The Motivational Effects of Using Mobile Devices in

Mathematics Classrooms by Students with Exceptionalities

by

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Abstract

Low motivation levels experienced by students with exceptionalities in the area of mathematics are often cited as a major factor negatively affecting their potential for success (Baird & Scott, 2009; Reichrath, de Witte, & Winkens, 2010). In the wake of many ongoing experiments using new mobile technology and tablet devices in schools, this study examines the use of iPads from Apple in a secondary mathematics classroom and its potential effect on the motivation of students with exceptionalities. In addition, the study also takes an exploratory approach to documenting the factors impacting the planning, implementation and student use of mobile devices in the classroom. A total of 16 students, 1 teacher and 1 educational assistant participated in this study. A mixed methodology approach was taken which included collecting evidence from surveys and scales as well as from descriptive journals, interviews and observational field notes. In order to assess the students' level of motivation, the four attributes from Keller's 2006 ARCS Model were used as the basic analysis framework. These were: attention, relevance, confidence and satisfaction (Keller, ARCS Model, 2006). Preliminary analysis of the attributes indicates relative consistency over the course of the study, with some minor oddities explained further in the conclusions. An extensive list of exploratory findings regarding planning, implementation and student use of mobile devices in the mathematics classroom with students with exceptionalities indicated both positive and negative aspects regarding the integration of the devices. Some positive aspects include the ability to meet the needs of different levels, and types, of learners with a number of applications, as well as a noticed increase in the collaboration and healthy competition among students. Contrary to this,

some negative aspects include the lack of availability of topic-specific applications and the level

of frustration experienced by some student in the initial stages of learning a new application.

Introduction

As a student in the public education system in Ontario (Canada) one is enrolled in a multitude of

courses throughout their educational career. Whether or not a student is successful in these

courses depends on a vast array of contributing factors. According to Steinmayer & Spinath

(2009) a student's motivation level is a key predictor of their educational achievement,

secondary only to intelligence. This reality is particularly evident in the area of mathematics,

where many students experience low levels of motivation and subsequently are often less

successful (Gottfried, Marcoulides, Gottfried, Oliver & Guerin, 2007).

Students with exceptionalities, unfortunately, are often reported to have adopted maladaptive

motivational orientations on a variety of fronts (Pintrich, Anderman & Klobucar, 1994).

Although somewhat consistent with the general population, these students tend to exhibit less

adaptive motivation profiles then those without exceptionalities, particularly in the area of

mathematics (Cleary & Chen, 2009; Bryant, 2005; Fuchs, et al., 2008). Understanding these

significant needs adds some clarity to the understanding that exceptional students with needs in

the area of mathematics can be seriously limited when it comes to their educational success

(Desoete, Roeyers, & De Clercq, 1992).

Who are students with exceptionalities? According to the Special Education Guide for

Educators, exceptional students are defined as those "whose behavioral, communicational,

intellectual, physical or multiple exceptionalities are such that he or she is considered to need

placement in a special education program by a committee" (Ontario Ministry of Education,

2001). Some examples of exceptionalities by which students are identified include

Communication (Learning Disability), Communication (Language Impairment), Communication

(Autism), Intellectual (Mild Intellectual Disability) and Physical (blind and low vision). Based

on the Education Act of Ontario (Regulation 181/98) a student who is experiencing educational

need can be identified as *exceptional* through the standardized Identification, Placement and

Review Committee (IPRC) process. School board personnel that constitute the IPRC make the

decision to identify a student as *exceptional* based on varying information sources, including (but

not limited to) reports from teachers, parents, psychologists and speech and language

pathologists. After being identified as *exceptional*, an Individual Education Plan (IEP) is

developed which serves to identify a student's strengths and needs, as well as necessary

programming and services. It is important to note the difference between being identified as an

exceptional student within a school board and being formally diagnosed by a professional.

Within an Ontario school board a student with educational need is identified as *exceptional* for

the purpose of planning appropriate programming, whereas a formal diagnosis involves a

professional's identification of a condition, disease or disorder based on specific signs and

symptoms. Some *exceptional* students within Ontario schools do possess a formal diagnosis,

while others are not formally diagnosed but are experiencing educational needs that constitute an

exceptionality, according to the IPRC. The participants in this study will be referred to as

students with exceptionalities according to the Ontario Ministry of Education definition given

above, with the understanding that they have been identified by an IPRC committee as an

exceptional student and that individual diagnoses were not investigated. It is also important to

note that in the literature, and in practice, the phrase *students with disabilities* is often used

interchangeably with *students with exceptionalities*. Although this paper will favor students with

exceptionalities, both phrases may be seen throughout.

In addition to regulating the identification of students with exceptionalities, the Education Act of

Ontario (2011) also states that all school boards must provide an appropriate education for all

students, including those with exceptionalities. According to the Ontario Ministry of Education,

nearly 10% of students in publicly-funded elementary and secondary schools were identified as

exceptional and are receiving special education programs and supports (Zegarac, 2008).

Unfortunately, despite these efforts, the results of the Canadian Participation and Activity

Limitation Survey indicated that 38.4% of adults with disabilities in Ontario did not successfully

complete their high school diploma, compared to 24.6% of adults without disabilities (Statistics

Canada, 2007).

Many studies have investigated the difficulties encountered by students with exceptionalities as

well as what can be done to remedy this issue. Carnahan, Musti-Rao, & Bailey (2009) suggest

that students with disabilities find more academic success when "teachers have high

expectations, use evidence-based practices, and design engaging learning experiences". On a

similar note, the Learning Disabilities Association of Canada (2002) affirms that when the needs

of students with learning disabilities are addressed, schools will increase the level of motivation

of these students, allowing them to take the risks required for learning. It would therefore be

apparent that students with exceptionalities tend to be less successful in school unless their areas of need are addressed directly.

The idea of being successful in school, or more accurately, of achieving *academic success*, can be defined in terms of performance (i.e. grades) and/or mastery (i.e. a student's acquisition of necessary skills or awareness of a concept and the effort put forth) (Harackiewicz, Barron, Tauer & Elliot, 2002). It is important to note that while reviewing the literature around academic success the term *academic achievement* was also very prevalent and at times used interchangeably. *Academic achievement* can be defined as how well a task is accomplished (i.e. a student achieved 70% in English) (Broussard & Garrison, 2002). When comparing the two concepts, it became apparent that *academic success* tends to incorporate *academic achievement*, which focuses solely on the individual's performance. As both the performance and mastery aspects are important to this study, *academic success* will be used and defined as an individual's degree of effort, performance and consequence surrounding a task.

To understand this definition it is important to define the terms *effort*, *performance* and *consequence* conceptually as they relate to *academic success*, and in turn this study. According to the Expectancy-Value Theory, *effort* is identified as a major measurable motivational outcome (Vroom, 1964). *Effort*, for the purpose of this study, will be defined as a conscious dedication to an assigned task. *Performance*, in relation to this study, will be defined as the quality of work completed. For example, how closely did the work match what was requested from the teacher. Lastly, *consequence* is the reinforcement attained by the student as a result of the work he/she

completed (i.e. positive or negative feedback from the teacher). *Effort*, *performance* and

consequence are components of the *academic success* being addressed in this study.

Examining the lower academic success rates of students with exceptionalities, the degree of

effort, performance and consequence surrounding a task became the target of this study.

Looking for possible causes of this lower effort or performance, the motivation levels of students

with exceptionalities have been investigated as one possible explanation for the lower levels of

academic success found in this particular group of individuals. Studies have found individuals

with exceptionalities are more likely to experience lower levels of achievement motivation,

suggesting this as a possible contributing factor for their tendency to experience decreased

academic success (Dunn & Shapiro, 1999; Oliver & Steenkamp, 2004; Pintrich, Andermann,

Klobucar, 1994).

When looking specifically at motivation the complexity of this concept becomes strikingly

evident. In the past many theories have been brought forward to help explain the concept of

motivation. In light of the approach used in this study an exhaustive history of all motivation

theories will not be outlined, focusing instead on those most relevant to the conceptual and

theoretical framework presented later.

As mentioned, many theories have been developed to help explain the concept of motivation.

They afford perspective for many compound questions: What is motivation? Why is someone

motivated or unmotivated? From a cognitive perspective the Expectancy-Value Theory suggests

that a learner's motivation toward a task is a result of how successful they expect themselves to

be, the connection(s) they make between the task and the reward, and the degree of value they

place on the activity (Vroom, 1964). In turn, the humanistic-based Self-Determination Theory

suggests that the motivation to learn is either intrinsic (i.e. internal desire to gain knowledge) or

extrinsic (i.e. obtaining high marks) (Deci & Ryan, 2000). Bringing this all together, the social

constructivist perspective suggests that motivation is both intrinsic and extrinsic. For example

when considering a student's motivation to learn, this would depend on an individual's internal

drive to understand, as well as the external reward available to the learner in his/her environment

(Vygotsky, 1978).

After a brief look at these theoretical perspectives of motivation is becomes increasingly clear

that the concept of motivation is multi-dimensional in nature, making it very difficult to define

(Obrach, 1979). In addition, it can vary extensively based on any particular situation or context

(Linnenbrink & Pintrich, 2002). For the purposes of this study, motivation will be defined as a

student's arousal, direction and persistence towards mathematical work in the classroom

(Franken, 1994; Klassen, 2008). For example, a student who is physically alert, on-task and

putting forth a consistent effort (no matter his/her degree of understanding) would be considered

motivated for this particular endeavor.

According to Means, Jonassen, and Dwyer (1997), motivation accounts for 16-38% of the

variation in student achievement, and consequentially a student's success. Knowing that

motivation is a significant factor impacting the success of students, it is important to understand

this concept and the many theories around it. Moving forward, this knowledge of motivational

theories and this definition of motivation will serve as a platform for understanding the

development of motivational strategies for students.

In a general sense, this study is driven by a need to increase the motivation levels of students

with exceptionalities in the area of secondary mathematics. To assist in making improvements in

this area, effective motivational strategies must be developed. Along with the knowledge of

motivation theories, and an accurate definition of motivation, a motivational design framework

would help ensure the strategy being used will be effective for increasing motivation. The types

of motivational design to be discussed include person-centered, environmentally-centered and

interaction models.

Motivational design is a practice in which resources and procedures are arranged in such a way

that allows for changes in motivation to occur. Motivational design models serve the educational

system particularly well in that they provide strategies, principles, and processes that promote

motivation in students (Keller, 2006). The first type of motivational design are person-centered

models, which are focused around the idea that each individual possesses internal drives,

motives, potentials and values that effect our motivation (Keller, 2006). An example of a

person-centered model of motivation is Bandura's theory of Self-Efficacy (1986). According to

this theory, motivation is directly influenced by one's belief about their capability to succeed at a

task, which is known as self-efficacy. Self-efficacy is measured based on an individual's

cognitive beliefs, which in turn are based on four types of experiences (Bandura, 1995). These

experiences include enactive experiences (based on direct personal experience), vicarious

influences (self-comparison with another individual), verbal persuasion (outcomes describes by

another individual) and physiological factors (fatigue, stress) (Zimmermann, 2000). According to this motivational design model, focus should be concentrated on all aspects of self-efficacy, therefore increasing motivation.

In 2008 Hsieh & Schallert conducted a study to assess the motivation levels of undergraduate students, using self-efficacy as one of the key indicators. In order to assess self-efficacy the students were given a questionnaire that listed seven possible test scores. Beside each score they were instructed to circle "yes" or "no" with regards to whether they believed they could achieve this. Then, for all the scores they answered yes to, they were asked to indicate how certain they were that they could achieve this score on a scale of 1-100. At the conclusion of the study, all scores were averaged to determine their level of self-efficacy and in turn their level of motivation.

Environmentally-centered models of motivation design are focused on the idea that motivation is solely influenced by our surroundings, negating any internal connections. Skinner's (1968) motivational design model, coined "programmed instruction", emphasizes the importance of instituting positive reinforcement immediately after a correct response as well as instructional strategies that allow for correct responses as much as possible (Keller, 2006).

Interaction models of motivational design are based on the idea that motivation is influenced by both internal and external factors (Keller, 2006). DeCharms motivational design model is based on the Expectancy-Value Theory (Vroom, 1964) and focuses on changing an individual's behavior in order to increase their confidence and perceived control of their destinies, in turn

improving their motivation. Also rooted in Vroom's Expectancy-Value Theory (Feng, 2005), a second model under the interaction models of motivational design is the ARCS Theory of Motivational design (Keller, 2006). This model is an attempt to synthesize behavioral, cognitive, and affective learning theories. The ARCS Theory was chosen as a foundation for this study and will be discussed in greater detail later on.

The preceding introduction section provided a definition of students with exceptionalities, an operational definition of motivation and brief introduction to motivational design, which will serve as a foundation moving forward. The literature review to follow will provide insight on previous research involving these concepts presented thus far.

Literature Review

Before moving forward with the present study it is important to understand the work that has been done in related areas of research. Studies presented include those investigating the low motivation levels, and overall decreased success levels, of students with exceptionalities, as well as the relationship between student motivation and the use of mobile devices. These studies were chosen as they provide a broad overview of what has been done in the field, as well as what areas require future research.

Students with Exceptionalities and Motivation

Many studies have been conducted that indicate a connection between students with exceptionalities and their tendency to experience low levels of motivation and subsequently lower levels of academic success. Baird (2009) studied a group of 1518 students from Grades 6 through 8. This large group of students consisted of those with and without disabilities. The aim of the research was to study whether students with disabilities exhibited the maladaptive cognitive self-regulatory characteristics which are thought to influence their learning motivation and performance. The cognitive characteristics analyzed included academic self-efficacy, theories of intelligence, academic goal preferences, and attributions for exerting effort in academic contexts. In order to measure these attributes the students completed a series of questionnaires including an Academic Self-Efficacy Questionnaire, Implicit Theories of Intelligence for Children-Self Form, Learning vs. Performance Goal Preference Scale and Effort Attribution Scale. After analyzing the responses, findings suggested that students with disabilities were more likely to exhibit maladaptive cognitive self-regulatory characteristics such as believing their intelligence is fixed and that they must put forth extensive effort because of their lack of ability, possessing low academic self-efficacy and preferring performance versus learning goals. Knowing students with disabilities are more likely to exhibit these maladaptive cognitive self-regulatory characteristics suggests further explanation for their known difficulties with learning motivation and performance.

Understanding the low motivation levels of students with exceptionalities, Garcia (2004) studied the effects of using motivational interventions with a group of 127 students in 5th and 6th grades

who were either low achievers or were diagnosed with a learning disability. Throughout the

study some students received motivational interventions when completing writing tasks, while

others did not. The motivational interventions were implemented with the intention that the

students would learn cognitive strategies to assist them in the writing process, as well as

encourage them to believe that their academic success depends on their own effort. Furthermore

it was the researcher's belief that if they encouraged self-belief then the students would be

further engaged in writing tasks. Each of the motivational interventions was developed based on

the four factors identified as important in developing students' motivation to write well. These

factors included value/relevancy, writing specific self-esteem, attitudes and self-efficacy and

attributions of performance as a result of effort. Some examples included essay templates and

prompt cards for essay planning. Results indicated that those students who received motivational

interventions showed significant changes in productivity, self-esteem, beliefs and expectations.

Also providing insight into the motivation levels of students with exceptionalities, other studies

have investigated the variables that best predicted group membership with regards to learning

disability status. Klassen (2008) asked a group of 309 undergraduate students (208 with learning

disabilities and 101 without learning disabilities) to complete self-reported surveys. Findings

indicated that increased levels of procrastination and decreased levels of metacognitive self-

regulation and self-efficacy reliably predicted that these particular individuals had learning

disabilities. Sideridis (2006) conducted 5 studies to examine how motivation, metacognition and

psychopathology predicted learning disabilities. Results of this study indicated that the level of

motivation (measured by self-efficacy, motivational force, task avoidance, goal commitment and

self-concept) was highly accurate in classifying which student had, or was at-risk of having, a

learning disability.

Different studies have also investigated the type of motivation students with disabilities are

inclined to have. In a study of 4th and 6th graders with and without disabilities Lincoln (1979)

had participants' complete self-ratings of perceived competence and motivational orientation.

Results showed that students with learning disabilities were more extrinsically motivated (more

dependent on teacher feedback, grades, etc.). Zisimpoulos (2009) also researched the type of

motivation displayed by those with learning disabilities. This study involved 908 5th and 6th

graders with learning disabilities at an elementary school in Greece. Findings indicated that

students with Learning Disabilities have lower levels of intrinsic motivation and lower perceived

academic competence than their counterparts without disabilities.

Students with Exceptionalities, Motivation and Mathematics

Sideridis (2003) looked more specifically at the motivation levels of students with

exceptionalities in the area of mathematics. Participants included students in 5th and 6th grade

(705 non-identified and 132 identified with a learning disability). Throughout the study students

were asked to complete self-report assessments prior to completing mathematical tasks. Results

indicated that students with learning disabilities had an increased negative affectivity, decreased

positive affectivity, lower self-esteem and a sense of hopelessness. The researchers indicated

that helplessness is very similar to low motivation and that students with this profile are often

found to be less persistent.

In 2007 Sideridis also conducted a study involving 104 participants who were recognized by their teachers as students who exhibited learning difficulties based on their previous performance in math. Each participant's goal orientation was determined to be either performance-approach (motivated) or performance-avoidance (a-motivated) based on subject matter rating scales completed by the students. Results indicated that the low achieving students with performance-avoidance goal orientations were more likely to experience negative affect, lower self-esteem, anxiety and depression.

Based on the two previous groups of research presented it would appear that students with exceptionalities tend to experience decreased academic success, and therefore decreased effort and performance, when compared to their peers. As outlined in a number of studies, the often low levels of motivation experienced by these individuals serve as strong indicating factors for this decreased academic success. It is also suggested that this lack of motivation is central to the low success rates of students with exceptionalities in the area of mathematics.

This relationship between motivation and academic success presents the possibility that students with exceptionalities experience a continuous cycle of negative events. As with most relationships, one variable usually affects the other(s), which then in turn affects the other(s), and so on. In the case of students with exceptionalities it could be speculated that their low motivation levels contribute to their decreased academic success which in turn affects their motivation level, and the cycle continues on. As stated earlier, the general problem being

addressed by this research are the low levels of motivation, and subsequent low levels of success, experienced by students with exceptionalities in the area of mathematics in particular. This study will specifically aim at exploring a possible means to break this proposed negative chain of events experienced by students with exceptionalities.

Technology and Motivation

Over the years much research has investigated possible strategies to assist with increasing the motivation levels of all students, including those who are identified as exceptional. With the recent surge of technologies in the past few decades, many studies have investigated the use of technology in the classroom, including computers (Seo & Bryant, 2009; Seo & Woo, 2010), gaming software (Rosas, et al., 2003; Facer, et al., 2004; Lui & Chu, 2010; Annetta, Minoguem Holmes & Cheng, 2009) and mobile devices (Looi, et al, 2009; Franklin, et al, 2007; Lui, et al., 2003). According to Anthony & Clark (2011) computer technology is generally recognized as a valuable tool to help engage students in complex mathematical processes in particular. In addition to this, many studies also indicate that technology plays a key role in allowing students with exceptionalities to find success in the area of mathematics (Okolo, 1992; Irish, 2002).

Mobile Devices

Given the popularity and continuous emergence of mobile devices in our everyday lives the opportunity to use them in the classroom continues to present itself as well. A recent article in *Professionally Speaking* (March, 2011), a magazine published by the Ontario College of

Teachers, took an in-depth look at some of the "electronic classrooms" throughout the province

of Ontario. One school board in particular introduced mobile technology into Grade 7 and 8

classes in five different schools and teacher-based focus groups reported low-achieving students

becoming more engaged and a marked increase in collaboration between peers and teachers.

Many teachers in the article also spoke about the fact that their students are already using mobile

devices in their everyday lives and involving these in the classroom seems like the next step.

According to Liu & Chu (2010) *"mobile devices"* serve to enhance one's learning experience

and can be used to engage and motivate learners. *Mobile devices* provide 'real-time' information

to the learner, whenever and wherever they need it (Lai, Yang, Chen, Ho & Chan, 2007). When

considering a definition of *mobile devices* it is important to incorporate and detail both the

mobile hardware (Apple iPads) as well as the included software (downloaded applications)

(Looi, et al., 2009). For the purposes of this study *"mobile devices"* will be defined as handheld,

Wi-Fi-enabled instruments with a variety of accessible applications.

According to Virvou & Alepis (2005) mobile technologies in particular can make significant

contributions in the field of education. Studies incorporating mobile devices have yielded many

positive reactions from the subjects involved. Positive attributes described by students who have

used mobile devices include their mobility, flexibility, variety of applications, convenience,

immediacy and expediency (Franklin, Sexton, Lu & Hongyan, 2007; Seppala & Alamaki, 2003;

Walton, Childs & Blenkinsopp, 2005; Motiwalla, 2007). Similarly, a study by Huang, Lin &

Cheng (2010) revealed that the feature of immediacy, along with other advantageous aspects of

mobile devices such as accessibility, flexibility, interactivity and affordability, allow learners to take an active role in the learning process.

Further to the advantageous features mentioned above, there are many specific qualities of mobile devices that could fit the needs of students with exceptionalities. Some of these include ease of use, simple touch screens and accessible applications. In addition, these devices provide students with exceptionalities the opportunity for ownership, the ability to understand without extensive training and a sense of belonging as they interact on the same level as others. In addition to this, many applications which are downloaded onto mobile devices provide students with exceptionalities the opportunity to access the curriculum more effectively. For example many applications "chunk" larger concepts into smaller pieces, allowing the student to focus on one primary problem and eliminating the other "noise" that often causes confusion. Understanding the many valuable aspects of mobile devices, and in particular how they can be used to accommodate the needs of students with exceptionalities, make them an excellent option to increase the motivation level of these students.

Mobile Devices, Education and Motivation

Through an extensive literature review it is evident that many studies have been done on the use mobile devices in the area of education. Chen, Chang & Wang (2008) evaluated the use of a PDA-oriented bird watching system in order to determine the advantages of using mobile technologies, as well the effect these had on student learning. Results from this study indicated that children who used the mobile device experienced significant improvements over those who

did not. Similar results were found by Swan, van Hooft, Kratcoski & Unger (2005) who

explored students' use of mobile devices in the area of language and science. Results indicated

that 75% of the participants willingly used their mobile technology devices outside of class time

to complete tasks and teachers indicated a significant improvement with regards to student

achievement and work habits.

Previous research has also indicated a relationship between mobile devices and their effect on the

level of student motivation in the learning process. Huang, Lin & Cheng (2010) studied the use

of mobile technology devices equipped with *Mobile Plant Learning* software and how these

devices assisted students in the process of learning botany. Results indicated that students who

used the mobile devices were more engaged, motivated and enthusiastic. Similarly, Chao &

Chen (2009) provided students with mobile phones to complement a paper textbook in order to

facilitate verbatim note-taking, resolving comprehension questions, and receiving reading

recommendations. Researchers concluded that the use of mobile phones sustained and/or

aroused students' motivation for learning. Finally, Facer, Joiner, Stanton, Reid, Hull & Kirk

(2004) studied the effects of integrating mobile gaming technologies into the study of

environmental science at the elementary level. Results here also indicated that the use of mobile

technologies fostered the students' motivation for the learning activities.

Mobile Devices, Education, Motivation and Students with Exceptionalities

Knowing the positive relationship between mobile devices and motivation, it is not surprising

that some have argued the possibility of using technology to foster motivation in the learning

process for students with exceptionalities (Seo & Bryant, 2009). Swan et al (2005) studied the uses and effects of mobile computing in kindergarten to grade 8 classrooms and concluded that not only did mobile devices prove to motivate all students but they also "seemed to lessen the gaps in academic achievement between regular students and special needs students".

Recognizing the lack of research regarding the motivational effects of using mobile devices for students with exceptionalities in general, the researcher continued the investigation for studies pertaining specifically to the area of secondary mathematics. After an extensive literature review no research surrounding the motivational effects of students with exceptionalities using mobile devices in the area of secondary mathematics was revealed.

Planning, Implementation and Student Use of Mobile Devices

Consistent with the primary purpose of this study, it is important to mention other factors that need to be considered because of their impact on the school context of these learners. The academic success of any student is undeniably connected to the proficiency of the classroom teacher and support staff. More specifically, it is evident that teachers and support staff play an integral role in the successful use of technology in the classroom (Liu & Szabo, 2009). Throughout the years many studies have revealed barriers encountered by teachers when planning for and implementing technology into their classroom routines (Anthony & Clark, 2011). Anthony & Clark (2011) interviewed five elementary mathematics teachers participating in laptop programs with their classes. Obstacles to successful practice included lack of clarity around the role of technology, meeting misaligned expectations and the necessity of gaining

knowledge and skills despite limited professional development. Similarly, Donnelly, McGarr &

O'Reilly (2011) interviewed science teachers who were incorporating Information and

Communications Technology (ICT) resources into their classroom practice. Results of this study

revealed first- and second-order barriers when integrating technology in the classroom. First-

order barriers included limited resources and insufficient training and second-order barriers

included extensive time preparing for integration outside of the classroom, inability to

personalize questions and feeling "stretched out" when it came to answering student inquires

throughout the classes.

Although the factors effecting the planning, implementation and student use of the mobile

devices in the classroom is not the main research objective, this information will be explored as

it is an important contribution to the study. The data collected on these factors will provide a

context for the research question being investigated, as well as valuable information for future

endeavors.

The previous review of literature clearly suggests that low levels of motivation lead to an

increased probability that a student will not succeed academically (Rau, Gao & Wu, 2008).

Understanding this connection has led many researchers to investigate different strategies to help

increase a student's motivation level (Seo & Bryant, 2009; Seo & Woo, 2010; Rosas, et al.,

2003; Facer, et al., 2004; Lui & Chu, 2010; Annetta et al., 2009; Looi, et al., 2009; Franklin, et

al., 2007; Lui, et al., 2003). One such strategy has been the use of mobile devices, which has

been shown to positively affect the motivation levels of students, including those with

exceptionalities (Huang, Lin & Cheng, 2010; Chao & Chen, 2009). As mentioned earlier, when considering students with exceptionalities in particular, the literature review did not reveal research surrounding the use of mobile devices particularly in the area of mathematics for students with exceptionalities.

Research Objective

Understanding the connection between the use of mobile devices and their effect on student motivation creates a probable opportunity to address the general problem presented in this study. This research will investigate the use of mobile devices to potentially increase the motivation levels of students with exceptionalities in mathematics. Along with the many positive attributes mentioned previously, the mobile devices used in this study are intended to simplify the learning process (i.e. chunking complex concepts), provide opportunity to understand without extensive training, increase collaboration and foster a sense of belonging and ownership amongst other things.

This study will look specifically at a structured pedagogical use of one mobile device, the first generation Apple iPad, and its effect on the level of motivation experienced by students with exceptionalities in secondary mathematics classrooms. Specifically, this study focus on the following two questions:

1- What are the effects on motivation when students with exceptionalities use Apple iPads in a secondary mathematics classroom?

2- What are the factors that impact the planning, implementation and use of the Apple iPads in a secondary mathematics classroom by students with exceptionalities?

Conceptual Framework

This study stems from a perspective developed by post-revolutionary Soviet psychologist, Lev Vygotsky (1978). According to this author, learning is a collaborative process, and can be broken down into two developmental levels. The level of actual development is where the learner is able to work independently to solve problems and the level of potential development is where the learner requires others (i.e. peers, teachers, technology) to assist them in the learning process (Vygotsky, 1978).

From a social constructivist perspective, motivation is seen as both extrinsic and intrinsic. Learners are driven by the external rewards that are provided by the "knowledge community" in which they exist (extrinsic), as well as their own "internal drive" toward understanding (intrinsic) (Vygotsky, 1978).

Instructional strategies, from a social constructivist perspective, need to be linked to the student's motivation and be relevant to the learner's daily life, allowing them to understand the "functional meaning of what they are learning" (Martin-del-Campo, Garcia, Larco, Minguez, & Diaz-Perea, 2010). In addition to this, the social constructivist perspective also emphasizes the importance of collaboration between peers and teachers when considering planning for the classroom (Lave & Wenger, 1991). Knowing this, the tasks and activities planned throughout the study attempted to

foster an understanding of how the student's new knowledge could be linked to their daily life

and involved many opportunities for collaboration.

Based on the social constructivist perspective technology can play an important role in the

learning process for students. It is viewed as a "cognitive tool" that assists students in the

construction of knowledge through hands-on activities within a social environment (Gredler,

1997; Prawat & Folden, 1994; Jonassen, Peck & Wilson, 1999). Cognitive tools can be defined

as both cognitive and computational devices that support, guide and extend the thinking process

of their users (Jonassen, 1995). Similarly, Belland (2009) refers to technology as a type of

mental activity, which is required for cognitive behavior that can be used to enable learning.

Baylor & Ritchie (2002) continue on to suggest that when technology is used along with a

constructivist methodology it can facilitate "high-order thinking".

These basic assumptions outlined by the social constructivist perspective surrounding motivation

and technology provide the logical theoretical basis behind the conception of this study. As

mentioned earlier, the general problem being addressed is the low motivation levels of students

with exceptionalities in the area of mathematics. From this perspective, the mobile devices

(Apple iPads) were introduced as the cognitive tools used to potentially increase student

motivation both intrinsically and extrinsically. In addition to this, the mobile devices were

therefore intended to foster collaboration between students as well as deepen the understanding

of how the new knowledge related to their daily lives.

As mentioned earlier, there are a variety of motivational design models available to provide a foundation for the development of effective motivational strategies. When considering a model for this particular study, the ARCS Model of Motivational Design (an interaction-type model) was investigated. According to Feng & Tuan (2005), this model (Keller, 1983) has been considered a "systemic and easy-to-apply model for designing motivational instruction".

ARCS Theory of Motivational Design (Keller, 1983) allows for the researcher to *define*, *design* and *evaluate* motivational strategies. The *define* stage involves classifying the motivational problem, conducting an audience analysis and preparing motivational objectives. The *design* stage encourages the development of a list of potential motivational strategies and critically reviewing potential strategies, followed by the development of the chosen strategy. The final stage is to *evaluate* the motivational strategy based on motivational outcomes and learning outcomes (Keller, 1987).

Keller's model (Keller, 2006) states that motivation can be measured according to four major attributes, which are:

- Attention
- Relevance
- Confidence
- Satisfaction

Attention refers to whether or not a student's interest is captured and preserved during a learning activity. Relevance is whether or not a student thinks a learning activity applies to them personally. Confidence is a student's perception of whether or not they will be successful at the

activity. Lastly, satisfaction refers to whether or not the learner considers there to be a reward

that is derived from the learning (Kebritchi, Hirumi, & Bai, 2010).

The interactions, or relationships, between the four variables outlined by Keller are also

important in understanding the ARCS model of motivational design. Keller (1979) explains that

"the outputs of effort, performance and consequences are affected by the shared inputs of the

person and the conditions of instructional environment, which include design, media, strategies,

delivery". Keller (1979; 1983) states that "effort is affected by a person's affective inputs of

motives (values) and expectancy". Whereas the environmental inputs affecting effort comes from

motivational design and management. Performance is influenced by the person's cognitive inputs

of abilities, skills and knowledge. The environmental inputs affecting performance are learning

design and management. Consequences are influenced by the person's inputs of cognitive

evaluation and equity, which include one's satisfaction with one's performance. The

environmental input is the contingency design and management of rewards".

Keller's ARCS Model is supported in the literature and has been used for a variety of purposes

surrounding the concept of motivation (Huett, Kalinowski, Moller & Huett, 2008). Research

using the ARCS model has been many areas including the traditional classroom, computer-

assisted instruction, blended learning environments and online education (Huett, et al. 2008;

Keller, 2006). In addition to the various areas of research, ARCS has been used for various

purposes including the defining/analyzing (Feng & Tuan, 2005), designing/developing (Feng &

Tuan, 2005; Liu & Chu, 2010; Huett et al., 2008) and evaluating (Liu & Chu, 2010; Huett, et al.,

2008; Kebritchi, et al., 2010) motivation and motivational strategies.

Feng & Tuan (2005) studied the motivation and achievement outcomes of students after

completing an acid and bases unit in Grade 11 Chemistry. Following ARCS Theory of

Motivational Design, the researchers analyzed the audience and existing instructional materials,

estimated the learners' motivational status and selected motivational strategies. In order to

analyze the students' motivational needs, anticipate possible obstacles and select appropriate

strategies, the researchers used the four attributes of motivation as their point of assessment.

Based on this assessment, the researchers were able to accurately design motivational learning

activities for the acids and bases chemistry unit. Results indicated that using the ARCS-based

learning activities helped improve the motivational level of the students who participated.

Liu & Chu (2010) studied a group of Grade 7 students using ubiquitous games on PDA phones

and the effect on their English learning achievement and motivation. This study applied Keller's

Theory of Motivational Design when creating the learning activities involved in this study. In

addition to this, the ARCS Theory of Motivation was also used to develop a motivation survey

and interview questions, both used to measure the motivational effects of the learning activities.

Results of the study indicated that the use of ubiquitous games positively effects the learning

motivation of students.

Similar to Liu and Chu (2010), Huett, et al. (2008) incorporated the use of ARCS Theory of

Motivational Design into their research. This study analyzed the effects of motivational e-mails

sent to undergraduate students enrolled in an online computer course. The researchers developed

the mass e-mails according to the ARCS model and their interpretation of the four attributes of

motivation. In addition, the study also incorporated the ARCS model into the development of a

survey used to assess the overall motivation score of the students. Results indicated that

receiving ARCS-based motivational emails positively affected the motivational needs of the

students.

Similar to the topic area being investigated in the present study, Kebritchi, et al (2010), examined

the motivational effects of using computer games when learning mathematics. The ARCS model

was used specifically to evaluate the motivational effects of using computer games in

mathematics. The motivation surveys used to measure student motivation were Likert style

items based on the four attributes of motivation (attention, relevance, confidence and

satisfaction). Results of this study indicated that although no significant improvement in

motivation was found, one possible explanation could be that the games used in the study were

not designed based on ARCS theory.

ARCS has been incorporated into many research studies, acting as a framework for either the

analysis of motivational needs, design/development of motivational strategies and/or the

motivational evaluation of the strategies. According to Huett et al. (2008), there is a lack of

empirical research that incorporates ARCS and technology-based learning. In addition to this, a

review of the literature also revealed an absence of research that used ARCS to measure the

motivational effects of strategies on students with exceptionalities. This study will attempt to

help close the gap in this significant area.

Understanding the components of the ARCS model for motivation, and the significance of

mobile devices in education, this study will attempt to capture these two concepts in an effective

manner. Apple iPad technologies will be implemented in the classroom in an attempt to foster a

more positive learning environment, and to increase the motivation potential of learning

activities. As a result of this stimulating environment, the students' attention levels during

learning activities are hoped to be improved. In addition to this, new learning activities with the

Apple iPads will provide students with the opportunity to find relevance in their learning while

gaining the confidence through successes they encounter along the way. Finally, it is hoped that

after completing tasks, students will gain the much needed satisfaction to sustain long term

motivation (Liu, 2010). Put simply, the use of Apple iPads is intended to have some effect on

the motivation of the students as it would be evidenced through a change in levels of attention,

relevance, confidence and satisfaction (see Figure 1). This in turn should have an effect on the

effort, performance and consequences.

Figure 1: Apple iPads are implemented to effect the four aspects of motivation, which are measured by various methods and further verified by observing student outputs.
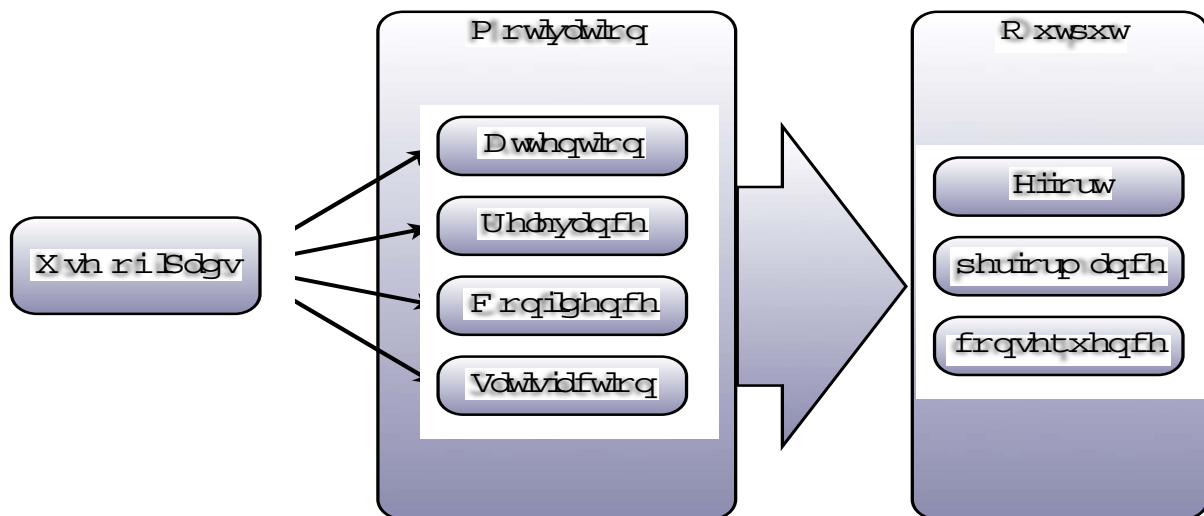
An extensive literature review suggests that mobile devices can play an important role in

motivating students towards success in school (Huang, Lin & Chen, 2010; Chao & Chen, 2009;

Facer, et al., 2004). In addition to this, the devices have also shown to be effective when used by

students with exceptionalities (Swan, van't Hooft, Kratcoski, & Unger, 2005). These two

positive relationships, and the lack of literature involving the use of mobile devices in

mathematics specifically for students with exceptionalities, prompted this study.

From a social constructivist perspective, the applications installed on the mobile devices were

viewed as cognitive tools. As mentioned earlier, cognitive tools can be defined as both cognitive

and computational devices that support, guide and extend the thinking process of their users

(Jonassen, 1995). These cognitive tools were implemented to serve a variety of functions

including support for cognitive processes (i.e. memory) and sharing the cognitive load by

providing support for lower level cognitive skills so that resources are available for higher order

thinking (Shim & Li, 2006; Lajoie, 1993). Understanding that students with exceptionalities

have various needs related to cognitive processes, etc., the functions of these cognitive tools

were particularly accommodating. The applications installed on the mobile devices allowed the

students to break larger problems into smaller chunks, as well as focus on the larger picture of

the problem by delegating the lower level tasks (i.e. basic computation).

The concept of cognitive tools is also connected to the Proximal Development stage of learning

(Vygotsky, 1978). The Proximal Development stage of learning is when the learner requires the

assistance of "others" in order to acquire new knowledge. The "cognitive tools" used in this

study provided the students with the assistance they needed to stay within their zone of proximal

development. For many students with exceptionalities, it is often difficult to get into, and stay

within, their zone of proximal development as they often struggle with the cognitive processes

required for this. The "cognitive tools" used in this study allow for the tasks to be broken down

into smaller steps. This chunking allows the students to work through more manageable pieces

of the task, improving their chances of reaching the Zone of Proximal Development. In addition

to this, the "cognitive tools" also foster collaboration between users, which provides the

assistance required to reach the Proximal Development stage. This collaboration allows them to

co-construct their new knowledge, versus acquiring the knowledge.

When in the Zone of Proximal Development, through the use of the applications installed on the

mobile devices, the participants are more likely to be motivated towards what they are learning.

Understanding the complexity of the concept of motivation, this study looked to the ARCS

Model of Motivational Design (Keller, 1983) for more direction with regards to designing

motivational strategies and evaluating student motivation levels.

According to the ARCS Theory of Motivational Design, motivation can be attributed to the

combination of four different variables, which are Attention, Relevance, Confidence and

Satisfaction. The mobile devices were used in the classroom to positively affect the Attention,

Relevance, Confidence and Satisfaction that the students' experienced towards the mathematical

concepts they were being taught. With regards to attention, the mobile devices allowed for

perceptual arousal (gaining interest through an interesting device and interesting applications),

inquiry arousal (presenting critical thinking opportunities through various applications) and

variability (offering a variety of applications). The relevance variable of motivation was also

intended to be fostered by the use of mobile devices in that it would serve to provide real-world

connections of concepts, motive matching (allowing choice depending on their level of learning)

and familiarity (applications that mimic paper-based work, but allow for more practice).

Confidence, the motivation variable that addresses the need for a student to have a sense of self-

worth and success ability in challenging tasks, was also intended to be positively affected by the

use of mobile devices. In order to have a positive effect on the students' confidence the mobile

devices were used to set clear objectives for the student (specific goals at the end of each

application), provide early success opportunities in each application and allow for personal

control over which application they chose to use to learn a mathematical concept. Finally, the

mobile devices were used to increase the satisfaction experienced by the students by

emphasizing the natural consequences of learning the concepts through applications that build

progressively through topics, by providing frequent feedback through the applications and

providing consistent and reliable standards and consequences when working through an

application.

The use of the mobile devices was implemented with the intention of positively affecting the

students' attention, relevance, confidence and satisfaction towards mathematics. According to

the ARCS Theory of Motivational Design, if these four variables show an increase then the

overall motivation should increase as well.

The final pieces of Figure 1 are the students' output of effort, performance and consequence. These outputs are the result of motivational changes, which are the effect of changes in student attention, relevance, confidence and satisfaction regarding mathematics.

The output of effort is affected by the students' value and expectation for the task as well as environmental inputs such as motivational design and management. Performance is affected by the students' cognitive abilities, skills and knowledge as well as the learning design and management. Finally, the output of consequence is affected by the students' cognitive evaluation and equity of the situation (including their degree of satisfaction) as well as the design and management of rewards (Keller, 1979).

With regards to this particular study, although the outputs of effort, performance and consequence (see Figure 1) could not directly measured, they were considered and assessed. The outputs of effort and performance in particular were looked at to indirectly support, or refute, the observations made on student motivation. The intention was to be aware the students' output of effort and performance as a checkpoint to ensure that there were not faults with the ARCS model, or how the observations were made using the ARCS model. Based on the dynamics of the class and the research study the output of consequence will not be observed.

The conceptual framework provides a theoretical rationale for the present study. Grounded by ARCS Theory of Motivational Design, the Apple iPads will be implemented into the classroom with the intention of effecting motivation levels of students (as indicated by their attention, relevance, confidence and satisfaction) and sub sequentially using their level of effort,

performance and consequence as evidence for the motivational effects. Understanding the

conceptual framework, and the relationships presented within this framework, the focus now

turns to developing a solid methodological approach that will provide rich data to answer the

research questions.

Methodology

Methodological Approach

A review of the methodologies used throughout the literature revealed a wealth of information

when formulating the selections used in this research. Kebritchi, Hirumi, & Bai (2010) studied

the achievement and motivational effects of using computer games in mathematics. In order to

assess the motivation levels the researchers had students complete pre- and post- Motivation

Surveys. In addition to this, interviews were also conducted on the students and teachers to gain

further information on motivational effects. Feng and Tuan (2005) took a similar

methodological approach when studying the motivational effects of using ARCS-based lessons

when teaching a chemistry unit. The methods used to collect data on the motivation levels of

students included a Student Motivation Towards Science Learning survey as well as an open

ended questionnaire given to students. The third piece of research which this study's

methodology was based upon was conducted by Liu and Chu (2010). The purpose was to

analyze the motivational effects of using ubiquitous games with students learning English as a

second language. The methods used to collect data around the motivation levels included an

English Learning Motivation Scale (based on ARCS model) and student interviews probing their

opinions surrounding the learning activities.

Understanding the methodologies used successfully in previous research, the next step was to use

this information to formulate the methodological approach for this study. Before doing this it is

important to restate the research questions being investigated:

Research Questions

1- What are the effects on motivation when students with exceptionalities use Apple iPads in a
secondary mathematics classroom?

2- What are the factors that impact the planning, implementation and use of the Apple iPads in a
secondary mathematics classroom by students with exceptionalities?

The motivational effects on students presented in the main research question were examined

through a variety of evidence collected and analysis strategies used. Student motivation was

examined through weekly Motivation Surveys completed by students and Observational Scales

completed by the principal investigator. The student's motivation level was also assessed based

on qualitative data including weekly student journals, weekly teacher and educational assistant

interviews and daily observational field notes collected by the principal investigator.

The sub-question, which addresses the planning, implementation and student use of the mobile

devices, was considered through qualitative data only. The use of qualitative methods were

deemed most appropriate here since they often provide more insight into understanding the

social phenomenon from the subjects perspective and often allow for more detailed and context-specific open-ended responses (McMillan & Schumacher, 2010). For this sub-question, weekly teacher and educational assistant interviews as well as daily observational field notes maintained by the principal investigator were the chosen data sources.

While developing the methodological approach for this study the concepts of validity and reliability were also considered. The quantitative instruments used in this study (Motivation Scale, Observation Survey) were pre-established instruments used in research studies with similar objectives, therefore providing some validity for the inferences made on the results (McMillan & Schumacher, 2010). The reliability of the scores from the quantitative instruments were enhanced by establishing standard conditions for data collection (completed at the same time and in the same context every week), accommodating the language of the questions to ensure comprehension and maintaining a serious environment during data collection (i.e. no talking, passing papers) (McMillan & Schumacher, 2010). Strategies used to improve the validity of the qualitative research included the use of multiple methods (i.e. teacher and educational assistant interviews, observational field notes), appropriate wording of student journal questions to ensure understanding and member checking (i.e. ensured understanding of journal questions by speaking with students directly). Another important aspect of the methodological approach used in this study was triangulation. The motivation surveys, observation scales and student journals were implemented in order to provide multiple viewpoints with regards to student motivation. Similarly, the teacher and educational assistant interviews, as well as the observational field notes were used to allow for different insights into the planning, implementation and student use of the mobile devices. By instituting various data

collection strategies for each research question the intention was to increase the validity of the

results (Olsen, 2004). The teacher and educational assistant interview and observational field

notes also allowed for inter-rater reliability, allowing for the presence of commonalities between

how the different persons assessed the same situations.

Researcher Effects

Next it is important to address the researcher effects that are relevant to this study. Researcher

effects can be explained as the influence of the researcher on the results, including any

assumptions or biases the researcher might bring forward to the study (McMillan & Schumacher,

2010). In many cases the researcher effect can be a threat to the internal validity of the study, or

the extent to which the independent variable actually produces the effects on the dependent

variable.

As a Special Education Specialist working as a full-time Special Education Resource Teacher in

the school where the study took place, this knowledge and position opens up the researcher to

make many assumptions and biases. Recognizing that these facts could not be escaped, the

researcher made constant efforts to remain completely objective throughout the study. Along

similar lines, as a full-time teacher within the school, many of the subjects knew the researcher

as an authority figure prior to the study. Recognizing that this could influence the results, the

researcher addressed the subjects on the first day of the study, explaining the role of a researcher

versus a teacher. Of course still abiding by the professional obligations of a teacher at all times,

the researcher assured the students that there would be no involvement in any type of

assessment/evaluation, minimal instruction and no input on academic placement for future

mathematics classes.

The researcher in this particular study also assumed a complete insider role, taking on an

established role in the classroom on a daily basis. This type of role allowed the researcher to

build a rapport with the students, therefore making the environment more natural. Alternatively,

taking on a complete insider role meant the researcher needed to be hyper-aware of avoiding

influences of any type. In order to safeguard against this, the researcher made a genuine effort to

remain completely neutral in all classroom discussions, collaborate with each subject regularly

and ensure equal observation of all subjects. The final point to make with regards to the

researcher effects is the length of the data collection period. The collection of data took place

over a four month period, which the researcher hoped was enough time for the data to become

clearer, understanding that the subjects could initially respond based on what the researcher

would want them to say and with time this could dissipate.

Overall, it is important to acknowledge the possible researcher effects present in this study as

well as the strategies used to circumvent them. Moving forward the early planning stages of the

study will be discussed in the preliminary logistics section.

Preliminary Logistics

In order to provide a context for the early portion of this study, the logistics of the preparations will be explained. This section will outline the steps in the approval process, classroom and teacher selection, as well as receiving and setting up the Apple iPads.

The Academic Resource room, in which the principal investigator works full-time, is an extremely busy place, servicing students with exceptionalities on a variety of subjects on a daily basis. Although all subjects are supported, mathematics is one that students tend to struggle with very frequently. Understanding this reality first-hand was the inspiration for this study. The next step in making this study a reality was obtaining approval from the school principal. After making a detailed presentation the principal approved this study taking place within the school.

After receiving approval from the school principal, the principal investigator organized a meeting with the technology department at the Board Office to ensure the study concept was acceptable and achievable. After presenting the study outline the technology department agreed to assist with setting up appropriate wireless internet connections in the designated classroom as well as on-going technical support leading up to, and during, the study.

While searching for a class to participate in this study there were a number of criteria that needed to be met. The most important component of the class was that the students were all identified as exceptional and also experienced difficultly in the area of mathematics. The other key

components of the classroom were a classroom teacher and educational assistant who had experience with students with exceptionalities and were also motivated to participate. Meeting all criteria, the Grade 10 Learning Strategies Academic Mathematics class was chosen as the classroom to participate.

The concepts of the Learning Strategies classes at this school are unique in many ways. Coming into Grade 9, a small number of students with exceptionalities are offered the opportunity to enroll in both "*Learning Strategies Mathematics*" and "*English*", earning credits at the academic or applied Grade 9 and Grade 10 levels. When choosing who will be offered a spot for these classes, the students are assessed based on criteria that include being identified as an exceptional student, working at grade level academically, a history of difficulty in the subject area and the likeliness to benefit from assistance with learning skills such as organization and time management.

The classroom teacher was in her fourth year of teaching, with two of those being with the Learning Strategies mathematics classes at both the Grade 9 and Grade 10 levels. With training in special education and mathematics, she understood the significant needs that many of her students face when it comes to mathematical concepts. When approached about participating in this study she accepted the opportunity immediately and embraced the chance to assist her students. Although she had not used an Apple iPad in the past, she was willing to work with the device prior to commencing in order to be prepared for the study.

The educational assistant assigned to this classroom was appointed just prior to commencing the study. This individual had worked within this school for a number of years and had worked specifically in Learning Strategies mathematics classes numerous times. Once given her assignment, she was given the choice of participating and fortunately she agreed without hesitation. In contrast to the classroom teacher, the educational assistant owned a personal Apple iPad and was proficient in its use. She offered to bring her iPad in to use throughout the study.

With the classroom, teacher and educational assistant in place, and having received approval from the Board Office, the next task was to recruit the participants for the study. The principal investigator telephoned each student's parent/guardian to briefly discuss the study and invite them to a Study Information Presentation. A printed invitation was also sent via letter mail (Appendix A). The presentation was well attended with 10 of 16 families present. The presentation provided a detailed explanation of the study and the responsibilities of study participants.   A Study Information Letter and Consent Form (Appendix B), as well as an Assent for Minors form (Appendix C), was also distributed at this time. Prior to commencing the study all 16 participants agreed to participate and their parents/guardians granted permission. Each student and parent signed an iPad Use Agreement (Appendix D), concurring to appropriate use of, and care for, the equipment.

Two months prior to the commencement of the study the principal investigator received two Apple iPads from the University of Ontario Institute of Technology, where she was studying. One of these devices was used by the principal investigator to assist in finding/choosing applications for the concepts to be taught throughout the course. The second device was used by

both classroom teacher (in order to become more familiar with it) and the technology department

to ensure appropriate set-up.

The study was scheduled to begin on February 1st, 2011, which was the first day of classes for

semester two. Unfortunately, the order was delayed coming from the Apple factory, where all

mass orders are required to come from. As a result of this delay, the Apple iPads did not arrive

until the end of February, 2011.

Once the devices arrived at the school, the principal investigator needed to begin setting them up.

The setup process began by providing the Board's technology department with the Media Access

Control (MAC) addresses for each device, which was required to allow wireless internet access.

The physical organization of the devices was the next task. Fortunately the devices were already

removed from their packaging and placed in their protective covers; a significant task completed

by the principal investigator's supervising professor. In order to assign the devices to individual

students the teacher recorded serial numbers and labeled them with student names. In order to

charge the devices the principal investigator made the decision to charge them bi-weekly with

power cords, taking this task away from the students all together. Being that the Apple iPads

were stored on the first floor in the office vault and the classroom was on the third floor a plan

safe transportation was also very important. After investigating numerous options, the principal

investigator decided on a small wheeled suitcase.

The next task was to figure out how the new applications would be "synced" onto each of the

individual devices. After searching for a way to do it wirelessly, the principal investigator

downloaded the required applications through iTunes on her personal laptop and then

individually attaching each device to "sync" the new applications. As much as possible, the

principal investigator would attempt to "sync" all the application required for one full week on

the Friday prior. This said, there were times when a new application was needed the next day,

which was somewhat cumbersome because of the extensive time it took to complete the syncing

process.

The first day the devices were introduced in the classroom the principal investigator, classroom

teacher and educational assistant explained and emphasized the rules and routines surrounding

the devices. When distributing the devices the students were called to the front individually to

pick them up and bring them back to their desk. Students were also instructed to return their

device to the suitcase when they left the classroom. Finally, although wireless internet was

always accessible, students were instructed to stay off the internet unless permission was

granted.

Equipment

The Apple iPads were on loan to the principal investigator from the EILAB, University of

Ontario Institute of Technology for the duration of the study. The Apple iPad is a tablet

computer measuring approximately 19.1 x 14.8 cm and is controlled by the user through a multi-

touch screen (Apple, 2011). The specific version used in this study was the first generation

Apple iPad, with a Wi-Fi connection to the school internet, and no 3G connection or built-in

camera. Each Apple iPad was fitted with a case that allowed the device to be elevated on the

desktop for easy access. Specific applications were downloaded through the iTunes store and

synced to the students' Apple iPads by the principal investigator.

Both the physical and the human dimensions of the Apple iPad were appropriate to use with

students with exceptionalities. The physical dimensions that are appealing to the participants

include the device's light weight, convenient small size, portability and large built-in touch

keyboard. The human dimension of the mobile device that was appealing to the students was

that they were able to get a sense of ownership of their device. Each individual student was

assigned one particular device which "belonged" to them for the duration of the study. Each

device was labeled with each individual's name and they were permitted to create personalized

screen savers. It was thought that if students felt ownership over the device they may show pride

of, and responsibility for, the device.

Participants

Study participants included 16 students, one classroom teacher and one educational assistant.

The 16 student participants in this study made up the entire Grade 10 Learning Strategies

Academic Mathematic class at a small city secondary school in Ontario, Canada. Students

ranged in age from 15-17 years.

Each of the 16 students were identified as an exceptional student; 14 identified with

Communication-Learning Disability, one with Communication-Language Impairment and one

with Autism (Appendix E for definitions). These students were individually selected for the

Learning Strategies mathematics class based on meeting criteria mentioned earlier, a

recommendation from their previous mathematics teacher and parental approval.

As mentioned earlier, the parents of all 16 students were made aware of the equipment selection

and the procedure of use in the classroom. After information sessions and ample opportunity to

ask questions/raise concerns, all parents agreed for their child to participate. The only concern

that the parents brought forward was concerning whether the devices would be taken away from

the students' part way through the semester. The principal investigator and faculty supervisor

reassured that them that they would be in place until the end of the course.

Treatments

As mentioned earlier the study was scheduled to begin in February, 2011 but was delayed due to

backorder of the devices. The study took place over a 15-week period during the spring semester

from March, 2011 until June, 2011. The mathematics class took place on a daily basis and was

75 minutes in length.

The classroom teacher, principal investigator and each participant were assigned their own Apple

iPad. The educational assistant used her own personal device.

The research treatment included student use of the Apple iPads whenever possible. A typical

day began with Socratic teaching of the lesson, followed by the completion of paper worksheets.

Once worksheets were completed the students were given their Apple iPads. Students would

then use the mathematics-based applications (Appendix F) which were related to the concepts being taught in the lessons.

Applications (or "Apps" as they are called by Apple Inc.) were chosen by the principal investigator, teacher and educational assistant based on the concept being learned and the students' level of understanding. In addition, applications were also chosen based on its ability to foster deeper understanding, with intentions to avoid those which were either too difficult or too simplistic. Students were usually assigned identical applications, but were often directed to use different difficulty levels. Different applications were only assigned if a student's level of understanding was not such that he/she would benefit from a particular application.

In the case where an application was not self-explanatory the teacher or principal investigator would provide instruction on how to use it. This was done by either explaining it individually to the each student (especially if he/she was starting particularly early or late compared to others) or to the group as a whole. For very complex applications overhead notes or whiteboard diagrams were used to provide visual examples.

All applications were purchased through iTunes.ca. Thankfully once an application was downloaded it could be synced to each of the 18 devices. Although the majority of the applications were free of charge, some did cost up to $15.99. After discovering that some applications would need to be purchased, the principal investigator approached the school principal to assist in covering these costs. Fortunately, the host school provided a $100.00

budget to go towards the application purchases and this budget was not exceeded.

The principal investigator, classroom teacher and educational assistant used each application thoroughly before the students in order to understand how it worked. The majority of time this was possible, but there were a few cases where applications were used which had only been minimally investigated.

Data Collection

This study was a quasi-experimental, single-subject design with a mixed methodology approach. Quasi-experimental design is defined as an experimental design that does not meet all requirements necessary for controlling influences of extraneous variables ((McMillan & Schumacher, 2009)). This research design type fit the circumstances of the study in that there were many variables within the classroom, and the profiles of the participants, that could not be controlled. Single-subject design relies on comparing treatment effects on a single subject or single group of subjects, rather than comparing groups of subjects (McMillan & Schumacher, 2009). This type of design fit the circumstances of this study since there were not two identical courses running at the same time and the principal investigator had a limited time to conduct the study within her daily teaching schedule. Finally, as mentioned earlier, the mixed methodology approach was chosen to allow for increased internal validity and triangulation of the results.

The design type explained above allowed the researcher to examine the effects of the treatment on a group of single subjects while measuring them both qualitatively and quantitatively. To

obtain information on the effects of student motivation when using the mobile devices the

quantitative instruments used were observation scales completed weekly by the principal

investigator for each participant, as well as motivation surveys completed weekly by the

students. Qualitative instruments used to collect information on the motivational effects

included weekly journals completed by each student, weekly interviews with the teacher and

educational assistant and daily observational field notes collected by the principal investigator.

In order to examine the factors effecting the planning, implementation and student use of the

mobile devices the qualitative data was collected through daily observational field notes from the

principal investigator as well as teacher and educational assistant interviews that were completed

on a weekly basis.

As a key player in this study it is important to address the role played by the principal

investigator (PI) throughout the data collection portion of the study. As a teacher in the school

where the study took place, the PI used her preparation period to collect data in the classroom

where the research was taking place. The PI would pick up the Apple iPads from the school

vault and take them to the classroom. Once in the classroom the PI would actively engage in all

classroom activities (i.e. distributing Apple iPads, answering student questions, etc.). When not

participating in class, the PI was taking observational field notes of what was occurring in the

classroom. In the absence of the classroom teacher a supply teacher would assume that role,

allowing the principal investigator to continue making observations.

Motivation Survey (Appendix G).

The motivation survey was administered to students on a weekly basis and provided quantitative

data regarding the motivation levels of the participants. The Motivation Survey was derived

from Kebritchi, et al. (2010) and developed based upon the ARCS Model of Motivational

Design. The Motivation Survey consisted of 16 questions and responses were based on a five-

point Likert scale, ranging from 1 for "Not True" to 5 for "Very True". This survey was

comprised of four sub-scales, Attention (Group A – Q2, Q5, Q8, Q12), Relevance (Group B –

Q4, Q6, Q9, Q15), Confidence (Group C – Q1, Q11, Q13, Q16) and Satisfaction (Group D – Q3,

Q7, Q10, Q14). From the original Motivation Survey developed by Kebritchi, et al. (2010), Q3,

Q8, Q12 and Q20 were eliminated in order to shorten the length of the survey and to equalize the

amount of questions per sub-scale.

Observation Scale (Appendix H).

Quantitative data measuring student motivation levels was also collected through the

Observational Scale completed by the principal investigator on a weekly basis. This scale

gauged the student's focus/attention to tasks, classroom behaviour, participation in class

activities, overall body language, amount of collaboration with peers and degree of work

completion.

The Observational Scale (Appendix H) was developed based on ARCS Model of Motivational

Design (Keller, 2006) as well as a scale developed by Annetta, Minogue, Holmes and Cheng

(2009) which was based on the Protocol for Classroom Observations from the Annenberg Institute for School Reform (2004). The scale was comprised of 3 sub-scales, Attention (Group A - Q1, Q4, Confidence (Group B – Q3, Q6, Q7) and Satisfaction (Group C – Q2, Q5). It is important to note that relevance was not included as it is difficult to observe externally.

Student Journals (Appendix I).

Students completed a written journal at the end of every week. Each journal was broken into two questions. Question #1 was a more general one regarding their overall feelings about using the iPad. Question #2 was geared to assessing one of the four indicators of motivation (attention, confidence, relevance or satisfaction) surrounding the use of the iPad. Students were given ample time to complete these journals and were encouraged to answer the questions based on the interaction they had with the Apple iPad that week.

The overall intention of the student journals was to provide the students with an open-ended opportunity to share how they felt about using the Apple iPads in their mathematics classrooms. The indirect aspect of the journal allowed the student to express feelings and concerns that they might not have done in a face to face interview. The journal questions were developed to encourage deeper thinking on the student's behalf, although they needed constant reminders to expand on their answers.

Classroom Teacher and Educational Assistant (EA) Interviews (Appendix J).

The principal investigator asked the classroom teacher and educational assistant to complete a series of written interview questions at the conclusion of every week. The questions were developed to gather qualitative data regarding the factors that could have impacted the planning, implementation and student use of the Apple iPads in the classroom.

The first question was designed to reveal the teacher and EA's feelings/attitudes around the planning phase of implementing the devices in the classroom. This data that was being sought after in these responses included any positive moments throughout the planning, as well as any frustrations they encountered through the planning phases. The second question was intended to allow the teacher and EA the opportunity to discuss any revelations around the implementation of the devices, as well as any frustrations they may have encountered. Finally the third question was used to probe any observations they made surrounding how the student interacted with the device, as well as overall classroom observations.

Principal Investigator Observational Field Notes.

The principal investigator played an active role in the planning for, and implementation of, the mobile devices in the classroom. During planning periods, and in-class time, comprehensive field notes by the principal investigator were taken to generate qualitative data. During class time the principal investigator would write point form notes on observations made in the classroom. These field notes were intended to capture specific details regarding the students'

interactions with the devices as well as the overall mood/atmosphere of the classroom. Some

examples of the information collected in the field notes included student reactions to using the

devices, interactions between students, quotes overheard from students and answers from direct

questions asked to students.

At the end of each class the principal investigator would type out precisely what happened

throughout the class (i.e. applications used, student reactions, individual comments), as well as

all field notes collected throughout that particular day. In addition to the daily information

collected in the classroom, the principal investigator also maintained regular notes throughout

the planning times.

As mentioned earlier, the various data collection methods were chosen to allow for triangulation

of results and provide further validity. The motivation survey was completed weekly by the

students in order to reveal quantitative data surrounding student motivation levels. The

Observation Scale completed weekly by the principal investigator provided further quantitative

information on student motivation levels through assessing individual's classroom behavior,

collaboration with peers, participation in activities, etc. Students were also asked to complete

weekly journals which provided qualitative data regarding their perceived levels of attention,

relevance, confidence and satisfaction, as well as their feelings/attitudes towards using the

devices in the classroom. Classroom teacher and educational assistant interviews were

completed individually at the end of every week to provide qualitative information on the

planning, implementation and student use of the Apple iPads in the classroom. The on-going

observational field notes, collected by the principal investigator, also provided qualitative

information on the planning, implementation and student use of the iPads as well as an overall

picture of the classroom routines, as well as direct student reactions and behaviors. Overall, the

data collection was instated in this manner because it allowed day-to-day information collecting

as well as weekly summaries.

Data Analysis

After the data collection period was complete the next step was to analyze the data in a way that

it could be interpreted accurately. This section will explicitly outline how each different piece of

collected data was analyzed by the researcher, including the sequential order of the procedure as

well as the programs and strategies used.

   Motivation Survey.

The Motivation Survey questions were typed into a Microsoft Excel spreadsheet. After typing

out each individual question, every question was highlighted one of four colors, based on which

category it fit into (Attention, Relevance, Confidence or Satisfaction).   Within this file separate

identical sheets were made for each individual student. Student answers for each week were then

entered by the principal investigator. Four questions in the survey were scored negatively;

meaning the lower the answer the student gave the better it was. For these negatively scored

questions (Q8, Q13, Q15, Q16) the answers were reversed when entered into the spreadsheet.

This meant that if a student answered 1 on the survey it was entered as a 5, 2 entered as 4, 3

remained the same, 4 entered as 2 and 5 entered as 1. After all data was entered the PI used the

program to calculate monthly medians for each individual question within each of the four

categories, for each individual student. In addition to this, an overall median of the answers

given for each individual question throughout the whole study was also calculated. Finally, an

overall median was calculated for all the answers to all the questions within each category for the

entire course of the study for each student.

Separate bar graphs were then constructed for each of the four categories, representing the total

monthly medians for each individual student. The individual student medians were grouped into

months, providing an overall picture of the individual median scores on a month to month basis

(Figures 2, 3, 4, 5).

Observation Scale.

Each of the questions included in the Observation Scale were entered by the principal

investigator into a Microsoft Excel spreadsheet. After being entered, each of the questions were

highlighted one of four colors based what category it was intended to address (Attention,

Confidence, Satisfaction). Within the one file, identical sheets were started for each individual

student. The answers to every observation scale question were then entered for each individual

student. After all data was entered the PI used the program to calculate monthly medians for

each individual question within each of the three categories, for each individual student.

Subsequently, overall monthly medians were calculated, which included each of the questions

addressing each category, each month, on an individual basis.   Finally, an overall median was

calculated for all the answers to all the questions within each category for the entire course of the

study for each student.

Separate bar graphs were then constructed for each of the three categories, representing the total monthly medians for each individual student. The individual student medians were grouped into months, providing an overall picture of the individual median scores on a month to month basis (Figure 6,7,8).

Student Journals.

All hand-written journal responses were transcribed verbatim into Microsoft Word. All spelling and grammar mistakes were maintained throughout the transcription, with the exception of unrecognizable words and incomplete sentences, in which corrections were made in parenthesis. All student weekly journals were then separated based on what the second question was addressing that week (attention, relevance, confidence, satisfaction). The principal investigator then read through each of the student journals and performed a content analysis, picking out the constructs (or representative words) that appeared most frequently. From this list, the constructs were divided into positive and negative, based on being either promoters or inhibitors of motivation. Although most constructs are self-explanatory, two negative constructs in particular require more clarification. The negative construct "paper" was consistently used in a negative context regarding the student preferring to use paper instead of the iPad or being able to do it faster on paper than the iPad. Also, the negative construct "sensitive" was used throughout the student journals when referring to applications that were very touchy/finicky when using them.

Using the 'Find' function in Microsoft Word, derivatives of each positive and negative construct

was searched throughout individual responses in each category (totals in Appendix K). It is

important to note that the principal investigator read the excerpt in which each construct was

found, ensuring that words were not used out of context. For example, the majority of the time

the construct "paper" was used in a negative context with regards to preferring to use paper over

the iPad, but there were instances where it was used in a positive context and therefore these

were not counted in the totals.

The total number of positive and negative constructs found within each individual's journals, for

each separate week, was tabulated separately for Question #1 only and Question #2 only

(Appendix K). In addition to this, the total number of individual constructs was also tabulated

for each weekly journal, separated into Question #1 only and Question #2 only (Appendix K).

Teacher and Educational Assistant Interview Responses and Principal Investigator

Observational Field Notes.

Written responses to interviews and field notes were transcribed verbatim in Microsoft Word.

Each individual was designated a different text color, ensuring the ability to maintain

perspective. All responses were then read through and categorized based on providing

information on planning, implementation, student use or observations. Within each of these

categories the responses were further divided into the sub-categories of positive, negative and

mixed, based on the content of the response.

In summary, both the motivation survey and observation scale followed a similar data analysis

procedure with the use of Microsoft Excel and the calculation of medians. Alternatively, the

student journals were analyzed based on the frequency of positive and negative constructs, while

the teacher and EA interviews and observation notes were categorized based on positive or

negative aspects of planning, implementation and student use. Overall the data analysis

techniques used in this study yielded information that allowed the data collected to be interpreted

in the results section.

Results

The results section will outline what was found after analyzing the data collected. Each of the

different data collection pieces (motivation survey, observation scale, student journal, teacher

and EA interviews and observational field notes) will be presented separately. The Motivation

Survey and Observation Scale will be further sub-divided into attention, relevance, confidence

and satisfaction, where total monthly medians (overall and month by month) will be revealed, as

well as looking at three distinct groupings of subjects and oddities in the data. The student

journal results will be presented based on Question #2 and Question #1 separately. Question #2

results will be separated based on what the journal was intended to assess (attention, relevance,

confidence, satisfaction), after which the total number of positive and negative constructs will be

compared and supported by direct quotes. Question #1 will also consider the number of positive

and negative constructs but will be presented on a chronological basis, referring directly to the

applications being used during each week and using direct quotes for supporting evidence.

Finally, the teacher and EA interview and observational field notes results will be presented

based on categorization into positive or negative aspects of planning, implementation or student use.

Motivation Survey

As mentioned earlier, the questions in the Motivation Survey were designed to assess one of attention, relevance, confidence or satisfaction. The data from each question was separated into individual categories and results will be discussed accordingly.

      Attention.

The Motivation Survey contained four questions which were designed to allow students to report on their level of attention. Figure 2 depicts the total monthly median scores for all four attention-based questions for each individual student. Looking at the overall results in Figure 2 the students appear to have reported attention levels that remained relatively consistent from month to month, with some notable surges in April and declines in May. Considering each month separately, some discrepancies exist with regards to how individuals reported their levels of attention. Students reported the most consistent levels of attention during the month of April, whereas the remaining months observed students reporting attention levels that were much more variable (see Figure 2).

Upon closer examination of the attention levels reported by students, three distinct groupings emerge. The first grouping includes those students reporting high levels of attention, with median scores of four and above. Throughout the study the number of students reporting high

attention levels remains fairly consistent. With this said, the month of April observed the largest

number of students who reported high levels of attention, while May saw the lowest number of

students. The second grouping is composed of the students who reported attention levels that

tended towards the middle, with medians between three and four. From month to month the

number of students who reported these middle-range attention levels also remained relatively

consistent. The largest number of students reporting attention levels in the middle range took

place in May, versus the lowest number was observed in April. The final grouping consists of

students who reported the lowest levels of attention with medians below three. The number of

students reporting low levels of attention remained consistently low throughout the study. The

month of April only had one student reporting low attention levels, while March, May and June

only had two. Combining all individual scores for each grouping throughout the study, the

largest number of students were those reporting high levels of attention, followed by those who

reporting middle-range levels of attention and finally low levels of attention.

Looking at Figure 2 there are some oddities in the individual data that are worth noting. One

student (KM) reported consistently low levels of attention throughout the study. Contrary to this,

other students (CL, KS, NU, TH) reported consistently high attention levels throughout the

study. Within this group, each student reported the highest possible attention level in the month

of April. Finally, one student (KH) reported attention levels that were more erratic from month

to month. Student KH showed variation in attention scores, reporting extremely low attention

levels in March and relatively higher attention levels in the later part of the study.

Figure 2: Monthly Motivation Survey results for attention-based questions for each individual student
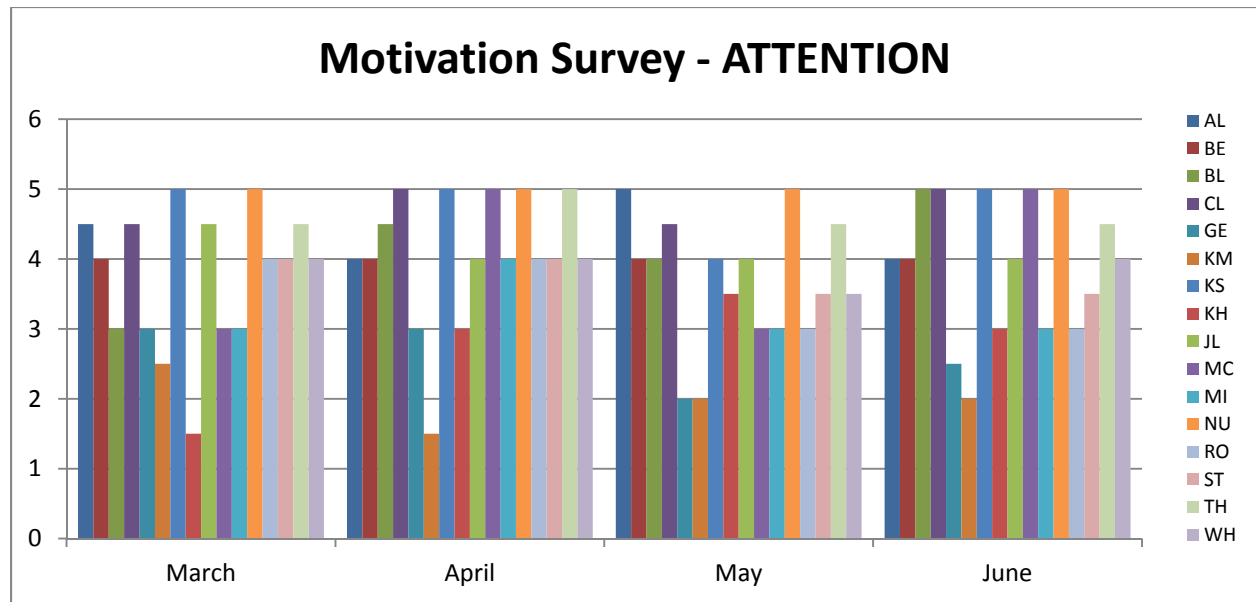
Relevance.

Similar to attention, the Motivation Survey contained four questions which were designed to allow students to report on the degree of relevancy they were experiencing in the mathematics classroom. Figure 3 depicts the total monthly median scores for all four relevance-based questions for each individual student. Looking at the overall picture in Figure 3 the students appear to have reported relevance levels that remained comparatively consistent from month to month. Considering each month separately, some discrepancies exist with regards to how individuals reported the degree of relevancy they were experiencing. Students reported the most

consistent levels of relevancy during the month of March; whereas the remaining months observed students reporting relevancy levels that were much more variable (see Figure 3).

Upon closer examination of the relevancy levels reported by students, three distinct groupings emerge. The first grouping includes those students reporting high levels of relevancy, with median scores of four and above. Throughout the study the number of students reporting high relevancy levels remains fairly consistent. With this said, the month of March observed the largest number of students who reported high levels of relevancy, while June saw the lowest number of students. The second grouping is composed of the students who reported relevancy levels that tended towards the middle, with medians between three and four. From month to month the number of students who reported these middle-range relevancy levels was somewhat consistent, with the exception of March, which was distinctly lower than the other months. The largest number of students reporting relevancy levels within this middle range took place in June, versus the lowest number was observed in March. The final grouping consists of students who reported the lowest levels of relevancy with medians below three. The number of students reporting low levels of relevancy remained consistent throughout the study. The months of April and June only had one student reporting low relevancy levels, while March and May only had two. Combining all individual scores for each grouping throughout the study, the largest number of students were those reporting high levels of relevancy, followed by those who reporting middle-range levels of relevancy and finally low levels of relevancy.

Looking at Figure 3 there are some oddities in the individual data that are worth noting. One student (GE) reported consistently low levels of relevancy throughout the study. Contrary to

this, other students (Al, BL, CL, KS, TH) reported consistently high relevancy levels throughout

the study, with the majority of these students reporting the highest possible level of relevancy

throughout the entire study. Finally, one student (KM) reported relevancy levels that were more

erratic from month to month, reporting relatively higher levels of attention earlier in the study

when compared to later.

Figure 3: Monthly Motivation Survey results for relevance-based questions for each individual student
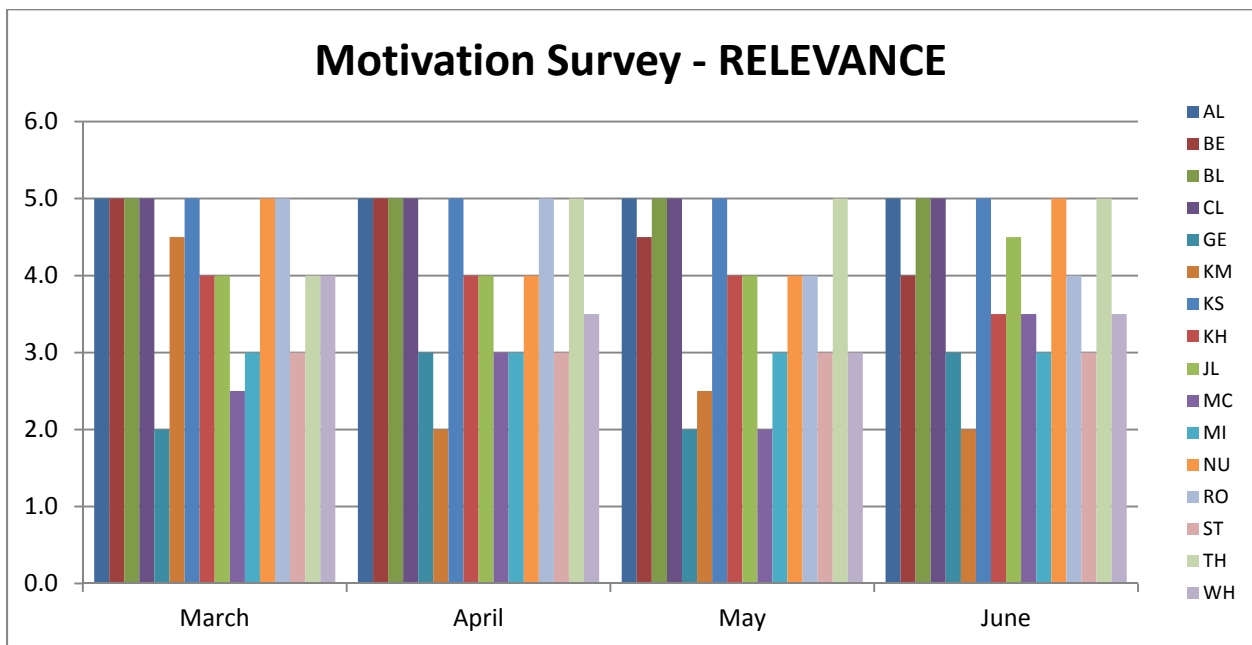
Confidence.

The Motivation Survey also contained four questions, which were designed to allow students to

report on their level of confidence. Figure 4 depicts the total monthly median scores for all four

confidence-based questions for each individual student. Looking at the overall picture in Figure

4 the students appear to have reported confidence levels that remained relatively consistent from

month to month, with some notable surges in April and declines in May. Considering each month separately, some discrepancies exist with regards to how individuals reported their levels of confidence. Students reported the most consistent levels of confidence during the month of March; whereas the remaining months observed students reporting confidence levels that were much more variable (see Figure 4).

Upon closer examination of the confidence levels reported by students, three distinct groupings emerge. The first grouping includes those students reporting high levels of confidence, with median scores of four and above. Throughout the study the number of students reporting high confidence levels remained relatively high, with a notable surge observed in April. The months of March, May and June each had an equal number of student reporting high attention levels. The second grouping is composed of the students who reported confidence levels that tended towards the middle, with medians between three and four. From month to month the number of students who reported these middle-range confidence levels was much more variable. The largest number of students reporting confidence levels in the middle range took place in March, whereas April saw very few students within this range. The final grouping consists of students who reported the lowest levels of confidence, with medians below three. The number of students reporting low levels of confidence remained relatively low throughout the study. With this said, the month of March had zero students reporting low levels of confidence, whereas April, May and June each had a small consistent amount. Combining all individual scores for each grouping throughout the study, the largest number of students were those reporting high levels of confidence, followed by those who reporting middle-range levels of confidence and finally low levels of confidence.

Looking at Figure 4 there are some oddities in the individual data that are worth noting. Two

students (GE and RO) reported consistently low levels of confidence throughout the study.

Contrary to this, two other students (CL and NU) reported consistently high confidence levels

throughout the study. Finally, one student (KM) reported confidence levels that were more

erratic from month to month. Student KM showed variation in confidence scores, reporting

relatively higher levels of confidence in the earlier parts of the study.

Figure 4: Monthly Motivation Survey results for confidence-based questions for each individual student
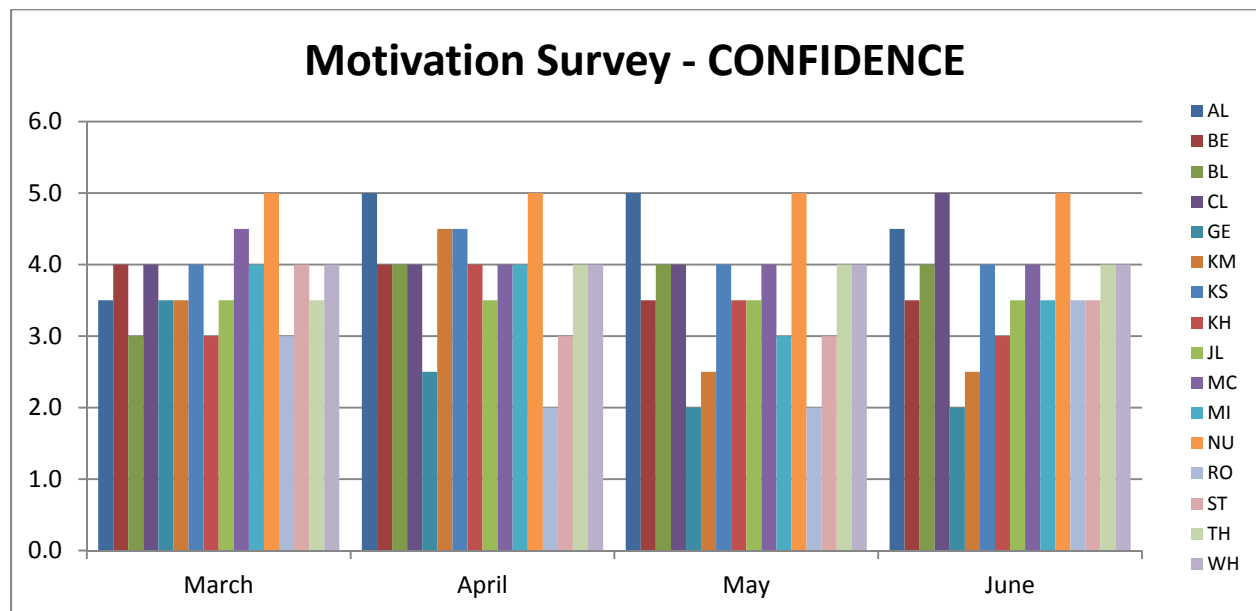

Satisfaction.

Finally, the Motivation Survey also contained four questions, which were designed to

allow students to report on their level of satisfaction. Figure 5 depicts the total monthly median

scores for all four satisfaction-based questions for each individual student. Looking at the

overall picture in Figure 5 the students appear to have reported satisfaction levels that remained

relatively consistent from month to month, with some notable surges in April and declines in

May. Considering each month separately, discrepancies exist with regards to how individuals

reported their levels of satisfaction. Students reported varying levels of satisfaction during all

four months of the study, with no particular month standing out as being more consistent than the

next (see Figure 5).

Upon closer examination of the satisfaction levels reported by students, three distinct groupings

emerge. The first grouping includes those students reporting high levels of satisfaction, with

median scores of four and above. Throughout the study the number of students reporting high

satisfaction levels remains fairly consistent. With this said, the months of March and April had a

much higher number of students who reported high levels of satisfaction, when compared to the

much lower number of students in May. The second grouping is composed of students who

reported satisfaction levels that tended towards the middle, with medians between three and four.

From month to month the number of students who reported middle-range satisfaction levels was

somewhat variable. The largest number of students reporting satisfaction levels in the middle

range took place in May, versus a relatively lower number in March. The final grouping consists

of students who reported the lowest levels of satisfaction, with medians below three. The

number of students reporting low levels of satisfaction remained consistently low throughout the

study. Combining all individual scores for each grouping throughout the study, the largest

number of students were those reporting high levels of satisfaction, followed by those who

reporting middle-range levels of satisfaction and finally low levels of satisfaction.

Looking at Figure 5 there are some oddities in the individual data that are worth noting. Two

students (GE and KM) reported consistently low levels of satisfaction throughout the study.

Contrary to this, other students (AL, BL, NU and TH) reported consistently high satisfaction

levels throughout the study. Within this group, two students reported the highest possible level

of satisfaction throughout the whole study. Finally, one student (BE) reported satisfaction levels

that were more erratic from month to month. Student BE showed variation in satisfaction scores,

reporting extremely high levels of satisfaction earlier in the study, followed by relatively lower

scores as the study progressed.

Figure 5: Monthly Motivation Survey results for satisfaction-based questions for each individual student
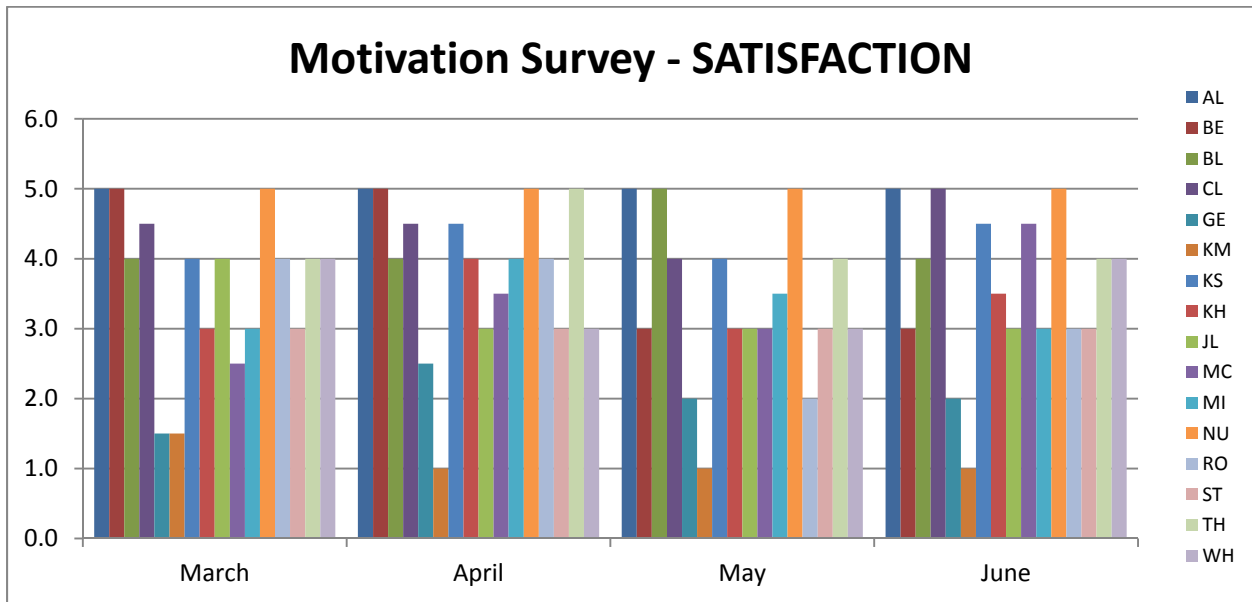
The Motivation Survey results will be summarized based on overall consistency and notable

surges and declines. For each of the categories (attention, relevance, confidence and

satisfaction), the overall monthly medians showed the students reporting relatively consistently

throughout the study. In the categories of attention, confidence and satisfaction the students

reported increased levels during the month of April, while decreased levels were reported in

May.

Observational Scale

The Observation Scale questions were each formulated to assess the students' attention,

confidence or satisfaction. The data from each individual question was categorized based on the

variable it was intended to measure and the results will be discussed accordingly.

Attention.

The Observation Scale included two questions that were used to assess students' attention levels

according to the PI's observations. Figure 6 below depicts the total monthly medians for both

questions used to assess the attention levels of each individual student. Looking at the monthly

data as a whole, there appears to be some variability from month to month. During the months

of May and June the students' attention levels were observed to be consistently high, whereas the

attention levels were observed to be much more variable during March and April (see Figure 6).

Similar to the Motivation Survey, the Observation Scale results can be broken down into three distinct groupings. The first grouping includes those students observed as having high levels of attention, with median scores of four and above. The number of students observed as having high attention levels appears to be lower earlier in the study and much higher as the study progressed. The second grouping is comprised of the students who were observed as having attention levels that tended towards the middle, with medians between three and four. The number of students observed as having attention levels in this middle range appears to vary from month to month, with the highest amount in April and lowest in June. The final grouping consists of students who were observed as having the lowest levels of attention, with medians below three. Although the number of students observed to have low attention levels remained consistently low throughout the study, March had the largest amount of students while June had the least. Combining all individual scores for each grouping throughout the study, the largest number of students were those observed as having middle-range levels of attention, followed by those were observed with high levels of attention and finally low levels of attention.

Figure 6 also reveals some noteworthy exceptions with regards to individual student data. One student (KM) was observed to have consistently low levels of attention throughout the study. Contrary to this, other students (NU, RO and TH) were observed to have consistently high levels of attention throughout the study. Finally, three students (BL, MC, WH) were observed to have attention levels that were more irregular from month to month. Each of these three students was observed to have lower levels of attention in the beginning of the study, followed by heightened attention levels later on.

Figure 6: Monthly Observation Scale results for attention-based questions for each individual student
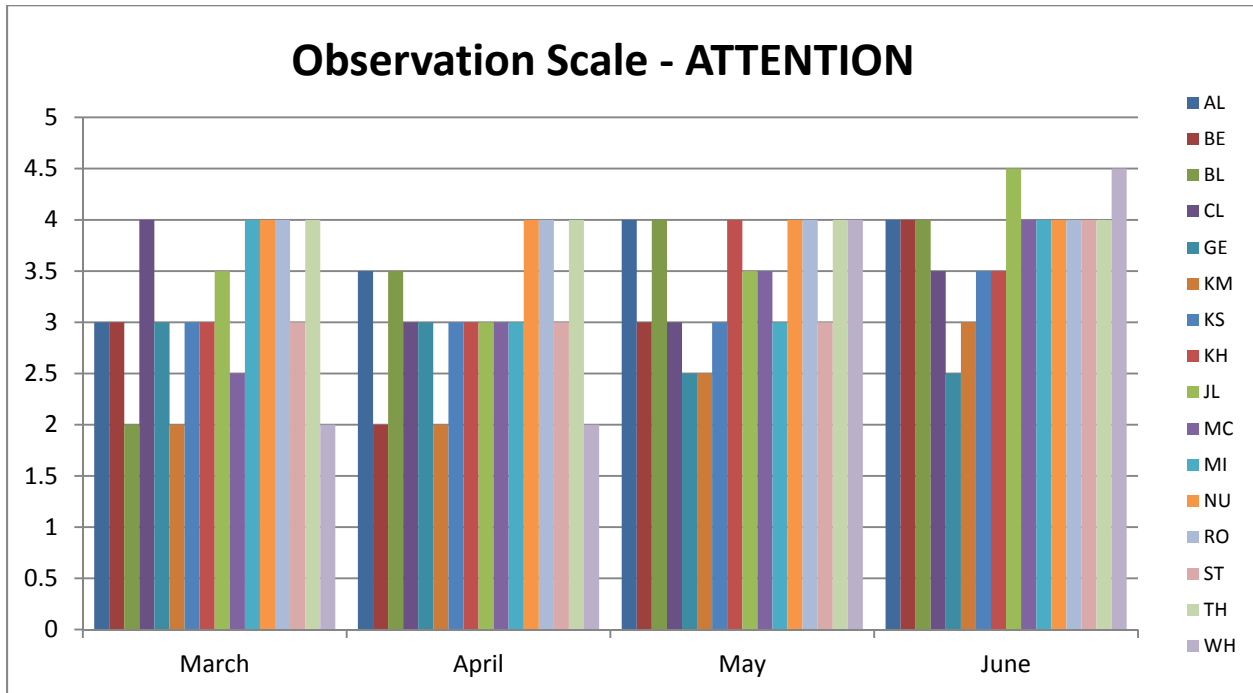
Confidence.

The Observation Scale included three questions that were used to assess students' confidence levels according to the PI's observations. Figure 7 below depicts the total monthly medians for both questions used to assess the confidence levels of each individual student. Looking at the monthly data as a whole, there appears to be variability from month to month. During the months of May and June the students' confidence levels were observed to be consistently high,

whereas the confidence levels were observed to be consistently mid-range during March and April (see Figure 7).

As mentioned earlier the Observation Scale results can be broken down into three distinct groupings. The first grouping includes those students observed as having high levels of confidence, with median scores of four and above. The number of students observed as having high confidence levels appears to be lower earlier in the study and much higher as the study progressed. The second grouping is comprised of the students who were observed as having confidence levels that tended towards the middle, with medians between three and four. The number of students observed as having confidence levels in this middle range appears fairly consistent from month to month, with the highest amount in April and lowest in June. The final grouping consists of students who were observed as having the lowest levels of confidence, with medians below three. The number of students observed as having low confidence varied considerably from month to month, with relatively larger numbers of students in March and April when compared to May and June. Combining all individual scores for each grouping throughout the study, the largest number of students were those observed as having high levels of confidence, followed very closely by those observed with middle-range levels of confidence and finally low levels of confidence.

Figure 7 also reveals some noteworthy exceptions with regards to individual student data on observed confidence levels. One student (GE) was observed to have consistently low levels of confidence throughout the study. Contrary to this, other students (NU and RO) were observed to have consistently high levels of confidence throughout the study. Finally, one student (WH) was

observed to have confidence levels that were more irregular from month to month. This student

was observed to have confidence levels that tended to be lower earlier on, followed by an

increase later in the study.

**Figure 7: Monthly Observation Scale results for attention-based questions for each
individual student**
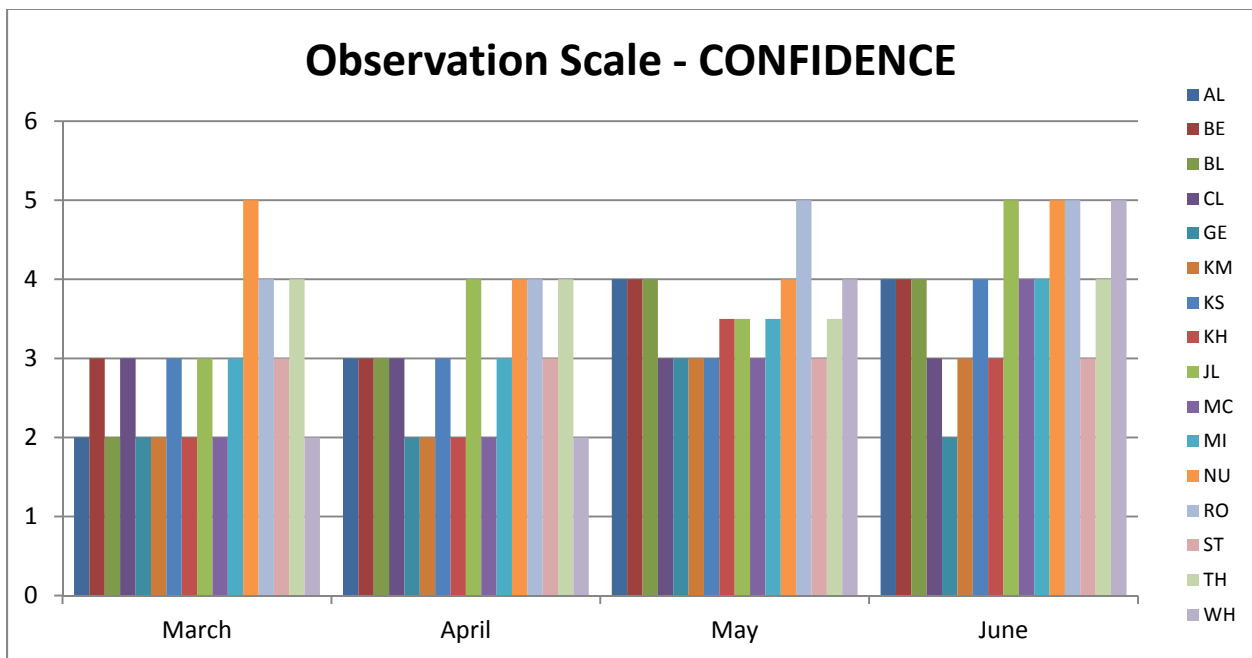
Satisfaction.

Finally, the Observation Scale included two questions that were used to assess students'

satisfaction levels according to the PI's observations. Figure 8 below depicts the total monthly

medians for both questions used to assess the satisfaction levels of each individual student.

Looking at the monthly data as a whole, there appears to be somewhat consistent from month to

month, showing some variability as well. During the months of May and June the students'

satisfaction levels were observed to be consistently high, whereas the satisfaction levels were observed to be much more variable during March and April (see Figure 8).

Once again the Observation Scale results can be broken down into three distinct groupings. The first grouping includes those students observed as having high levels of satisfaction, with median scores of four and above. The number of students observed as having high satisfaction levels appears to be consistently high from month to month, although more students were observed in this range in the later parts of the study. The second grouping is comprised of the students who were observed as having satisfaction levels that tended towards the middle, with medians between three and four. The number of students observed as having satisfaction levels in this middle range appears to be relatively consistent from month to month, with the highest amount in both April and May, and lowest in June. The final grouping consists of students who were observed as having the lowest levels of satisfaction, with medians below three. The month of March had the largest number of students observed to have low levels of satisfaction, while May had zero students in this range. Combining all individual scores for each grouping throughout the study, the largest number of students were those observed as having high levels of satisfaction, followed by those observed with middle-range levels, and finally those observed with having low levels of satisfaction.

Figure 8 also reveals some noteworthy exceptions with regards to individual student data. Two students (BE and KM) were observed to have consistently low levels of satisfaction throughout the study, although relative increases were made as the study progressed. Contrary to this, other students (JL, MC, RO and TH) were observed to have consistently high levels of satisfaction

throughout the study. Finally, one student (WH) was observed to have satisfaction levels that

were irregular from month to month. This particular student was observed to have lower levels

of satisfaction in the beginning of the study, followed by heightened satisfaction levels later on.

Figure 8: Monthly Observation Scale results for attention-based questions for each individual student
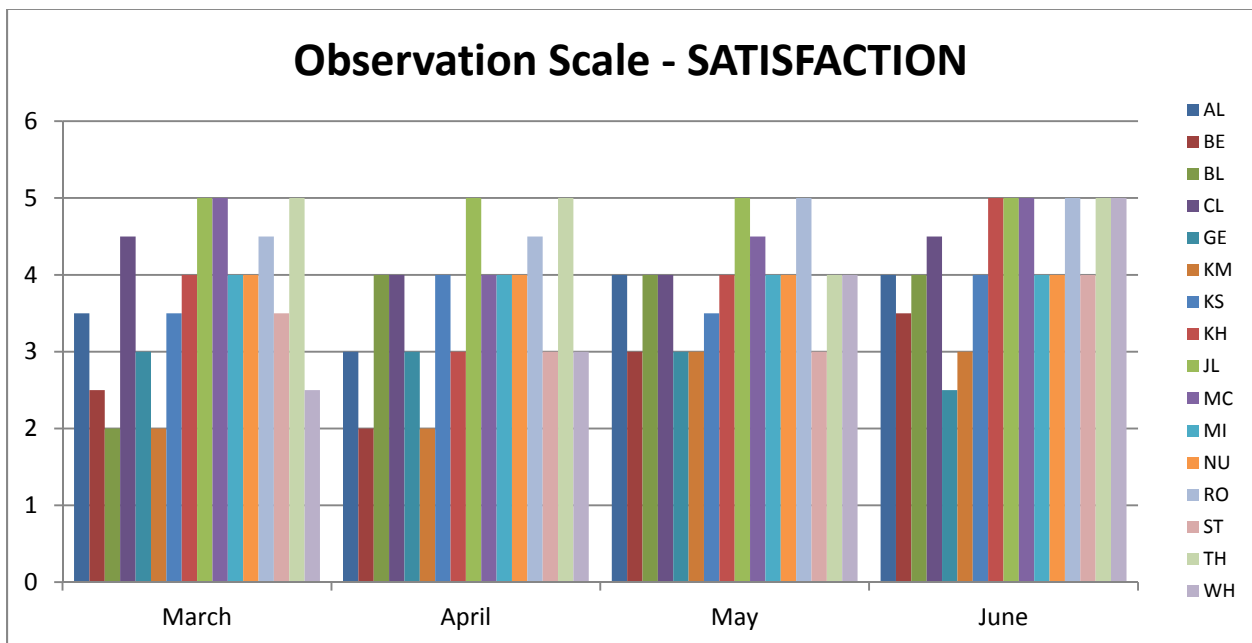
The results from the Observation Scale can be summarized based on overall consistency and

notable surges and declines. For each of the categories (attention, confidence and satisfaction),

the students were observed as having variable overall median scores. During the months of May

and June the students were observed as having consistency high levels of attention, confidence

and satisfaction, while the scores were more variable and noticeably lower during the months of

March and April.

Student Journals

As mentioned earlier for data analysis purposes, the responses to journal question #1 and journal question #2 were analyzed separately. Question #1 focused on how the student felt about using the devices, while question two focused directly on one of the four variables (Attention, Relevance, Confidence, Satisfaction). Since the Motivation Survey and Observation Scale that were recently mentioned also assess the four variables, the results of the second journal question will be presented first.

Student Journals - Question #2 Only.

Attention.

The journals on March 4, 2011, April 8, 2011, May 6, 2011 and June 3, 2011 each had a second question that was geared at assessing the student's attention for the preceding week. Table 1 outlines the total number of positive and negative constructs in question #2 in each of the four individual journals that were used to assess attention. Throughout the course of the study the total number of positive constructs in question #2 of the attention-based journals decreased, while the total number of negative constructs was variable.

During all four months of the study (March, April, May, June) the number of positive constructs

in the journals was greater than the total number of negative constructs. The months of March,

April and May all had the largest number of positive constructs (16). Conversely, the month of

June had the lowest number of positive constructs (7). The total amount of negative constructs

was highest during June (3) and March (2), while the April and May each has 0 negative

constructs found.

Table 1: Student Journals (Attention) – Construct Totals for Question #2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 4, 2011	16	2
April 8, 2011	16	0
May 6, 2011	16	0
June 3, 2011	7	3

During the March 4, 2011 journals the second question regarding attention yielded a larger

number of positive constructs (16) then negative constructs (2). Tables in Appendix K detail the

number of individual constructs that were found within each journal for question 2 only. During

the March 4, 2011 journal the positive constructs found included "fun" (5), "help" (3), "focus"

(2), "interest" (2), "excite" (1), "cool" (1), "easy" (1) and understand (1). The negative

constructs found included "boring" (1) and "paper" (1).

> "The iPad kept me focused because it is fun to use. Learning new skills on it makes it
> more exciting and it is very satisfying when you finish a task" (CL, March 4, 2011)

> "I believe that the iPad helped keep my attention because it looked cool and it is touch
> sensitive so it is fun to move things around" (TH, March 4, 2011)

> "No. Not really. Math is still math to me…boring" (KH, March 4, 2011)

Throughout the question 2 responses for the April 8, 2011 journals there were a greater number

of positive constructs (16) then negative constructs (0). The positive constructs "help" (8),

"focus" (3), "fun" (2), "easy" (2) and "enjoy" (1) were found, versus zero negative constructs

were found.

>   "Yes it did keep my attention and its because of the games they really help me and its
>   good practice for math" (AL, April 8, 2011)

>   "Yes it did keep my attention because I was focused on getting the fractions of the
>   number right and I had to keep thinking ahead of time" (BE, April 8, 2011)

Similarly, the May 6, 2011 journal had a larger number of positive constructs (16) than negative

constructs (0) throughout Question #2. The positive constructs found included "fun" (5), "help"

(5), "easy" (2), "focus" (2), "interest" (1) and "cool" (1).

>   "It helped me keep it because I focused on one thing and that helped me" (BL, May 6,
>   2011)

>   "Yes it did because it was something that we could learn with fun and it just kept my
>   mind on the math because it also felt easier with no paper all over and figuring out what
>   you are doing" (WH, May 6, 2011)

Finally, the journal completed in June also had a larger number of positive constructs (7), then

negative constructs (3). More specifically, the positive constructs "help" (2), "cool" (1), "easy"

(1), "focus" (1), "understand" (1) and "enjoy" (1) were found, while the negative constructs

"boring" (1), "confuse" (1) and "paper" (1) were also found.

>   "Yes the iPad did help (keep my attention) because it keeps me trying because it shows
>   one when I am wrong" (JL, June 3, 2011)

"Yes it did (keep my attention) because I was doing stuff that had to have me interact with what we had to do instead of listening" (WH, June 3, 2011)

"No, other than the game on the iPad I do not think it will keep my attention. I can do my math much faster on paper than the iPad" (KM, June 3, 2011)

Relevance.

The journals on April 1, 2011, April 29, 2011 and May 27, 2011 each had a second question

which was geared to assess the student's relevance for the preceding week. Table 2 outlines the

total number of positive and negative constructs in question #2 in each of the four individual

journals that were used to assess relevance. Throughout the course of the study the total number

of positive constructs in question #2 of the relevance-based journals decreased and the total

number of negative constructs decreased as well.

During all four months of the study (March, April, May, June) the number of positive constructs

in the journals was greater than the total number of negative constructs. The April 1, 2011

journal had the largest number of positive constructs (21), in comparison to the two later journals

on April 29, 2011 (9) and May 27, 2012 (5). The total amount of negative constructs was

highest during early April (3), followed by later April (2) and May (1).

Table 2: Student Journals (Relevance) – Construct Totals for Question #2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
April 1, 2011	21	3
April 29, 2011	9	2
May 27, 2011	5	1

During the April 1 journals the second question regarding relevance yielded a larger number of positive constructs (21) than negative constructs (3). Tables in Appendix K detail the number of individual constructs that were found within each journal for question 2 only. During the April 1 journal the positive constructs found included "help" (12), "easy" (3) and "understand" (6). The only negative construct found in the April 1 journals was "confuse" (3).

> "I think the iPad helped me because it showed me how I can use the new math skills I learned" (TH, April 1, 2011)

Similarly, the April 29 journal had a larger number of positive constructs (9) than negative constructs (2) throughout Question #2. The positive constructs found include "help" (5), "understand" (2), "easy" (1) and "focus" (1). The negative construct found was "confuse" (2).

> "Yes it did help me recognize the importance this weeks math task, it helps me figure out the time it takes to do things or how far something is" (AL, April 29, 2011)

Finally, the journal completed on May 27 had a larger number of positive constructs (5), then negative constructs (1), although this difference was much less. The positive constructs "help" (2) and "understand" (3) were found, while the negative construct "not understand" was found once.

> "Somewhat the word problems kinda show me how it can be related to real life situations" (CL, May 27, 2011)

"The iPad did in a way because on the iPad it can give you examples to help you understand more" (ST, May 27, 2011)

"I still do not really understand how it can be used in everyday life" (MC, May 27, 2011)

Confidence.

The journals on March 10, 2011, April 15, 2011, May 13, 2011 and June 10, 2011 each had a second question which was geared to assess the student's confidence for the preceding week. Table 3 outlines the total number of positive and negative constructs in question #2 in each of the four individual journals that were used to assess confidence. Throughout the course of the study the total number of positive and negative constructs in question #2 of the confidence-based journals were variable.

During the last 3 months of the study (April, May, June) the number of positive constructs in the journals was greater than the total number of negative constructs, while they were equal in March. The month of June had the largest number of positive constructs (10). Conversely, the month of March (4) had the lowest number of positive constructs. The total amount of negative constructs was highest during March (4) and June (4), while the April (2) and May (2) each had the lowest number of negative constructs.

Table 3: Student Journals (Confidence) – Construct Totals for Question #2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 10, 2011	4	4
April 15, 2011	9	2
May 13, 2011	5	2
June 10, 2011	10	4

During the March 10 journals the second question regarding confidence yielded an equal number

of positive constructs (4) and negative constructs (4). Tables in Appendix K detail the number of

individual constructs that were found within each journal for question 2 only. During the March

10 journal the positive constructs found included "fun" (2), "help" (1), and "easy" (1). The

negative constructs found included "long" (2), confuse (1) and "difficult" (1).

> "I think that my confidence has increased I think that the iPad has shown that if I need
> help it is there for me" (NU, March 10, 2011)

> "It didn't increase my confidence in math because it was taking me long to figure it out"
> (RO, March 10, 2011)

Throughout the question #2 responses for the April 15 journals there were a greater number of

positive constructs (9) than negative constructs (2). The positive constructs found include "help"

(6), "understand" (2) and "interest" (1). The negative constructs found included "frustrate" (1)

and "long" (1).

> "Yes it did (increase my confidence) because I know I can get it done in time" (BL, April
> 15, 2011)

> "I do not think it did because it makes everything take longer" (GE, April 15, 2011)

> "It did because having the iPad makes me want to learn more about it and about the
> tasks" (ST, April 15, 2011)

The May 13 journal had a larger number of positive constructs (5) than negative constructs (2) throughout Question #2. The positive constructs found include "easy" (2), "enjoy" (2) and "understand" (1) and the negative constructs include "confuse" (1) and "paper" (1).

> "Maybe I still think that it decreases my confidence in math tasks because I do better on the paper then the iPad" (MI, May 13, 2011)

> "I felt it did. I felt like I knew what I was doing when I worked on the iPad it seemed like it came easier" (WH, May 13, 2011)

Finally, the June 10 journal also had a larger number of positive constructs (10) than negative constructs (4). More specifically, the positive constructs "understand" (4), "help" (2), "easy" (2), "fun" (1) and "cool" (1) were found and the negative constructs "paper" (2), "frustrate" (1) and "not understand" (1) were also found.

> "It did not increase my confidence because it made me frustrated and not understand most of the problems on the iPad" (BE, June 10, 2011)

> "The iPad really increased my confidence today. I got a lot of them right and if I got one wrong I saw what a still mistake" (CL, June 10, 2011)

Satisfaction.

The journals on March 25 and May 20, 2011 each had a second question which was geared to assess the students' satisfaction for the preceding week. Table 4 outlines the total number of positive and negative constructs in question #2 in each of the four individual journals that were used to assess satisfaction. Throughout the course of the study the total number of positive

constructs in question #2 of the satisfaction-based journals decreased, while the total number of

negative constructs also decreased.

Throughout both journals in March and May the number of positive constructs in the journals

was greater than the total number of negative constructs. The month of March had the largest

number of positive constructs (7), while May 20 had the lowest number of negative constructs

(0). May 20 had the lowest number of positive constructs (5), while March 25 had the highest

number of negative constructs (3).

Table 4: Student Journals (Satisfaction) – Construct Totals for Question #2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 25, 2011	7	3
May 20, 2011	5	0

During the March 25 journals the second question regarding satisfaction yielded a larger number

of positive constructs (7) than negative constructs (3). Tables in Appendix K detail the number

of individual constructs that were found within each journal for question 2 only. During the

March 25 journal the positive constructs found included "fun" (4), "excite" (1), "interest" (1),

and "focus" (1). The negative constructs found included "long" (1), "paper" (1) and "hard" (1).

> "Yes (it did increase my satisfaction) because I know I just learned a new way of completing the task" (BL, March 25, 2011)

> "It is in the middle (regarding my satisfaction) because doing my work on the iPad is the same as doing work on paper but the iPad is more fun" (ST, March 25, 2011)

> "No (it did not increase my satisfaction) because it is harder than just writing out" (GE, March 25, 2011)

Throughout the question #2 responses for the May 20 journals there was a greater number of positive constructs (5) than negative constructs (0). The positive constructs "focus" (2), "understand" (2) and "happy" (1) were found, versus zero negative constructs were found.

> "I feel like it did because when we did the quizzes on the iPad it showed me how good I was doing and also if I was doing it right" (BL, May 20, 2011)

> "Yes it did increase my satisfaction a little because it has shown me by us doing the flash cards on the iPad that I know what to do and I get all the flash cards right" (NU, May 20, 2011)

> "It increased my satisfaction of completing the math task because I was able to do the math in steps separately and as a whole equation which meant I understood the work" (RO, May 20, 2011)

> "The iPad increased my satisfaction because when you play a game and then you know how to do the math in the game it made me feel satisfied" (TH, May 20, 2011)

The results from question #2 of the student journals revealed a wealth of information. Over the course of the study, there was a consistently higher number of positive constructs then there were negative constructs in each of the journals, with the exception of those used to assess confidence where the numbers were found to be variable. In addition to this, there were notable cases such as the relevancy- and satisfaction-based journals which had a distinctly small discrepancy between the number of positive and negative constructs found.

Student Journals - Question #1 Only

The results of question #1 in the student journals will be revealed in the context of which

applications were being used during the days prior to the journal entries, considering this is what

the questions were referring to (Appendix I). Table 5 summarizes the applications being used as

well as the number of positive and negative constructs for each corresponding journal.

During the week prior to the March 4, 2011 journal the students were working on mathematical

tasks that required graphing. Applications used included Quick Graph, Sketch Book O, OmniGS

and WhiteBoard. Quick Graph generated graphs based on data entered by the student. Images

of the graphs were then saved and opened in Sketch Book O (a sketch pad application) and

appropriate labels were added here. OmniGS was an application that allowed the students to

generate their own graph and add appropriate labels. WhiteBoard was used alongside this to

perform needed calculations. With regards to constructs for March 4, there was a larger number

of positive constructs versus negative constructs (Appendix K). The following quotations are

taken from the student journals:

> "I think using the iPad is a fun and exciting new experience. I'm glad we got the
> opportunity to use them." CL

> "I felt like I was understanding what was going on. At points I got confused but
> understood what to do after a little bit." MC

> "I think that it's nice to have but if I was given the options of using pen and paper or the
> iPad I would pick pen and paper because it is a lot faster than using the iPad." GE

The following week (leading up to March 10 journals) the students continued to use OmniGS

and Sketch Book O in the same capacity as the week before. In addition to this a new

application, Underscore Notify, was also introduced. This application was used in place of

pencil and paper in order to write out mathematical calculations, using both the regular and math

functions keypad. Once the calculations were done the students used OmniGS to plot their

graph. During the March 10 journals, an equal number of negative constructs than positive

constructs (Appendix K). The following quotations are from the student journals:

> "I felt frustrated because on the app called "OmniGS" the line was acting extremely weird and it was messing up the equation of the solution." BE

> "I feel okay it still gets me mad when it deletes on its own or it disappears and I cannot get it back and I have to start over. I also get mad because it slows me down." BL

> "Now I am feeling kind of frustrated cause sometimes the buttons won't show and you have to click the keyboard so many times but I am kind of getting use to it." MI

The students continued to use Underscore Notify and OmniGS during the week of March 25,

2011. These two programs continued to be used to replace pencil and paper for mathematical

calculations and plotting graphs respectively. The one new application that was introduced this

week was Scrabble. In accordance with school rules, in which each class must undertake a

literacy initiative, the students were asked to play this word find game. During the week of

March 25, 2011 the number of positive constructs was greater than the number of negative

constructs found (Appendix K). The follow are quotes from the student journals for the week of

March 25.

"I think the iPad is fun when we play fun games (i.e. Scrabble) but to work on it takes too long" GE

"Excited and frustrating…I think they are fun to use. But can be frustrating when doing a math program since you have to press a lot and can be confusing." JL

"I like the iPads I like it when we get to play games like scrabble…I like playing games because there educational and fun too, and I like how I learn new things about the iPad every day." ST

The week leading up to the April 1, 2011 journal included the introduction of a new application for the students. Moving on to the concept of factoring the students were introduced to an application called Factor Race. This was a "game-based" application that was based around a car moving around a race track. The premise of the game was that if you were able to factor an equation properly your car would move around the track. The more laps you completed the harder the questions became. During this week there was a much larger number of positive constructs when compared to negative constructs (Appendix K). The follow are quotes from the student journals, commenting on the use of the Factor Race application.

"I felt excited…It was fun to play the racing game." KH

"I was excited to use it…I had lots of fun using new apps and stuff like that (Factor Race)." KS

"I feel excited, but it depends on what we are doing with the iPad…If we were doing something I can finish on paper faster than I can do on the iPad then it somewhat frustrates me but when we do math games I enjoy the experience more." CL

"I feel good when I am using the iPad the games really help me understand it more than before I didn't like it so much but now I really like it…I feel good because it gets it more into my mind, it helps me practice especially the games we play and I know how to use them now." AL

Continuing on with the factoring unit during the week of April 8, 2011, the students continued to use the Factor Race application, as well as a number of new factor-related applications. DIA Math was a fast-paced, interactive application that worked on the concept of determining what two numbers add to a given number and multiply to another given number. Sigma was a timed application where students needed to know the multiples of different numbers and place them in the correct column. Finally, Scrabble was used again for Literacy Friday. During the week of April 8 the positive constructs outnumbered the negative constructs throughout the journals (Appendix K). The follow are quotations from the student journals during the week of April 8.

> "I feel excited when using the iPad, I love playing the games…I feel good when using them because the games help me understand the math better and I can do it faster on the iPad, now that I know how to do the math I like using the iPad." AL

> "I feel excited when using the iPad, I love playing the games…I feel good when using them because the games help me understand the math better and I can do it faster on the iPad, now that I know how to do the math I like using the iPad." BE

> "It was okay this week we played game that will help us with our math skills." GE

> "I felt like I understand the work more…Because the apps helped me get a feel for what we were doing." RO

> "When I was using the iPads today I felt relaxed and more able to learn because with an iPad all I have to do it touch the screen." TH

Students' iPad use was more limited this week of April 15, 2011 since they were working mostly on word problems. The students were introduced to a new application called Class.com where they completed an interactive quiz that included video tutorials on how to complete the questions. In addition to this, the students continued using the Sigma application once they were finished their work to continue understanding the multiples of a number. During this week there

was a higher number of positive constructs versus negative constructs (Appendix K). The

following are comments from the student journals.

> "I felt excited because I know how to use them and I like to see if there are knew ways we can learn how to use math." BL

> "Excited…Because there are fun games that we play to help us in math." GE

> "I felt excited…Because the apps make it interesting to me to practice the solutions." JL

The week of April 29, 2011 the students were working on changing equations between different

forms (i.e. standard to vertex form). For these mathematical calculations the students used

Underscore Notify in place of pencil and paper. A new aspect of this program that they used was

the recording function, where they were required to orally explain the steps they took in the

mathematical calculations. During this week there was almost an equal number of negative and

positive constructs (Appendix K). The following are student journal comments.

> "A bit frustrated with certain programs…Yesterday Notify was not working properly but today I really enjoyed using it." CL

> "I feel frustrated with using the iPad…At first it was fun but when I go on the iPad I just seem to slow and I hate taking time to type in the math." KM

> "Frustrated. When writing the equation the numbers and math symbols buttons were hard to do because they are do hard to press because of their size." KS

> "Frustrated…Connecting the dots and graphing was difficult." KH

> "Frustrated…Since it takes a long time to write the equation out and to do the equation." JL

During the week of May 6, 2011 the students were asked to use the Class.com application which

they had completed a quiz on in an earlier week. Students were instructed that they were

required to review all incorrect answers and understand where they went wrong. Throughout the

journals for this week there was a larger number of positive constructs than negative constructs

(Appendix K).

> "It felt frustrated…Because the screen kept going black when I was trying to get the equation." BE

> "Excited and frustrated…I feel excited when we use fun apps and when I complete a problem. I get frustrated when an app does not work or if it takes a lot longer to do something on the iPad then it would on paper." CL

> "Good…I feel good when we did the quiz on it." KM

The students revisited a number of applications they had previously used during the week of

May 13, 2011. Working on quadratic transformations they used the OmniGS program to

illustrate their knowledge of translations and used Quick Graph to generate the graphs to which

they could compare their answers to ensure accuracy. The number of positive constructs and

negative constructs found throughout the journals this week were equal (Appendix K).

> "I like using the iPad, it is really useful and I do get excited using it…I like using it because it helps me understand my math better, and it gives me extra practice for graphing the x,y." AL

> "I get frustrated when the iPad doesn't work or I cannot plot a graph properly. In the program we used today, OmniGS, it is very sensitive and takes longer to use." CL

> "Frustrated because it takes so long to do one thing when it would take like 10 seconds just to write it out." GE

> "Frustrated…The new apps take longer to finish an equation then on paper." KS

"Slightly frustrated…I got a bit frustrated with the plotting on the graph in the beginning." MC

"I felt like I was accomplishing something…I felt this way because with the help of my classmates we were able to figure out an easier way to plot the U shape on a graph." NU

"I feel the iPad can get be a bit frustrated but I also enjoy using it…I feel this way because if for example on OmniGS the points won't go where you point it to go or if a dot travels in a line all over the place, it gets me frustrated and I usually have to start over, both other than that I enjoy using it." ST

During the week of May 20, 2011 the students were introduced to many new applications on the Apple iPads. The students used EZ Squares, a spatial connections game where students had to fit objects into the proper spaces within a controlled period of time, as an introduction to shapes as they moved into learning trigonometry. The students used an application called Trigonometry where they were required to work through an interactive lesson that included oral teaching of concepts with quizzes built in. The students were required to use paper and pencil or separate interactive whiteboards to complete the mathematical calculations. Finally the students used gFlashPro, an interactive flash card application that was generated by the PI through the use of a Google App spreadsheet. The PI developed flash card quizzes on the concept being learned in class (i.e. questions on the SINE ratio) and the students answered the multiple choice questions, using paper and pencil for their rough work. Whether they got the answer right or wrong was shown immediately. After the quiz was completed the questions that the students got wrong, along with a few they got right, were put together into a new quiz for them to complete. For the week of May 20, 2011 the number of positive constructs found throughout the journals

outnumbered those which were negative (Appendix K). The following are comments from the

student journals for this week.

> "Frustrated…Other than the game on the iPad I hate using to do math on. It slows me
> down a lot." KM

> "Frustrated…In the google program when we were doing cos, tan and sin quizzes, when
> you tap the screen twice it would be skipping a question and it kinda got annoying." KS

> "Slightly frustrated…I got confused with the Google app." MC

> "I feel like it is helping me understand the concept and remembering all the steps
> needed…I feel like this because the iPad makes things a lot more entertaining so if
> working on the apps that have to do with math it will stick in my head." NU

> "I really like using the iPad…I enjoy using it because I like using the apps to improve my
> math and get a better understanding. I also love using the games." ST

> "I feel more interested in the class…I feel like I am focusing more on the tasks at hand
> now." RO

Throughout the week leading up to May 27, 2011 the students used the Trigonometry application

once again. Since they were unable to complete the quiz during the last attempt they were given

the chance to start again and try to complete it. For the literacy component of the class the

students were introduced to Spell Stacker, a program that requires word generation like Scrabble,

but also gives them the definition as well.   During this week there was a larger number of

positive constructs found throughout the journals than negative constructs (Appendix K).

> "I really enjoy using the iPad…It is a very fun and interesting way to help me learn math.
> I really like the math games." CL

> "I really enjoy using the iPad…I feel this way because I really enjoy using the games on
> it the most." ST

During the week of June 3, 2011 the students were working with two applications they had used

before. Through Google Docs, the PI shared a worksheet containing Cosine word problems.

The students opened the Google Docs worksheet in Underscore Notify, where they were required

to answer the questions by either using the keypad or writing with their finger. In addition to

this, the students also used the gFlashPro program to complete multiple choice quizzes regarding

cosine law problems. Throughout these journals there was a greater number of negative

constructs than there was positive constructs (Appendix K). The following are quotes from the

student journals.

> "I love using the iPad because it makes me understand the math better, and it makes me
> focus on it. The app that really helps me focus is gFlashPro. That app gets me into math
> and helps me understand it, when I get the wrong answer I know its wrong because it not
> one of the options in gFlash Pro." AL

> "Because I did not understand some questions and I disliked the app Notify because it is
> hard to control, which makes me frustrated." BE

> "I really enjoy using gFlashPro, it is just as easy as using worksheets." CL

> "When using Notify I feel very frustrated because is very sensitive and its hard to zoom
> in and out or move up and down. It never works for me and it is very difficult to do my
> work and stay concentrate on the task when I am taking 30 mins to get the question up
> and I can do whole question in 2 mins on paper." RO

> "When using Notify I feel very frustrated because is very sensitive and its hard to zoom
> in and out or move up and down. It never works for me and it is very difficult to do my
> work and stay concentrate on the task when I am taking 30 mins to get the question up
> and I can do whole question in 2 mins on paper." JL

Finally, during the week of June 10, 2011 the students were working on reviewing for their final

exam. Throughout this week they used applications that allowed them the practice that they

needed. They used gFlashPro to complete an exam review quiz on flash cards, Fraction Drills to

work on adding, subtracting, multiplying and dividing fractions, Easel algebra to complete

multiple choice questions along with a built in whiteboard for rough work and finally Your

Teacher to complete practice problems for different areas. Throughout the journals for this week

there was a greater number of negative constructs than positive constructs found (Appendix K).

The following are comments from the student journals.

> "I really enjoyed using all the apps we used today (ex. Fraction drills, easel algebra, slope of line)…All of these apps were very easy to use. I really liked that if you got a problem wrong there was a button to show you where you went wrong." CL

> "When I use the iPad I feel frustrated…I feel frustrated because it takes forever to do one on it when if I just write it then it would take 30 secs." GE

> "I felt excited…Because there was a new app and it was easy to use, I like how I was able to write on the app to help me understand the question." KH

> "Helpful but at the same time frustrated…If I did something wrong it would let me know (fraction drill) and give me steps. Frustrated because I would do the fractions with different denominators faster on paper." JL

> "I feel comfortable…Because I know how to work the apps. What apps work best for each math task and it is easier to use." RO

Table 5: Timeline of Applications Used and Number of Positive and Negative Journal Constructs

Journal Date	Applications Used	Number of Positive Constructs	Number of Negative Constructs
March 4, 2011	Quick Graph + SketchBookO (March 3, 2011) OmniGS + Whiteboard (March 4, 2011)	19	8
March 10, 2011	OmniGS (March 7, 2011) SketchbookO + OmniGS (March 9, 2011) Underscore Notify (March 10, 2011)	7	10
MARCH BREAK			
March 25, 2011	Notify + OmniGS (March 21, 2011) Scrabble (March 25, 2011)	21	13
April 1, 2011	Factor Race (March 29, 2011) Factor Race (April 1, 2011)	20	10
April 8, 2011	DIA Math (April 5, 2011) DIA Math, Factoring (April 6, 2011) Factor Race, Sigma + Scrabble (April 8, 2011)	23	9
April 15, 2011	Class.com (April 11, 2011) Sigma (April 13, 2011) Sigma (April 14, 2011)	24	2
April 29, 2011	Underscore Notify (April 29, 2011) Underscore Notify (April 28, 2011)	12	16
May 6, 2011	Class.com (May 3, 2011)	16	10
May 13, 2011	OmniGS + Quick Graph (May 10, 2011) OmniGS (May 12, 2011)	20	20
May 20, 2011	EZ Squares (May 16, 2011) Trigonometry (May 17, 2011) gFlashPro (May 18, 2011) gFlashPro (May 19, 2011) gFlashPro (May 20, 2011)	17	8
May 27, 2011	Trigonometry (May 25, 2011) Spell Stacker (May 27, 2011)	16	2
June 3, 2011	Underscore Notify + Google Docs (May 31, 2011) gFlashPro (June 1, 2011) gFlashPro (June 3, 2011)	19	33
June 10, 2011	gFlashPro (June 6, 2011) Fraction Drills + Easel Algebra + Your Teacher (June 10, 2011)	6	13

Overall the results from question #1 of the student journals indicate an increase in the number of positive constructs when applications such as Quick Graph, Scrabble, Factor Race, DIA Math and Sigma were used. In contrast, there was an increase in negative constructs during weeks when applications such as Underscore Notify and OmniGS were used regularly.

Teacher, EA Interviews and PI Observational Field Notes.

The teacher and educational assistant interview and principal investigator observational field notes data will be combined when stating the results. This results section will be split into 3 categories, being planning, implementation and student use. Within each of these categories the results will be outlined based on being a positive or negative aspect. Also, from this point on the classroom teacher will be referred to at times as teacher, educational assistant as EA and principal investigator as PI. Together these three individuals will be referred to at times as "the team".

Planning.

Throughout the planning stages one of the most positive discoveries was the ability to make use of applications to practice skills which were already taught. These applications eliminated the need to create multiple worksheets to facilitate this. The classroom teacher used these repetition-based applications most regularly for the topic of factoring.

"Had a lot of opportunity to use the iPads to practice factoring skills which was a concern of mine when we first started, but this week was great" (MM, April 8, 2011)

"DIA Math worked on factoring skills which is a concept the students have been struggling with" (LW, April 8, 2011)

The planning process was also simplified by applications such as gFlashPro which instantly created flash cards for students based on information entered relatively effortlessly into an online spreadsheet by the principal investigator. The instantaneous delivery of information via the wireless internet connection to the Apple iPads also allowed for impromptu variations/changes if necessary. The following principal investigator observation sums up how the simplicity of gFlashPro made the planning so easy:

"Created a Google Spreadsheet on Google Apps with 34 multiple choice questions for trigonometry review in only a few minutes and shared it with all the students in the classroom…so easy" (LW, June 3, 2011)

Finally, another portion of the planning process that was found to be positive was when the daily expectations allowed for the use of applications previously used. From a planning perspective, the team observed that there was often not enough time to explore new applications. In contrast, when a previous application was used this afforded the team more time to learn more intricate features of the previously used applications, instead of just trying to learn the basics of how it works. The classroom teacher also expressed how using previously used applications made the planning process so much easier for her.

"It was very easy and straight forward this week since the apps used were apps they had used throughout the semester" (MM, June 17, 2011)

Some negative aspects of planning were also observed by the team. The most significant of these was the lack of breadth with regards to available applications. The team spent an substantial amount of time searching for applications that corresponded to the concept being taught and this was often not successful. Since the principal investigator did the majority of the investigations for appropriate applications, the following comments from the observational field notes explain the frustration very clearly:

> Word problems???? Apps???? iPad???? What to do!!!" (LW, April 15, 2011)

> "No trigonometry apps….grrrrrrr. So frustrating when I look and look and there are no apps that apply to what we are working on" (LW, May 27, 2011)

Once the team came to the conclusion that specific applications could not be found for every math concept they decided to investigate general applications that could be adapted to fit the topic. This was another time consuming task during the planning process for two reasons. Firstly, many hours were spent trying to find general applications that allowed for accommodations and secondly, the process of manipulating it to fit the need was very time consuming. One topic in particular that the team needed to use general applications was trigonometry. The Underscore Notify application was used as an alternative to pencil and paper for students to demonstrate their knowledge of concepts such as completing the square and changing the form of equations. There were many aspects of this program that were conducive to this process, such as a mathematical functions keypad, ability to write free hand, draw diagrams, etc. On the other hand, the negative part of using this general application (that was not intended for mathematics) meant that it was very cumbersome for the students to use.

"Trigonometry requires a few steps to solve – Notify graph allows students to write or type answers but without having proper images that did not matter" (MM, June 3, 2011)

"Students were not really motivated to do this in this program because they find it cumbersome. The program is great because it has all the math symbols, etc. that you need but it is not overly easy to manipulate. Heard some grumblings like I wish we could just do this on paper, etc." (LW-April 29, 2011)

Another negative aspect of planning was the inability to send work between the students and teacher. Many different applications were investigated but failed for a number of reasons. One particular example of this was when the teacher wanted the students to complete a test on their mobile devices. In order to attempt this many different routes were investigated.

"Starting to plan next week's lessons – concerned how we can use the iPads for them to complete their tests" (MM, May 27, 2011)

"…in Dropbox the students cannot connect, GFlash Pro I could not import images, and Notify was much too finicky" (MM, June 3, 2011)

In summary, the positive aspects of the planning process as outlined throughout the Teacher and EA interviews and observational field notes include the use of practice based applications for the students to hone their skills, applications that allowed for easy entering of information and when applications that were previously used could be used subsequently for another class. Negative aspects that were identified included the lack of breadth of applications available, the time spent seeking out and sub sequentially manipulating general applications for more specific purposes as well as the inability to send work and back forth between the students and teacher.

Implementation.

When it came to implementing the Apple iPads into the classroom the most positive observation

was the ability to cater to different levels of learners easily and discreetly. The teacher was able

to assign different levels of the same application, or completely different applications, based on

each student's level of understanding. The following quotes from the principal investigator's

observational field notes provide one example of how different levels of one application were

used to accommodate students and one example of how different applications were used to meet

the needs of the students.

> "Students started out with DIA Math (application for factoring that was used the day
> before) and as the students were beginning to find it easy they were instructed to change
> the settings to hard as this would be more of a challenge for them; being able to adjust the
> difficultly of the app was very useful as this allowed for all students to be able to work at
> their own pace (there were students working at all levels and still finding success)" (LW,
> April 8, 2011)

> "Those who were on the iPads were playing either Factor Race or Sigma. The teacher
> Informed the student which app they should be working on based on where they were at
> with factoring. This was excellent because nobody felt as though they were "behind"
> because they were on a certain application" (LW, April 8, 2011)

Similarly, most applications could be adapted to reach different types of learners with different

areas of need. For example, the principal investigator implemented a general application for the

students to demonstrate their understanding of a trigonometry concept. Within this application,

the students were allowed to choose how they wanted to demonstrate their knowledge, either

through written work, and/or visual diagrams and/or audio recording. The day in which this

particular application was implemented was on a day when a supply teacher was in the

classroom and her comment below provides an outsider's take on how this day went:

> "The variety of ways to teach the same lesson is helpful – writing, drawing and recording voices very helpful in reaching a variety of learners (audio, visual, tactile)". (SS, April 29, 2011)

Throughout the course of the study the team found themselves taking a significant amount of

time demonstrating applications whenever a new one was being introduced. Without this, the

team experienced the students spending a wealth of their time trying to understand the

application and not necessarily learning about the mathematical concept. One particular

application that took a wealth of time to teach to the students was OMNI Graph, which was used

to plot graphs during many different classes. Before using this application for the first time the

team took approximately twenty minutes to prepare the students. In addition, each subsequent

time it was used the students needed a brief explanation as well. With the assistance of

overheads created by the principal investigator, the team went through how to set up a template

graph (i.e. setting axis to 10 point, adjusting tick space to 1 and inserting a grid) (May 13, 2011).

After completing the set-up process as a class the students seemed comfortable using and even

exploring the application. Overall, the time spent teaching the students how to use the

application was unfortunate because this meant less time actually using it, but it was also positive

because it gave them the confidence to use it once they had the chance to do so.

Another aspect of the implementation that was both negative and positive was the "check work"

aspect of many applications. This feature provided the students with solutions for them to check

their work once finished. Although some benefited from this feature, some took advantage and

avoided doing the actual work. One application called Trigonometry was a quiz-based

application that allowed the students to look back to the questions they got wrong and view the

correct responses. Observations by the principal investigator indicated that "those students who

used the review feature of the application indicated much more satisfaction at the end since they

knew exactly where they went wrong" (May 6, 2011).

Some negative aspects of implementing the Apple iPads into the classroom were also observed.

The most significant of these was that many applications required the students to continue using

paper and pencil and external calculators, in addition to their Apple iPads, to complete the tasks

presented. This created organization issues and clutter on their desk. Since organizational skills

are explicitly taught to the students in the Learning Strategies class, this was counter-productive.

The principal investigator observed the students becoming very frustrated when they were

required to use pencil and paper, a calculator, as well as their iPad.

> "Using pencil and paper and a separate calculator looked extremely frustrating because it
> was a lot on the desk and annoying for the students. Often time by the time they had their
> question solved on the paper their iPad was in sleep mode and it was a process for them
> to get back on" (LW, May 20, 2011)

The PI also observed the inability to use the recording function of programs properly because of

background noise and lack of headsets with microphones. During one particular class the

students were trying to record in Notify and when they played their recording back it was very

hard to hear because all the other students were speaking in the background (April 29, 2011).

Unfortunately this did not motivate the students to want to continue.

Next, if the students were finishing their written work at different times it became difficult to not

distract those who were still working while distributing the Apple iPads and demonstrating

applications to those who were done. The team attempted strategies such as delivering the iPad,

and explaining the application to individual students and explaining, or stopping everyone

(including those who were not done) and explaining the application all at once. Unfortunately

both of these strategies were not effective.

Technical issues, although there were not too many of them, severely impacted the students'

ability to focus on the concept being learned. One specific example of this was when gFlashPro

(a flashcard program used for quizzes) was originally implemented into the classroom. Prior to

class, the principal investigator created usernames and passwords for each student based on the

Google Docs accounts previously made for each student by the host school. Once in the

classroom each student was instructed to sign in to gFlash Pro and unfortunately some of them

were unsuccessful in doing this. Although this issue was resolved relatively quickly, the students

were clearly frustrated and this technical issue overshadowed the students' experience with the

program for about half the period (May 20, 2011).

Finally, the teacher, PI and EA each found frustration when they were unable to answer the

questions that arose pertaining to the applications. The team found this usually happened when

they did not have sufficient time to learn them prior to their usage in the classroom.

"The students have questions about new apps that we aren't always able to answer. I need more practice too!!" (MM, March 10, 2011)

In summary the positive aspects of the implementation process identified by the teacher and EA interviews and the observational field notes include the ability of many applications to cater to both the different levels of learners as well as the different types of learners. Some aspects that were both positive and negative include the fact that applications needed to be demonstrated, which was time consuming but beneficial with regards to efficiency in the classroom, as well as the check work function of application which was very beneficial to students but was not often used. Finally there were a number of negative aspects of the implementation process that were identified. The most significant one was the fact that many applications still required the students to use paper, pencil and an external calculator, making their desks extremely unorganized. Other negative aspects included the inefficiency of the recording function, the students finishing at different times and being unaware of when to demonstrate, minor technical problems and being unable to answer student questions regarding applications.

Student Use.

The team made many positive observations with regards to student use. One that stood out to all three members of the team was the increased collaboration between students when using the mobile devices. The following quotes demonstrate each individual's observation of the increased collaboration between students:

"The students are much more engaged with each other when using the iPads" (CG, April 15, 2011)

"Many students were helping each other out if they could not figure out the answers using the Factoring app" (LW, April 8, 2011)

"They help each other out with explaining how to play certain games" (MM, April 1, 2011)

In addition to collaboration, the team also observed a degree of healthy competitiveness among the students when using certain applications, which pushed them to keep trying to outperform their classmates. On one particular day, with only 15 minutes left in the class, the students were asked open up an application called Factor Race. This application was based around the participant's car moving around the track every time they factored an equation properly and staying still if they were incorrect. The team instructed the students to turn the volume on their device to high and prepare to race their classmates to the finish line. After being counted in by the principal investigator the students began working on factoring their equations. If they factored their equation properly everyone heard their car "zoom" around the track, at which time we observed others become extremely determined to take the lead. The principal investigator recorded one student's comments during this competition which explained how "exciting it was to be a part of" (RO).

The instant feedback provided by the applications was observed by the team to be something the students enjoyed. Knowing right away if they were right or wrong allowed them to correct their mistakes right away. The educational assistant picked up on how much they enjoyed the instant

feedback. The gFlash Pro (flashcard) application was particularly good at providing immediate

feedback.

> "(The students) seem to like using gFlashPro as it have them immediate feedback on their
> work (i.e. answers)". (CG, June 3, 2011)

The principal investigator also commented on how the students (and teacher) appreciated the

immediate feedback of many of the applications.

> "Immediate feedback on the multiple choice was great for many of them because if they
> got it wrong this allowed them to go back to their work themselves and see where they
> went wrong and fix it. Without it they simply got it wrong and if it was not checked then
> they did not know where they went wrong. The application was ensuring the answer is
> right all the time." (LW, June 3, 2011)

The students became extremely frustrated when they did not understand, or were unable to

manipulate, an application. This was a negative observation echoed by the teacher, EA and PI.

The graphing applications in particular were very "touchy" and students were observed by the

team to be so frustrated that many wanted to just use pencil and paper instead.

> "Students were given an equation and asked to put the equation from standard form to
> vertex form using completing the square method in NOTIFY. Students were not really
> motivated to do this in this program because they find it cumbersome. The program is
> great because it has all the math symbols, etc. that you need but it is not overly easy to
> manipulate. Heard some grumblings like I wish we could just do this on paper, etc."
> (LW, April 29, 2011)

With regards to positive aspects of student use, the team did observe that as the students began to

understand how to manipulate the Apple iPad and the applications, the level of frustration

declined and their comfort and confidence level increased. One specific example of this

involved one of the participants who has autism and would not normally speak at the front of the

classroom. After working on one of the applications he discovered features that even the team

was unaware of and when asked he complied with demonstrating this at the front of the

classroom.

One particular day the principal investigator observed how the student's reactions to using a new

application changed from how they reacted at the beginning of the study:

> "Being the first time they were using the app, the team was expecting more of an "up-roar" (moaning, freaking out, etc.) as we had experienced with other apps when using it for the first time. The "up-roar" was not seen this time. Seems students are not as "scared" to try new apps and are not complaining. They seem to dive in and not afraid to make mistakes as much. More comfortable" (LW, May 20, 2011)

The classroom teacher and educational assistant also picked up on this positive trend with the

students as they became more comfortable with the mobile devices.

> "They are becoming a lot more comfortable with them – also more willing to try new apps" (MM, April 1, 2011)

> "Are more willing to use the iPad. They were using new programs without hesitation" (CG, May 20, 2011)

> "Their frustration levels have dropped drastically" (CG, May 27, 2011)

> "Are more willing to use new apps with little to no direct instructions" (CG, June 10, 2011)

Each of the team members also commented on the students' increased ability to focus and remain engaged as the study progressed. When using the DIA Math application, which focuses on factoring, both the teacher and principal investigator noticed how focused the students were on the task.

> "Students worked directly through to the end of the period (we had to pry them out of their hands) and were very excited about using them today (DIA Math)" (LW, April 8, 2011)

> "Look very engaged and excited when on their iPads" (MM, April 8, 2011)

Both negative and positive aspects of student use were identified throughout the teacher and EA interviews as well as the observational field notes. Some positive aspects of student use included the increase collaboration between students, increased healthy competition amongst students and student enjoyment of instant feedback from many applications. The most prevalent negative aspects noticed with regards to student use was the increasing frustration demonstrated by students when they did not understand how to manipulate an applications. On a positive note, the team did notice a marked decrease in frustration once they became more confident in using the application.

Discussion

This study was designed to explore the use of Apple iPads by students with exceptionalities in their mathematics classes. In a mid-size suburban high school in Ontario, Canada 16 students, their teacher and educational assistant embraced the opportunity to use these new devices. The principal investigator set out to explore the effects on student motivation levels based on ARCS

Theory of Motivational Design, looking at attention, relevance, confidence and satisfaction as indicators. Secondary to this, the factors that impacted the planning, implementation and student use of the devices were also considered, as this information provided valuable reference points for the other data collected.

Overall results from this study indicated that student motivation levels remained relatively consistent throughout the course of the study. Some minor exceptions include student reports of elevated attention, confidence and satisfaction levels during the month of April and the increasing student attention, confidence and satisfaction levels observed by the PI towards the end of the study period. The relative consistency in motivation levels found in this study are similar to the results obtained by Chao & Chen (2009), who implemented the use of mobile phones to compliment paper textbooks, and reported that the mobile phones served to either sustain or arouse student motivation levels. Results pertaining to the planning, implementation and student use of Apple iPads revealed a wealth of positive and negative aspects of these different areas. Some notable examples include the lack of topic-specific applications, the ability to accommodate applications to different learning levels and styles, as well as the significant amount of time spent preparing outside of the classroom. Donnelly, McGarr & O'Reilly (2011) also reported that the time spent doing preparation outside of the classroom was a significant negative aspect of planning the use of mobile technology in the classroom. Finally, results also indicated that the students interacted more positively with "game-like" applications versus "general-use" applications.

Referring back to the conceptual framework in Figure 1, this will inform the interpretation of the results. As per the conceptual framework, the Apple iPads were implemented into the classroom in order to have an effect on student motivation, which was indicated by four variables, namely attention, relevance, confidence and satisfaction, and evidenced by the outputs of effort and performance. After implementing the Apple iPads, the four indicators of motivation were assessed through student motivation surveys and journals, as well as observation scales completed by the PI. As mentioned earlier, the attention, relevance, confidence and satisfaction levels remained relatively consistent, which some minor exceptions. According to the framework, this relative consistency of the indicators reflects a relative consistency in student motivation levels overall. Further evidence to support these results came from the teacher and educational assistant interviews and observational field notes, where direct comments reported relative consistency in the outputs of student effort and performance over the course of the study.

Some minor discrepancies were found amongst the results of the instruments used to assess student motivation. Results from the motivation surveys indicated that students reported elevated attention, confidence and satisfaction levels during the month of April. Conversely, results from the student journals (Q#2 only) revealed a larger number of positive constructs than negative constructs in the journals assessing each of the individual variables, with the exception of the confidence-based journals that had variable results. Finally, the observation scale results indicated that the students were observed as having higher attention, confidence and satisfaction levels towards the end of the study period. One possible explanation for this discrepancy could be the nature of the questions asked in the motivation survey and observation scale in particular (Appendices G and H). As an example, the attention-based questions in the Motivation Survey

pertained specifically to how interested the students were in the mathematics being learned;

versus the Observation Scale questions referred to how physically attune the students were to the

task. Knowing this, it is possible that a student could have been uninterested in a topic, but to the

PI he/she still appeared physically engrossed in their work. Referring back to the conceptual

framework, the PI could have observed an output of effort and performance, while the student

was not actually putting forth an effort or performing to their best. The differences in the results

could also be explained by the possibility that the students were reporting in their surveys and

journals based only on the application(s) they were using on that particular day, versus the PI

who used the running record of observations made throughout the week to complete the

observation scale.

In addition to this, it is possible that the type of application being used could further explain

some of the exceptionalities in the results. Based on the results from the student journals (Q#1

only), students appear to have embraced some applications more than others. The "general use"

applications, namely OmniGS and Underscore Notify, which were implemented as enhanced

pencil and paper applications, appeared to be very poorly regarded by the students. During the

weeks in which only "general use" applications were used (scattered throughout the study

months) the students reported consistently higher numbers of negative constructs throughout

their journals. In contrast, the students appeared to eagerly accept the use of "game-based"

applications, which were developed to interactively address the topic directly. Examples of

applications within this "game-like" category include Factor Race, DIA math and Trigonometry.

During the weeks in which students used only these "game-like" applications (specifically

April), there was a consistently higher number of positive constructs throughout the student

journals. These increased results in April specifically correlate with the increases in attention,

confidence and satisfaction reported in the motivation surveys during this month as well. These

results offer the possibility that "general use" applications cause students frustration, confusion, a

preference to work with pencil and paper, as well as many other negative feelings that the

journals suggest. Alternatively, the results could also suggest that the "game-like" applications

may foster feeling of being helped, excitement, fun and many other positive affirmations

suggested by the students.

As stated previously, the factors, which affected the planning, implementation and student use of

the Apple iPads in the classroom were also considered. This information was gathered based on

teacher and educational assistant interviews, as well as principal investigator field notes. Results

indicated that the factors that affected the planning process in a positive manner included the

availability of applications that provided practice drills, were easy for the teacher to transfer

information to, and were previously understood by the students, which allowed the teacher

opportunity to discover different features. The negative aspects of the planning included the lack

of applications available on all topics studied, the extensive amount of time used trying to

accommodate general applications to meet specific needs, and the inability to send work

efficiently between the teacher and student. With regards to implementation, the most positive

aspects were that many of the applications could easily and discreetly be manipulated to fit the

learner's level of understanding and/or their individual needs and preferred learning style. Lying

in the middle of positive and negative with regards to implementation was the need to perform

demonstrations for all new applications, which then eliminated the fury of questions but was

time consuming, and the check work option of the applications, which only some students took

advantage of. Negative aspects of the implementation process included the need to use pencil

and paper with many applications, the students beginning iPad use at different times and causing

distractions, technical issues causing frustration for the students, and finally the teacher being

unable to answer questions if time spent learning the application beforehand was not sufficient.

Finally, the interviews and field notes assessed the factors, which impacted student use of the

Apple iPads. These results indicated that as the study progressed, both collaboration and healthy

competition between peers appeared to increase, as well as their appreciation for instant feedback

provided by the applications. On a negative note, the frustration levels of the students increased

significantly if they did not understand how to manipulate an application and many of them

became bored if they were on the application too long.

Overall the results discussed above do provide insight into the use of mobile devices by students

with exceptionalities in the mathematics classroom. With the exception of minor oddities in the

data, it appears the overall motivation level of students (using ARCS as a framework) remained

relatively consistent throughout the study. Although this may appear to be somewhat

insignificant to some, understanding the profiles of these students, as well as the experiences of

those previously enrolled in this course, suggests that maintaining consistent levels of motivation

throughout the semester is encouraging. Although extremely capable individuals, many of the

students enrolled in this particular class have a history of difficulty with mathematics. In

addition to this, the specific topics presented during the study period are known to cause

frustration and defeat in many students, even those not identified as exceptional. Knowing these

precluding factors leads to the possibility that using mobile devices provided these students with

exceptionalities a beneficial tool, allowing them to persevere in a time when they might have normally given up.

This study provided a basis of opportunity for everyone involved. Starting with the students, they were given a chance to use one of the most innovative pieces of technology, but more importantly they were granted the time to further understand themselves as a learner. Many discovered different aspects of the devices that worked, or did not work, for them, which was often a reflection of their learning style. This new awareness and knowledge regarding their personal learning style is sure to assist them in other educational endeavours. The teacher. educational assistant and principal investigator were also beneficiaries of this study. Through the planning and implementation processes in particular each of these individuals gained a wealth of knowledge surrounding the use of mobile devices in the classroom. Moving forward, this team of people will be able to serve as guides and sources of reference for future teachers looking to bring mobile technology into the classroom.

Study Limitations

After discussing the results above, it is also important to state the limitations of this research. The sample size used in this study (n=16) was small, limiting the generalizability of the findings. A relatively short study period (4 months) could also have limited the consistency of the results. The unavailability of topic-specific applications for the devices was also a limitation because this forced the researcher to implement more general-use applications which were not designed for

that purpose. Finally, despite being acknowledged and compensated for upfront and throughout

the study, the researcher effects mentioned earlier were inevitably present.

Conclusions

Recognizing the general acceptance of mobile devices for mainstream use it seems logical that

their move into the education system is inevitable. Many studies have attempted to bridge this

gap, but their place in the educational world has not yet been established. The results of this

small study contribute to the possibility that mobile devices can serve a purpose in the

motivation of students with exceptionalities in mathematics. This conclusion can be evidenced

by the relatively consistent motivation levels observed of, and reported by, the students

throughout the course of the study. In addition, the results from this study also revealed

numerous factors that need to be investigated with regards to the planning, implementation and

student use of mobile devices in the classroom. The most notable negative factor was the lack of

topic-specific applications that are currently available and the subsequent task of adapting

general applications to fit more specific needs. Alternatively, some of the more positive factors

include the ability of many applications to meet the needs of different learning levels and the

student collaboration fostered by the use of the devices. In conclusion it is clear that although

mobile devices can play a role in motivating students in the mathematics classroom, further

inquiry is required on how to do this most effectively.

Future Implications

Future studies of this nature should include both larger sample sizes and longer periods of study time, allowing for increased validity of the results. Additionally, in order to increase the efficiency of mobile device use, and the study overall, a number of other parameters should also be considered. Application development should be based on ARCS Theory of Motivational Design, ensuring that each dimension of motivation is supported. Students should be permitted and encouraged to use their devices beyond the classroom, including in other classes and at home. By doing this, it is possible that this would foster a better relationship with the device, allowing the student to become more familiar with it and more confident to incorporate it into their daily routines. Students should also be given permissions to add their own applications, eliminating this cumbersome process for one individual to undertake, as well as encouraging the feeling of ownership in students.

References

Education Act of Ontario. (2011, September 20). Retrieved from Ontario Ministry of Education: http://www.edu.gov.on.ca/eng/general/elemsec/speced/edact.html

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M. T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers and Education, 53*, 74-85.

Anthony, A. B., & Clarke, L. M. (2011). Examining dilemmas of practice associated with the integration of technology into mathematics classrooms serving urban students. *Urban Education, 46*(6), 1300-1331.

Apple Incorporated. (2011, September 23). *Apple iPad: Apple Incorporated*. Retrieved from Apple: http://www.apple.com

Baird, G. L., & Scott, W. D. (2009). Cognitive regulation in youth with and without learning disabilities: Academic self-efficacy, theories of intelligence, learning vs. performance goal preferences, and effort attributions. *Journal of Social and Clinical Psychology, 28*(7), 881-908.

Bandura, A. (1986). *Social foundations of thought and action.* New Jersey: Engelwood Cliffs.

Bandura, A. (1995). *Self-efficacy in changing societies.* New York: Cambridge University Press.

Barkatsas, A., Kasimatis, K., & Gialamas, A. (2009). Learning secondary mathetmatics with technology: Exploring the complex inter-relationship between students' attitudes, engagement, gender and achievement. *Computers & Education, 52*, 562-570.

Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and percieved student learning in technology-using classrooms? *Computers & Education, 39*(4), 395-414.

Belland, B. (2009). Using the theory of habitus to move beyond the study of barriers to technology integration. *Computers & Education, 52*, 353-364.

Bennett, S. (2009, January). *What works: Research into Practice*. Retrieved September 28, 2010, from What works: Research into Practice: http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Bennett.pdf

Broussard, S. C., & Garrison, M. E. (2004). The relationship between classroom motivation and academic achievement in elementary school-aged children. *Family and Consumer Sciences Research Journal, 33*(2), 106-120.

Bryant, D. P. (2005). Commentary on early identification and intervention for students with learning disabilities. *Journal of Learning Disabilities, 38*, 41-54.

Bryant, D. P., Bryant, B., & Hammill, D. D. (2000). Charactertic behaviours of students with LD who have teacher-identified math weaknesses. *Journal of Learning Disabilities, 33*(2), 168-177.

Carnahan, C., Musti-Rao, S., & Bailey, J. (2009). Promoting active engagement in small group learning experiences for students with autism and significant learning needs. *Education and Treatment of Children, 32*(1), 37-61.

Chao, P. Y., & Chen, G. D. (2009). Augmenting paper-based learning wtih mobile phones. *Interacting with Computers, 21*, 173-185.

Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Comptuers & Education*, 77-90.

Cleary, T. J., & Chen, P. P. (2009). Self-regulation, motivation and math achievement in middle school: Variations across grade level and math contexts. *Journal of School Psychology, 47*(5), 291-314.

Deci, E. L., & Ryan, R. M. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67.

Desoete, A., Roeyers, H., & De Clercq, A. (2004). Children with mathematics learning disabilities in Belgium. *Journal of Learning Disabilities, 37*(1), 50-61.

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education, 57*, 1469-1483.

Duffy, T. M., & Cunningham, D. J. (Eds.). (1996). *Constructivism: Implicaions for the design and delivery of instruction.* New York: Simon & Schuster MacMillan.

Dunn, P. B., & Shapiro, S. K. (1999). Gender differences in achievement goal orientations of ADHD children. *Cognitive Therapy and Research, 23*(3), 327-344.

Facer, K., Joiner, R., Stanton, D., Reid, J., Hull, R., & Kirk, D. (2004). Savannah: mobile gaming and learning. *Journal of Computer Assisted Learning, 20*, 399-409.

Feng, S. L., & Tuan, H. L. (2005). Using ARCS model to promote 11th graders' motivation and achievement in learning about acids and bases. *International Journal of Science and Mathematics Education, 3*, 463-484.

Franken, R. E. (1994). *Human motivation* (3 ed.). California: Brooks/Cole.

Franklin, T., Sexton, C., Lu, Y., & Ma, H. (2007). PDAs in teacher education: A case student examining mobile technology integration. *Journal of Technology and Teacher Education, 15*(1), 39-57.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59-109.

Fuchs, L. S., Fuchs, D., Powell, S. R., Seethaler, P. M., Cirino, P. T., & Fletcher, J. M. (2008). Intensive intervention for students with mathematics disabilities: Seven principles of effective practice. *Learning Disability Quarterly, 31*, 79-92.

Garcia, J. N., & Caso, A. M. (2004). Effects of a motivational intervention for improving the writing of children with learning disabilities. *Learning Disabilities Quarterly, 27*, 141-159.

Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach* (4 ed.). New York: Longman.

Gottfried, A., Marcoulides, G., Gottfried, A., Oliver, P., & Guerin, D. (2007). Multi-variate latent change modelling of developmental decline in academic intrinsic math motivation and achievement: Childhood through adolescence. *Journal of Behavioural Development, 31*(4), 317-327.

Gredler, M. E. (1997). *Learning and instruction: Theory into practice* (3 ed.). Saddle River, New Jersey: Prentice-Hall.

Harackiewicz, J. M., Barron, K. E., Tauer, J. M., & Elliot, A. J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Education Psychology, 94*(3), 562-575.

Heider, F. (1958). *The psycholoy of interpersonal relations.* New York: Wiley.

Howard, K. (1989). A comprehensive expectancy motivation model: Implications for adult education and training. *Adult Education Quarterly, 39*(4), 199-210.

Hsieh, P. P., & Schallert, D. L. (2008). Implications from self-efficacy and attribution theories for an understandin of undergraduates' motivation in a foreign language course. *Contemporary Educational Psychlogy, 33*(4), 513-532.

Huang, Y. M., Lin, Y. T., & Cheng, S. C. (2010). Effectiveness of a mobile plant learning system in a science curriculum in Tiawanese elementary education. *Computers & Education, 54*, 47-58.

Huett, J. B., Kalinowski, K. E., Moller, L., & Huett, K. C. (2008). Improving the motivation and retention of online students through the use of ARCS-based emails. *The American Journal of Distance Education, 22*, 159-176.

Irish, C. (2002). Using peg- and keyword mnemonics and computer assisted instruction to enhance basic multiplication performance in elementary students with learning and cognitive disabilities. *Journal of Special Education Technoloy, 17*, 29-40.

Jonassen. (1995). Computers as cognitive tools: Learning with technology, not from technology. *Journal of Computing in High Education, 6*(2), 40-73.

Jonassen, D., Wilson, B. G., & Peck, K. L. (1999). *Learning with technology: A constructivist perspective.* Upper Saddle River, New Jersey: Merrill/Prentice Hill.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education, 55*, 427-443.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education, 55*, 427-443.

Keller, J. (1979). Motivation and instructional design: A theoratical perspective. *Journal of Instructional Development, 2*(4), 26-34.

Keller, J. (1983). Motivational design of instruction. In C. Reigeluth, *Instructional design theories and models: An overview of their current status* (pp. 383-434). Hilldale, New Jersey: Lawrence Erlbaum Associates Inc.

Keller, J. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development, 10*(3), 2-10.

Keller, J. (2006). *ARCS Model*. Retrieved February 19, 2012, from ARCS Model: http://www.arcsmodel.com/home.htm

Keller, J. (2010, October 12). *Home: ARCS Model of Motivational Design*. Retrieved from ARCS of Motivational Design: http://www.arcsmodel.com/home.htm

Klassen, R. (2002). The changing landscape of learning disabilities in Canada. *School Psychology International, 23*(2), 199-219.

Klassen, R. M., & Lynch, S. L. (2007). Self-efficacy from the perspective of adolescents with LD and their specialist teachers. *Journal of Learning Disabilities, 40*(6), 494-507.

Klassen, R. M., Krawchuck, L. L., Lynch, S. L., & Rajani, S. (2008). Procrastination and motivation of undergraduates with learning disabilities: A mixed-methods inquiry. *Learning Disabilities Reseach & Practice, 23*(3), 137-147.

Lackaye, T. D., & Margalit, M. (2006). Comparisons of achievement, effort and self-perceptions among students with learning disabilities and their peers from different achievement groups. *Journal of Learning Disabilities, 39*(5), 432-446.

Lai, C. H., Yang, J. C., Chen, F. C., Ho, C. W., & Chan, T. W. (2007). Affordances of mobile technologies for experiential learning: The interplay of technology and pedagogical practices. *Journal of Computer Assisted Learning, 23*, 326-337.

Lainema, T. (2009). Constructivusm as a meaning-making structure for stimulation gaming. *Simulation & Gaming, 40*(1), 48-67.

Lajoie, S. P., & Derry, S. J. (Eds.). (1993). *Computers as cognitive tools.* Hillsdale, New Jersey: Lawrence Erlbaum.

Lave, J., & Wenger, E. (1991). *Situated learnin: Legitimate peripheral participation.* Cambridge, UK: Cambridge University Press.

Learning Disabilities Association of Canada. (2002, January). *Official Definition of Learning Disabilities*. Retrieved September 28, 2010, from Learning Disabilities Association of Canada: http://www.ldac-acta.ca/en/learn-more/ld-defined/official-definition-of-learning-disabilities.html

Learning Disabilities Association of Canada. (2007, March). *Putting a Canadian Face on Learning Disabilities*. Retrieved September 28, 2010, from PACFOLD: http://www.pacfold.ca/download/NationalProfiles/en/16-21.pdf

Liem, A. D., Lau, S., & Nie, Y. (2008). The role of self-efficacy, task value, and achievement goals in predicting learning strategies, task disengagement, peer relationship and achievement outcome. *Contemporary Educational Psychology, 33*, 486-512.

Lincoln, A., & Chazan, S. (1979). Percieved competence and intrinsic motivation in learning disability children. *Journal of Child Psychology*, 213-216.

Linnenbrink, E. A., & Pintrich, P. R. (2002). Motivation as an enabler for academic success. *School of Psychology Review, 31*(3), 313-327.

Liu, T. C., Wang, H. Y., Liang, J. K., Chan, T. W., Ko, H. W., & Yang, J. C. (2003). Wireless and mobile technologies to enhance teaching and learning. *Journal of Computer Assisted Learning, 19*, 371-382.

Liu, T. Y., & Chu, Y. L. (2010). Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation. *Computers & Education, 55*, 630-643.

Liu, Y., & Szabo, Z. (2009). Teachers' attitudes toward technology integration in schools: A four-year study. *Teachers and Teaching: Theory and Practice, 15*(1), 5-23.

Looi, C. K., Wong, L. H., So, H. J., Seow, P., Toh, Y., Chen, W., . . . Soloway, E. (2009). Anatomy of a mobilized lesson: Learning my way. *Computers & Education, 53*, 1120-1132.

Marks, H. (2000). Student engagement in instructional activity: Patterns in the elementary, middle, and high school years. *American Educational Research Journal, 37*(1), 153-184.

Martin-del-Campo, B., Garcia, L. R., Larco, M. M., Minguez, G. H., & Diaz-Perea, M. R. (2010). When the old is stronger than the new: Introduction of constructivist methodology in a special education school. *Linguistics & Education, 21*, 143-170.

Maslow, A. (1943). A theory of human motivation. *Psychological Review, 50*, 370-396.

Maslow, A. (1954). *Motivaiton and personality.* New York: Harper.

McDermott, P. A., Goldberg, M. M., Watkins, M. W., Stanley, J. L., & Glutting, J. J. (2006). A nationwide epidemiologic modelling study of LD: risk, protection, and unintended impact. *Journal of Learning Disabilities, 39*(3), 230-251.

McMahon, T. (2006). Teaching for more affective learning: Seven maxims for practice. *Radiography, 1*, 34-44.

McMillan, J., & Schumacher, S. (2010). *Research in Education: Evidence-Based Inquiry.* Upper Saddle River, New Jersey: Pearson Education.

Means, T., Jonassen, D., & Dwyer, F. (1997). Enhancing relevance: Embedded ARCS strategies vs. puspose. *Educational Technology Research and Development, 45*, 5-17.

Moghaddam, F. M. (2005). *Great ideas in psychology: A cultural and historical introduction.* New York, New York: On World.

Moos, D. C., & Azevedo, R. (2009). Learning with computer-based learning environments: A literature review of computer self-efficacy. *Review of Educational Research, 79*(2), 576-600.

Motiwalla, L. F. (2007). Mobile learning: A framework and evaluation. *Computers & Education, 49*, 581-596.

Murphy, M. M., Mazzocco, M. M., Hanich, L. B., & Early, M. C. (2007). Cognitive characteristics of children with mathematics learning disability (MLD) vary as a function of the cut-off criterion used to define MLD. *Journal of Learning Disabilities, 40*(5), 458-478.

Niemiec, C. P., & Ryan, R. (2009). Autonomy, competence, and relatedness in the classroom. *Theory and Research in Education, 7*(2), 133-144.

Obrach, E. (1979). Simulation games and motivation for learning: A theoretical framework. *Simulation and Games, 10*(1), 3-40.

Okolo, C. (1992). The effect of computer-assisted instruction format and inital attitude on the arithmetic facts proficiency and continuing motivation of students with learning disabilities. *Exceptionality, 3*, 195-211.

Oliver, M. A., & Steenkamp, D. S. (2004). Attention-deficit/hyperactivity disorder: Underlying deficits in achievement motivation. *International Journal for the Advancement of Counseling, 26*, 47-63.

Olsen, W. (2004). Triangulation in social research: Qualitative and quantitative methods can really be mixed. In M. Holburn (Ed.), *Developments in Sociology.* Ormskirk: Causeway Press.

Ontario Ministry of Education. (2001). *Special Education - Guide for Educators.* Retrieved September 20, 2011, from Special Education - Guide for Educators: http://www.edu.gov.on.ca/eng/general/elemsec/speced/guide.html

Papastergiou, M. (2009). Digital ame-based learning in high school computer science education: Impact on educaiton effectiveness and student motivation. *Computers & Education, 52*, 1-12.

Pintrich, P. R., & Anderman, E. M. (1994). Intra-individual differences in motivation and cognition in students with and without learning disabilities. *Journal of Learning Disabilities, 27*(6), 360-371.

Pintrich, P. R., & Schunk, D. (2002). *Motivation in education: Theory, research and applications* (2 ed.). Upper Saddle, New Jersey: Prentice-Hall Inc.

Prawat, R. S., & Folden, R. E. (1994). Philosophical perspectives on constructivist views of learning. *Educational Psychologist, 29*(1), 37-48.

Rau, P. L., Goa, Q., & Wu, L. M. (2008). Using mobile communication technology in high school education: Motivation, pressure, and learning performance. *Computers & Education, 50*, 1-22.

Reichrath, D., de Witte, L. P., & Winkens, I. (2010). Interventions in general education for students with disabilities: a systemic review. *International Journal of Inclusive Education, 14*(6), 563-580.

Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., . . . Salinas, M. (2003). Beyond Nintendo design and assessment of educational video games for first and second graders. *Computers & Education, 40*, 71-94.

Ryan, E. I., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behaviour. *Psychological Inquiry II*, 227-268.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67.

Seo, Y. J., & Bryant, D. P. (2009). Analysis of studies of the effects of computer-assisted instruction on the mathematics performance of students with learning disabilities. *Computers & Education, 53*, 913-928.

Seo, Y. J., & Woo, H. (2010). The indentification, implementation, evaluation of critical user interface design features of computer-assisted instruction programs in mathematics for students with learning disabilities. *Computers & Education, 55*, 363-377.

Seppala, P., & Alamaki, H. (2003). Mobile learning in teacher training. *Journal of Computer Assisted Learning, 19*, 330-335.

Shim, J. E., & Li, Y. (2007, July 26). *Applications of cognitive tools in the classroom*. (M. Orey, Editor) Retrieved September 24, 2011, from Emerging perspectives on learning, teaching,

and technology:
http://projects.coe.uga.edu/epltt/index.php?title=Cognitive_Tools_in_the_classroom

Sideridis, G. D. (2003). On the origins of helpless behaviour in students with learning disabilities. Avoidance motivation? *International Journal of Educational Research, 39*, 497-517.

Sideridis, G. D. (2007). Why are students with LD depressed? A goal orientation model of depression vulnerability. *Journal of Learning Disabilities, 40*(6), 526-539.

Sideridis, G. D., Morgan, P. L., Botsas, G., Padeliadu, S., & Fuchs, D. (2006). Predicting LD on the basis of motivation, metacognition, and psychopathology: An ROC analysis. *Journal of Learning Disabilities, 39*(3), 215-229.

Skinner, B. (1938). *The behaviour of organisms.* New York, New York: Appleton Century Crofts.

Skinner, B. (1968). *The technology of teaching.* New York, New York: Appleton Century Crofts.

Smagorinsky, P., Wright, L., Augustine, S. M., O'Donnell-Allen, C., & Konopak, B. (2007). Student engagement in the teaching and learning of grammar. *Journal of Teacher Education, 58*(1), 76-90.

Statistics Canada. (2007, November 30). *Participation and Activity Limitation Survey*. Retrieved from Participation and Activity Limitation Survey: http://www23.statcan.gc.ca:81/imdb/p2SV.pl?Function=getSurvey&SDDS=3251&lang=en&db=imdb&adm=8&dis=2

Stears, M. (2009). How social and critical constructivism can inform science curriculum design: A study from South Africia. *Educational Research, 51*(4), 397-410.

Stefanou, C., & Salisbury-Glennon, J. (2002). Developing motivation and cognitive learnin strategies through an undergraduate learning community. *Learning Environments Research, 5*, 77-97.

Steinmayr, R., & Spinath, B. (2009). The importance of motivation as a predictor of school achievement. *Learning and Individual Differences, 19*, 80-90.

Swan, K., van't Hooft, M., Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *Journal of Research on Technology in Education, 38*(1), 99-112.

US Department of Healthcare Research and Quality. (2012, February 25). *Definition of Internal Validity*. Retrieved from Effective Health Care Program: http://www.effectivehealthcare.ahrq.gov/index.cfm/glossary-ofterms/?pageaction=showterm&termid=36

Virvou, M., & Alepis, E. (2005). Mobile educational features in authoring tools for personalized tutoring. *Computers & Education, 44*, 53-68.

Vroom, V. (1964). *Work and motivation.* New York, New York: Wiley.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, Massachusetts: Harvard University Press.

Waltons, G., Childs, S., & Blenkinsopp. (2005). Using mobile technologies to give health students access to learning resources in the UK community setting. *Health Information and Libraries Journal, 22*, 51-65.

Wang, Y. S., Wu, M. C., & Wang, H. Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational Technology, 40*(1), 92-118.

Weiner, B. (2010). The development of an attribution-based theory of motivation: A history of idea. *Educational Psychologist, 45*(1), 28-36.

Zegarac, G. (2008, March 24). *Closing the gap as the overarching goal: Changing special educaiton practices and outcomes.* Retrieved from Ontario Ministry of Education - Special Education: http://www.edu.gov.on.ca/eng/research/specEd_AERA_CSSE.pdf

Zimmerman, B. (2000). Self-efficacy: An essential motive to learn. *Contemporary Psychology, 25*, 82-91.

Zisimopoulos, D. (2009). Academic intrinsic motivation and percieved academic competence in Greek elementary students with and without learning disabilities. *Learning Disabilities Research and Practice, 24*(1), 33-43.

Zyngier, D. (2008). (Re) conceptualizing student engagement: Doing education not doing time. *Teaching and Teacher Education, 24*, 1765-1776.

Invitation to Study Information Presentation

Date of Letter

Dear Parent(s)/Guardian(s),

My name is Lisa Wray (LeFort) and in addition to being a teacher at J. Clarke Richardson Collegiate, I am also a graduate student in the Faculty of Education at the University of Ontario Institute of Technology. As a part of my graduate studies I am the principal investigator in a study THAT will look at the effects of implementing mobile devices (Apple iPads) in the classroom. As a student in Grade 10 Learning Strategies Mathematics at J. Clarke Richardson Collegiate your son/daughter is being given the opportunity to participate in this research study.

In order to obtain more detailed information regarding this study you are invited to attend a Study Information Presentation.

DATE

J. Clarke Richardson Collegiate - LIBRARY

Please RSVP to this event by returning the bottom portion of this invitation with your son/daughter to Ms. Mpermperacis.

Thank you in advance for your interest in this exciting opportunity.

Sincerely,

Lisa Wray (LeFort)

Student Name: _____

☐ Yes we **WILL** attend the Study Information Presentation

☐ No we will **NOT** attend the Study Information Presentation

Parent/Guardian Signature: _____ Date: _____

RESEARCH STUDY LETTER OF INFORMATION AND CONSENT FORM

Dear Parents/Guardians:

I am a graduate student at the University of Ontario Institute of Technology (UOIT) and I am conducting a study on the use of mobile devices by students with learning disabilities in secondary mathematics classrooms. This project is aimed at understanding the factors that impact the teacher planning for, and use of, these devices in the classroom as well as the effects they have on student motivation for mathematics material. I would like to give your child the opportunity to participate in the study.

Students will be provided with individual Apple iPads (Wi-Fi___33 only) to be used in the classroom. In daily 75 minute classes from February 2011 to April 2011, I will ask students to use a variety of content-based applications on their Apple iPads. These applications will range from simple to complex, but will always focus on what is being learned at the time. Study instruments which directly involve the students will include a weekly Motivation Survey and Student Journal. Both the student survey and journal will be completed in 15-20 minutes on the final day classes each week. Data will also be derived from the use of an Observational Scale by study researchers, direct researcher observation notes, and weekly teacher interviews. One potential benefit of this study is the opportunity to use a new and innovative mobile device, which will increase student motivation in the area of mathematics. In addition, this study will also contribute to a growing body of research focused on the use of mobile technology in schools.

A full written report of the study will be developed and will be available at the end of the study. As security and confidentiality are a prime concern when it comes to children in any school-based research, all data collection is designed to ensure complete confidentiality of all children as no name or any other identifier will be used. In addition, all data will be kept securely and completely anonymous and can only be accessed by the principal investigator and faculty supervisor.

It is also understood that you and/or your child can choose to withdraw from the study at any time. The procedure to withdraw from the study will require either the study participant or parent/guardian to contact the classroom teacher in person, by phone or email at any time. The teacher will then inform the principal investigator. Withdrawal will not have any effect on the general classroom activities or the students' participation in his/her normal learning activities. In addition to this, the student will be permitted to continue using the iPad should he/she choose to do so. Once withdrawn, there will be no research data collected from or about this particular student and all existing data will be destroyed immediately.

This study has been officially approved by your child's school Principal, the Durham District School Board's Research Advisory Committee, and Research Ethics Board at UOIT. When the study is complete, a report on the findings will be available to the parents.

Please complete the form at the bottom of this letter and return it to Ms. Mpermperacis (class teacher) February 11th, 2011. Please retain a copy of this letter for your records. I sincerely appreciate your co-operation. If you would like to receive more information about the study, please contact me at any time.

Lisa Wray (LeFort), Researcher   Dr. Francois Desjardins, Supervisor   Scott Harris, Accountability Officer
Graduate Student, UOIT   Associate Dean, (Education) UOIT   DDSB Research Advisory Committee
(905) 619-9571 Ext. 228   (905) 721-8668 Ext. 2198   (905) 666-6026

School Name: _____   Child's Name: _____
_____
___ I do give permission for my child to participate in the UOIT conducted by Lisa Wray (LeFort).
___ I do **NOT** give permission for my child to participate in the UOIT study conducted by Lisa Wray (LeFort).

Signature of Parent/Guardian _____ Date _____

RESEARCH STUDY LETTER OF INFORMATION AND ASSENT FOR MINORS FORM

Dear Potential Study Participant:

Just as you are a student of J. Clarke Richardson Collegiate, I am also a student at the University of Ontario Institute of Technology. As a final project for my schooling I am completing a research project on the use of mobile devices by students in secondary mathematics classrooms. By the end of my project I am hoping to better understand how teachers can best plan to use mobile devices in the classrooms and also the effect they have on motivating students to learn mathematics. I would like to give you the opportunity to participate in the study.

Each study participant will be given an Apple iPad (Wi-Fi___33 only) to be used in the classroom. During every mathematics class from February 2011 to April 2011, I will ask study participants to use a number of math-based applications on their Apple iPads. These applications will range from simple to complex, but will always focus on what is being learned in class. During the final class each week, study participants will be asked to complete a Motivation Survey and a Student Journal. At the end of the study the participants will be allowed to view a paper that explains the results of what was found. When collecting the information each participant will be assigned a code instead of his/her name so that it is kept anonymous. All information collected will be stored in a secure location and will not be shown to anyone other than the researcher and the researcher's supervisor.

Study participants are allowed to stop participating in the study at any time. In order to withdraw from the study, the study participant and/or parent/guardian needs to inform the classroom teacher in person or by phone. The teacher will then inform the researcher. By choosing to withdraw the student's classroom activities and participation in learning activities will not change. In addition to this, the student will be permitted to continue using the iPad should he/she choose to do so. Once withdrawn, there will be no information collected from or about this particular student and all previous information will be destroyed immediately.

This study has been officially approved by the school Principal, the Durham District School Board's Research Advisory Committee, and Research Ethics Board at UOIT. When the study is complete, a report on the findings will be available.

Please complete the form at the bottom of this letter and return it to Ms. Mpermperacis (class teacher) by February 11th, 2011. Please keep a copy of this letter for you. I sincerely appreciate your co-operation and should you need more information about the study, please do not hesitate to ask.

Lisa Wray (LeFort), Researcher   Dr. Francois Desjardins, Supervisor   Scott Harris, Accountability Officer
Graduate Student, UOIT   Associate Dean (Education), UOIT   DDSB Research Advisory Committee
(905) 619-9571 Ext. 228   (905) 721-8668 Ext. 2198   (905) 666-6026

School Name: _____   Participant's Name: _____

___ I hereby agree to participate in the UOIT study conducted by Lisa Wray (LeFort).

___ I do NOT consent to participate in the UOIT study conducted by Lisa Wray (LeFort).

Signature of Study Participant _____ Date _____

iPad Use Agreement

School: **University of Ontario Institute of Technology and J. Clarke Richardson Collegiate**

Student: _____

We acknowledge receipt of the following specialized equipment to be used exclusively by _____ while he/she is participating in the research study being conducted by Lisa Wray at J. Clarke Richardson Collegiate. Further, we acknowledge that this equipment is the property of the University of Ontario Institute of Technology.

Equipment:
Apple iPad   Serial #
Apple iPad Case

We agree that this equipment will be used solely for curriculum related purposes.
The iPad device is valuable and fragile. We agree that it will be handled in a careful manner so as not to result in damage or loss.

There are a few things you must know about using this valuable equipment:
•   You are responsible for it.
•   No applications should be downloaded onto the iPad without the permission of the teacher or principal researcher.
•   Materials such as games, music and videos are NOT to be downloaded. This can compromise the configuration, or even introduce viruses.
•   Follow any school guidelines that may be in place regarding computer usage.
•   Do not leave the iPad unattended. When leaving the classroom, the iPad should be checked in by the teacher or researcher until your return.
•   Always keep the iPad in its case.
•   Heavy textbooks and binders should not be placed on top of the iPad at any time. The iPad screen is fragile, and can be easily damaged as a result of increased pressure.
•   Safely transport the iPad at all times within the classroom
•   Place liquids away from your iPad to avoid spills

I understand the above conditions regarding the iPad and will follow them. Failure to do so may result in damage to the equipment and a loss of use during repair.

Student Signature: _____   Date: _____

Parent Signature: _____   Date: _____

Categories and Definitions of Exceptionalities (excerpt from Special Education; A Guide for Educators)
http://www.edu.gov.on.ca/eng/general/elemsec/speced/guide/specedpartae.pdf

<u>**Communication:**</u>

Autism
A severe learning disorder that is characterized by:
       a) disturbances in:
       – rate of educational development;
       – ability to relate to the environment;
       – mobility;
       – perception, speech, and language;
       b) lack of the representational symbolic behaviour that precedes language.

Language Impairment
A learning disorder characterized by an impairment in comprehension and/or the use of verbal communication or the written or other symbol system of communication, which may be associated with neurological, psychological, physical, or sensory factors, and which may:
       a)   involve one or more of the form, content, and function of language in communication;
             and
       b)   include one or more of:
           – language delay;
           – dysfluency;
           – voice and articulation development, which may or may not be organically or functionally based.

Learning Disability
A learning disorder evident in both academic and social situations that involves one or more of the processes necessary for the proper use of spoken language or the symbols of communication, and that is characterized by a condition that:
       a)   is not primarily the result of:
           – impairment of vision;
           – impairment of hearing;
           – physical disability;
           – developmental disability;
           – primary emotional disturbance;
           – cultural difference;
       b)   results in a significant discrepancy between academic achievement and assessed intellectual ability, with deficits in one or more of the following:
           – receptive language (listening, reading);
           – language processing (thinking, conceptualizing, integrating);
           – expressive language (talking, spelling, writing);
           – mathematical computations; and
       c) may be associated with one or more conditions diagnosed as:
           – a perceptual handicap;
           – a brain injury;
           – minimal brain dysfunction;
           – dyslexia;
           – developmental aphasia.

Appendix F

List of Applications Used

W/E March 4, 2011
March 3 – Quick Graph, SketchBookO
March 4 – OmniGS, WhiteBoard

W/E March 10, 2011
March 7 – OmniGS
March 9 – SketchbookO + OmniGS
March 10 – Underscore Notify

W/E March 25, 2011
March 21 – Notify, OmniGS
March 25 - Scrabble

W/E April 1, 2011
March 29 – Factor Race
April 1 – Factor Race

W/E April 8, 2011
April 5 – DIA Math
April 6 – DIA Math, Factoring
April 8 – Factor Race, Sigma, Scrabble

W/E April 15, 2011
April 11 – Class.com
April 13 – Sigma
April 14 - Sigma

W/E April 29, 2011
April 29 - Notify

W/E May 6, 2011
May 3 – Quadratic Equations (Class.com)

W/E May 13, 2011
May 10 – OmniGS, Quickgraph
May 12 – OmniGS

W/E May 20, 2011
May 16 – EZ Squares
May 17 – Triginometry
May 18 – gFlashPro
May 20 – gFlashPro

W/E May 27, 2011
May 25 – Triginometry
May 27 – Spell Stacker

W/E June 3, 2011
May 31 – Notify, GoogleDocs
June 1 – gFlashPro
June 3 - gFlashPro

W/E June 10, 2011
June 6 – gFlashPro
June 10 – Fraction Drills, Easel Algebra, Your
Teacher (Slope of a Line, Slope-Intercept)

W/E June 17, 2011
June 16 – DIA Math
June 17 – Factor Race

Motivation Survey   (Circle your answer)

1. I think this mathematics class will be challenging, but not too easy or too hard for me.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

2. There is something interesting about this mathematics class that will capture my attention.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

3. I believe that completing this mathematics class will give me a feeling of satisfaction.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

4. It is clear to me how this mathematics class is related to things I already know.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

5. I believe this mathematics class will gain and sustain my interest.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

6. I believe that the information contained in this mathematics course will be important to me.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

7. I believe that I will enjoy this mathematics class so much that I would like to know more about this topic.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

8. This mathematics class seems dry and unappealing.

    1-------------------2-------------------3-------------------4-------------------5

    Not true   Slightly true   Moderately true   Mostly true   Very true

9. The mathematics class is relevant to my interests.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

10. I will really enjoy completing assignments for this mathematics class.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

11. After working on this mathematics class for awhile, I believe that I will be confident in my ability to successfully complete all class assignments and requirements.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

12. I think that the use of the iPad will help keep my attention on this mathematics class.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

13. The iPad that is incorporated to deliver the mathematics content may be frustrating/irritating.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

14. It will feel satisfied to successfully complete this mathematics class.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

15. The content of this mathematics class does NOT include information that will be useful to me.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

16. I do NOT think that I will be able to really understand the information in this mathematics class.

1-------------------2-------------------3-------------------4-------------------5

Not true   Slightly true   Moderately true   Mostly true   Very true

Observational Scale

1. Student is focused on tasks assigned

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

2. Student is behaving within the guidelines of classroom expectations (i.e. not disrupting others)

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

3. Student is actively participating in classroom tasks and activities

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

4. Student is showing attentive body language (i.e. eye contact, upright posture, alertness)

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

5. Student collaborates with peers and teacher appropriately when suitable

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

6. Student desires to participate in unfamiliar tasks

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

7. Student completes all assigned tasks to the best of their ability

                1-------------------2-------------------3-------------------4-------------------5

            Not true   Slightly true   Moderately true   Mostly true   Very true

Student Journal Examples

EXAMPLE OF ATTENTION JOURNAL:

Student Journal – FRIDAY April 8, 2011   Name:_____
How did you feel when using the iPad? (i.e. excited, frustrated, etc.)
_____
EXPLAIN Why…
_____
Did the iPad help to keep your attention on the math tasks? If so, then <u>how</u> did the iPad help keep your attention?
_____
_____

EXAMPLE OF RELEVANCE JOURNAL:

Student Journal – FRIDAY April 29, 2011   Name:_____
How did you feel when using the iPad? (i.e. excited, frustrated, etc.)
_____
EXPLAIN Why…
_____
Did the iPad help you recognize the importance of this week's math tasks in your everyday life? If so, then <u>how</u> did the iPad increase your understanding of their importance?
_____
_____

EXAMPLE OF CONFIDENCE JOURNAL:

Student Journal – FRIDAY April 15, 2011   Name:_____
How did you feel when using the iPad? (i.e. excited, frustrated, etc.)
_____
EXPLAIN Why…
_____
Did the iPad increase your confidence in the math tasks? If so, then <u>how</u> did the iPad increase your confidence?
_____
_____

EXAMPLE OF SATISFACTION JOURNAL:

Student Journal – THURSDAY April 21, 2011   Name:_____
How did you feel when using the iPad? (i.e. excited, frustrated, etc.)
_____
EXPLAIN Why…
_____
_____
Did the iPad increase your satisfaction when completing the math tasks? If so, then how did the iPad increase your satisfaction?
_____
_____

Classroom Teacher and Education Assistant Written Interview

1. Discuss any factors that affected the **planning** of implementing the Apple iPads into today's lesson.

2. Discuss any factors that affected the **implementation and student use** of the Apple iPads into today's lesson.

3. Discuss any observations made of the study participants and their interaction with the Apple iPads.

STUDENT JOURNALS:

Total Positives and Negatives

Total Positives	Total Negatives
344	186

Weekly Overall Total Positive and Negatives

ATTENTION:

Q1 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 4, 2011	19	8
April 8, 2011	23	9
May 6, 2011	16	10
June 3, 2011	19	33

Q2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 4, 2011	16	2
April 8, 2011	16	0
May 6, 2011	16	0
June 3, 2011	7	3

RELEVANCE:

Q1 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
April 1, 2011	20	10
April 29, 2011	12	16
May 27, 2011	16	2

Q2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
April 1, 2011	21	3
April 29, 2011	9	2
May 27, 2011	5	1

STUDENT JOURNALS:
Weekly Overall Total Positive and Negatives Continued

CONFIDENCE:

Q1 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 10, 2011	7	10
April 15, 2011	24	2
May 13, 2011	20	20
June 10, 2011	6	13

Q2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 10, 2011	4	4
April 15, 2011	9	2
May 13, 2011	5	2
June 10, 2011	10	4

SATISFACTION:

Q1 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 25, 2011	21	13
May 20, 2011	17	8

Q2 ONLY

JOURNAL DATE	TOTAL POSITIVE CONSTRUCTS	TOTAL NEGATIVE CONSTRUCTS
March 25, 2011	7	3
May 20, 2011	5	0

Attention
ATTENTION – Positives (Q1 and Q2)

	Mar 4, 2011	Apr 8, 2011	May 6, 2011	June 3, 2011
Excited/Exciting	8	7	6	0
Happy	0	3	1	1
Interested/Interesting	1	0	1	0
Fun	2	5	4	0
Helped/Helpful	1	4	0	4
Cool	2	0	0	0
Easy	2	0	2	7
Focused/Focusing	0	0	0	2
Simple	1	0	0	0
Understand	2	4	1	4
Enjoy	0	1	2	1
Total	19	23	16	19

ATTENTION – Positives (Q2 only)

	Mar 4, 2011	Apr 8, 2011	May 6, 2011	June 3, 2011
Excited/Exciting	1	0	0	0
Happy	0	0	0	0
Interested/Interesting	2	0	1	0
Fun	5	2	5	0
Helped/Helpful	3	8	5	2
Cool	1	0	1	1
Easy	1	2	2	1
Focused/Focusing	2	3	2	1
Simple	0	0	0	0
Understand	1	0	0	1
Enjoy	0	1	0	1
Total	16	16	16	7

Attention
ATTENTION – Negatives (Q1 and Q2)

	Mar 4, 2011	Apr 8, 2011	May 6, 2011	June 3, 2011
Frustrated/Frustrating	3	3	6	12
Slow	0	0	0	2
Long	0	0	3	3
Boring	0	0	0	0
Confused/Confusing	1	4	0	1
Mad	0	0	0	1
Paper	2	0	1	3
Difficult	0	0	0	1
Sensitive	0	0	0	4
Hard/Harder	0	0	0	5
Not understanding	1	2	0	1
Total	8	9	10	33

ATTENTION - Negatives: (Q2 only)

	Mar 4, 2011	Apr 8, 2011	May 6, 2011	June 3, 2011
Frustrated/Frustrating	0	0	0	0
Slow	0	0	0	0
Long	0	0	0	0
Boring	1	0	0	1
Confused/Confusing	0	0	0	1
Mad	0	0	0	0
Paper	1	0	0	1
Difficult	0	0	0	0
Sensitive	0	0	0	0
Hard/Harder	0	0	0	0
Not understanding	0	0	0	0
Total	2	0	0	3

Confidence
CONFIDENCE: Positives - (Q1 and Q2)

	Mar 10, 2011	Apr 15, 2011	May 13, 2011	June 10, 2011
Excited/Exciting	3	9	4	0
Happy	0	1	1	0
Interested/Interesting	2	2	0	0
Fun	2	6	2	0
Helped/Helpful	0	2	5	0
Cool	0	0	0	0
Easy	0	2	3	3
Focused/Focusing	0	0	0	0
Simple	0	0	0	0
Understand	0	0	2	1
Enjoy	0	2	3	2
Total	7	24	20	6

CONFIDENCE: Positives – (Q2 only)

	Mar 10, 2011	Apr 15, 2011	May 13, 2011	June 10, 2011
Excited/Exciting	0	0	0	0
Happy	0	0	0	0
Interested/Interesting	0	1	0	0
Fun	2	0	0	1
Helped/Helpful	1	6	0	2
Cool	0	0	0	1
Easy	1	0	2	2
Focused/Focusing	0	0	0	0
Simple	0	0	0	0
Understand	0	2	1	4
Enjoy	0	0	2	0
Total	4	9	5	10

Confidence

CONFIDENCE: Negatives - (Q1 and Q2)

	Mar 10, 2011	Apr 15, 2011	May 13, 2011	June 10, 2011
Frustrated/Frustrating	4	0	12	8
Slow	1	0	1	0
Long	1	0	3	0
Boring	0	0	0	0
Confused/Confusing	1	2	1	1
Mad	2	0	0	0
Paper	0	0	1	3
Difficult	0	0	0	0
Sensitive	0	0	1	0
Hard/Harder	1	0	0	0
Not understanding	0	0	0	2
Total	10	2	20	13

CONFIDENCE: Negatives - (Q2 only)

	Mar 10, 2011	Apr 15, 2011	May 13, 2011	June 10, 2011
Frustrated/Frustrating	0	1	0	1
Slow	0	0	0	0
Long	2	1	0	0
Boring	0	0	0	0
Confused/Confusing	1	0	1	0
Mad	0	0	0	0
Paper	0	0	1	2
Difficult	1	0	0	0
Sensitive	0	0	0	0
Hard/Harder	0	0	0	0
Not understanding	0	0	0	1
Total	4	2	2	4

Relevance
RELEVANCE: Positives - (Q1 and Q2)

	Apr 1, 2011	Apr 29, 2011	May 27, 2011
Excited/Exciting	10	5	1
Happy	0	1	4
Interested/Interesting	0	0	2
Fun	8	2	2
Helped/Helpful	0	1	3
Cool	1	0	0
Easy	3	1	1
Focused/Focusing	0	0	0
Simple	0	0	0
Understand	2	1	0
Enjoy	1	1	3
Total	20	12	16

RELEVANCE: Positives - (Q2 only)

	Apr 1, 2011	Apr 29, 2011	May 27, 2011
Excited/Exciting	0	0	0
Happy	0	0	0
Interested/Interesting	0	0	0
Fun	0	0	0
Helped/Helpful	12	5	2
Cool	0	0	0
Easy	3	1	0
Focused/Focusing	0	1	0
Simple	0	0	0
Understand	6	2	3
Enjoy	0	0	0
Total	21	9	5

Relevance
RELEVANCE: Negatives - (Q1 & Q2)

	Apr 1, 2011	Apr 29, 2011	May 27, 2011
Frustrated/Frustrating	7	9	2
Slow	0	1	0
Long	1	1	0
Boring	0	0	0
Confused/Confusing	3	1	0
Mad	0	0	0
Paper	2	0	0
Difficult	0	1	0
Sensitive	0	0	0
Hard/Harder	1	2	0
Not understanding	0	0	0
Total	10	16	2

RELEVANCE: Negatives - (Q2 only)

	Apr 1, 2011	Apr 29, 2011	May 27, 2011
Frustrated/Frustrating	0	0	0
Slow	0	0	0
Long	0	0	0
Boring	0	0	0
Confused/Confusing	3	2	0
Mad	0	0	0
Paper	0	0	0
Difficult	0	0	0
Sensitive	0	0	0
Hard/Harder	0	0	0
Not understanding	0	0	1
Total	3	2	1

Satisfaction
SATISFACTION: Positives - (Q1 & Q2)

	March 25, 2011	May 20, 2011
Excited/Exciting	8	6
Happy	0	0
Interested/Interesting	0	1
Fun	10	1
Helped/Helpful	1	2
Cool	0	0
Easy	1	1
Focused/Focusing	0	1
Simple	0	0
Understand	0	3
Enjoy	1	2
Total	**21**	**17**

SATISFACTION: Positives - (Q2 only)

	March 25, 2011	May 20, 2011
Excited/Exciting	1	0
Happy	0	1
Interested/Interesting	1	0
Fun	4	0
Helped/Helpful	0	0
Cool	0	0
Easy	0	0
Focused/Focusing	1	2
Simple	0	0
Understand	0	2
Enjoy	0	0
Total	**7**	**5**

Satisfaction
SATISFACTION: Negatives - (Q1 & Q2)

	March 25, 2011	May 20, 2011
Frustrated/Frustrating	10	4
Slow	0	1
Long	2	0
Boring	1	0
Confused/Confusing	1	2
Mad	1	0
Paper	0	1
Difficult	0	0
Sensitive	0	0
Hard/Harder	1	0
Not understanding	0	0
Total	13	8

SATISFACTION: Negatives - (Q2 only)

	March 25, 2011	May 20, 2011
Frustrated/Frustrating	0	0
Slow	0	0
Long	1	0
Boring	0	0
Confused/Confusing	0	0
Mad	0	0
Paper	1	0
Difficult	0	0
Sensitive	0	0
Hard/Harder	1	0
Not understanding	0	0
Total	3	0