the traditional passive learning environment that these graduate students are used to.

While this course was a great learning experience for instructor and students, many students expressed that they feel there is value in the incorporation of student-led courses into traditional graduate required course work without the elimination of lecture-based courses. When taught well, lecture courses not only teach students selected information directly, they teach students how to figure out what specific information is important for their interests and/or research questions, which in turn improves their performance in student-led courses. Many students felt like encouragement to be creative and incorporate different, innovative technologies in presentations in all graduate level courses would be valuable.

This course transformation provided a new experience for everyone involved and was successful at both helping the students' acquire the biochemical knowledge and expand the student's technological repertoire. It is likely that whenever a new technology or new technique is introduced into the classroom, that there will be room for improvement. However, in taking innovative risks in course design, more effective learning strategies will also

likely spawn from these creative endeavors. Also, involvement of the students in the course reflection greatly enhanced this process and more importantly, contributed to the growth and experience for the next class.

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