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Creation and use of an iBook as well as chemistry videos to improve student learning experiences in general chemistry Laboratory

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Abstract

Digital books have revolutionized the way student accesses books and information. An alternative to a static e-book, is an interactive textbook designed with iBooks Author, a free Apple software program. This technology allows teachers to develop textbooks based on the needs of their students. In this study a digital interactive book—iBook (for use on the Apple iPad and iPhone)—was created to teach general chemistry laboratory for first year collage. In this study the flipped classroom is a form of hybrid instructions in which active form of engagement inside as well as outside the classroom are made possible by designing an iBook for general chemistry laboratory supported by a set of video lectures. This study documents the implementation of partially flipped class over one semester and presents results of students' perception toward flipped learning and using the iBook. It is found that students respond positively to flipped learning and they are excited to use this technology (iBook) to introduce general chemistry laboratory.

Keywords: *General chemistry Laboratory; iBooks; Flipped Learning; Active Learning; undergraduate chemistry education; Computer-assisted learning.*

1. Introduction

Electronic e-learning is often defined as the learning experience taking place through the computer/desktop medium (Evans, 2008), whereas mobile m-learning has the added benefits of the learning package being available on tablets, smartphones, personal digital assistants (PDAs),and so forth . Furthermore, mobile learning involves devices that are more affordable for users and therefore easier to obtain than traditional desktop computers [1]. This enables the student to learn where and when they want. They are able to dictate the rate of delivery and consumption of educational materials[2], though few speculate the value of such an approach[3]. The "one-size-fits-all" approach of informative lectures is upcoming under greater examination, and it is realized that a multipronged approach to pedagogy is required to keep students engaged with the presented topic[4]. Additionally, some British universities have concerns that students lack in independent inquiry, higher order thinking, and research skills [5].

Table 1 Survey questions based on Likert-type survey[6]

(1)	I would take another course that used iBook alongside of textbook.
(2)	I would take another course that has video lectures alongside textbook
(3)	The iBook and video lectures were easy to access.
(4)	The video lectures helped me learn.
(5)	The iBook helped me learn
(6)	Sharing function in iBooks with classmates helps me learn.
(7)	Embedded links, gallery in iBook helps me learn.
(8)	The ability to rewind the video clips helps me learn.
(9)	) Knowledge about chemistry experiments from other sources helps my understanding.
(10)	Using Video lectures and digital resources were a valuable learning and fun experience.

Blended courses have begun offering by many colleges and universities[7], which combine best practices from face-to-face and online learning. Flipped or inverted classroom has come to the forefront in education recently. Flipped learning maximizes the learning process by moving content delivery online, allowing for classroom sessions to emphasis on student-centered activities[8]. While this concept of shifting the learning of course material to outside of class so that more meaningful student engagement can take place in class has been around since the 1990s[9]. The advent of new and improved technology has allowed the flipped classroom to become more widely implemented [10] Jonathan Bergmann and Aaron Sams are of the earliest developers of the technology-enhanced flipped instructional method, who recorded online lectures for their chemistry course and published their observations and recommendations in their book “Flip Your Classroom: Reach Every Student in Every Class Every Day”[11]. When course content and assessment tools are integrated and centered around the student, educators agree that the flipped learning model offers a number of benefits. This strategy can lead to higher levels of student performance [12]. Using the Flipped learning strategy maximizes the learning experience by moving content delivery online, where learning can be self-paced, allowing for class time to focus on student-centered active learning [13]. Quantitative information regarding student learning gains in the flipped learning environment is limited[14]. The purpose of this research has been to assess the impact of a flipped learning instructional format on student performance and knowledge retention in a general chemistry laboratory course for preparatory general chemistry students. In this study two research questions are answered

- ✓ Does the use of an iBooks format impact student performance as compared to the more traditional instructional format?
- ✓ Does the use of a flipped learning format impact student motivation and attitude toward learning?

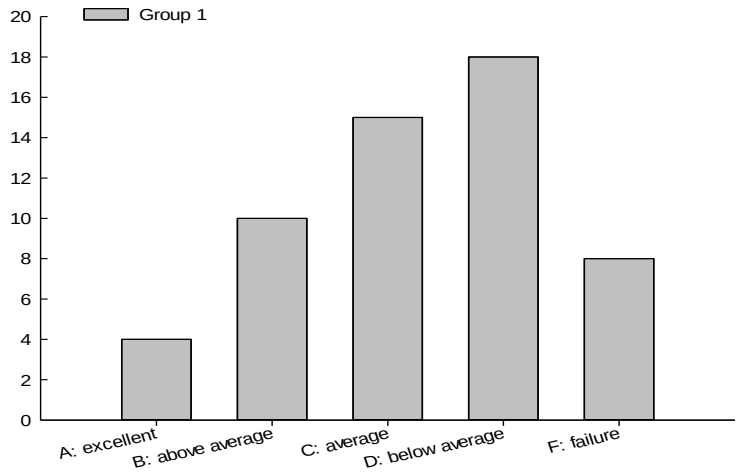


Figure 1. Final exam results for group 1 that use the traditional learning format.

2. Methods

An iBook titled "Chemistry Laboratory Lecture Notes Inorganic Qualitative Analysis" have been designed and made available to the students through this link:

https://itunes.apple.com/us/book/chemistry-laboratory-lecture-notes-inorganic-qualitative/id942125898?mt=11

This iBook is used as a replacement to the traditional textbook. It provides an excellent source of descriptive chemistry information that no other laboratory experience in general chemistry comes as close to providing a feeling for the flavor of scientific research. Solubility concept is explained. Qualitative analysis scheme was developed taking into consideration the safety criticism to the traditional schemes that were used H_2S gas. Anions and cations have been investigated using these developed schemes. One element which really causes iBook to shine is the level of interactivity that is possible between the student and an iBook. This is one aspect where traditional, printed books simply cannot compete. The content of conventional books is confined to text and static images, whereas the content within an iBook is able to raise this to a whole new level. Instead of small, static images that are common in many textbooks, through the use of Widgets, iBooks are able to display stunning images in full screen which student can interact with using gestures they are familiar with like pinch to zoom, great for when you want to focus on a particular feature within a picture[15]. Furthermore, the inclusion of galleries enables student to swipe through multiple images. The Interactive Image Widget brings a new dimension whereby student can access additional information about a picture simply by tapping a label [15-17]. This study was conducted at first year chemistry students; two groups of 55 students each were subjected to study the general chemistry laboratory by traditional and flipped learning methods. The chemistry laboratory course covers the same materials and uses the same textbook for both groups. These materials were taught by the same instructor using a traditional format in group 1 and flipped learning format in group 2. In group 1 student uses the traditional text book for general chemistry laboratory that include very few pictures for the equipment's used in the general chemistry laboratory in addition to some tables for recording the observations.

In group 2, several in-class activities utilized technology to teach process skills and critical thinking. Every two students from the group 2 checked out the prepared iBook on their iPad or iPhone, use the apps designed by the

authors which involving simulations via embedded screen casts and videos. Most class periods either began or ended with quizzes that assessed class preparation and/ or concept comprehension.

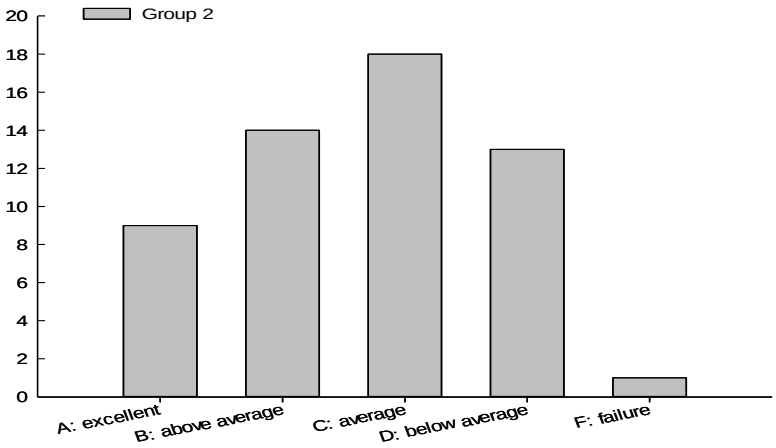


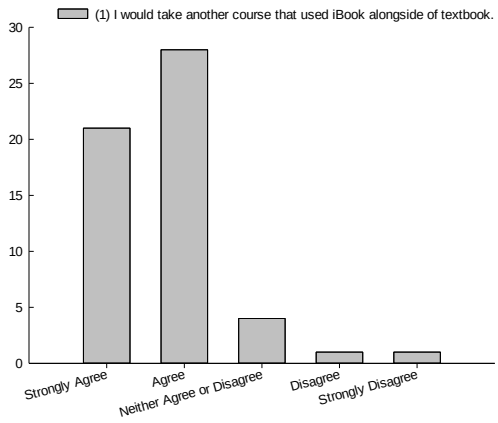
Figure 2. Final exam results for group 2 that use the Flipped learning format.

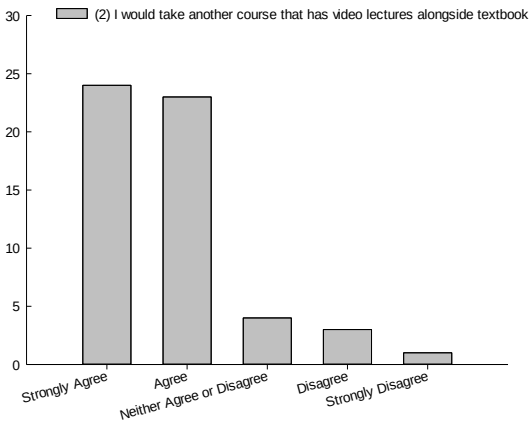
A YouTube channel (Khaled Academy) was established with videos for the laboratory for prelab activities in this link: https://www.youtube.com/playlist?list=PLjatJgAU0ToYhjsCmRzQHeAzPTUi_2Esf

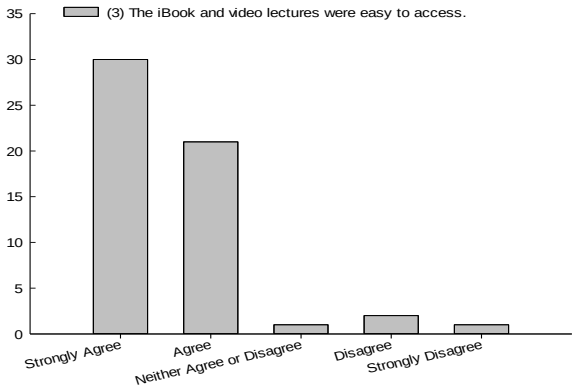
In these videos the instructor narrates the Laboratory procedures and how to perform the experiments in the laboratory. For prelab activities students were assigned iBook reading which tied with instructor-narrated online lecture from YOUTUBE channel. Post lab activities consisted of using quizzes from their iBook. In order to measure group 2 students' perceptions toward using iBook and video lecture, students were surveyed. The survey was distributed at the end-semester to collect qualitative data (Table 1) in order to help refine the method and delivery of the video-lectures and iBook. This survey asked simple questions like: What works well? What helps you learn? What does not work well? What changes would you suggest? [6]

3. Results

The results of the final exam for group 1 and group 2 are presented in Figures 1-2







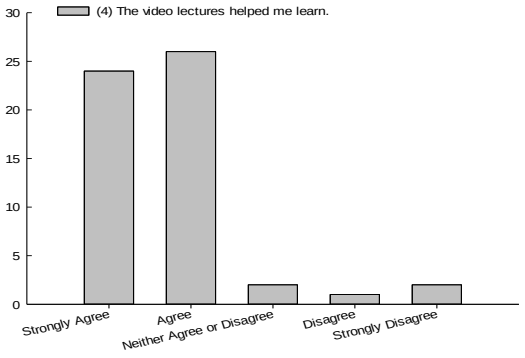
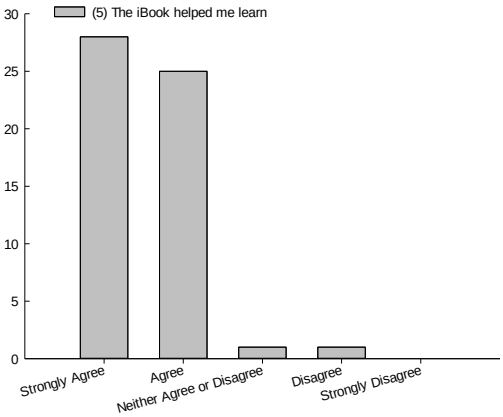
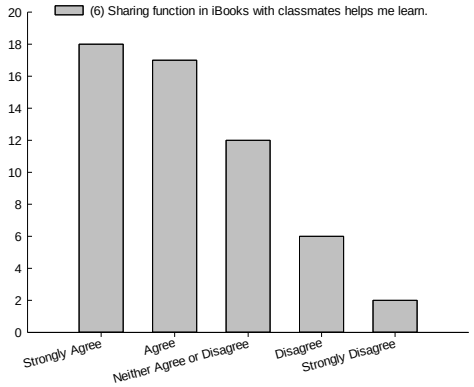
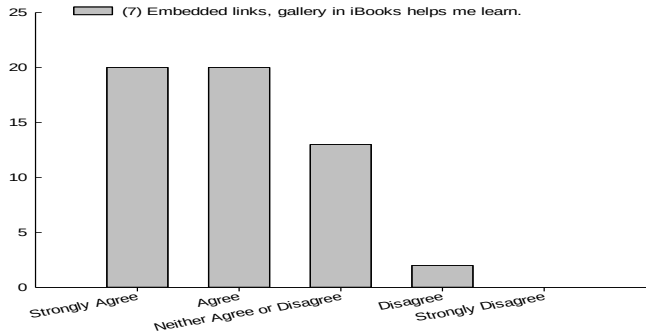
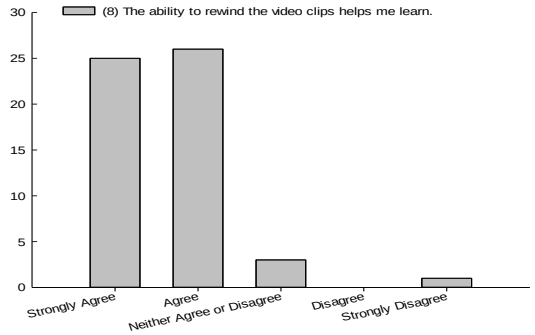


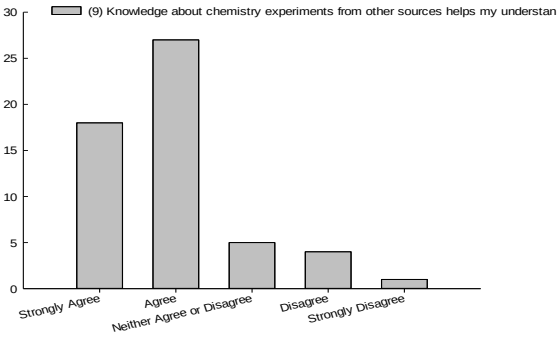
Figure 3 shows the responds to the first 1-4 questions in the Likert-type inventory











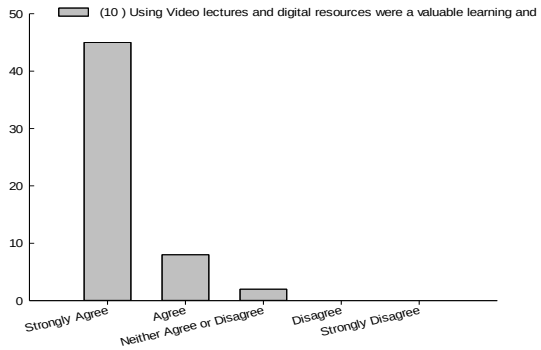


Figure 4 shows the responds to the 5-10 questions in the Likert-type inventory

4. Discussions

The flipped classroom model of teaching is spreading across more and more educational institutions, as it seems to better respond to the learning needs of student living in today's ever more connected world. Flipping the classroom is a win-win situation for both students and teachers. Figures 1-2 show that the embedding technology in the learning situation enhances the overall results for students in group 2 over group 1. The learning situation in group 1, the classroom for example where the place where students spend most of their time preparing to become successful chemists in our ever more connected modern world hasn't evolved much since the pre-industrial era. Markers and whiteboards have replaced chalk and blackboards, the furniture is nicer, and there's a projector in each classroom. But the setting is the same as always. In this situation a lot of class time is allocated to keep students attention to what the teacher is lecturing[13]. While the learning situation in group 2 , instead of paying attention to lectures while in class and applying the new knowledge in their homework after school, students will watch or listen to the lectures at home, before the class starts, and use the time in the classroom to do their homework. Instead of telling students what to learn, how to learn, when to learn and how to prove that they learned, teachers support them in becoming self-directed learners. Overall, it was observed that using iBook and video lectures were beneficial in improving student performance as evidenced by a comparison of final exam results for both groups from classes using the flipped learning format to those taught using a traditional lecture format (Figures 1-2). One of the most important aspects of using an innovative instructional format is the impact on student motivation. The flipped learning format requires students to take ownership of their learning and rewards those who are motivated to learn. The majority (81%) of students in the in house anonymous survey indicated that being responsible for their own learning motivated them to succeed in the course. This relationship between motivation and success was reflected in the course grade outcomes (Figures 1-2). While most students saw the benefits in using this system, others indicated (Figures 3-4) that it took too much of their time to complete. Student preparation also impacted final grades as observed when assessing student notebooks; those coming to class unprepared did not perform as well. It is clear that those students who mastered time management and organizational skills were able to take full advantage of this pedagogical methodology. In response to ''what works well?'' many students mentioned the ability to watch the videos on their own time, and being able to pause and rewind the video when they became confused (Figures 3-4). One student mentioned that, ''it really helped me to pause the acid radical video and do the experiment and see results before he did.'' Another mentioned that it was nice to ''watch the video again really quick while walking to class.'' As an instructor, it was beneficial to have students who had a previous exposure to the material beyond a cursory reading of the textbook. In response to ''What does not work well?'' some students mentioned that they did not like the video lectures that more closely resembled actual lectures (Figures 3-4). Specifically, one student wrote that, ''the video-lecture that is just notes is helpful, but it's kind of boring.'' Others intimated similar feelings, but most noted that it helped them during the application of the lesson. Many students also used this question to motivate their response to ''What changes would you suggest?'' Somewhat surprisingly, many students suggested having more videos per week. Others mentioned that it would be nice to have a forum to discuss the videos while online. The most mixed responses came in terms of suggesting future videos.

5. Conclusion

This study has shown how students responded to using iBook and educational video lectures in flipped learning format to improve the learning experience of general chemistry laboratory for preparatory students. In general, students responded quite positively to flipped learning with 89% of students responding that flipped learning helped them learn, 97% of students responded that this class was more interactive than other courses they had taken. For those that

believe active and collaborative learning is a benefit to educational development this is a very promising result. A key finding was that by implementing a flipped design more time can be allocated to active-learning techniques without the worry of losing time covering essential course material. Further, by engaging students with a media-type that they may appreciate more than the standard textbook it is entirely possible that course material is covered more quickly because the students have a better understanding of the material before coming to class, and thus deeper learning can occur in a short time period. This paper has shown responses from students over one semester in a specific discipline, but more work must be done to test the efficacy of flipped learning in a collegiate chemistry curriculum.

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