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CONTENTS

A Note from the Editor

This issue features two interesting articles on pedagogy with emphasis on student engagement outside of the classroom. If you find you have something to add to this discourse or similar studies like that of the iPad study discussed in this issue, please consider submitting a follow-up or response for the Spring 2012 issue.

The upcoming Spring 2013 issue will emphasize the topic—*depth, not breadth*. How is it that we can get our students to engage mathematics in way that gives them a greater understanding of mathematical topics? Perhaps more importantly, how can we assess for this deeper understanding?

As always, we also continue to welcome general topic papers you wish to submit. The Editorial Policy is included at the back of this bulletin. April 10, 2013 is the deadline for submissions for the Spring issue. We look forward to hearing from you!

John C. Jackson
Co-Editor-in-Chief
john.jackson@usma.edu

The Benefits of Using Email to Maintain Structured Instructor Accessibility in Assisting Student-Driven Learning of Mathematics

Major Troy A. Bupp
Department of Mathematical Sciences
United States Military Academy

Abstract

At the United States Military Academy at West Point, the Thayer Method requires that cadets prepare their academic lessons prior to receiving the classroom instruction [1]. Typically, a cadet will prepare for each lesson the evening prior to attending class. A common cadet misperception is that this method does not work well for math. When a cadet is unable to grasp a mathematical concept provided in an assignment, a cadet's ability to complete the associated homework problems prior to the classroom instruction diminishes greatly. The opportunity for a cadet to learn math and gain confidence in his or her abilities may be lost for that evening. With the competing demands on a cadet's time in the Academy's academic, military, and physical programs, a cadet's focus and energy to struggle to learn new math concepts may not be the most efficient use of his or her time. Many cadets have difficulty in attending normal office hours due to their full day's worth of requirements. Having a structured timeframe to email an instructor with a specific question in which a response is both timely and reliable has proven effective in resolving the issue of cadets losing interest in math preparation and learning. An instructor's increased accessibility through email during the evenings prior to the classroom instruction has shown to benefit not only the cadet in saving time and facilitating the learning of new math concepts but also, and more importantly, shown to benefit the instructor. This paper explores both the qualitative and quantitative outcomes during a one-year pilot study of maintaining structured instructor accessibility in assisting student-driven learning of mathematics.

Key words: email, Thayer Method, pedagogy

Background

During my first semester as a graduate student at the College of William & Mary, my linear programming professor, Professor David Phillips (currently assigned as an Assistant Professor at the United States Naval Academy), encouraged his students to email him at any time for assistance. I leveraged this opportunity frequently, probably more so than Professor Phillips forecasted when he made the offer. One specific instance occurred around 2 a.m. While working on an assignment to code George Dantzig's Simplex Method in MATLAB®, I became stymied on a particular line of code. With a desperate email for help sent at that late hour, I planned to retire for the evening. However, as promised, within a few moments after sending my email and just prior to shutting down my laptop, the response I needed arrived. Professor Phillips's email

provided insight, saved me hours of delay, and gave me the confidence to continue to code successfully. Now, as a math instructor at West Point, I strive to provide that same responsiveness and support to my cadets as they prepare their math lessons prior to the classroom instruction. With significant requirements placed upon the cadets, a reliable and timely email response from an instructor can be the difference between maintaining a cadet's focus to learn new mathematical concepts or losing their energy and efforts to something else.

Premise

On the first day of each class, I draw the survivor plot shown in Figure 1 on the chalkboard.

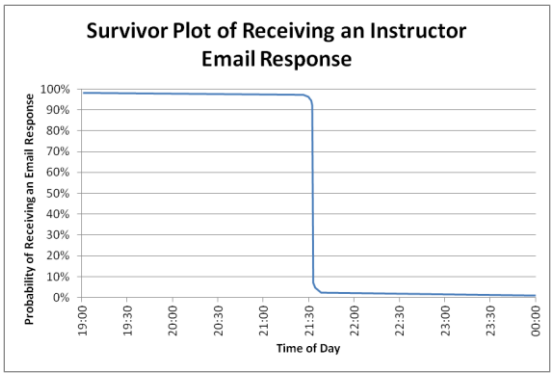

Figure 1: Survivor plot of receiving an instructor email response based upon the time sent.

Without even explaining the concept of probability or survival plots, the cadets quickly realize that I am available through email until 2130 each night, at which time I plan on retiring for the evening. I use this opportunity to explain the importance of sleep in a cadet's lifestyle and the effects that sleep has on retention and learning [2]. I then follow with a discussion about cadets having a plan to prepare their academic requirements for the next day during the Evening Study Period (ESP)[1]. When I ask cadets what their plan is for ESP, the typical response is simply "study." However, I challenge each cadet to have a precise plan or schedule for his or her ESP time. Then I provide for them a simple, blank timesheet as shown in Figure 2 as a guide to formalize their plan.

[1]*Evening Study Period* is the designed time of study beginning at 1930 and ending at 2400 (when lights out for the Corps of Cadets occurs). The Dean allocates and reserves this timeframe for cadets to prepare their lessons in accordance with the Thayer Method. The Dean holds ESP the evenings prior to each academic lesson and on certain Friday evenings.

Figure 2: Blank schedule for a cadet to plan lesson preparation during Evening Study Period.

In reality, the blank schedule for ESP serves as an opportunity for me to stage three important reasons why I believe that cadets should begin ESP with their math preparation. First, both of the primary Plebe (or freshmen) math courses—MA103 (Mathematical Modeling and Introduction to Calculus) in the fall and MA104 (Differential Calculus) in the spring—each meet 64 out of the 80 class days during a semester. With this frequency of meetings, the regularity to prepare math lessons during ESP is nearly constant. Second, MA103 and MA104 are 4.0 and 4.5 credit hours, respectively. The course with the next highest credit hours is chemistry with 3.5. The rest of the Plebe courses are 3.0 credit hours or less. Thus, their Plebe math courses have the greatest impact on their grade point average (GPA). If these first two reasons were not enough, I then conclude by explaining that I will answer cadet questions sent through email with the probability shown in Figure 1. Thus, if a cadet emails me with a question before 2130, there is a great likelihood that he or she will receive a response from me to assist with his or her math preparation during the same evening. With these three arguments, my desire for my cadets is for them to begin their ESP with their math preparation.

My email accessibility serves to assist cadets with specific questions to resolve a lack of understanding that prevents them from continuing with their math preparation. There are numerous, competing demands for their time. Spending time attempting to figure out a math problem without success can be frustrating given the numerous, competing requirements that the Academy places upon the cadets. If a lack of understanding goes unresolved, any math learning that could have occurred in the evening gets quickly absolved in favor of another focus. The academic course load alone is approximately 18 credit hours per semester. In the physical program area, each cadet must be involved in a competitive sport. Additionally, the cadets must maintain the Army physical fitness standards. In the military program area, each cadet has a role with defined duties and responsibilities within the Corps of Cadets. For Plebes especially, there is also the adjustment to the military regiment within the academic structure. Other demands on their time involve maintaining social connections and hobbies. Thus, cadet time is very precious and a valuable commodity. Hosting a dedicated timeframe for a cadet to access

his or her instructor during ESP serves to assist cadets in maintaining their focus on learning math.

Implementation and Data Collection (Reference Appendix 1)

For the context of this research, I did not use *every* email that I received. Rather, I defined a *recordable email* as a cadet initiated email which contains a specific question(s) in regards to the lesson material or any concerns regarding the administrative requirements that corresponded to completing an assignment. I excluded tabulation of emails that asked to schedule an additional instruction (AI) through an office call (though important and also addressed) and any other reason other than those previously stated. Appendix 1 contains the concept on how I collected the data used for this one-year pilot study. Through analyzing this data, I was able to conclude the qualitative and quantitative outcomes described in the subsequent sessions.

Qualitative Outcomes

The most basic qualitative outcome is that through email, every cadet in all of my sections has the ability to receive math assistance if needed. Emailing the instructor is purely voluntarily. Learning math prior to receiving the classroom instruction is new for nearly all of the entering Plebe class. If a cadet struggles to learn the material, a cadet may realize that there is a point of diminishing returns in continuing to attempt to understand a new math concept without success. If a textbook, a fellow classmate, or another source is unable to resolve the struggle with learning the material, a cadet may lose the motivation to continue with his or her math preparation. This is the exact opportunity that an instructor should seize upon in order to provide a cadet with an appropriate amount of assistance to maintain the cadet's focus on math. Maintaining a reliable and timely email timeframe and responsiveness does just that.

An instructor increases his or her opportunities for cadets to seek assistance. Having available and reliable email hours is similar to holding office hours. At West Point, the common trend is not to hold routine office hours but rather to have cadets schedule an appointment with an instructor. This method (referred to as additional instruction or "AI") of scheduling and attending an appointment with an instructor nests well with a cadet's development to become an Army officer. Scheduling and attending appointments is a regular occurrence in the Army. As I instruct all of my classes during the morning hours, I am unavailable to conduct AI in the morning. Some cadets have their free hours in the morning and classes in the afternoon. Scheduling an AI session becomes a challenge. I can increase my availability to all of my cadets outside the classroom by encouraging them to email me at anytime with a question. Having the structured timeframe is just a means to ensure a timely response. The Premise contains my rationale for this timeframe, and I make answering a cadet's email a top priority.

Receiving an email from a cadet allows the instructor to see firsthand how the student articulates, in writing, his or her problem. Communicating in writing is one of the core math curriculum goals for our cadets. A cadet must properly articulate his or her problem through email to the instructor. Emails related to course material provides cadets additional opportunities to improve their ability to communicate math in writing. I have also found that cadets will occasionally incorporate both Microsoft® Excel and Mathematica® code into their questions. This shows yet another level of understanding. In response to a cadet's email, I have the flexibility to answer questions in a number of ways. Of course as I begin to know and understand my cadets' abilities on an individual level, my email responses range to meet their specific needs. My response can range from providing the answer needed, providing a source for a cadet to resolve his or her own problem, providing code in Excel or Mathematica®, or answering a question with a question of my own.

Through cadet emails, the instructor can draw conclusions as to how cadets prepare for class. The math courses that I taught during the past two semesters had individual lesson objectives that corresponded to larger block outcomes for the course. A typical lesson requires that a cadet read in their math textbook and then practice the material from the reading with related homework problems. The Thayer Method warrants that a cadet arrives to class having prepared his or her notes, homework problems, and has formulated any questions that he or she has of the instructor to solidify the learning. One of the earliest assessments I made was that cadets are more inclined to email me about the homework problems more than the reading. This should come as no surprise because there exists a more objective train of thought that is typically associated with math problems than there is with math readings. The reality of the Thayer Method is that majority of cadets proceed straight to the problems and reference the reading only when they need assistance to solve the problems. Thus, I received very few emails about the reading. Acknowledging this, there are certain lessons where I know that I must cover the mathematical theory in greater depth than others.

For a first year instructor, the greatest benefit that I gained from this research was in knowing ahead of time what questions or problems I might encounter from the lesson in the classroom the next day. If I received a couple of emails the night before my classroom instruction regarding the same issue(s) within a lesson, I could immediately tailor my lesson plan for the next day. This is especially true when I receive an email from one of my better performing cadets. Our math lessons are structured such that not every lesson objective may be covered during the classroom instruction. With the Thayer Method, the cadets are responsible for all the lesson objectives whether or not I address them or the cadets ask about them in class. Email questions from cadets allow for an instructor to determine the cause of the lack of understanding. A single email from a cadet to an instructor can develop into a dialogue useful to understand a cadet's perspective. This understanding can translate to improved instruction the next day.

Answering cadet email questions the night prior to the lesson reduces the amount of questions asked in class. A minimal investment of maintaining an instructor's email accessibility the night prior to the classroom instruction can actually provide additional classroom time. Through email, I have already answered questions that are normally asked at the beginning of class about the lesson. This time savings allows for either a deeper discussion about the material or more opportunities to practice with applications. Additionally, I have found that email availability benefits many types of personalities. For the introverts, cadets will often email me questions the night prior to the class instruction. In doing so, they minimize the number of questions they may ask during class. As I got to know and understand these personalities, I realized how important having the ability to have one's question(s) answered outside of the classroom setting is.

An instructor's timely response is a subtle way of displaying that the instructor cares about the cadet's learning of mathematics. I overheard a few of my cadets talking about my email availability and assistance that I provided. The comment overheard was in regards to how quickly that I responded to their question. Even if they do not like the response that I provide (as my typical response is to offer them a different approach to resolve their own problem), my cadets realize that my assistance is available if needed. Even with West Point's small ratio of the number of cadets to one instructor (no more than 18:1), developing personal rapport with each cadet in the classroom is limited. Through email, I can create a small, additional opportunity to engage a cadet towards learning math that I do not have during the academic day. Developing this rapport with a cadet can serve to motivate a cadet's math performance.

Finally, I have two suggestions to another instructor to reinforce his or her email availability to cadets. First, I have implemented an overt method to reinforce my email availability for every lesson in which I receive an email. Immediately after class begins, I ask each cadet who had emailed me the night prior if my email response assisted with his or her preparation efforts. Now, I know the answer ahead of time through the prior night's email dialogue. However, to hear a fellow cadet publically proclaim that I positively affected his or her preparation efforts the night prior has, in my opinion, caused others to begin or increase their frequency of emails. A second way to reinforce my email availability occurs during my homework problem checks. Routinely before class begins, I individually check each cadet's homework preparation. When I come across a cadet who has not completed any or all of his or her homework problems, I immediately ask the question "why?" With email availability, I have removed the cadet excuse that he or she did not understand and could not, therefore, complete the assignment. Structure email available places greater emphasis on a cadet to learn math as a cadet should not arrive to class with a prior lack of understanding of the material.

Quantitative Results

Below are the quantitative results from my one-year pilot study from academic year (AY) 2012. (Specific terms—1 fall, 2 spring, 3 summer—are hyphenated after the academic

year.) During AY 2012-1, I instructed MA103. This is the entry level course that approximately 75% of entering Plebe class have. During the spring semester, I instructed the Plebe follow-on math course of MA104. Both courses met for 64 lessons, but MA103 contained eight Problem Solving Labs (PSL) that are not credited as a lesson which reduced the number of credit hours to 4.0. MA104 is a 4.5 credit hour course. Table 1 displays some of the general quantitative data associated with my structured email availability and responsiveness for each course.

Table 1. General Quantitative Outcomes for MA103 and MA104.

	MA103 (AY 2012-1)	MA104 (AY 2012-2)
Total number of cadets in all my sections	51	51
Total number of cadets who emailed the instructor at least one recordable email	46 (90.2% of total)	32 (62.7% of total)
Total number of recordable emails received	252	78
Total number of recordable emails received between 1930-2130	98 (38.8% of total)	36 (46.2% of total)
Total number of recordable emails received during ESP	198 (78.6% of total)	50 (64.1% of total)
Average instructor email response time between 1930-2130	20 minutes	16 minutes

From Table 1, there were more cadets who emailed the instructor with at least one recordable email and more recordable emails for MA103 than there were for MA104. For MA103, I would receive at least one recordable email for all most every lesson as shown in Figure 3. However, there were many lessons in MA104 from which I never received an email as shown in Figure 4.

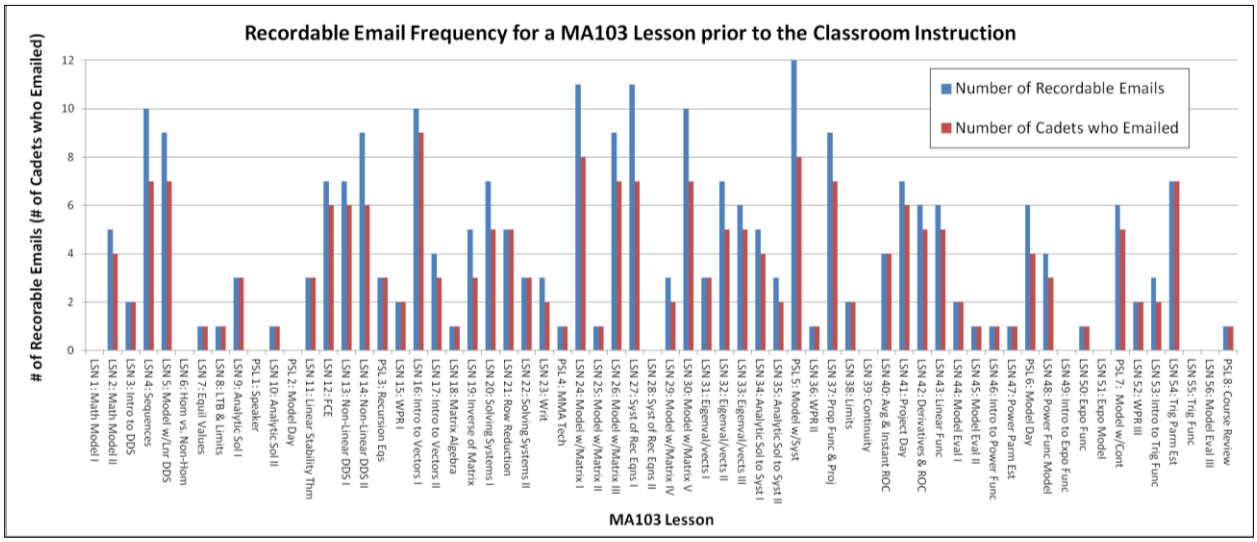

Figure 3. Number of recordable emails received and the number of cadets who sent a recordable email for each MA103 lesson during AY 2012-1 prior to the classroom instruction.

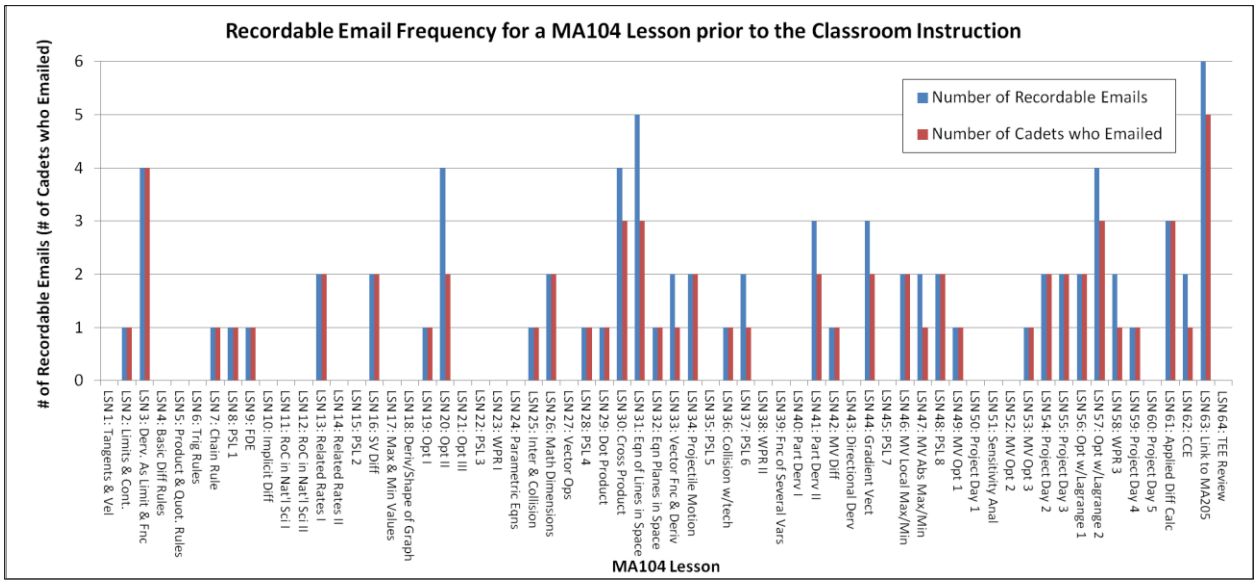

Figure 4. Number of recordable emails received and the number of cadets who sent a recordable email for each MA104 lesson during AY 2012-2 prior to the classroom instruction.

Based on the frequency of emails I received during MA103, I was actually surprised by the fewer amount of recordable emails that I received for MA104. From this reduced number of emails, I realized the following about MA104 and second semester Plebes. First from an objective standpoint, a number of cadets had previous exposure to differential calculus prior to entering West Point. Thus, the cadets had fewer questions during ESP. Second from a more subjective standpoint, I realized that second semester Plebes tended to accept more risk by not preparing their lessons as thoroughly as they did as during their first semester. In both courses, I conducted the same number of spot checks on the cadets' homework preparation. In MA104, I experienced a noticeable increase in the number of cadets who came to class unprepared and were more willing to accept some loss of points for doing so than during first semester.

An increased email frequency for a particular lesson tended to indict that the material was more difficult for the cadets to grasp. The email frequency of a particular lesson contributed to my lesson preparation. For a lesson that generated a number of recordable emails, I allocated more classroom time on the conceptual understanding of the lesson prior to the lesson application. I used the same concept in reverse. For a lesson that received few to no emails, I focused on lesson applications more than the conceptual understanding in the classroom. I also gained greater insight into potential issues that I may see in the classroom when a higher achieving cadet sent an email. Receiving just one email from a higher achieving cadet may indicate potential issues that other cadets may not have realized without instruction in the classroom. In the current AY 2013-1, I have found myself referring to Figure 3 as I prepare my MA103 lessons for the second time. With the information gained from Figures 3 and 4, I can now implement measures

to conduct a small pre-teach of future, potentially troubling lesson in the classroom prior to ESP. This small amount of time can make a cadet's preparation efforts more efficient and effective. The pre-teach can also reduce the number of emails sent to the instructor and, ultimately, facilitate the cadets in learning math.

Based on my average response time, there is room for improvement. As a first year instructor, I was concerned with provided the "perfect response." Rarely did a cadet email me with a yes or no question. Upon receiving an email question, I attempted to reference the textbook and attempt to focus a cadet's attention upon a particular example or portion of the reading so he or she can resolve the issue. Sometimes, I crafted an example. As I would go through the various math steps working towards the solution, I interjected context to explain the various steps. Then I proofread what I wrote and verified the steps to ensure that I did not miss any or make any mistakes when typing. Proofreading became iterative and time consuming as I strive to provide the perfect response. Through analysis, I realized that this took time as I had always thought that my average response time was significantly less. But from the cadet perspective in MA103, waiting for an average of 20 minutes lacked efficiency when other requirements were pending. For AY 2013, I now attempt to respond more rapidly with an acknowledgement of the email's receipt. In this first response, I provide a hasty time estimate as to how quickly I can provide the assistance needed. A second email response provides the assistance. This allows a cadet to budget other requirements during the lag time and know that the email was not sent in vein.

I can infer when cadets prepare for their lessons from the time and frequency of recordable emails sent. With my increased emphasis on sending emails, I have received recordable emails throughout the entire day as shown in Figures 5 and 6.

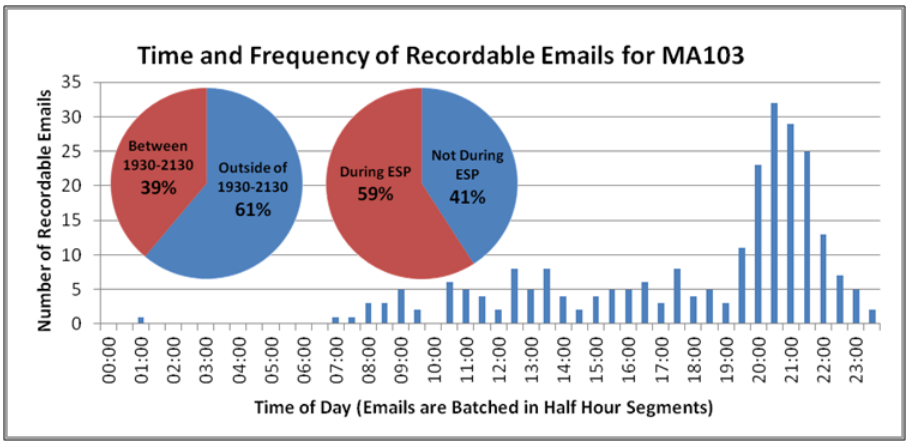

Figure 5. Time and Frequency of Recordable Emails for MA103 (AY 2012-1).

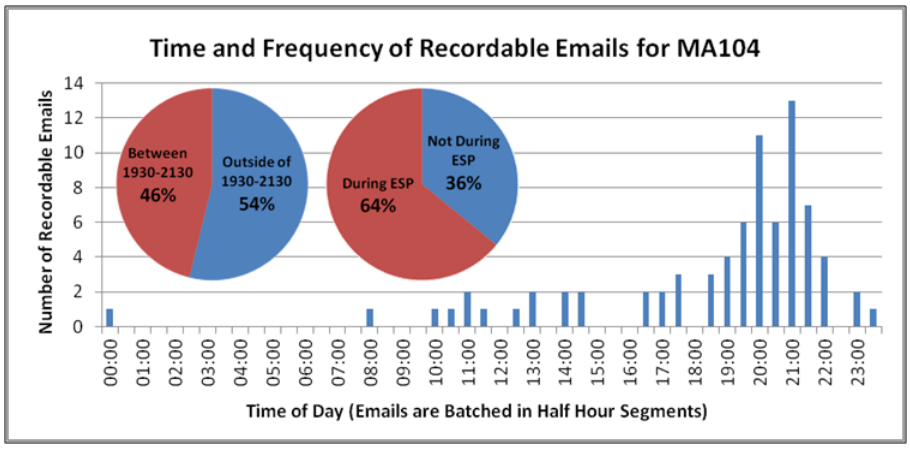

Figure 6. Time and Frequency of Recordable Emails for MA104 (AY 2012-2).

As shown in Figures 5 and 6, cadets sent nearly 20% of their emails in both courses after 2130 but before 2400. Last year, I did not inquire from my cadets why they were emailing me during this portion of the ESP. My goal for them was to prioritize their math preparation at the beginning of the ESP. During my second year, I will seek to identify the reasons why cadets do not prioritize their math studies at the beginning of the year. I suspect that having graded events in other subjects could be the reason. I have the ability to map the graded events in the other Plebe courses against the times in which I receive recordable emails. However, I will ask this question of my current sections in a survey later in the year.

Does a cadet who emails his or her instructor with greater frequency achieve a better grade? Figure 7 shows that for MA103, the answer may be inconclusive. For MA104, the answer also seems to be inconclusive, except for the extreme of those who achieved an A+.

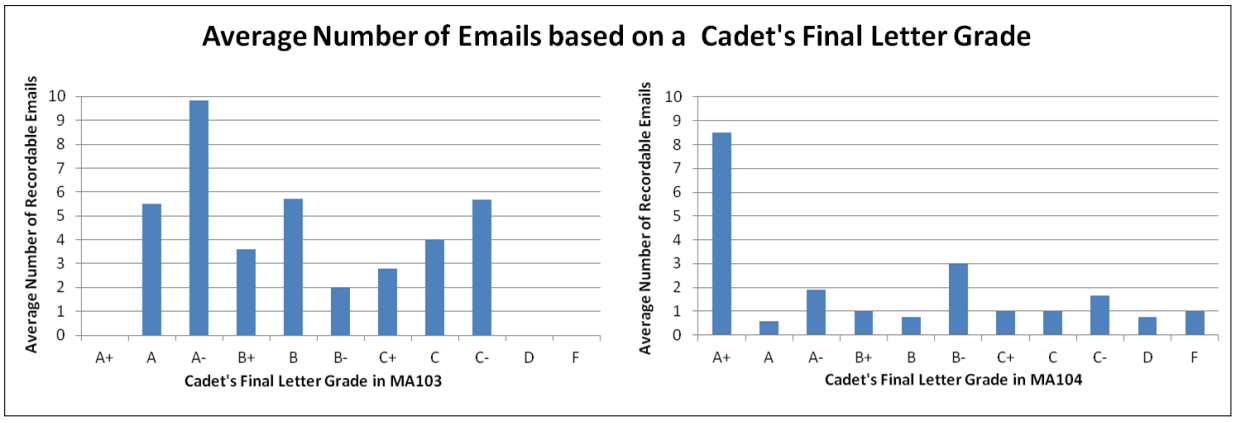

Figure 7. Average Number of Emails based on a Cadet's Final Letter Grade.

Aside from the small population size, the disparity between the two graphs in Figure 7 was most likely is due to the course material. Cadets who had a preliminary

understanding of differential calculus had prior insight to ask the questions of the instructor needed to achieve an A+ level of success. Our math curriculum uses MA103 as a bridging course to take incoming Plebes with various mathematical backgrounds and introduce them to undergraduate mathematics through a modeling based approach. Very few incoming Plebes had prior exposure to math modeling.

Cadet Feedback

At the end of both semesters, I surveyed my cadets to receive feedback about their ESP preparation and to what effect my email accessibility had upon their math preparation efforts and learning. 58% of the cadets who participated in the survey stated that my email accessibility did influence their ESP to prioritize math first. The general theme of those who responded in this fashion mentioned about the efficiency in time saved to resolve an issue. Combining the Thayer Method, the regimented timeframe of ESP, and increased instructor accessibility led one cadet to state, "there is no excuse to not take complete control over your learning when you have a teacher available at night for Q&A."

I believe that my increased availability places even more emphasis on cadets to prepare their math lessons the night before. During the next day's classroom instruction, my email availability removes the cadet excuses associated with a lack of understanding. If a cadet was not able to understand his or her math lesson and was unable to find any other source of assistance, my expectation is that the cadet will send me an email at some point prior to the classroom instruction. Once class begins, the only excuse left from a cadet who arrives to class unprepared is that he or she failed to prepare properly for class. When this occurs, I have the opportunity to discuss with them the responsibilities of being a future leader which usually leads to a cadet proclamation that he or she will never arrive to class unprepared again. For those who proclaim this, they most likely will arrive to class unprepared again. However, there is a greater sense of guilt associated with arriving unprepared two or more times.

My goal with my increased instructor accessibility is to assist cadets so that they can learn math. I used the survey to understand how helpful my emails were. I had a sense of these responses already as I would routinely follow up with an in-person confirmation with the cadets about my email response. Figure 8 displays that for every cadet who emailed me with an issue, he or she accessed that they achieved a "B" level or higher understanding of the material after my email assistance. For those who did not email me, I made two assumptions. They either understood the material without needing to send an email, or they failed to prepare properly.

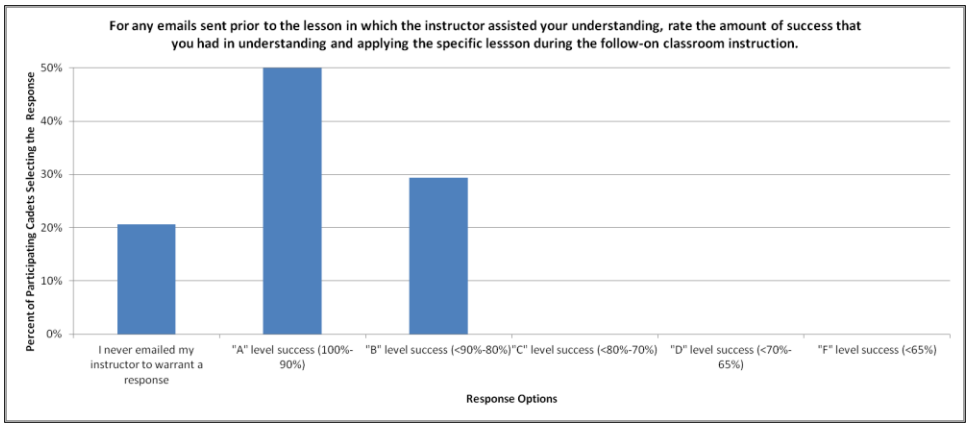

Figure 8. Cadet Assessed Level of Understanding after receiving an Instructor Email Response to His or Her Issue in Understanding a Math Lesson.

Outcomes Summary

Table 2. Summary of Qualitative and Quantitative Outcomes Associated with Increased Instructor Accessibility through Email.

Qualitative Outcomes	Quantitative Outcomes
<u>For the cadet:</u> • Receives timely and reliable math assistance needed for continued math learning. • Has increased instructor accessibility. • Provides additional practice to communicate mathematics in writing. • Increases the emphasis on learning math. • Realizes the instructor cares about his or her math learning. <u>For the instructor:</u> • Increases an instructor's understanding in how cadets prepare for class. • Enables an instructor to tailor the next day's lesson plan to meet the cadets' needs. • Reduces the number of questions during class making class time more efficient for other classroom objectives. • Provides more opportunities to engage cadets than just those in the classroom. • Enables reinforcement techniques to encourage more cadets to seek assistance through email.	<u>About the Cadet:</u> • Allows inferences about the timing when cadets conduct their math preparations. • Provides inconclusive grade outcome for MA103 with the number of emails sent. • Infers the possibility that a cadet will have greater success in MA104 with increased emails. <u>About the Material:</u> • Exposes the differences between courses. • Indicates the potential difficulty of a lesson based on the frequency of emails received (number of cadets who emailed). • Indicates the potential difficulty of a lesson based on who is sending the email (higher achieving versus lower achieving cadets provide indicators to overall understanding). <u>About the Instructor:</u> • Recognizes improvements needed to the amount of time to response to help maintain a cadet's math focus during ESP. • Realizes the impact of assisting cadets to learn math outside of the classroom after reviewing the number of email responses sent over the entire academic year.

Conclusions

There are many qualitative and quantitative outcomes associated with an instructor increasing his or her accessibility through email. The Thayer Method requires cadets to learn math prior to receiving instruction in the classroom. For most plebes, this style of learning is new (especially for a math course) and presents a challenge to understand new mathematical concepts prior to an instructor explaining them. Through my own experiences at graduate school, I realized that providing a timely and reliable opportunity for my cadets to resolve a lack of understanding actually promotes more math learning. Thus, I established a framework for my cadets to prioritize their math preparation at the beginning of their ESP. Then, should an issue arise that prevents further math learning, a cadet has the opportunity to seek assistance from the instructor through an email.

After a year of implementing this opportunity and maintaining a log of each recordable email sent by my cadets, I was able to reflect on the qualitative and quantitative outcomes. Table 2 best summarizes these outcomes. For qualitative outcomes, one may think that only the cadet would benefit from such an opportunity. However, I believe that an instructor can yield great benefits as well. These benefits vary from understanding

how cadets learn the material through their email questions to making a small connection which builds future rapport in the classroom. For quantitative outcomes, an instructor has advanced warning if a lesson is difficult for cadets to understand from the number of emails received prior to the classroom instruction. Also, an instructor can track when cadets send their emails and how long it takes for the instructor to respond. Knowing this information can assist the instructor to realize that every minute counts when a cadet needs math assistance. There are too many other competing demands on a cadet's time. Timely and reliable email responses from the instructor can help to keep the cadets focused on learning math.

My concluding thought is best summarized by a cadet's response from my survey:

> *"I knew that if I sat down and worked on math first, I could get help on very short notice if I needed it. That would make it worthwhile to struggle through some of the homework because I knew that the struggle would be fruitful, where it isn't always in other classes, and is instead just frustrating."*

Future Research

In the upcoming semesters, in addition to maintaining my current approach, I want to attempt to understand what motivates cadets to email their instructor. I would like to develop a list of these reasons why a cadet emails the instructor. I will share this list with the cadets in an effort to have them connect with at least one reason. I would really like to know how my availability through email actually motivates cadets to study, practice, and learn math.

Appendix A (Implementation and Data Collection)

Over the academic year 2012-2013, I maintained and recorded every email from the cadets in my sections. For the context of this research, I did not use *every* email that I received. Rather, I defined a *recordable email* as a cadet initiated email which contains a specific question(s) in regards to the lesson material or any concerns regarding the administrative requirements that corresponded to completing an assignment. I excluded tabulation of emails that asked to schedule additional instruction (AI) through an office call (though important and also addressed) and any other reason other than those previously stated.

I organized recordable emails into two matrices, one each for MA103 and MA104. I will explain the matrix structure specifically for MA103 as the matrix structure for MA104 was identical. Each row of the matrix represented an individual cadet by his or her name. For MA103, the sample size of my cadets was 51. For each cadet row, I tallied the number of emails sent by each cadet along with displaying their final grades for the course. Each column of the matrix represented a course lesson. For MA103, there were 56 lessons with eight problem solving labs (PSLs) spread throughout the course. I divided each course lesson column into two sub-columns. I logged the arrival time of each recordable email in the left sub-column for a corresponding lesson. In the right sub-column, I recorded the time of my email response. In situations where a cadet continued to respond with follow-up questions in regards to my response to an initial question, I only logged the first two emails from that particular email change. Each lesson column has the following statistical outcomes: (1) the total number of recordable emails received during 1930-2130, (2) the average response time during 1930-2130, (3) the total number of recordable emails received outside of 1930-2130, (4) the average response time outside of 1930-2130, (5) the total number of emails per lesson, and (6) the total number of cadets who emailed me per lesson. (NOTE: (6) is not displayed in Figure 9.) Figure 9 displays a visual representation of the matrix structure for MA103.

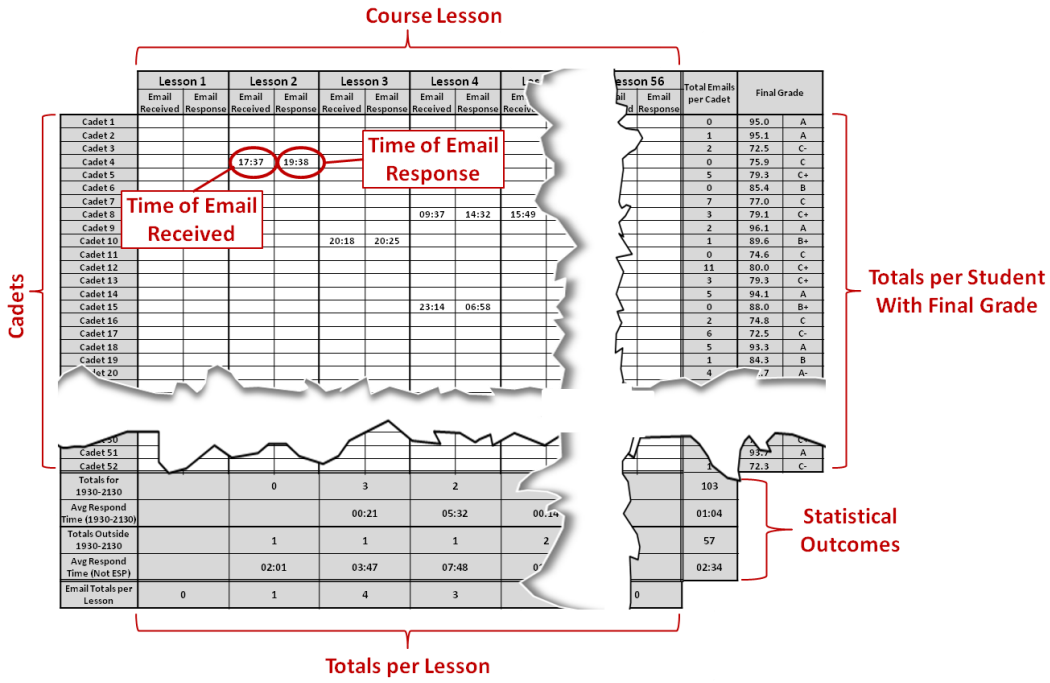

Figure 9. Visual representation of the matrix of recordable emails for MA103 (AY 2012-1).

The statistical, quantitative outcomes that I gathered from my research are obviously unique to my sections. Instructors contemplating to implement a similar email opportunity for their students can leverage my quantitative outcomes to shape their own desired outcomes. With all the outcomes considered, an instructor will hopeful discover that implementing an evening email opportunity is an effective tool not only to assist cadets, but also, and more importantly, to assist the instructor.

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Teaching Mathematics with the iPad and Social Media

Major Ashok K. Deb
Department of Mathematical Sciences
United States Military Academy

Abstract

Given the rise of social media and mobile devices, the Army is looking at ways to leverage these technologies. There was an iPad study at the U.S. Military Academy that searched for best practices for teaching with iPads where all the students have iPads as well. I taught 3 sections of Differential Calculus and developed some best practices for incorporating the iPad and social media into the classroom. Provided the proper infrastructure is in place, the content delivery method significantly changes from a more traditional course. Additionally, with the plethora of applications available to aid in learning, it can seem overwhelming which ones to use requiring careful preparation on the instructor's part. Lastly, the iPad as a mobile platform allows greater access to the social media outlets that many students already use. In this study, Facebook was utilized as a mechanism to get students to engage math in a more provocative way outside of the classroom.

Key Words: iPad, SpaceTime, Facebook

Introduction

The iPad was a revolutionary device that was announced in January 2010 by Apple Inc. At the time, no one could really predict the full potential for this product. It was joked that the iPad was merely a larger version of the iPod Touch and therefore was not revolutionary. The multi-touch screen, virtual keyboard, wireless connectivity, Internet access and camera were all features that existed in the iPod Touch and iPhone. However, having a device with a 9.7 inch screen has allowed learning to enter a different dimension. The iPad is truly an amazing piece of technology that has transformed many classrooms as it has opened eyes, broadened minds and sparked some motivation. This paper discusses the findings from conducting an iPad study and its use in teaching college mathematics. After an explanation of the study design for my courses and the technology infrastructure, the next topic to be discussed are the applications that were used. Results are presented concerning student attitude and feedback along with recommendations for teachers who are considering implementing iPads in their courses. Additionally, there is a discussion of the increase Social Media played in the classroom as result of the iPads.

The Study

The purpose of the iPad study conducted by the Math Department in MA104 (Differential Calculus) during the spring semester of Academic Year 2011-12 was three-fold. First was to evaluate the SpaceTime application (app) in its ability to replace Mathematica as the Computer Algebra System used for the course. Second was to quantify the added benefit of students having the iPad to augment their technology resources in the course. Lastly, the study was to provide insights and recommendations for if or when all cadets were issued an iPad in addition to their cadet-issued laptop. It is the strong position of the Math Department that cadets be issued a PC laptop with Mathematica for the foreseeable future.

I taught two classes that were iPad enabled. Every student was issued an iPad, wireless keyboard, smart cover and stylus. I had 14 students in one class in 18 students in the other class. I was also issued an iPad as the instructor. Fortunately, I received my iPad before the end of the fall semester so I had the entire winter break in order become familiar with the device and structure my lesson plans around using it. The main advantage of having the iPad over the break is that I was able to travel with it and discuss its limitless potential with friends and coworkers. There is only so much that googling will allow you to learn and face-to-face collaboration is critical. I highly recommend that any teaching organization either send instructors to iPad focused workshops or conferences. If any do not exist, then I would highly recommend hosting one. If you do host one, ensure students are invited because they will likely provide some of the most valuable insights on the use of the device.

Infrastructure

While the iPad is a very capable device by itself, its full power is not unleashed until it is connected to a high-speed wireless network. In a military setting this can be quite difficult and expensive. In order to connect to the internet at West Point, we had to establish a separate contract for commercial internet services. That service had to be pushed over existing lines to the buildings designated for iPad connectivity and then wireless access points had to be placed in those specific locations. It was two weeks into the semester before Cadets had internet access which was critical for downloading the apps, updates and levering the dynamic capabilities of the device. By the midpoint of the semester, there was iPad connectivity in my office, our classroom and in one study area of the Library. While these areas should be considered as a bare minimum for coverage areas, not having internet access in the barracks was very detrimental. The course is designed for each Cadet to spend 3 hours preparing outside of class for each hour in class. It is unreasonable to expect all of that preparation to be done in the Library. Additionally, if this program were to be implemented Academy wide, the Library wouldn't have the space for everyone.

Applications

The thousands of applications available for the iPad are probably its key selling point. The functionality of the device is both customizable and boundless. From a previous study, there were a select number of applications that I was confident would be helpful for Cadets. There were some other applications that were evaluated to see if they were better suited. This is an area where a lot of thought needs to be focused before starting a study with the iPad.

The SpaceTime app is a paid mobile application that is available on iTunes for $19.99. It was required for those who participated in the study. For future implementations, it should be the cadet's responsibility to download this application. One option of payment would be to include a $20 iTunes gift card in the class bundle from book issue. SpaceTime app has very good tutorials that explain major functions. The instructor should augment this with a technology lab handout and a quick reference card specifically designed for the SpaceTime app and the course the iPad is used for. I found that all of the technology objectives of MA104 were accomplished using the SpaceTime app. The advantages of using SpaceTime are its reduced cost, its response speed in launching and computing commands and its ease to use. The disadvantages are the difficulty in cutting and pasting into a Word document for a project write up, its limited help and tutorial feature which is not as robust as Mathematica's and its limited error messages which make it more difficult for troubleshooting. However, half of the cadets would prefer to use a calculator app on the iPad instead of the cadet issued calculator. On the other hand, 75% of the cadets would prefer to use the SpaceTime app over Mathematica.

An added benefit of SpaceTime over Mathematica is that there is a good chance that my students would still have access to SpaceTime after they graduate. As the cadets become Second Lieutenants in the U.S. Army, it is highly unlikely that they will personally pay for the license for Mathematica on their future personal computers. What is even more unlikely is that their Army unit will buy a Mathematica license for their work laptop. However, if they had bought SpaceTime for the iOS devices, they would access to the program and future updates conceivably for their lifetime. Additionally, they many not take their laptop of a foot patrol in Afghanistan, but it wouldn't be unreasonable to carry an iPad or iPhone. Whatever shortcomings SpaceTime may have as a Computer Algebra System (CAS) it more than makes up for them with its portability and access.

Each iPad also had the Notes Plus note taking application which costs $7.99. It is very easy to use both the stylus and your finger to write with Notes Plus and it has all of the basic options you would expect such as different colors and line sizes. However, since there is not dual screen option on the iPad, you either use it for taking notes or for the CAS. It is very difficult to do both simultaneously. This is one area where group work is great. Students can pair up and use one iPad for the CAS and take notes with the second

iPad. At the end, it is very easy to save the notes as a .pdf file and then email to the other student. This way groups can work on different parts of a larger project and quickly share the results electronically at the end without having to make a trip to the copier or digital sender. While it was not used course wide as part of this study, Notability was identified as a better alternative to Notes Plus. In addition to being cheaper ($1.99), it is easier to sync with either Google Drive or Dropbox and it is has a voice record option as well.

Social Media

The iPad did a fantastic job of facilitating the use of social media in teaching. This is where the iPad performed excellent in the pedagogically sense. There was a closed Facebook group created just for this class. Of the 42 students, 38 joined voluntarily. One cadet did not have an account and did not want one while three other cadets did not want to join. Extra credit was offered to students who found and posted interesting articles that leveraged math. The goal was to help the students realize that applied math exists in all of their current interests and hobbies. Over time, the group became a self-governing forum where students would post questions about the reading and homework. The great thing was that other students would start answering the questions, even when the question was posed to the instructor. Eventually, students found the group to be a faster and just as reliable source as emailing the instructor. While most cadets had a Facebook account before the study, the iPads actually increased their participation in group. While this is possible with the laptops that all the other students have, they do not get the instant notifications that come with mobile devices.

This changed the teaching style in a dramatic way. The instructor could see updates and comments during the evening and weekend period as cadets did their homework and studied. Before going to teach class, the instructor would have knowledge of the exact problems students had with the reading or homework, because those issues were voiced over social media that night. This provides a wealth of intelligence for the instructor as opposed to just guessing what the students may have had trouble with. This is also great for understanding the sentient in a class. The instructor could get instant feedback on what students thought about a quiz or exam by going to the Facebook group. In most cases it was raw, honest, unsolicited feedback that the instructor had before even grading the papers. Normally, an instructor would not get that until after the next class meeting.

Results

In general, the fact that the SpaceTime app is on the iPad which is a mobile device with longer battery life gives it a significant advantage over a laptop with Mathematica. Furthermore, since the SpaceTime app was not allowed on the Term End Exam or the Course Project nor would the cadets keep the iPad for use in other classes, there was resistance in learning the SpaceTime syntax which proves to be an advantage for the laptop with Mathematica option. This situation is specific to West Point and the

current study at hand and should not affect the evaluation criteria between the SpaceTime app and Mathematica.

The potential benefits of having the iPad in the classroom were numerous and require further research to discover its full capacity. While the iPad allowed us to conduct some more dynamic exercises in class, it was also evident that it significantly assisted the learning of the material. The exercises conducted in class were:

a. Record presentations by fellow cadets and use the video playback to give constructive criticism.
b. Record the flight of a remote controlled helicopter and then use the playback to develop parametric curves.
c. Use iMessage on the iPad to distribute board problems (problems worked by students in the classroom).
d. Use the camera app to take pictures of completed board problems for notes.
e. Complete board problem sheets electronically by writing using a stylus on a .pdf file.

There were other activities conducted with the iPad which could have also been done with a laptop computer. The added benefits of the iPad in the classroom were based on the camera, iMessage capability and touch screen writing. The iPad's network had the additional benefit have having unrestricted internet access which would not be expected for an Academy wide implementation. From the students' perspective, 73% did not feel that taking notes on the iPad was better than using a paper notepad. Only 13.3% of the cadets said that the iPad helped them learn the material. Additionally, 86.7% said that the iPad did not help or hinder their learning, so there was no harm done. Although, it is hard to make a fully assessment on the usefulness of iPads on learning the material since 93.3% of the cadets said that they would use the iPad more if internet was available in the barracks.

Summary of Recommendations

If the Academy were to issue an iPad to every cadet, there are a few recommendations from the cadets who took part in the study and me. First and foremost, there needs to be iPad capable WIFI throughout the Academy area. Next, the SpaceTime app needs to be allowed on all assignments and graded events. Additionally, there needs to be extra training geared on teaching cadets how to use the SpaceTime app built into the course syllabus. Other applications are needed to make the iPad platform sustainable. There needs to be a seamless way to create Word, Excel and PowerPoint documents as these formats are used in other courses. One cadet recommended replacing the laptops with iPads, while one cadet recommended not issuing iPads at all, and yet another cadet believes that iPad program is trying to solve a problem that does not exist. Personally, I feel that iPads would serve as a great augmentation to the core math program and would help most cadets in learning the material, provided the above issues are addressed.

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