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## The Use of an iPad as a Classroom Tool

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### Abstract

*The Apple "i" line has been steadily increasing in popularity and many educators believe these devices offer great potential as instructional adjuncts. Many schools (including colleges) have begun issuing iPads to students with the assumption that they would enhance the students' educational experience. Little experimental evidence has been produced supporting this claim. This study was an attempt to experimentally evaluate the effectiveness of iPads on learning educational material. Participant's interest and enjoyment while using the iPad versus traditional material presentation (paper images or physical models) were also examined. Participants were randomly assigned to learn 24 anatomical brain structures using one of three conditions; 1) control color paper images, 2) plastic anatomical model, and 3) iPad application "3-D Brain", produced by Dolan DNA Learning Center. Participants were given 10-minutes with their assigned material and were then immediately tested on the material. The results demonstrated that learning & memory performance using the iPad was significantly better than the plastic model, and no different from paper pictures. Compared to the plastic model, participants also reported that they enjoyed the task more, felt more prepared, felt their performance was better, and would be more likely to take a class using the iPad. A gender difference was also discovered, suggesting that females might benefit more from the use of the iPad than males. The limitations and implications of these findings are discussed.*

### Introduction

The recent advent of highly mobile digital computing devices has stimulated a movement to incorporate these devices into the educational process. In recent years, the Apple (Cupertino, CA) iPad has been adopted by many teachers and students for use in the classroom with the assumption that they would serve as useful adjuncts to classroom instruction (Banister, 2010). As limited supporting experimental evidence can be found in the literature, these claims are currently based on a combination of anecdotal evidence and suggestive media.

Modern students have developed in a world surrounded by rapidly evolving technology and some speculate that these students need to utilize this technology to effectively comprehend the material presented to them in the classroom (Bevins, 2011). Tanaka, Hawrylyshyn, and Macario (2012) describe the modern student as belonging to the millennial generation (those born between 1982 and 2001) and who prefer technology use in the classroom, while those born after 2001 are dubbed the On-Demand generation (Learmonth, 2010). The On-Demand generation has never

known a world without texting, Facebook™ or Youtube™, and they expect to have access to information at their fingertips. Bevins (2011) asserts that for the modern student to actively engage in the learning process, they need to experience learning by using hands-on applications they have grown up using, such as those provided by the Apple iPad. Bevins also notes that the National Academy of Engineering and the National Research Council support the need for technological literacy as a tool to help students solve real-world problems. Bevins illustrates a new modern age of information sharing that requires its consumers and producers to be technologically savvy to efficiently conduct business. He also believes that modern students need more than traditional teaching or lecturing and to effectively prepare our students for this new age of technology we must implement this technology as a new educational paradigm. Much of the information regarding current technology's impact on learning is anecdotal, so consumers are left to base decisions regarding its implementation within the educational system on suggestions from expert opinions, experiences of early adopters, and media influences.

There are several features standard to the popular iPod touch and the iPhone which are also standard to the iPad, and have been suggested as useful to educators. *Photos*, *Music*, *Movies*, and *YouTube* are among them and seem to have educational value depending on the imagination of the educator (Banister, 2010). For example, Warringa Park in Melbourne Australia is providing entire classes with applications by gifting them to the entire class, ensuring that the students will have access to the required applications (Ellis, 2011). In one of the rare studies to evaluate the use of the iPad in learning, medical residents at Stanford University School of Medicine were given an iPad for a two-week rotation and the student evaluations of the rotation with the iPad were retrospectively compared to the evaluations of regularly taught rotations (Tanaka, 2012). Residents rated the iPad-taught rotation higher on the quality of the syllabus, better access to information not already part of the case, and the goals of the rotation were more adequately defined than the traditional rotation on several measures.

One of the most useful features of these devices is their accessibility to the internet allowing students and educators to have ready access to content and applications that might enhance the learning experience (Banister, 2010). Beyond internet access, downloadable applications appear to be a unique feature of these highly mobile devices, providing interactive educational experiences to enhance learning for all ages (Banister). From ABC's to math, science and social studies, the mobile market appears to have an "App for that."

Some schools have begun implementing iPod touch and iPads as educational tools and have seen encouraging results. Newcomer Center in Arlington Heights, IL, caters to recent immigrants from all over the

world who are learning English as a new language. The school has issued students iPads in an attempt to extend learning beyond the classroom and beyond traditional learning (Demski, 2011). Similar to the Newcomer Center, Comal Independent School District in New Braunfels, TX has issued an iPod Touch to each of their students (Demski). An iPod Touch and an iPad are similar in all regards except for their size; the iPod touch is smaller. Comal Independent has seen increases in comprehension and participation since implementing the iPod touch and one educator has even heard one of her students speak in English for the first time because he could record himself at home where he felt more comfortable (Demski). Clark County, Nevada schools have begun issuing iPads with a pre-loaded interactive textbook to middle school and high school students taking Algebra I classes, but data on the initiative have not yet been published (Takahashi, 2011). An increasingly useful feature of these highly mobile devices is their ability to share information between units using "cloud" storage/computing.

Regardless of the lack of formal research in this area, a handful of universities and colleges have begun implementing the iPad as an educational tool. In 2010 Oklahoma State University issued an iPad to students enrolled in Communications and Business classes in the fall (Handy, 2011). They report that the iPad increased the students' ability to work in unison and to add a depth to the learning not previously achieved by traditional teaching. Conversely, Reed College in Portland, Oregon issued an iPad to staff members to gain feedback on its utility as a teaching aide (Marmarelli, 2011). The staff reported that as a tool the iPad is mobile and more manageable than a laptop or desktop while being able to present lectures and take notes or recordings when

auditing another professor's class. Duke University has been providing iPads through the library and also for research opportunities suggested by faculty (Sussman, 2010). Of the reports found, the most striking is the commitment of New Belmont Abbey College to issue each incoming freshman an iPad beginning fall 2012 (Merrick, 2011). The commitment of these institutions faced with a profound lack of quantifiable data on their effectiveness speaks to the alluring promise of this modern technology as an educational tool.

While there is great excitement about the implementation of this technology into the classroom (and some unpublished evidence has been found for the benefit of a single application Riconscente, 2012), empirical research on its use is very limited at present. To fill this void, the current study was conducted to determine the relative value of the iPad as an educational tool. Specifically, we addressed whether an iPad application provides any benefits over classical teaching methodology on learning and remembering a list of key anatomical brain structures. We hypothesized that participants studying anatomical brain structures from an iPad would score higher when asked to label the structures on a test and they would also take greater interest in the task when compared to those who studied from images printed in color on paper or a plastic anatomical model of the brain. We also compared the use of the iPad versus classical teaching methods on the perceptions and motivational features of the user. As suggested by Silverman, Choi & Peters (2007) males have a greater capacity for 3-D mental rotation, but women are significantly better at object location memory, because of this we were also interested in determining whether there would be a gender difference in performance.

## Methods

### Participants

Forty-two Students enrolled in a spring 2012 Introduction to Psychology class at Illinois College were recruited for this experiment. Participants' mean age was 19.0 and mode class level was freshman. Participants included 21 males and 21 females; the sample was 2.3% Hispanic, 4.7% African-American, and 92.8% White. Participants were offered extra credit in the course for participating in the experiment. The study was approved by the Institutional Review Board at Illinois College.

### Materials

Three conditions were tested and participants were randomly assigned to one and scheduled to participate individually. Condition 1 (Figure 1A) used a three-ring-binder of color images on paper, which were taken using the screenshot tool on the iPad from the application that was used in the condition with the iPad, and because of their two dimensional format, the participants could not manipulate the angle at which the images were presented. Condition 2 (Figure 1B) used a plastic model of a human brain which was labeled with white paper adhesive labels to designate the 24 structures of the brain that were to be studied and could be partially deconstructed to allow exploratory investigation of the structures. Condition 3 (Figure 1C) used an application on an iPad2, called "3D Brain" produced by the Dolan DNA Learning Center at Cold Spring Harbor Laboratory, that allowed them to manipulate the angle of view a full 360 degrees horizontally and vertically. They could choose from a menu bar which structure to look at and they could view that structure from any angle they wished on either the horizontal plane or the vertical

(note: the application does not allow for a combination of manipulation on both planes concurrently). Each participant was given a reference list of 24 structures to study (amygdala, basal ganglia, brainstem, Brocha's Area, cerebellum, cingulate gyrus, corpus callosum, frontal lobe, hippocampus, hypothalamus, middle and inferior gyrus, occipital lobe, parietal lobe, perirhinal cortex, pons, prefrontal cortex, premotor cortex, primary motor cortex, somatosensory cortex, superior temporal gyrus, temporal lobe, thalamus, ventricles, Wernicke's Area). A paper test using the images taken from the 3D Brain App was administered, asking the participants to label each of the 24 brain structures. A short questionnaire (see Appendix) was also administered to determine the participants experience and enjoyment of using the material they were presented. Participants were presented with two brief (< 1 minute) video instructions, one prior to the review and the other prior to the test. Each video was recorded with the same demonstrator and in the same room but with instructions relevant to the appropriate format.

### Procedure

Each participant in all conditions watched the instructional videos played on an iPad, and then were provided with the information in their respective formats and given 10 minutes to study the material in the format they were assigned. After watching the second instructional video, participants were given a test on the material. For the test, all participants were asked to identify pictures of the structures of the brain in a physical color paper format (the images were taken from those used in the paper color picture condition and had labels removed). This was done to ensure that the test was consistent across all conditions and also to be consistent with typical classroom

exams. Participants were also asked to fill out a short survey rating their attitudes about the format of review (pictures, model or iPad) they were given. The number of correctly labeled structures was the primary dependent variable measure and was compared between conditions. Questionnaire responses were also compared between the three conditions.

A brief follow-up survey was conducted to determine the usage of Apple products (iPads, iPods, iPhones and MacBooks.) The survey was given to the class the original participants were recruited from, but did not determine which group the participant had been in originally. They were asked their gender, how many Apple products they owned and how much time they spend using the Apple products.

### Results

The method of instruction had a significant impact on the test performance as the one-way ANOVA was significant across conditions,  $F(2,36)=15.992$ ,  $p=.000$  (Figure 2). Follow-up multiple comparisons with Tukey's HSD tests showed there was no difference between the color paper image and iPad conditions ( $p=.999$ ). However, both the iPad ( $p=0.000$ ) and paper control conditions ( $p=0.000$ ) resulted in better performance than the plastic model. A significant Condition X Gender interaction was observed,  $F(2,36)=4.391$ ,  $p=0.02$ , suggesting that females differentially benefitted from the iPad condition (Figure 3). Concerning participant attitudes, the iPad was reported by participants to be significantly more enjoyable than the plastic model ( $p=0.019$ ; Figure 4) and there was a non-significant trend for the iPad to be more enjoyable than the color paper images ( $p=0.072$ ; Figure 5), with the plastic model being rated lower than both other conditions.

When participant ratings of preparedness for the test were compared there was no difference between conditions except for a trend for the iPad being rated higher than the plastic model ( $p=0.071$ ; Figure 4).

Comparing the performances from the entire sample, combining the mean scores from all three conditions for males' and females', there was no significant overall difference in performance nor was there a significant difference in the mean scores between males and females in both the color paper image and plastic model conditions. However, specifically in the iPad condition, females outperformed males by approximately 50% ( $p=0.012$ ; Figure 3). However, as seen in Figures 6, 7, and 8, females are not more likely to own or use Apple products.

## Discussion

The use of an iPad resulted in learning and memory of brain structures equivalent to that of traditional color paper pictures, both of which outperformed a plastic anatomical model. Previous research has indicated that students enjoy greater portability and ease of use of an iPad over traditional printed information (Tanaka et al, 2012). While not significant, there was a trend that students might be more willing to take a class using an iPad as a method of instruction over color paper pictures.

One study that assesses the usefulness of computer based 2D vs 3D representation on learning physiology of the inner and middle ear is done by Nicholson, Chalk, Funnell, & Daniel (2006) provides evidence for the differential benefit of participants using a computer based 3D representation over those who had access only to the computer based 2D representation. The data from this study imply that a computer based 3D model

is more conducive to learning anatomical and physiological information than a computer based 2D model and from this can be extrapolated that using a computer based 3D model could be more beneficial than using a paper based 2D figure.

The design of the brain structures test was biased in favor of the color paper images condition, as the test was in the same format, and also the iPad condition because the images for the test were taken from the application used on the iPad. Prior experience has been shown to facilitate retrieval of similar information, thus participants who utilized these conditions to initially learn the anatomical structures would have an advantage based on previous contextual cuing and this could explain why participants in the plastic model condition performed lower (Chun and Jiang, 2003). Had the test been matched to the format for review (i.e. iPad review with iPad test and plastic model review with plastic model test) it seems likely that the participants in the plastic model condition would have performed better and that those in the iPad condition may have improved because of a familiarity with the format and increased their scores to surpass those in the color paper images.

Interestingly, a gender difference was observed, but only for those using an iPad. A follow-up analysis was done to look into possible differential use of Apple products by the sample, but this proved fruitless as there was no observable difference in ownership or use of Apple products by gender. Evidence for gender differences in mental rotation and object location memory have been recorded with males performing better at mental rotation tasks and females performing better with object location tasks (Silverman, Choi & Peters, 2007). This correlates with our data suggesting that

women were better able to label the brain structures in the iPad condition than men. However, it seems that women differentially benefited from using an iPad because it was the only group where women performed significantly better than men. Participants' attitudes of the method of review favored the iPad to the plastic model in four areas, they found it more enjoyable, they felt more prepared, they felt they performed better and they would be more willing to take a class that used an iPad as a teaching tool. Anatomy courses in undergraduate and graduate and professional school often make use of plastic models to teach students body structures. Nicholson et al (2006) cited a decreased use of cadavers and plastic models for anatomy education because lack of availability and increased cost. Further research will need to be done to determine if a digital anatomical model available on a tablet market is more effective for education than a plastic model.

There are a few potential problems associated with use of iPads in the classroom. With immediate access to internet through applications such as Facebook, Twitter, or simply e-mail, as well as the popularity of many iPad games, having an iPad in the hands of students may prove distracting for both students and teachers and use should be monitored while allowing for freedom to search out material complimentary to the lesson. Another potential concern with the iPad is that its portability might make it more likely to be lost, stolen, or broken, resulting in unplanned replacement costs.

Cost is obviously an important factor when schools are deciding which method to invest their precious resources. There are many applications for free and many more still that are only a few dollars. Some of these apps might have potential educational

value. In addition to the many topic-specific applications available for learning material (such as the one tested in the current study), many supporting apps are available that could aid the learning and memory process. For example, many apps are available for classroom note-taking, for reading and making notes in digital textbooks, and for looking up reference materials. An anecdotal cost analysis of books for the first author's classes shows a potential savings of \$150.00-\$200.00 for one semester of textbooks, compared to college bookstore prices.

The current study only explored one application and future research should look into the iPad's use as a tool covering the spectrum of classroom experiences such as note taking, textbook use and internet use. It also does not account for the spectrum of socioeconomic diversity, as it was conducted at a small private college in the mid-west. This study did not assess prior iPad exposure in a classroom setting and was conducted with a small sample size. This study only tested recall of the brain structures immediately after the review and did not attempt to test retention of the information long-term. The results of the current study would be difficult to generalize to a broader population. Nevertheless, the results of the current study provide experimental evidence of the potential benefits of a tablet on learning and memory in an educational setting.

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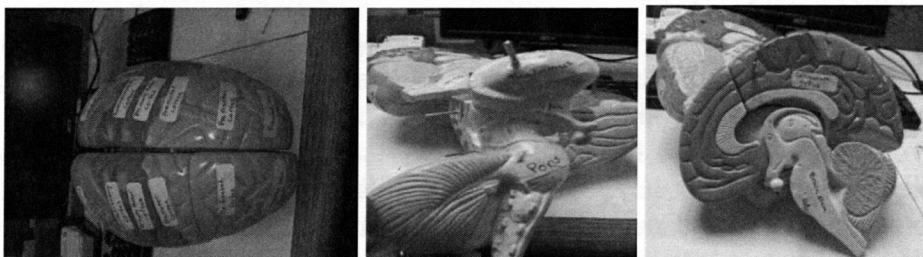


**Figure 1** Conditions for Review

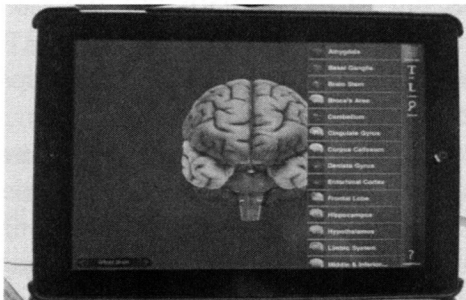
- A. Paper Images: A three-ring binder with color images printed on paper and put into plastic page protectors. Each picture has a label in the bottom left corner of the image and some have a second label pointing to the structure on the picture.



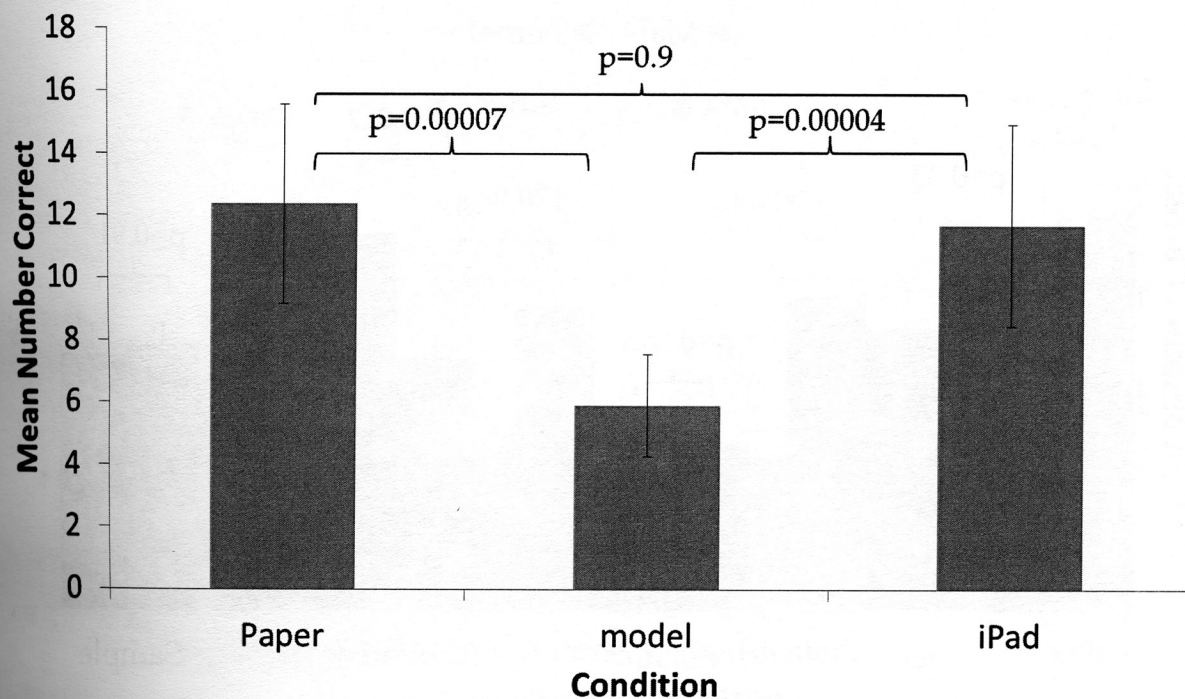
- B. Plastic Model: Plastic model of the brain that disassembles into four pieces and has adhesive white labels with the name of the structure written on it.



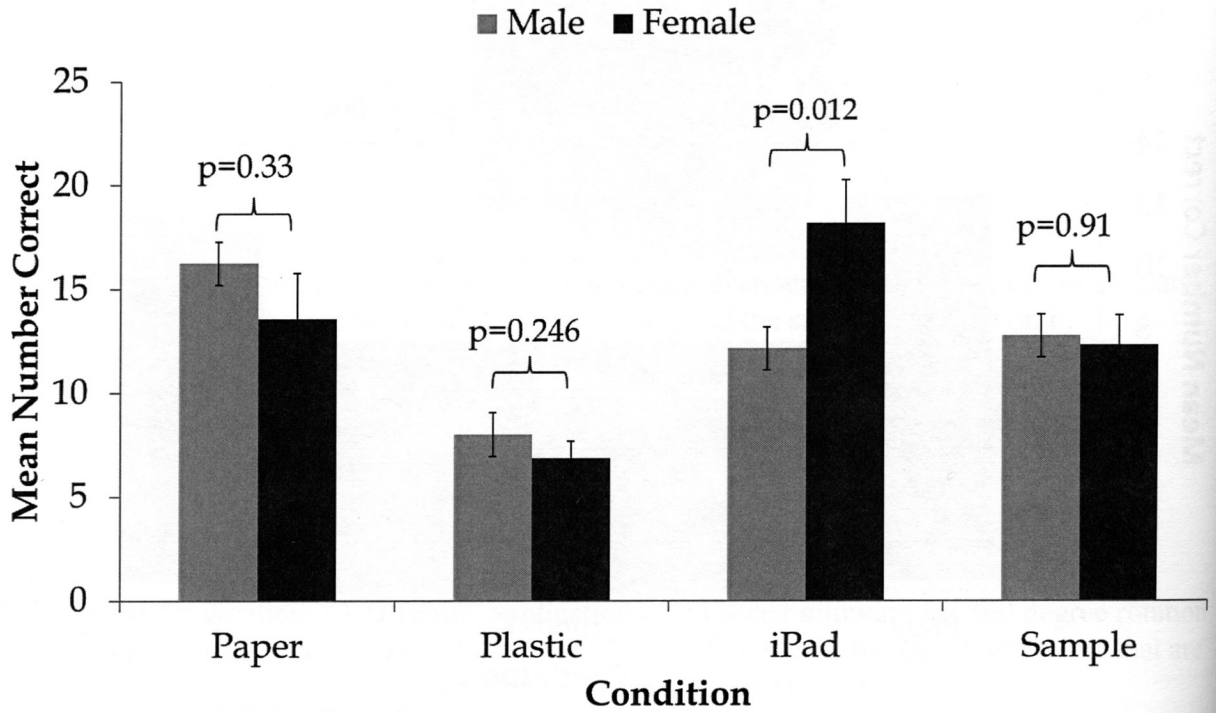
- C. iPad Application: "3-D Brain" application on an iPad2 allowing for 360 degree rotation vertically and horizontally. At the right hand side it shows the list of structures that are available for selecting and viewing.



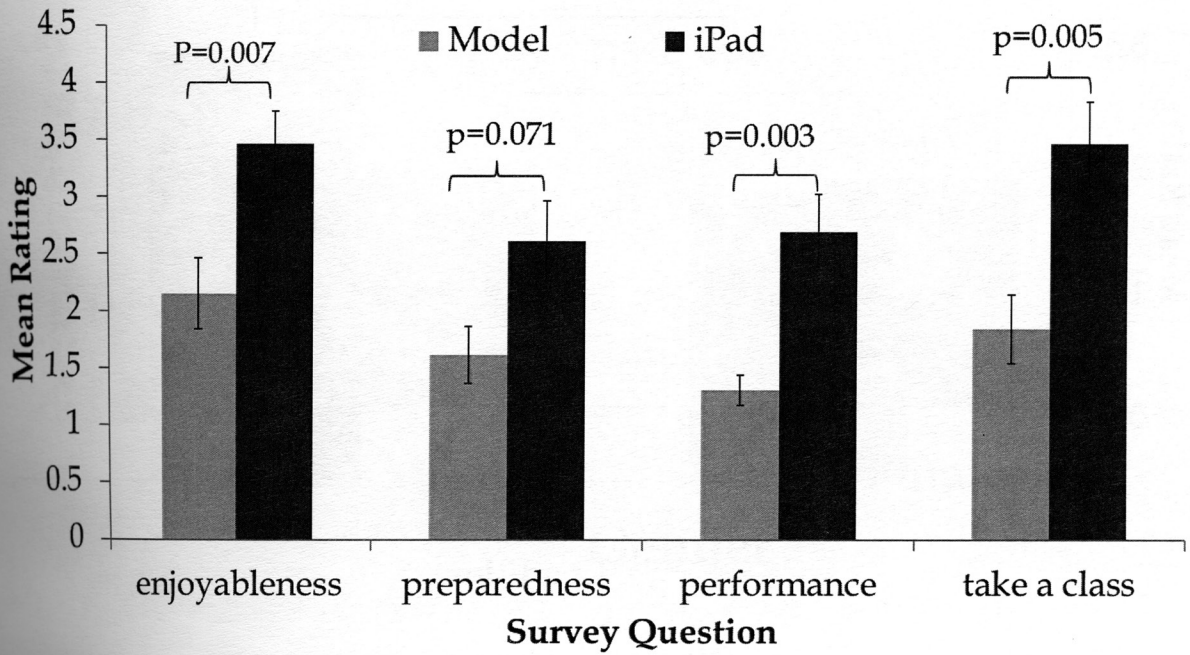
**Figure 2.** Mean Number of Correctly Labeled Structures. Score on the paper test as a function of experimental condition. Color paper images and the iPad scored nearly the same as the plastic model scoring significantly lower than both the color paper images and the iPad.



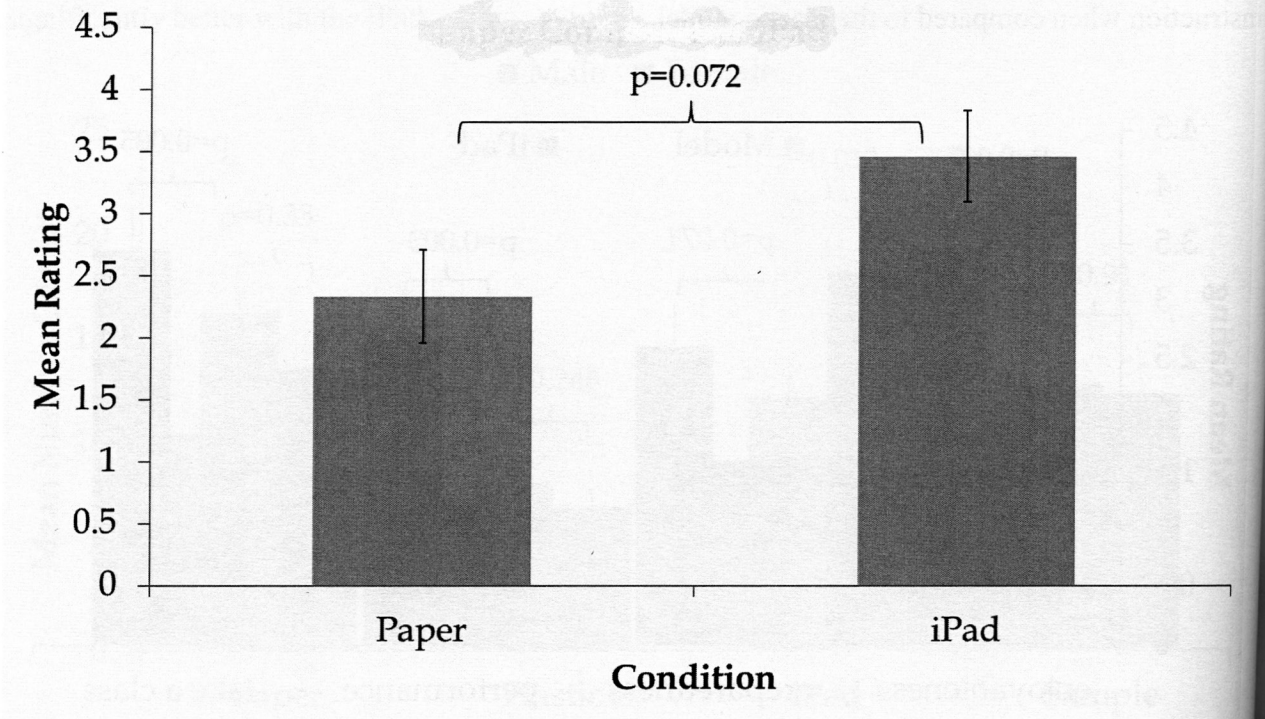
**Figure 3:** Gender Differences. Mean score of both males and females in each condition. “Sample” represents all three conditions combined. Males and females did not score significantly different in either the color paper images or with the plastic model, but females scored significantly better with the iPad.



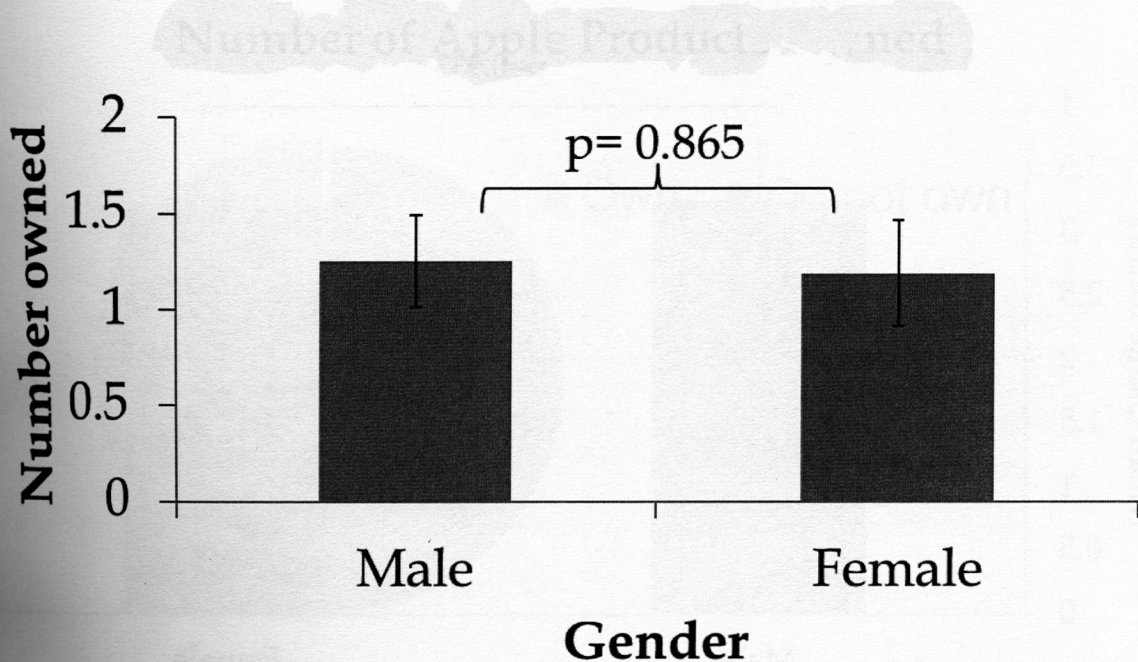
**Figure 4:** Participant Attitudes, iPad versus Plastic Model. Participants enjoyed using the iPad compared to the plastic model; they felt more prepared for the test and they felt they performed better on the test, and they were more likely to take a class with the iPad as a method of instruction when compared to the plastic model.



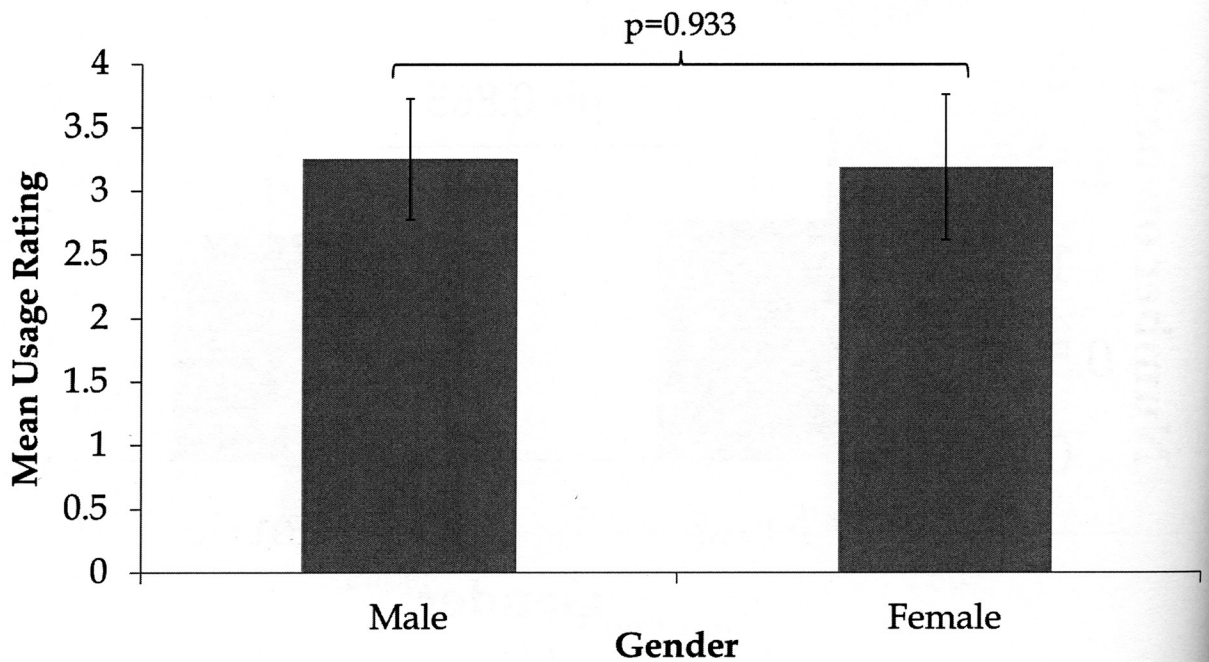
**Figure 5:** Participants Willingness to take a Class using the iPad versus Paper. There was a trend that participants were more willing to take a class with an iPad as a method of instruction compared to color paper images.



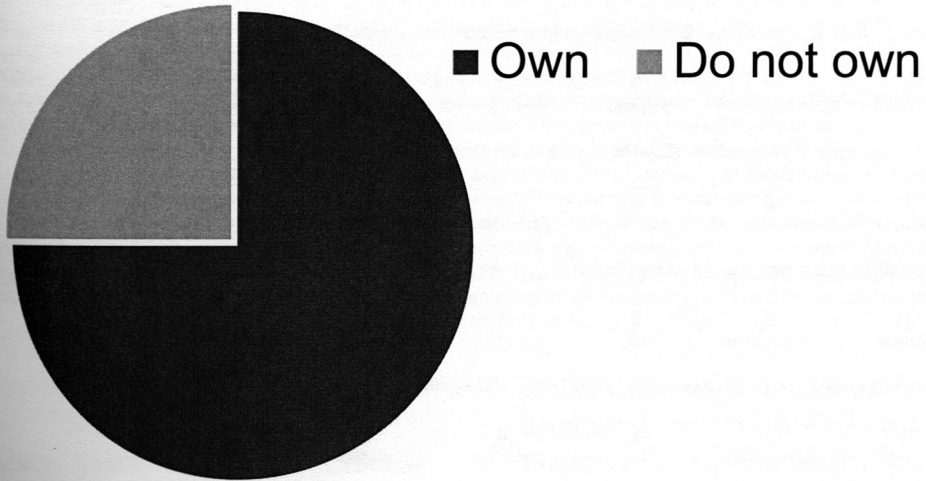
**Figure 6.** Number of Apple Products Owned. The number of Apple products such as iPods, iPhones, iPads, and Macbooks were assessed and the mean score represented here. There is no significant difference in the mean number of Apple products owned by males and females.



**Figure 7:** Use of Apple Products by Gender. Students were asked to rate the amount of time per week they spend using an Apple product. There is no significant gender difference in the amount of time spent using Apple products.



**Figure 8:** Percentage Who Own Apple Products by Gender. Seventy-five percent of males owned apple products and sixty-nine percent of females own apple products.





**Appendix 1:** Survey given to each participant asking them to rate their attitudes

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Please rate the following with **1 being low and 5 being high**

**1. How enjoyable was your experience learning the structures of the brain?**

1 - 2 - 3 - 4 - 5  
Not Enjoyable - Somewhat Enjoyable - Enjoyable - Fairly Enjoyable - Really Enjoyable

**2. How well prepared did you feel at the beginning of the test?**

1 - 2 - 3 - 4 - 5  
Not Prepared - Somewhat Prepared - Prepared - Fairly Prepared - Really Prepared

**3. How well do you think you scored on the test?**

1 - 2 - 3 - 4 - 5  
Not Well - Somewhat well - Well - Fairly Well - Really Well

**4. How likely would you be to prepare for a test in this way again?**

1 - 2 - 3 - 4 - 5  
Not Likely - Somewhat likely - Likely - Fairly Likely - Really likely

**5. How likely would you be to take a class that used this method of instruction?**

1 - 2 - 3 - 4 - 5  
Not Likely - Somewhat likely - Likely - Fairly Likely - Really likely

**6. How likely would you have been to continue studying if there was no time limit?**

1 - 2 - 3 - 4 - 5  
Not Likely - Somewhat likely - Likely - Fairly Likely - Really likely

**7. What is your gender?**

Male - Female

**8. What is your age?** \_\_\_\_\_

**9. What is your ethnicity?** \_\_\_\_\_

**10. What is your current year in college?**

Freshman - Sophomore - Junior - Senior