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# A Study of Effects of Institution-Wide 1:1 Computing Initiatives on University Freshman Student Engagement

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A STUDY OF EFFECTS OF INSTITUTION-WIDE 1:1 COMPUTING INITIATIVES

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It was the intended purpose for this research to explore, using the National Survey of Student Engagement, (NSSE), whether or not 1:1 initiatives have an effect on engagement of university first year students. The findings support previous research demonstrating increased student engagement in a technology-rich environment. Another noteworthy finding proved to be the significant difference of male respondents reporting increased engagement, in comparison with female respondents within the same dataset.

The results of examining the third independent variable, status as a first-generation college student, may have yielded the most significant findings in that there was no significant difference in engagement between this at-risk student population and their continuing-generation peers when measured in a 1:1 environment.

Although the examination of gender and status as a first-generation college student did not yield any causal correlations, findings may aid university administrators in their purchasing decisions surrounding future investments in classroom technology and also guide pedagogical practices and instructional methodologies geared toward engaging students in classroom activities.

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# CHAPTER ONE

## STATEMENT OF THE PROBLEM

How much technology is enough technology? Is it possible to satiate the ever-growing appetite for the latest digital device in today's college classroom? Several existing studies have indicated that without sufficient access to technology, effective pedagogical integration will not be achievable (Becker, 2000; Price, 2011; Ringstaff & Kelly, 2002; Rosen & Beck-Hill, 2012).

Additional research has leveled criticisms at the idea that access to technology has the potential to increase learning outcomes independently of pedagogical concerns (Cuban, 2006). This disagreement represents the theoretical issue of whether it is *access* technology or specific applications of technology that have the potential to affect learning outcomes. This is a noteworthy issue because the financial cost of providing the technology in 1:1 environments is often cost-prohibitive, but those expenses pale in comparison to initiatives that include funding and support for advanced technology training in specific applications.

Thus, the essential debate is between those who are advocating for further integration of digital technology and those who think that too many resources have already been invested in programs that are not having their intended affects. These divergent viewpoints underscore the need for additional research to provide a clearer picture of the variables that are at play for educational administrators who are tasked with investing scarce resources into technology initiatives.

Given the demand for technology to meet the diverse needs of students in academic environments, multiple colleges and universities have implemented 1:1

technology initiatives by program, department, and across the campus population (Bebell, O'Dwyer, Russell, & Hoffmann, 2010; Park, 2010; Schaffhauser, 2011). Implementation of such instution-wide 1:1 initiatives requires a substantial commitment from univeristy administrators because the benefits of these types of initiatives can take time to manifest in increases in learning outcomes (Muir, et al., 2004; Holcomb, 2009). Many researchers and educators have concerns about whether the potential benefits are worth the cost (Boardman, 2012; Cuban, 2001; Cuban, 2006; Fischman, 2011; Li & Pow, 2011; Weston & Bain, 2010).

The term *1:1 initiative* is used to describe learning environments permitting individual Internet connectivity to all participating students through the provision of Internet-enabled devices (Penuel & SRI, 2006). Universal Internet access can be delivered through a variety of devices including laptops, smart phones, or digital tablets (Penuel & SRI, 2006). The remainder of Chapter One will provide the rationale, methodology, significance, and limitations of the study.

## Background of the Study

Proliferation of digital technology to access the Internet on university campuses has exploded over the past decade, and has the potential to become an essential learning resource for today's college student (Chen, Lambert, & Guidry, 2010). Internet connectivity, both inside and outside the classroom, has been the standard for several years at the post-secondary level with most incoming first-year students bringing their own personal web-enabled devices to school (Hawkins & Rudy, 2008; Salaway & Caruso, 2008). The fact that students are providing their own computing devices introduces considerable complexity to the value of such devices in colleges and universities because of the significant degree of variability in the quality of these devices, as well as significant differences in how such devices are (or can be) used in educational pursuits. Because of these concerns, proponents of 1:1 computing initiatives prefer a standard device to ensure all students are provided the same opportunities to learn inside and outside of the classroom, as well as to ease the workload of technology support departments which would otherwise be asked to troubleshoot and train on a variety of devices (Holcomb, 2009).

Unfortunately, colleges and universities are making these unprecedented investments to connect students to the Internet through the provision of mobile technologies without empirical evidence that demonstrates this access results in statistically significant improvements in academic achievement (Cuban, 2006; Rosen & Beck-Hill, 2012; Weston & Bain, 2010). Technology for technology's sake is not the objective of a university or state when they decide to invest scarce funds to provide and support computers for their students, faculty, and staff (Weston & Bain, 2010). Cuban (2006) criticizes 1:1 supporters for claiming that the provision of a computer for each student has improved instruction and learning and has led to higher paying jobs. He argues 1:1 computing advocates are setting unreasonable expectations for technology by confusing the medium (digital devices) and the message (effect).

There have been various large-scale assessments of the effectiveness of 1:1 initiatives, however, that suggest that the relationship between access to technology and increases in student learning outcomes likely depends on a variety of factors that have nothing to do with technology access per se, and everything to do with when, by whom, and for what purpose those technologies are used.

The Mitiri group is an organization that supports, advances, and evaluates 1:1 initiatives in educational settings. In 2006, the Mitiri group published a summary of select, but representative, research investigating the effectiveness of 1:1 initiatives in K-12 educational settings (Mitiri, 2006). This report indicated that a majority of the existing scholarship of 1:1 was correlational in nature, and that appropriate comparison groups were not often included. In addition, foreshadowing the aforementioned concerns of Weston & Bain (2010), this report highlighted the importance of pedagogical issues, and warned of placing too much emphasis on access to the technology. The Mitiri group report (2006) concluded by suggesting that research investigating the effectiveness of 1:1 computing initiatives should include carefully selected control groups, should specifically address the needs and challenges of specific schools, and should pay particular attention given to professional development for teachers (Mitiri, 2006).

In most public and many private primary and secondary schools, financial support for technology as well as professional development tailored to the use of that technology are cost prohibitive. Studies that investigate the effect of such development on the potential of 1:1 initiatives are scarce.

One purpose of the present research, therefore, is to investigate the effects of a 1:1 initiative in ways that are in line with suggestions in the Mitiri report. Specifically, the present research explicitly compares student engagement data before the initiative to engagement data after the initiative in an institution that is committed to the use of technology in the classroom. Importantly, the institution under investigation in this research also has significant faculty development support that is directed at appropriate use of instructional technology in the classroom. Thus, far from being an investigation merely of the effects of access to technology, the present study assesses the effect of 1:1 technology from within an institutional environment that is committed to providing comprehensive training in instructional technology to faculty, and to providing technical support staff for all day-to-day operations, malfunctions, and maintenance of the technology.

Another gap in the current literature is reflected by the fact that a significant portion of the existing data on 1:1 initiatives has been collected in a K-12 public school environment (Bebell & O'Dwyer, 2010; Holcomb, 2009; Culp, Honey, & Mandinach, 2005; Kulik, 2003; Lei & Zhao, 2008; Park, 2010; Penuel, 2006; Schaffhauser, 2011; Silvernail & Gritter, 2007; Weston & Bain, 2010 ). This is significant because as discussed previously, justifiable attention has been drawn regarding the importance of consistency in implementation of computing initiatives as well as the extent of professional development training in instructional technology that is available to teachers in 1:1 environments (Cuban, 2006; Holcomb, 2009; Weston & Bain, 2010). Because state-wide (and even district-wide) implementations represent significant logistical and financial challenges in terms of consistency in delivery and training, a small undergraduate institution with a dedicated grant for ensuring institution-wide implementation and professional development is an ideal environment to assess the potential of 1:1 technology initiatives (Weston & Bain, 2006; Holcomb, 2009).

Several contemporary studies suggest that Internet access in a 1:1 computing environment will have a transformative effect on instructional methodology, as well as on how students learn (Chen, Lamert, & Guidry, 2010; Hu & Kuh, 2001; Spears, 2012). Other research, however, has revealed that students as well as teachers are spending significant peripheral time engaged with social media such as Facebook and Twitter (Holcomb, 2009; Bebell & O'Dwyer, 2010) . This process of digital socialization has been negatively correlated with time preparing for class, thereby impairing academic achievement (Bebell & O'Dwyer, 2010; Junco & Cotten, 2010; Junco, 2012; Weider, 2011).

Moreover, the "transformative effects" on learning advocated by supporters of technology are not consistent, either between separate studies or within large-scale studies assessing the impact of district and/or state-wide initiatives. Research evaluating the Texas Technology Immersion Pilot (TIP), for example, found no evidence connecting student self-directed learning with an immersive technology environment or with the students' overall satisfaction with school (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). In contrast, the Maine Learning and Technology Initiative (MLTI) suggested significant positive effects on student learning outcomes such as math, science, and the visual and performing arts, but conceded that results differed "significantly by school" (Muir, Knezek, & Christensen, 2004).

Two papers are especially helpful in summarizing the extant research on the effect of 1:1 initiatives on various outcomes in primary and secondary educational settings (Weston & Bain, 2010; Holcomb, 2009). Both papers describe and summarize results of small-scale initiatives as well as major state- and/or district-wide initiatives on student outcomes. This literature is decidedly mixed: Some schools indicate increases in learning outcomes, lower absentee rates, increased engagement, increased scores in reading, writing, math, and problem solving; while other schools demonstrate either no effects of the initiatives at all, or effects that indicate that the use of technology is actually harming student outcomes (Holcomb, 2009; Weston & Bain, 2010). Importantly, both reviews include entire sections that highlight the importance of consistency in implementation of 1:1 initiatives, the prohibitive logistical and financial costs associated with district- and/or state-wide implementation, and significant variation in the extent to which teachers are comfortable with and up-to-date on the effective use of technology in the classroom.

Finally, of the research that exists at the post-secondary level, most involves select majors or another subsection of a university's student population (Allsopp, Kyger, & Lovin, 2007; Hawkes & Hategekimana, 2009; Schaffhauser, 2011). This complicates matters further because it is unclear whether the effects of the technology are on learning outcomes or if they are limited to specific academic contexts (e.g., journalism majors). Related to the criticisms outlined above, the inconsistency of institution-wide implementation is a significant barrier in explaining the role of technology in learning contexts because it is impossible to disentangle the effects of the subject matter from the effects of the technology. In order to truly assess the effects of 1:1 initiatives on student outcomes, it is necessary to have institution-wide implementation and standardized outcomes that are not limited to or dependent upon any one academic area.

Clearly, the answer to whether or not 1:1 computing initiatives positively affect learning outcomes depends on a variety of factors. The most compelling arguments appear to be the need to address consistency of implementation, consistency of outcome measure, and consistency in the resources available for the professional development of the teachers. These ideas resonate well with research demonstrating that faculty integration of classroom technology as an active learning tool in everyday teaching can facilitate group discussion, significantly increase student engagement, and, in the end, enhance academic outcomes (Edens, 2008; Meyer, 2011; Stephens, 2012). Taken together, the available evidence suggests that technology's effect on learning outcomes depends on the manner in which the technology is used.

Based upon the aforementioned considerations, the present research was conducted on a small university campus in which every incoming student and every faculty member was assigned a laptop computer and an iPad. Because it is difficult to assess the effects of technology on learning if every class, major, or department has different outcome measures, the present study used a standardized measure of student engagement as the primary outcome measure. Finally, the study took place in a university that had initiated a 15-week training session involving seven two-hour workshops on integrating technology into the classroom in which all teachers were strongly encouraged to participate. Thus, a major contribution of the current investigation is to hold as constantly as possible the three most commonly listed barriers to assessing the impact of 1:1 initiatives: consistency in implementation, (every student and teacher on campus was given an iPad and a MacBook), consistency in access to professional development and technology support, and consistency in outcome measured across the entire sample.

## Introduction to the Study

In the study, I assessed the impact of a 1:1 technology initiative on student engagement at a small, private liberal arts university in southwestern Pennsylvania. In so doing, I examined the effects of an institution-wide 1:1 initiative on student engagement at the undergraduate level, with "student engagement" defined as the time and energy students devote to educationally sound activities inside and outside of the classroom (Kuh, 2003). The initiative was supported by two consecutive Title III grants. The funds supported the acquisition of the technology, the hiring of support staff to train faculty and to provide technical support, and the licenses for specific software applications that were developed for instructional use and targeted for inclusion in the curriculum.

The survey respondents in this study were equipped with iPads and Macbook Pros manufactured by Apple Inc. In order to measure the impact this technological investment has on student engagement, the National Survey of Student Engagement (NSSE) was made available to all first-year and final-year students. The university participates in the NSSE on a regular basis as a part of their institutional assessment plan, so this data was readily available.

## Purpose of the Study

It is the intended purpose of this research to use data generated through the National Survey of Student Engagement (NSSE) in order to determine whether or not 1:1 initiatives have an effect on engagement of first-year undergraduate university students. The NSSE has created five benchmarks of effective educational practice, including active and collaborative learning (NSSE, 2011), which comprised the extant data this study examines.

In this study, I sought to discover if a difference exists between student engagement before 1:1 student access to the Internet and after the Internet and web-enabled devices were provided. The NSSE incorporates survey items focused on favored practices in undergraduate education based on multiple objective measures and acceptable psychometric properties (Kuh, 2002). Furthermore, I sought to discover the outcomes of gender on student engagement in a 1:1 environment and whether the educational background of the participants' families impacted levels of student engagement.

Given that technology access naturally predicates technology use, and that the use of technology predicates impact on student engagement (O'Dwyer, Russell, & Bebell, 2004), a 1:1 setting seemingly provides the optimal environment for studying how technology access can impact student engagement. A review of existing studies on 1:1 initiatives indicates that opinions differ on whether technology has a positive, negative, or negligible impact on student engagement (Cuban, 2001; Kuh, 2009; Lei & Zhao, 2008; Weston & Bain, 2010).

## Research Questions

This study seeks to add clarity to the issue by examining the following research questions:

1. For first-year undergraduates, what are the outcomes in levels of student engagement before and after implementation of a 1:1 technology initiative? Is there a difference in these outcomes depending on gender?
2. After implementation of a 1:1 technology initiative, what are the outcomes in levels of student engagement, and are there differences based on gender and first-generation status?

## Research Methodology

In this study, I interpreted data collected through the National Survey of Student Engagement (NSSE) in 2009 and 2011 at a private, regional university with an average annual enrollment of 2100 students, investigating a unique set of variables utilizing self-reported NSSE data. I compared NSSE measures of student engagement on first-year undergraduate students prior to the 1:1 computing initiative with first-year undergraduate students after implementation of the 1:1 computing initiative.

## Significance of the Study

The potential exists for 1:1 initiatives to create a substantial change in the status quo of classroom instruction (Dwyer, 2000) and the existing educational paradigm which limits instruction on a more personalized basis (Christensen, Horn, & Johnson, 2008). Situated within the existing framework of engagement theory, research has shown environments where students who direct their time and energy on educationally purposeful activities generate improved learning outcomes (Kuh, 2003). Several existing studies have found increased levels of student engagement in 1:1 classrooms (Holcomb, 2009; Negroponte, 2010; Spears, 2012). Not only are there a variety of methodological uses of Internet access by instructors in the classroom (Pitler, Hubbel, Kuhn, & Malenoski, 2010), this number grows exponentially when considering the multiple ways Internet-enabled devices can be used by students (Warschauer, 2006).

There have been a number of studies done on the role of Internet access as it pertains to academic achievement, and the challenges faced by educators tasked to design a curriculum for an entirely new classroom environment (Bebell & O’Dwyer, 2010; Boardman, 2012; Murphy, 2011; Penuel, 2006; Spears, 2012). However, no available study focuses attention on the effects of institution-wide Internet access on student engagement, comparing data collected both before and after the 1:1 implementation. Moreover, at the time of this research, the majority of studies on 1:1 computing initiatives had been conducted in K-12 public school settings (Bebell & O'Dwyer, 2010; Kulik, J.A., 2003; Lei & Zhao, 2008; Silvernail & Gritter, 2007), or subpopulations of a university (Allsopp, Kyger, & Lovin, 2007; Hawkes & Hategekimana, 2009; Schaffhauser, 2011).

Research is needed across the student population to either affirm or refute previous findings related to the effectiveness of 1:1 initiatives for engaging students in the classroom. This study adds to the limited body of literature regarding 1:1 computing initiatives by reporting the outcomes of universal student access to computing devices, and the potential these devices represent for increasing student engagement, as compared to a traditional classroom on learning outcomes. Additionally, the study provides data on the effects of 1:1 computing initiatives on student engagement, differentiating by gender and the education level attained by the students' parents. There is both practical and theoretical significance to this study.

**Practical Significance and Theoretical Significance**

To date, there is modest empirical evidence available for university administrators to use to make informed decisions on the investment in 1:1 initiatives (Bebell & O'Dwyer, 2010; Penuel, 2006). Much of the existing research considers student time utilizing the Internet as a type of student engagement rather than as a vehicle for increasing student engagement (Guidry, 2010; Kuh, 2003; Kuh & Neslson, 2005). For the basis of this study, I utilized Kuh's definition of student engagement as the time and energy students devote to educationally sound activities inside and outside of the classroom (Kuh, 2003). This definition differentiates between recreational and social internet activities and narrows the focus of student engagement to purposeful educational activities.

Kennedy (2000) does suggest Internet access can be a valuable tool for actively engaging students in the learning process. Penuel (2006) contends more research needs to be conducted before educators begin to understand the general effects of 1:1 initiatives on academic achievement and student engagement.

This study expands what is known about the relationships between students' ubiquitous access to technology and engagement in other educationally effective practices, which prior research has shown lead to desired educational outcomes (Holcomb, 2009; Laird & Kuh, 2004; Lei & Zhao, 2008). By investigating a unique set of variables, the researcher seeks to demonstrate the applicability of engagement theory to universities investing in 1:1 initiatives. The study adds to the nominal body of literature exploring the implementation of 1:1 initiatives on university campuses as an effective tool to increase student engagement.

## Definition of Key Terms

*1:1 initiative*: learning environments permitting all participating students individual Internet connectivity (Penuel & SRI, 2006).

*Digital divide:* the inequitable distribution of information technology and Internet access based on characteristics such as ethnicity, income, and geographic location (Morse, 2004).

*First-generation college student:* individuals without a parent who participated in post-secondary education (Choy, 2001; Pascarella, Pierson, Wolniak, & Terenzini, 2004; Saenz, Hurtado, Barrera, Wolf, & Yeung, 2007).

*Gender:* the social characteristics associated with biological femaleness or maleness (Richardson, Taylor, & Whittier, 2003).

*iPad:* Apple's WiFi tablet computing device that offers a touch-screen high-resolution display, Internet access capability, and a picture camera. The iPad functions as a platform primarily for viewing and consuming media rather than as a communication and text-creating device (Apple, 2011).

*Mobile computing devices*: Any technology that offers computing capability in a compact and portable package (Doe, 2009).

*Mobile learning:* Refers to a capability or instructional delivery method that offers educational activities at any time and any place usually with the aid of a mobile computing or mobile communications device (Kukulska-Hulme, Traxler, & Pettit, 2007).

*Student engagement*: the time and energy students devote to educationally sound activities inside and outside of the classroom (Kuh, 2003).

## Limitations and Delimitations of the Study

The study has certain limitations. Data analyzed in this study were voluntarily self-reported by first-year students attending a single private, liberal arts university in southwestern Pennsylvania. The accepted definition for student engagement for the purposes of this study is the time and energy students devote to educationally sound activities inside and outside of the classroom (Kuh, 2003). Student reporting of increased levels of engagement could be due to several uncontrolled variables occurring both inside and outside of the classroom, however, thus preventing the researcher from demonstrating a causal correlation.

Although the data collected are based on respondents across all university programs, the sample size is relatively small and context-specific. Because of these conditions, research conclusions would not be generalizable to other universities implementing institution-wide

1:1 computing initiatives. The decision made in 2009 for the university to collect NSSE data only every other year presented an additional limitation when attempting to compare incoming groups of first-year students.

The extant data were collected three and five years prior to the date of the study. Although more recent data were available from 2013, it was deemed inadvisable to include this data due to changes in the NSSE survey tool. This intentional omission constitutes a delimitation for the study.

## Summary

The proliferation of web-enabled technologies on college campuses continues to rise. Internet access may help increase student engagement in classroom learning activities by providing additional opportunities for interaction with instructors and peers. The research examined the outcomes of implementing an institution-wide 1:1 initiative on student engagement in the classroom. The researcher also examined potential statistically significant variance in the level of student engagement based on gender and the educational attainment level of the participant’s parents. Chapter Two will proceed by describing, in more detail, the relevant literature on the effectiveness of 1:1 computing initiatives on learning outcomes.

# CHAPTER TWO

# REVIEW OF THE LITERATURE

Over the past decade, the proliferation of digital technology in post-secondary education has ignited a drive for university administrators to incorporate web-enabled mobile devices across college campuses. The decision to invest in such initiatives reflects acknowledgement that technology is (a) a set of tools for addressing the challenges of teaching and learning, (b) an agent for change, and (c) a central force in the economic competitiveness of nations (Culp, Honey, & Mandinach, 2003). This work suggests these rationales are not independent, but instead they all share a common premise that technology has influenced societal prosperity over the last century.

Implied in discussions of the academic benefits of technology are assumptions about the ability of technology to fuel student engagement. Indeed, based on their review of 20 years of research on academic engagement, Pascarella and Terenzini (1991, p. 610) state "one of the most inescapable and unequivocal conclusions we can make is that the impact of college is largely determined by the individual's quality of effort and level of involvement in both academic and nonacademic activities." Because of the importance placed on student engagement in education (Astin, 1985), the role of Internet access and mobile technology is of particular interest. One focus of the current research is to investigate the effects of an institution-wide 1:1 technology initiative on student engagement.

Despite growing interest surrounding 1:1 initiatives, there remains a lack of conclusive empirical evidence to support the capital investment required to provide ubiquitous access to the Internet by implementing a campus-wide 1:1 initiative (Culp et al., 2003; Holcomb, 2009; Muir et al., 2004; Penuel, 2006; Weston & Bain, 2010). As this chapter will demonstrate, however, there are emerging themes across the body of this literature that aid in demonstrating the importance of specific elements of the institutional ecology that surround technology implementation and integration. Importantly, these elements are identified by this literature as fundamental to successful implementation and integration of technology into the classroom. Another goal of this chapter, therefore, is to emphasize the importance of ubiquitous 1:1 access and implementation, a well-developed infrastructure for technical support, and ongoing professional development for faculty. Also, the relationship between these themes and student engagement will be discussed.

Chapter Two begins with a review of existing literature on the framework for contemporary theories regarding best practices for implementing and integrating technology into the classroom. Focus then shifts to a discussion of student engagement, with an emphasis on the impact of mobile technology (Doe, 2009; Kukulska et al., 2007). This part of the chapter includes an overview of the terms Participation Gap and Digital Divide (Morse, 2004) both of which have been added to the educational lexicon to describe disadvantages associated with students lacking access to the latest learning technologies (Steyart, 2002). In this context, I evaluate studies on web-enabled devices, and specifically classroom applications for the iPad, with regard to their potential effect on classroom engagement. Finally, I discuss gender and first-generation college student status insofar as these variables pertain to affecting the level of student engagement as it relates to the introduction of a 1:1 technology initiative.

## Implementation and Integration of Technology Initiatives

Whereas most 1:1 initiatives share in common the idea that all students have access to technology, the degree of access provided varies greatly between institutions (Penuel, 2006). A synthesis of the literature indicates that some initiatives may allow students to take the technology home while others may not; some have only a portion of the student body participating (teachers reporting significant variation in the extent to which the technology is actually used in classrooms); and some may require students to either buy or lease the technology (Culp et al., 2003; Muir, Knezek, & Christensen, 2004; Holcomb, 2009; Weston & Bain, 2010). All of these differences represent significant variation in what is meant by access to technology. By 1997, stakeholders including educators, policymakers, and researchers had recognized that physical access to mobile technology was only one dimension of accessibility (Culp et al., 2003). At this time, policy focus began to spread to the institutional ecologies' ability to support the infrastructure necessary to provide equitable access to relevant and appropriate content, adequate Instructional Technology (IT) support and training, and professional development of faculty.

Quasi-experimental and experimental research testing how variation in the aforementioned variables affects learning outcomes are not common. A notable exception is the work of Russell et al. which experimentally investigated the effect of computer-to-student ratio on how students used computers and how teachers organized instruction (Russell, Bebell, & Higgins, 2004). Not surprisingly, this research indicated that in 1:1 environments, students used their technology more frequently in general, more frequently at home, and had included computers in their beliefs about what good writing required when compared to students in 4:1 or 2:1 environments. Additionally, because everyone in the classroom had technology in 1:1 environments, the teachers were better able to effectively integrate technology into activities (Russell et al., 2004). This research is important, because it was able to experimentally demonstrate the value of ensuring that every student had access to their own technology. These findings mesh with research suggesting that limited student access contributes significantly to teachers' decisions to use technology in classes (Cuban, 2001).

To put these issues into a context, Penuel (2006) indicates that there are two overlapping theoretical frameworks for organizing the existing research into 1:1 initiatives. These are frameworks for understanding both why computing initiatives matter for learning, as well as the conditions under which such initiatives are more likely to be successfully implemented and integrated. The first type of research is about the potential of wireless technology to enhance student learning, and focuses on the ability of 1:1 initiatives to provide equitable access to resources and learning opportunities, and the potential of technology to transform learning environments (Penuel, 2006; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Roschelle & Pea, 2002). The findings of these studies was extremely inconsistent, which led to the need for the second type of research, examining the conditions under which implementation and integration are more or less likely to be successful.

In a research synthesis of 20 years of policy reports that address the challenges of implementation and integration into teaching, Culp et al. (2003) identify basic themes of research evaluating 1:1 initiatives. At various levels of complexity, these themes force a critical analysis of what is meant by equitable access to technology. Although the specific details vary by study, a commonality emerges in an acknowledgement that the potential of technology to impact learning depends upon the surrounding institutional ecology in ways that are critical to teacher effectiveness in integrating technology into the classroom. Applied to an institution, the concept of ecology refers to the institutional infrastructure within which initiatives are implemented and integrated. Ecological perspectives acknowledge that in order to be successful, integrating technology into instruction requires the commitment, focus, and resources from multiple stakeholders (Culp et al., 2003), and that messages about instruction in the environment strongly influence teaching practices through teachers' beliefs about autonomy and support (Coburn, 2004). Of relevance to the present research, many of the studies reviewed by Culp et al. contain specific recommendations for professional development in technology; such development is identified as the most important step in integrating technology into education (Culp et al., 2003).

## Student Engagement

Over the past decades, learning theorists have consistently called for active student engagement in the classroom (Bain, 2004; Beatty, Gerace, & Dufresne, 2006; Walberg, 1986). Several factors have been found to affect student engagement, including sound pedagogy (Chickering & Gamson, 1987), individual student effort and academic rigor (Pace, 1990; Kuh, 1991), and assimilation into curricular and extracurricular activities (Tinto, 1993). The development of engagement theory is represented in the work of Astin (1984), Pace (1984), and Kuh and his colleagues (Kuh, 2002, 2003, 2008, 2009; Kuh & Vesper, 2001). How each of these researchers defines engagement varies, but consistencies among them include the premises that students learn from what they do in college, and that measurement of engagement should include information about how institutional infrastructure (i.e., policies and practices) influences levels of engagement (Kuh, Pike, & Vesper, 1997; Pike & Kuh, 2004).

The most widely used measure of this kind is the National Survey of Student Engagement (NSSE) (Kuh & Vesper, 2001). Astin's I-E-O model was created as a tool for examining student development and the subsequent impact this development has on academic outcomes (Astin, 1993). Pascarella and Terenzini (2005) refer to Astin's I-E-O model as "the first and most durable and influential college impact model" (p. 3). The I-E-O model identifies student input, the university environment, and student outcomes as the components determining academic outcomes at the post-secondary level (Astin, 1991).

According to Astin (1970), student inputs include individual skills, talents, and aspirations possessed by students when they arrive on campus. Astin's model is ecological in that it defines the collegiate environment as comprised of peer groups, extra-curricular activities, faculty, curriculum, physical buildings, and policies; all of which are hypothesized to affect students. The third component, student outputs, includes developmental factors that are influenced by the university ecology. These outputs are quantified through metrics of student interests, activities, values, attitudes, achievements, and knowledge (Astin, 1970, 1993; Pascarella & Terenzini, 2005).

The foundation of Astin's model is Tyler's time on task (Merwin, 1969). As a starting premise, Astin (1984) points out that educators are competing with a student's desire to spend time with family and friends, pursue hobbies and outside interests, and engage in recreational activities and work. Student engagement involves a wide range of activities including time spent studying, time on campus, involvement in academic organizations, clubs, athletic teams, and frequency and quality of interactions with faculty, staff, and peers. Highly engaged students in the classroom are conceptualized as active members of campus organizations that frequently interact with instructors and peers, and that spend significant time outside of the classroom studying. For the purposes of this study, student engagement will be defined as the time and energy students devote to educationally sound activities inside and outside of the classroom (Kuh, 2003).

Tyler’s concept of time on task has since evolved into Pace’s College Student Experiences Questionnaire (CESQ), which is a measure of student activity level that is able to describe student learning and development (Pace, 1984). The amount of time that students spend socializing with peers, studying, and interacting with faculty are some examples shown to be correlated with academic achievement. The Pew Commission went on to report the high potential value of national normative statistics on higher education quality for both prospective students and the participating institutions (Kuh & Vesper, 2001). In order to understand the implications of Astin’s model for institutions, it is necessary to highlight the relationship between the NSSE and university accreditation processes.

In 1998, The Pew Charitable Trusts commissioned post-secondary education leaders in order to address the inability of third-party organizations and governmental agencies to accurately report on the quality of education being provided. The group initially concluded that measuring undergraduate satisfaction of the university is a better indicator of quality than reporting on the reputation of various higher education institutions. Their findings suggested relationships between student satisfaction, learning outcomes, student engagement, and academic rigor.

The accreditation process is a generally accepted measure of institutional effectiveness, employed by colleges and universities across the United States. Although academic outcomes are part of the accreditation equation, the major area of evaluation focuses on pedagogical process and institutional resources (Kuh, 2003). Popular media reports often used by prospective students and their parents to rate institutional effectiveness can be based on how selective the admittance program is and the at-large reputation of the college or university (Kuh, 2003). What had been missing from the third-party rankings was a metric designed specifically to rate the overall college experience for the undergraduate student and the subsequent academic outcomes; the NSSE was designed to fulfill this role (Kuh, 2003) and is thus a part of the accreditation process.

The NSSE relies on survey data volunteered by undergraduate students regarding their higher education experience. Considered by its developers as a game-changing assessment, the NSSE challenges institutional administrators to rethink the quality of education that their undergraduate students are receiving. The NSSE employs five benchmark measures: (a) Level of Academic Challenge, (b) Active and Collaborative Learning, (c) Student-Faculty Interaction, (d) Enriching Educational Experiences, and € Supportive Campus Environment to categorically report on the students’ perception of their undergraduate experience. These benchmarks are derived from 100 important questions developed to collect self-reported data on the quality of undergraduate education delivered (Kuh, 2009).

The importance of effective ways to engage students was not a new idea. The introduction of Chickering and Gamson's (1987) "Seven Principles for Good Practice in Undergraduate Education" turned the conversation away from student-centered instruction, and focused on the importance of engagement. These seven principles are (a) student-faculty contact, (b) active learning, (c) prompt feedback, (d) time on task, (e) high expectations, (f) respect for diverse learning styles, and (g) cooperation among students (Kuh, 2009). According to this work, these seven principles represent the best indicators of student engagement at a university.

Before further discussing engagement at the individual student level, it should be noted that a variety of measures exist for engagement at the post-secondary level. Pike and Kuh (2005, p. 202) utilized NSSE data to identify seven different ways institutions engage their students, and they suggest that engagement is defined differently depending upon which type of engagement is focused on. They reported that no one institution scored consistently high or consistently low across all types of engagement, suggesting the importance of a strategic institution-wide engagement plan that accounts for the implications of the various types. The seven institutional engagement types of Pike and Kuh (2005) are listed below:

1. Institutions are diverse, but interpersonally fragmented.
2. Institutions are homogeneous and interpersonally cohesive.
3. Institutions are intellectually stimulating.
4. Institutions are interpersonally supportive.
5. Institutions are high-tech, low-touch.
6. Institutions are academically challenging and supportive.

7. Institutions are collaborative.

Echoing the need to recognize the complexity of engagement, Coates (2007) proposed that student engagement can change depending on a variety of factors including, but not limited to, the learner's emotional state, the classroom environment, and instructional methodology. Specifically, his research identified the following four distinct typologies of student engagement:

1. Intensely engaged students are highly involved with curricular and extracurricular activities, and consider their learning environment to be challenging, yet supportive.
2. Independently engaged students are academically engaged but less interested in collaborative learning or social forms of engagement. These students consider faculty approachable and encouraging.
3. Collaboratively engaged students are involved with the campus community and a variety of extracurricular activities. They enjoy interaction with faculty, staff, and peers.
4. Passively engaged students rarely participate in educationally purposeful activities.

Other researchers highlight the importance of the distinction between passive participation and active engagement by recognizing that there are behavioral, emotional, and cognitive components of engagement that contribute to expectations about the learning environment (Fredericks, Blumenfeld, & Paris, 2004). According to this work, behavioral engagement consists of following the rules. These students are compliant with standards of classroom behavior, but are not necessarily cognitively or emotionally engaged with the material, the teacher, or their peers. Emotional engagement consists of emotional enjoyment of time in the classroom and higher levels of interest in supporting their instructor and peers. These students are usually behaviorally engaged as well, but may not necessarily be cognitively engaged. Cognitive engagement consists of a desire to be challenged academically; these students often go above and beyond assignment parameters (Fredericks et al., 2004). Parallel research places great value on the modality of engagement when understanding the competing ways that students invest themselves in the learning process (Finn, 1989; Harris, 2008). As this research demonstrates, the ability to engage students in learning, through the provision of instructional materials that are focused on the expectations of the learner, has been long viewed as a key component of engagement.

Beyond the implications of these issues for instructional material, Tinto (1997) suggests that researchers and policymakers recognize that academic and social experiences of college are not separate but, instead, the academic experience as a whole is nested within the larger social environment of the institution. Tinto’s work highlights the importance of reducing student isolation by transforming the classroom environment with the use of technology. His research demonstrated a relationship between peer collaboration, student-faculty interaction, and student engagement. To the extent that mobile technology facilitates collaboration and interaction, mobile technology should also have an impact on engagement. Indeed, research within engagement theory identifies technology as a potential vehicle that could deliver Tinto’s suggested changes into pedagogical practice (Kearsley & Schneiderman, 1998).

The challenge for educators is to provide opportunities for students to engage higher order reasoning skills through activities focused on problem-solving, decision-making, and evaluation of multiple problems at once (Feurzeig & Papert, 2011; Kearsley & Schneiderman, 1998). Obviously, these goals require more than just access to technology; implicit in these goals is consideration of the applications of the technology to specific learning objectives, as well as activities designed to increase student effort invested in the educational process. This type of learning generated through the integration of challenging tasks helps create meaning and value in the mind of the learner, and is therefore indicative of engagement (Schlechty, 2002).

Papert (2002) echoes the findings of Schlechty by describing the importance of difficult, but enjoyable, activities that are relevant both to the individual learner and to contemporary culture. This research suggests that the intersection between academic content, personal growth, and ecological application produces the potential for student engagement to thrive. When considering the importance of incorporating challenging educational activities in concert with the technology-centric mindset of today's college student, mobile technology initiatives became the preferred high-impact practices (Bain, 2004; Papert, 2002; Prensky, 2001; Schlecthy, 2002; Teo, 2013).

Kuh (2008) defines high-impact learning practices as those demanding a significant amount of time and effort on the part of the student to complete. The long-term investment needed to finish the task requires students to recommit on a daily basis, which often has the ancillary effect of increasing their dedication to the project, the class, and to the program of study. Another unintended consequence of challenging coursework is the increase in student interaction with faculty and peers. As stated earlier (Tinto, 1997), both types of interaction correlate positively with student engagement (Kuh, 2008).

At the post-secondary level, the belief that challenging activities increase student engagement is supported by observational research of a group of 63 high-impact professors in their classrooms (Bain, 2004). This research revealed that a common trait of high-impact professors was the ability to relate previous learning and student experience to course materials. Instruction in their classrooms focused on students' active construction of knowledge rather than their passive reception of information (Bain, 2004). At a theoretical level, deep learning presumably requires the development of metacognitive strategies that are required for difficult academic tasks (Feurzeig & Papert, 2011; Beatty, Gerace, Leonard, & Dufresne, 2006; Schraw & Moshman, 1995; Jonassen, Mayes, & Maleese, 1993). Metacognitive strategies force learners to think critically about how they learn, and can result in individualized strategies for learning that are best suited for a particular student. Additional studies agree with the general notion that deep learning fosters student use of higher order thinking skills and increased comprehension (Floyd, Harrington & Santiago, 2009; Majeski & Stover, 2007). The flexibility of mobile technology has the potential to facilitate the aforementioned types of deep learning activities. The next section of this chapter integrates the literature on student engagement with technology.

## Technology and Student Outcomes

The meta-analysis conducted by Liao (1992) examined cognitive performance of students in computer-assisted instruction (CAI) environments compared to non-computer-assisted instruction (non-CAI) environments utilizing extant research from

1968 to 1989. The time frame effectively encompasses computer use in the classroom until the onset of the online computing revolution. Thirty-one studies were located from three sources: ERIC, published journals, and comprehensive dissertation abstracts. The studies had to take place in actual classrooms and provide quantitative data on both CAI and non-CAI students. The results demonstrated a larger positive effect size in favor of the CAI classrooms in 74% of the studies analyzed when compared to the non-CAI control group. Specifically, students in CAI classrooms scored approximately 18 percentile points higher on a variety of cognitive assessments compared to the non-CAI students.

Prensky (2001) coined the term “digital native” to portray the technologically savvy learners that think about and process information in fundamentally different ways than students that were in universities prior to the development of mobile digital technologies. Educators began to realize that students positively value technology, are confident and flexible with their use of it, and believe that it can be used creatively in engaging instruction (Teo, 2013). The downside of this otherwise optimistic scene is that digital learners are often disinterested with more traditional modes of instruction, such as lecture, and therefore easily become bored in class. These students are more inclined to engage with gaming applications such as simulations (Vatuli & Rohs, 2007). If used properly, such simulations could result in higher academic achievement (Goddard, 2002). Learning outcomes that are associated with simulations using technology include (a) meaning-making, (b) higher levels of engagement and vested interest in creative projects, (c) increased systems-oriented thinking, and (d) positive perceptions of self-regulation and of self-efficacy  (Papert 1998).

In 2008, the World Wide Workshop Foundation implemented a study on game-based education wherein 199 students from middle school through community college responded to a series of open-ended questions online designed to measure engagement and comprehension in this type of learning environment (Reynolds & Caperton, 2011). Their findings indicate students considered the activities both relevant and appealing. This type of game-based instruction through exploration encourages student participation and subsequently enhances student engagement (Feurzeig & Papert, 2011; Heise & Himes, 2010; Pieratt, 2010). Given the emerging consensus that technology had the potential to increase student engagement, researchers and policymakers began to seriously consider the implications of economic disparities among college students. Critically, such disparities contribute in very real ways to disproportionate access to technology across levels of socioeconomic status.

Educators, administrators, and students have long pointed to inequitable resources as a major factor in determining student achievement (Becker, 2000; Carvin, 2000; Kirschenbaum & Kunamneni, 2001). Disparities in socioeconomic status, in the ability of institutions to effectively train and support faculty, and in degrees of family support are all key components of predicting academic success (Jehangir, 2009; Milner, 2010). Milner (2010) further developed this rationale by proposing a shift in attention from the achievement gap to the provision of digital technology as a potential tool for bridging the gap.

The concept of a digital divide was initially presented by the National Telecommunications and Information Administration (NTIA) of the US Department of Commerce in their 1995 report titled “Falling through the Net” (NTIA, 1995). Multiple researchers have defined this divide as a disparity in access to technology as well as to the Internet (Maxwell, 2003; Kirschenbaum & Kunamneni, 2001; Morse, 2004; Steyaert, 2002). Critically, some of this research suggests that such disparities align with socioeconomic and demographic data such as ethnicity, income, and geographical location (Morse, 2004). Taken together, digital divide theory states there are significant socioeconomic disparities between students, and that these disparities result in differential access to, utilization of, and proficiency with, technology (Markle Foundation, 1995).

These demographic comparisons brought about a new term, *digital equity*. In educational settings, digital equity endeavors to provide "every student, regardless of socioeconomic status, language, race, geography, physical restrictions, cultural background, gender, or other attributes historically associated with inequities, with equitable access to advanced technologies" (Solomon et al., 2003, p. xiii). This definition has been expanded beyond education technology hardware and software to include the quality and quantity of Internet access (Carvin, 2000; DiMaggio & Hargittai, 2001; Harrell & Fatemi, 2001).

Long (2008) built on the concept of digital equity by introducing the phrase *participation gap*, which describes individuals lacking broadband Internet connections and computers at home. Long's work suggests that these disparities result in less opportunity for the acquisition of digital literacy skills. Long summarizes his findings simply by stating, "The more opportunity young people have to spend online, the more their experience and comfort level grows" (Long, 2008, p. 3).

It is worth noting that student-level socioeconomic disparities are often representative of larger social inequalities. An economically disadvantaged student, for example, is likely to live in an economically disadvantaged school district. Thus, the economic hardships that are facing individual students are the same hardships that are facing the districts themselves. Indeed, research has demonstrated that efforts to close the digital divide may actually worsen the problem due to the propensity for students from high socioeconomic backgrounds to attend school districts that are already receiving the most advanced educational software and hardware (Kirschenbaum & Kunamneni, 2001; Schofield & Davidson, 2003). While some researchers emphasize the potential of web-enabled devices to provide access to a virtual world of information, regardless of their socioeconomic status (Negroponte, 2010), other researchers are not as confident.

There are researchers who believe that the provision of the latest technological devices is insufficient to bridge the digital divide. Wenglinsky's (1998) landmark study focused on the importance of how education technology is utilized, as opposed to the mere presence of technology in the classroom. This work followed 6,227 fourth graders and 7,146 eight graders and focuses on the relationship between different uses of technology and frequency of computer use, access to computers at home and in school, professional development of teachers in technology use, and the kinds of instructional methodologies that teachers implemented (Wenglinsky, 1998). Results demonstrated that the greatest inequities in technology use are not in access to technology, but instead are due to methods of pedagogical integration. Specifically, these findings varied based on socioeconomic status and geographical location and revealed that poor, urban, and rural students were less frequently exposed to more complex and integrated use of technology than were wealthier, suburban students (Wenglinsky, 1998). Moreover, the teachers in rural, urban, and poorer districts were less likely to have had professional development experiences in the use of technology in the classroom.

Wenglinksy's findings were influential in shaping the direction and focus of subsequent research. Slate (2007) reported that schools within low socioeconomic districts that were equipped with technology used it as a drill and practice device instead of challenging students with assignments that tapped into higher order thinking skills. The overall ecology of poorer school districts is such that there is probably little time or energy to devote to thoughtful preparation of learning activities for students. Moreover, because low income school districts are less likely to provide professional development for teachers, these teachers aren't aware of the full extent of technology's capability to enhance learning. Indeed, instructors unaccustomed to the use of technology often fail to correctly integrate these tools into the curriculum (Juarez & Slate, 2007; Herder & Marenzi, 2010; Ostashewski, Moisey, & Reid, 2011).

As this discussion demonstrates, physical access to technology and to the Internet are not enough to affect learning outcomes significantly. The available evidence suggests that professional development of teachers in the use of technology in a pedagogically sound manner, across the socioeconomic spectrum, is critical to successful integration.

These results redefine, in important ways, how policymakers conceptualize the cost of 1:1 initiatives. The cost of the physical technology alone is prohibitive for many school districts without significant federal aid, and such aid is almost always contingent on data-driven analysis of the effects of technology on achievement. Add in the cost of support staff and ongoing training opportunities for teachers, and the costs skyrocket.

Because of this, some educators are opposed to the implementation of 1:1 computing initiatives, citing high upkeep costs and shrinking education budgets making sustainability virtually impossible (Holcomb 2009; Lei and Zhao 2008; Rockman, 2004).

In this section of the chapter, I have attempted to illustrate that despite the research findings demonstrating improved academic performance and increased student engagement in 1:1 technology initiatives, there are serious concerns as to whether the benefits merit the substantial financial investment. The cost for these initiatives not only includes the individual cost of purchasing digital devices for every student, but also includes variable costs associated with maintaining the network, devices, and technology staff (Weston & Bain, 2010).

**Mobile Technology and Classroom Applications for iPads**

Several post-secondary institutions have committed to 1:1 initiatives focusing on mobile web-enabled devices and iPad applications. The inclusion of iPads into pedagogical practice is on the rise, and some educators believe these types of intuitive, web-enabled devices are transformative technologies for preparing learners to compete in a global, 21st-century economy (Meyer, 2011; Hill, 2011). Weighing in at 1.33 pounds, the multi-touch screen iPad, with high-speed Internet capability, is being touted as a revolutionary learning tool (Hill, 2011; Price, 2011). The interface of an iPad allows learners to engage visually, as well as with their tactile and auditory senses. It is this user-friendly interface, with its intuitive operating system, which positions the iPad as appropriate for both mainstream and special education classrooms. Moreover, because of the flexibility of the iPad for delivering content in multiple modalities, it makes information accessible by learners of all ages and at all comfort levels with digital technology use (Hill, 2011; Murphy, 2011; Price, 2011; Stevens, 2011; Wang, 2010).

Aronin and Floyd (2013) report that iPads provide portability and a wide variety of educational applications available at little or no cost. Furthermore, older versions of the iPad can be purchased at a lower cost and still provide educational opportunities for linking abstract concepts and commonly used technology to science and math curriculums (Aronin & Floyd, 2013). Thus, iPads have the potential to provide flexibility of application, and therefore to serve the needs of the greatest variety of learners, while keeping costs relatively low. However, the question in the minds of university administrators centers on the assessment of measurable improvements in academic achievement as the result of mobile learning devices.

Multiple studies have suggested a positive correlation between integration of mobile classroom technologies, such as the iPad, and academic success (Bell, 2007; Berk, 2010; Castelluccio, 2010; Hamilton, 2007; Park, 2008; Rosen & Beck-Hill, 2012; Stevens, 2011; Suki, Eshaq, & Choo, 2010; Todd, 2010; Traxler, 2010). Specific areas of improvement include writing, digital literacy (Russell et al., 2004), and higher standardized test scores (Suhr, Hernandez, Grimes, & Warschauer, 2010). Some of this interest comes from the ability of iPads to promote learning anytime, anywhere.

At Stanford University's School of Medicine, incoming students for the 2010 Fall semester received their own iPad. These students reported satisfaction in the ease of transporting the device, as well as its ability to facilitate mobile learning (Park, 2010). A study of Duke University medical students receiving iPads indicated increased levels of productivity, a result presumably due to the iPad's ability to have a contextualized learning experience with technology (Schaffhauser, 2011).

However, not all of the research and corresponding literature on iPad use in education is positive. Fischman (2011) points out that favorable student reporting on iPad use may stem more from the "cool" factor of the technology rather than any practical application in teaching and learning. Murray and Olcese's (2011) iPad research described the majority of education applications as unrelated to modern learning theory, depriving students of the 21st-century skills many believe iPads enhance. They went on to state that a precious few of the iPad applications actually support "truly innovative teaching and learning in the sense that they represent resources that extend what educators and students could otherwise do" (p. 46). Kolowich (2010) narrowly describes the benefits of iPads as confined to digital readers and multimedia players but lacking the file management capabilities and other tools important in educational settings. Wieder (2011) asserts that university instructors often consider the inclusion of iPads in the classroom as another distraction competing for the attention of their students.

Regardless of the compelling arguments for and against increasing the amount of digital technology available on campus, several iPad programs were introduced during the 2010-2011 academic year. Reed College students reported that iPads helped them keep pace with multiple channels of information while simultaneously improving efficiency through fast response times (Ferernstein, 2011). The same study also found iPads inadequate for the task of working with PDF files making use of the information cumbersome. One of the first graduate programs to widely use the iPad, Arizona State University's Carey School of Business, showed interest in ways to make transportation of class materials easier for their students. Their research concluded that the iPad was an excellent supplement but inadequate as a laptop replacement (Freeman, 2011). Another pilot program, at Abilene Christian University, touted the convenience of iPads for reading text but lamented the inability to annotate materials at the time of the study (Mostafavi, 2011). When comparing the iPad to popular eReaders, students at Buena Vista University felt the iPad provided increased flexibility and functionality (Schaffhauser, 2011). Thus, despite the fact that the iPad has limitations in some domains, it has remarkable value in the flexibility of application and the ease of transport.

A multitude of research suggests that mobile devices provide convenience (Ferernstein, 2011; Mostafavi, 2011; Park, 2010), contextual learning (Schaffhauser, 2011), and overall improved academic outcomes (Bell, 2007; Berk, 2010; Castelluccio, 2010; Hamilton, 2007; Park, 2008; Rosen & Beck-Hill, 2012; Stevens, 2011; Suki, Eshaq, & Choo, 2010; Todd, 2010; Traxler, 2010). As the iPad and digital technologies continue to add enhancements, most expect these devices to play an important role in 21st-century education if introduced in a pedagogically appropriate manner (Banister, 2010; Bauleke & Herrmann, 2010).

To this point, the purpose of this chapter has sought to describe the rationale behind the investigation of the major independent variable of the study: implementation of a 1:1 technology initiative. In the remainder of the chapter, I focus on the other two independent variables: gender and status as a first-generation college student.

## Gender

Due to a pervasive view among social scientists that digital technology use is biased by gender (Newcombe, 2005), in my research I have targeted gender as an independent variable. For example, the culture of computing has been described as unappealing to females (Wilson, 2003). Laroya (2014) points out that the “digital divide” regarding technology careers and development goes beyond socioeconomic factors and continues to include an ongoing “gender bias.” For the purposes of this study, gender is defined by the social characteristics associated with biological femaleness or maleness (Richardson, Taylor, & Whittier, 2003).

Conversely, gender stereotypes center on expected personality traits based on societal norms of gender-specific roles (Krueger, Hasman, Acevedo, & Vilano, 2003). These expected behavioral norms, reinforced by parents from birth, encourage males and females to take part in gender-appropriate behavior (Flannery, 2000). Martin and Ruble (2010) report that children as young as 18-24 months demonstrate the “ability to label gender groups” thus leading to more specific “gender-typed play.” Subsequently, children begin to identify with gender stereotypes by the age of three.

However, the lines of gender role delineation may be blurring. According to Weingarten (2015), new research conducted specifically with millennials demonstrates a progressive stance on gender. Results convey a general attitude that gender should not “define” nor restrict conformity to traditional roles. Weingarten goes on to cite research by gender theorist, Kate Borstein, who notes gender is not a “constant” but should be viewed in context. Borstein states, gender “is always relative to something.”

The research results examining the effect of gender on student engagement have been mixed. Zhao, Carini, and Kuh (2005) could not delineate significant differences between levels of engagement in the males and females participating in their study. Kuh (2003) does report males demonstrate a wider range of engagement, with part of the survey sample highly engaged and a similar number of male participants completely disengaged from the learning process. Still other research supports the position that females are more highly engaged students than their male counterparts (Downey & Yuan, 2005).

The lack of consistency in research findings on student engagement between males and females may stem from inconsistencies in the tools used to measure engagement, as well as the type of engagement being measured (Hu & Kuh, 2002). Additionally, significant variation is evident in the manner in which student engagement is defined. Behavior, emotion, and cognitive dimension are frequently used to define engagement parameters and often yield a wide range of analysis and outcomes (Fredricks & McColskey, 2012). Despite various measurement tools and mixed results, a trend has emerged depicting female students outperforming their male counterparts in academic achievement across a broad spectrum of educational outcomes (Marks, 2008; Mead, 2006). Several researchers have correlated this academic achievement gap between genders to student engagement (Clark & Trafford, 1995; Davies & Brember, 2001; Lamb, 1997). The question remains as to whether the higher academic performance of female learners can be attributed to an increase in educational technology or whether it is independent of the increased availability of education technology?

As stated previously in this section, Wilson (2003) describes the computing culture as unappealing to the female gender. However, a number of quantifiable metrics including the amount of money spent on electronic consumer goods per year, excluding video games, show a preponderance of female purchasers (Schofield, 2005). If indeed, a gap ever did exist between male and female engagement with computers, multiple studies have indicated this separation has been all but eliminated (Losh, 2004; North & Noyes, 2002; Mossberger, Tolbert, & Stansbury, 2003).

An emerging technological gender ubiquity may stem from the banality of computers in our everyday lives which has created a “unisex” perception, like a spoon or fork used regardless of gender (Cranmer, 2006; Miller & Slater, 2000). Schofield (2005) argues that not only have many technologies become “gender agnostic”, but manufacturers are now intentionally incorporating “female-friendly” functions. The type of technology can be a factor. Females tend to prefer instructional technology programs.

There is limited research on gender and mobile technologies. One consideration may be the impact of “social influence” for the disparity in gender outcomes (Diemer, Fernandez, & Streepey, 2012). Notwithstanding this progress, there remains the view among social scientists that digital technology use is biased by gender (Brown & Leaper, 2010; Ceci, Williams, & Barnett, 2009; Newcombe, 2005; Wit, Heerwegh, & Verhoeven, 2012). Lack of confidence on the part of female students in using technology may also be a factor.  Females are often “dismissive” in regard to their technology skills, viewing them as unfeminine (Yau & Cheng, 2012). Oftentimes the perceived environment acts as a gender-based deterrent insofar as traditionally, computer science is portrayed in a masculine manner. Despite skill set or penchant for a subject, females are often deterred by a sense of not belonging due to gender-defined stereotypes pervasive to the field (Cheryan, Davies, Plaut, & Steele, 2009).

In addition to the perception that technology use is gender-biased, other researchers believe that the lecture—the predominant teaching methodology on college campuses—is also biased in favor of male learners (Hayes, 2000; Tannen, 1994). The lecture style of communication, where faculty transmit information to their students, has been likened to “report talk” which is in opposition to “rapport talk”—the preferred mode of interaction for female learners (Tannen, 1994). Although many female students are comfortable in a “report talk” classroom environment, others become disengaged and restrained from participating (Hayes, 2000).

These differences in gender-based communication styles can be exacerbated in a technology-driven learning environment. Herring (1996), in her study of online communication, found female participants more engaged in two-way conversations than their male counterparts who demonstrated a greater propensity for making one-sided, declarative statements. Joiner et al. (2005) reports that students do not differentiate between face-to-face and online communication; that, in effect, digital communication is merely a different vehicle for relaying a message.

From the viewpoint of feminist constructivism, the previously male-dominated landscape of technology was aggravated by the intentional exclusion of female contributions in historical records (Zuga, 1996). This male-centric view of technology fields which inhibits participation of female learners can be linked to cultural norms (Wajcman, 1991). Laroya (2014) echoes this sentiment, pointing out the prevalence of the “male-biased tech industry” where female employment in technology-related jobs is down. Huffman, Whetton, and Huffman (2013) conclude in their study on gender and technology self-efficacy that due to the perception of technology as a male-sex-typed subject matter, women are less likely to receive opportunities and education for technology related fields.

Although both male and female students enjoy hands-on learning activities, a higher percentage of boys by middle school participate in laboratory-related courses (Jones, Mullis, Raizen, Weiss, & Weston, 1992). The ongoing gender disparity for enrollment in math, science, and computer-related courses may account for the present under-representation of women in STEM fields (Ceci, Williams, & Barnett, 2009). A 2011 Executive Summary from the United States Department of Commerce cited research from the Census Bureau's American Community Survey data showing that in 2009 only 24% of STEM-related jobs were held by women. One possible factor listed was gender stereotyping. In addition, the same survey showed that women still lag behind men in earned degrees in technology-related areas of study (Beede et al., 2011). Despite the disparity of women in STEM related fields, a recent study found that retention of female undergraduate engineering majors demonstrated no significant difference in persistence from their male counterparts. In addition, females demonstrated higher levels of "self-determination" and "academic involvement" (Haemmerlie & Montgomery, 2012).

## First-Generation College Student Status

First-generation college students have been defined as individuals whose parents have not participated in post-secondary education (Choy, 2001; Pascarella et al., 2004; Saenz et al., 2007). According to Ramos-Sanchez and Nichols (2007), "They are more apt to judge their own abilities and potential as inferior to others, making it difficult for them to be successful" (p. 8). Additionally, first-generation college students tend to have lower SAT scores and grade point averages stemming from lower math, reading, and critical thinking skills (Blackwell & Pinder, 2014; Bui, 2002; Riehl, 1994; Terenzini et al., 1996).

Multiple studies have described first-generation college students as an at-risk population more susceptible to attrition than their peers who have at least one parent who pursued post-secondary education (Bui, 2002; Jehangir, 2009; Lohfink & Paulsen, 2005; Riehl, 1994; Terenzini et al., 1996). Furthermore, enrollment of first-generation students is on the rise at colleges and universities across the country. This has drawn increased attention from educators who are concerned with the academic abilities, preparedness, aspirations, and attrition rates of first-generation students (Reid & Moore, 2008).

When compared with continuing-generation undergraduates, first-generation undergraduate students are more likely to arrive at school unsure of social and academic expectations (Jehangir, 2009). Additionally, first-generation college students enrolling at four-year colleges are more likely to have a non-white ethnicity, and come from lower socioeconomic backgrounds creating higher levels of anxiety regarding their ability to pay for school (Bui, 2002; Lohfink & Paulsen, 2005).

Financial support from family is often lacking for first-generation college students. This lack of financial stability at home can generate added pressure on first-generation students who perceive higher education as a vehicle for helping support their families financially, and as a means of adding status, respect, and honor to the family name (Khanh, 2002). Compounding this pressure, first-generation students report their parents being less supportive and less encouraging about higher education than their counterparts whose parents graduated from college (Choy, 2001).

Merullo (2002) describes being the first member of his family who participated in post-secondary education as a transition between two distinct worlds, in which the student tries to weld the separate worlds together. This added effort to reconcile home and academic life can be detrimental to the student's academic achievement. Bradbury and Mather (2009) contend that educators need to explore why first-generation college students succeed or fail if they seek to better serve this growing population. Lohfink and Paulsen (2005) commented that "researchers have noted and lamented the inequalities in educational experiences and outcomes for first-generation students" (p. 409).

Because no family member has direct experience with university life and culture, these students often fail to actively engage in campus life (Lohfink & Paulsen, 2005). First-generation college students tend to be less involved in social activities and to lack appropriate active coping strategies for higher education (Lohfink & Paulsen, 2005; Mehta, Newbold, & O'Rourke, 2011). Living off campus and lower educational aspirations are two major reasons for the engagement gap between first-generation and continuing-generation college students (Pike & Kuh, 2005).

When comparing first-generation students with continuing-generation students, first-generation students were found to spend more time commuting to school, were more likely to have a job, and maintained lower grade point averages (Chen, 2005; Pascarella et al., 2004; Pascarella & Terenzini, 1991). Pascarella et al. (2004) reported that the propensity for first-generation college students to commute fundamentally altered their college experience. The time spent off campus working and dealing with family obligations resulted in lower participation rates in clubs and other extracurricular activities (Lohfink & Paulsen, 2005; Pascarella et al., 2004). Pascarella and Terenzini

(1991) found that first-generation students living on campus and enrolled full-time engaged more with campus life and demonstrated increased academic achievement.

In summary, first-generation college students not only lack engagement in extracurricular activities (Lohfink & Paulsen, 2005; Pascarella et al., 2004), but also demonstrate lower levels of academic engagement in the classroom, resulting in decreased gains in learning (Pike & Kuh, 2005). Several practical explanations are evident when examining the lower levels of engagement demonstrated by first-generation college students, including time working to support themselves and their families and the higher likelihood of commuting to campus, compared with continuing-generation students (Inman & Mayes, 1999; Pike and Kuh, 2005).

The remainder of the chapter provides a summary of Chapter Two, followed by a brief introduction to Chapter Three.

## Summary

This chapter has described the theory and the available evidence regarding the major independent variable of the study: the implementation of a 1:1 technology initiative. Additionally, in this chapter I have attempted to make a case for the need of new research to focus on the three major methodological problems of existing research: (a) inconsistency of implementation, (b) inconsistency in technological infrastructure for training and support, and (c) instructor access to ongoing professional development activities.

From there, in this chapter I described the research on academic engagement, focusing on the literature suggesting the potential of technology to facilitate increased time on task, problem complexity, and increased interaction with both peers as well as teachers. Subsequently, the chapter examined the role of mobile technology in providing contextualized learning experiences consistent with the parameters of Kuh's (2008) high-impact practices. The remainder of the chapter discussed the other two major independent variables in the study: gender and first-generation status as a college student. Both of these variables have implications for the effect of 1:1 mobile technology initiatives to increase student engagement.

Chapter Three will begin by providing an overview of the setting as well as the sample of the current research, followed by a discussion of the major independent variables and a description of the research questions. Finally, the research design of the study will be presented.

# CHAPTER THREE

## RESEARCH METHODOLOGY

In this chapter, I intend to describe the research methodology and design which address existing gaps in research identified by the literature review in the previous chapter. I will present a brief review of the background and the significance of the study first, followed by the purpose of the study, the research questions, the research design, the study respondents and their data source, and the data analysis procedures. The results of the study will be covered in Chapter Four with subsequent discussion reserved for Chapter Five.

The majority of existing studies uncovered in the literature review involved primary, intermediate, or secondary education environments. Data collected at the post-secondary level typically involved a specific program, department, or other sub-section of a university's population. In light of this, I identified the analysis of student engagement in a 1:1 computing environment across a university population as a needed area for further exploration. To this end, I collected data for this study at a small, private, Catholic liberal arts university in western Pennsylvania with an approximate student population of 2,400 undergraduate and graduate students. In 2010, the university initiated a 1:1 mobile computing technology initiative that provided all faculty and students with the same mobile technologies (iPads and Macbooks). The university had staff for technology support and training, and was providing training workshops for faculty in mobile technology and its application.

In the 2004-2005 academic year, the university made the National Survey of Student Engagement (NSSE) available to first-year and final-year students. Data were collected every Spring semester during the academic years 2004 through 2009. In 2009, the university made the decision to collect NSSE data only every other academic year. In the Fall of 2010, all full-time incoming undergraduate first-year students were provided with iPads and Macbooks. All first-year students from 2009 (N = 419) and 2011 (N = 378) were asked to respond to the NSSE. Of those invited, 611 provided data.

## Purpose of the Study

In this study, I sought to discover if a difference exists between student engagement when comparing NSSE data gathered prior to the implementation of a 1:1 technology initiative with NSSE data gathered post-implementation of a 1:1 initiative. The NSSE incorporates survey items focused on favored practices in undergraduate education based on multiple objective measures and acceptable psychometric properties (Kuh, 2002). Additionally, I examined the outcomes of gender on student engagement in a 1:1 environment, and whether the educational background of the participants' families impacted levels of student engagement.

I derived the independent variables of gender and status as a first-generation college student from the results of the literature review presented in Chapter Two, demonstrating the affect these factors have on engagement and academic achievement. Although a broad scope of data exists on the role of gender as it pertains to the use of digital technology, much of this data was collected nearly a decade ago and may not account for the emerging gender ubiquity in technology use (Cranmer, 2006). Chapter Two also uncovered the growing alarm among university administrators regarding risk factors causing higher levels of attrition for first-generation college students (Reid & Moore, 2008). This higher attrition rate coupled with a continued rise in enrollment among first-generation college students is increasing the need to identify ways to engage them in the classroom and on campus (Bradbury & Mather, 2009).

## Research Questions and Design

The following questions were developed to help identify outcomes associated with implementing a 1:1 technology initiative, examine the changing landscape of gender in relation to technology use, and provide data for administrators seeking ways to increase engagement of first-generation college students:

1. For first-year undergraduates, what are the outcomes in levels of student engagement before and after implementation of a 1:1 technology initiative? Do these outcomes depend on gender?
2. After implementation of a 1:1 technology initiative, what are the outcomes in levels of student engagement that depend on gender and first-generation status?

Question 1 was assessed with the use of a 2 (1:1 initiative: not yet implemented vs. implemented) X 2 (gender: male vs. female) between-groups design. Question 2 was assessed with the use of a separate 2 (gender: male vs. female) X 2 (first-generation status: yes vs. no) between-groups design. The researcher utilized extant data sets from the NSSE administration in 2009 (pre-1:1 initiative) and 2011 (post-1:1 initiative). The 2009 data allowed for the investigation of research questions 1 and 2, respectively.

The data set included no personally identifiable information and was collected from students who voluntarily completed the NSSE during the Spring term of their first year at a four-year liberal arts university. The NSSE is a recognized instrument created to measure engagement in educational activities resulting in desirable outcomes (Kuh, 2009). The NSSE incorporates survey items focused on favored practices in undergraduate education based on multiple objective measures and acceptable psychometric properties (Kuh, 2002).

The research questions were addressed utilizing Multivariate Analysis of Variance (MANOVA). These techniques are the recommended method for analyzing the impact of combinations of fixed factors (implementation year, gender, and first-generation status) on multiple dependent variables. Results of these statistics allow for the researcher to determine if there is support for the hypothesis that student engagement is influenced by the 1:1 technology initiative, gender, and first-generation status.

## Survey Respondents

Mertens (1998) describes ex post facto studies as those situations in which the researcher utilizes data where the independent and dependent variables have already occurred and the groups studied are pre-existing. I therefore chose to use the ex post facto design to determine if, after the implementation of a 1:1 technology initiative, differences exist in the population studied based on the independent variables gender and status as first-generation college students. Because secondary data were utilized, I was unable to interact with the respondents and the survey questions were not designed expressly for the purpose of this study (Owens, 2009).

Prior to the university-wide implementation of a 1:1 technology initiative, NSSE data were collected each Spring semester during the academic years 2004 through 2009. Sampling was not deemed necessary due to the limited number of first-year students enrolled and the subsequently small number of students self-reporting NSSE data. All first-year and final-year students, whether traditional or non-traditional, were afforded the opportunity to participate. However, I utilized only data collected from first-year undergraduate students for the purpose of this study because data from final-year students who participated in the 1:1 technology initiative were not yet available.

In 2009, the university made the decision to collect NSSE data only every other academic year. Therefore, no data set was available for the Spring semester, 2010. All full-time incoming undergraduate first-year students in the Fall of 2010 were provided an iPad and Macbook Pro (laptop) computing device by the university as part of a 1:1 campus-wide technology initiative. This campus-wide technology initiative sought to provide ubiquitous Internet access twenty four hours per day, and seven days per week anywhere on campus. First-year students from the incoming Fall of 2010 were invited to participate in the NSSE in the Spring of 2011, through which I sought to identify whether statistically significant differences in self-reported levels of student engagement exist between the pre-technology initiative group sample from Spring of 2009 and the initial class of undergraduate first-year students participating in the 1:1 technology initiative who self-reported NSSE data in the Spring of 2011. Data for a second treatment group of incoming first-year students in the Fall of 2013 were removed from the study due to changes in the NSSE survey instrument.

In 2004 and 2005 the NSSE was administered in paper form only. From 2006 through 2008, first-year students had the opportunity to self-report NSSE data online, or they could opt to fill out a paper copy of the survey. In 2009 and 2011, the survey was administered via email invitation and taken online only. Kuh (2004) reported that a larger percentage of women completed the paper version of the survey. Kuh (2004) also indicated that first-generation college students, non-traditional students, and commuters are more likely to complete the paper version of the survey.

## Data Source (NSSE)

The NSSE was designed to help universities measure and enhance the quality of undergraduate education, provide quantitative data to support the accreditation process, and facilitate comparative benchmarking efforts of peer institutions. The survey is made available to first-year students and final-year students who self-report data in the latter portion of their Spring semester (Kuh, 2002). The NSSE is a survey instrument specifically developed to evaluate undergraduate pedagogical practice and overall student satisfaction, and to measure student engagement in the educational process (Kuh, 2001).

The Indiana Center for Postsecondary Research reports that surveys are cost-effective vehicles for collecting data on student efficacy and assimilation into their collegiate environment (Kuh, 2003; Pace, 1984). The NSSE is indicative of sound educational practice empirically demonstrated to produce desirable academic outcomes (Kuh, 2001).

All NSSE data are self-reported which typifies survey information collected for the purpose of evaluating the quality of undergraduate education (Kuh, 2003). The validity and reliability of self-reported data has been studied by multiple researchers who have uncovered two factors affecting the efficacy of self-reported data (Baird, 1976; Kuh, 2001; Pace, 1985; Pike, 1995). These factors include respondents intentionally falsifying information, or inaccurately responding to survey questions. In general, researchers (Bradburn & Sudman, 1988; Kuh, 2001; Pace, 1985; Pike, 1995) have found self-reported data to be valid when the following five conditions exist:

1. Respondents know the information requested.
2. The questions are clear and easily understandable by respondents.

3. The questions refer to recent activities.

4. Respondents believe the questions justify serious consideration.

5. The survey does not violate a respondent's privacy and respondents will not feel threatened or embarrassed by responding honestly.

The NSSE was intentionally designed to meet all of the aforementioned criteria within the following five benchmarks of effective educational practice:

1. level of academic challenge;

2. active and collaborative learning;

3. student-faculty interaction;

4. enriching educational experiences;

5. supportive campus environment.

Utilizing these benchmarks, university administrators and educators can evaluate how students perceive their college experience compared to national, regional, and self-selected peer institutions (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993). The test-retest format of the NSSE demonstrates reliable data collected over an extended period of time. To "determine if differences existed in student responses to individual survey items within a two-year period," the researchers used matched samples and found the NSSE is a reliable tool for measuring engagement (Kuh, 2001b, p. 16). Also, those researchers tasked with developing the NSSE survey instrument went to great lengths to design easily understandable questions across a broad demographic segment and utilized factor analysis to establish the NSSE's construct validity (Kuh, 2001b).

Kuh (2003), positing the importance of the NSSE on measuring academic success, stated "what students do" while attending college has a greater impact on their success than where they attend school or even who they are. Student engagement in academically relevant activities has been shown to improve an undergraduate's perception of the collegiate experience, increase retention of learning, and enhance academic performance (Kuh, 2001; Kuh et al., 2006; Kulik, 2003).

The NSSE utilizes Likert scales for the 100 questions constructed to "assess the extent to which students are engaged in empirically derived good educational practices and what they gain from their college experience" (Kuh, 2003, p. 1). The NSSE survey instrument also solicits demographic information from the respondents. For the purpose of this study, I selected the following as independent variables: participation in a 1:1 computing initiative, gender, and status as first-generation college students. On average, respondents require approximately 30 minutes to complete the NSSE. Appendix A lists the NSSE survey questions examined for the purpose of this study. Each were selected from the active and collaborative learning grouping.

## National Survey of Student Engagement (NSSE) Questions

For the study, I chose six questions from the active and collaborative scale which NSSE (2007) describes as measuring classroom participation and degree of collaboration on school related activities with peers and faculty both inside and outside the classroom. I selected these survey items due to their perceived relevance to the measure of student engagement defined in Chapter One as the time and energy students devote to educationally sound activities inside and outside of the classroom (Kuh, 2003).

Respondents indicated their agreement with these items on a four-point Likert scale. Responses to each item of the six dependent variables below were examined individually utilizing univariate analyses and en masse through multivariate analyses.

(1 = *Never*, 2 = Sometimes, 3 = Often, 4 = *Very Often*)

1a Asked questions in class or contributed to class discussions

1b Made a class presentation

1g Worked with other students on projects during class

1h Worked with classmates outside of class to prepare class assignments

1l Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment

1m Used email to communicate with an instructor

*Figure 1.* Four-point Likert scale items.

In addition to the six Likert items above which constituted the dependent variables in the study, respondents provided demographic information on the independent variables of gender and status as a first-generation college student by answering the following questions:

16 Your sex: Male – Female

27 What is the highest level of education that your parent(s) completed?

(Mark one box per mother and one box per father)

Did not finish high school

Graduated from high school

Attended college but did not complete degree

Completed an associate's degree (A.A, A.S., etc.)

Completed a bachelor's degree (B.A., B.S., etc.)

Completed a master's degree (M.A., M.S., etc.)

Completed a doctoral degree (Ph.D., J.D., M.D., etc.)

*Figure 2*. Demographic questionnaire.

## Data Analysis and Procedures

Data were extracted from two institution-wide NSSE administrations corresponding to periods before the implementation of the 1:1 initiative (2009) and after (2011). Importantly, time is a between-subjects factor in this analysis, as the students that were freshmen in 2009 were not the same as the students in 2011. To analyze the effect of the 1:1 initiative and gender, responses to the six NSSE items were subjected to a 2 X 2 MANOVA. To analyze the effect of gender and first-generation college student status following implementation of the initiative, responses to the six NSSE items (from the 2011 data set) were subjected to a 2 X 2 MANOVA.

## Summary

In this study, I first sought to determine if a statistically significant variance in engagement exists between first-year students prior to the implementation of a 1:1 technology initiative and first-year students after implementation of the 1:1 initiative at a small, private, regional university. Subsequently, I examined potential variance in engagement based on gender in a 1:1 environment, and whether the educational background of the respondents' families impacted levels of student engagement in a 1:1 environment. I employed quantitative statistical analysis of secondary data. The research questions were addressed by utilizing a 2 X 2 MANOVA, which helped determine if there is any support for differences in engagement due to gender and first-generation status where a campus-wide 1:1 technology initiative has been implemented. All research findings will be presented in Chapter Four.

# CHAPTER FOUR

# ANALYSES AND RESULTS

Chapter Three provided information about the purpose of the study, the research questions and design, the survey respondents, and the survey instrument. The purpose of Chapter Four is to impart an overview of the study context, and to report results and interpretations of the analyses of the research questions.

## Study Context

The extant data was collected at a small, private, liberal arts university in Pennsylvania with an approximate student population of 2,400 undergraduate and graduate students. In 2010, the university initiated a 1:1 mobile computing technology initiative that provided all faculty and students with the same mobile technologies (iPads and Macbooks). In addition, the university had a fully staffed technology support staff for faculty and students. The university provided ongoing professional development in the incorporation of technology into the classroom to all incoming instructors and current instructors on a voluntary basis. Thus, the study context provided consistency in implementation of technology, consistency in access to technology support, and consistency in access to professional development opportunities.

As discussed in Chapter Three, the National Survey of Student Engagement (NSSE) was designed to help universities measure and enhance the quality of undergraduate education, provide quantitative data to support the accreditation process, and facilitate comparative benchmarking efforts of peer institutions. The survey is available to first-year students and seniors who respond to a self-report questionnaire in the Spring semester (Kuh, 2002). The NSSE was developed specifically to evaluate undergraduate pedagogical practice and overall student satisfaction, as well as to measure student engagement in the educational process.

In the 2004-2005 academic year, the university made the NSSE available to first-year students and final-year students to self-report data on five benchmarks designed to measure institutional effectiveness. All full-time undergraduate first-year students and final-year students were invited to self-report data, but for the purpose of this study, I only collected data from first-year students. Prior to the university-wide implementation of a 1:1 technology initiative, NSSE data were collected each Spring semester during the academic years 2004 through 2009. In 2009, the university made the decision to collect NSSE data only every other academic year. Therefore, no data set was available for the Spring semester of 2010. All full-time incoming undergraduate first-year students in the Fall of 2010 were provided personal computing devices by the university as part of a 1:1 campus-wide, technology initiative. In the Spring of 2011, incoming first-year students in Fall of 2010, were invited to participate in the NSSE.

All first-year students from 2009 ($N$ = 419) and 2011 ($N$ = 378) were asked to respond to the NSSE by clicking a hyperlink that was embedded into an e-mail correspondence. For both years, respondents participated in an electronically administered survey that contained the NSSE questions. Of those invited, a combined total of 611 responded ($M_{Age}$ = 23.13, $SD$ = 8.91). Of the respondents, 144 (23.6%) were male; 467 (76.4%) were female; 11 (1.8%) identified as Asian, Asian American, or Pacific Islander; 27 (4.4%) identified as Black or African American; 486 (79.5%) identified as White (non-Hispanic); 21 (3.4%) identified in other categories; and 30

(4.9%) indicated that they preferred not to respond. Within the 2011 NSSE data, 145 (60.7%) identified as a first-generation college students.

The major independent variable in this research is the implementation of the 1:1 mobile technology initiative, which was operationalized in the period spanning pre-1:1 initiative (2009 data) and post-1:1 initiative (2011 data). For the study, I selected data representing the respondent’s gender (male vs. female) and first-generation college student status as independent variables. Data reflecting first-generation status was only available for 2011, so analyses for the effect of first-generation status are limited to a single year.

For the purposes of this research, and as discussed in chapter three, I identified six NSSE questions as relevant to the use of technology for academic purposes, to be included as dependent variables in the analyses. On a scale of 1 (Never) to 4 (Very Often), students indicated how often they had (a) asked questions in class or contributed to discussions, made a class presentation, (b) worked with other students on projects during class, (c) worked with classmates outside of class to prepare class assignments, (d) used an electronic medium to discuss or complete an assignment, and (e) used e-mail to communicate with an instructor. Participants also indicated their gender (male or female), and the 2011 sample indicated whether or not they were a first-generation college student.

Table 1 provides information on response rate, gender, and first generation status for each year of the NSSE survey administration for the six NSSE items that were selected for analysis. Because 2011 was the only year for which first-generation status of students was available, only the 2011 dataset was used to investigate the effect of first-generation status on responses to the six NSSE items.

Table 1

*Response Rate, Gender, and First-Generation Status by Year of NSSE Administration*

| Year of Administration | Response Rate (%) | Male | Female | 1st Generation Status |
|---|---|---|---|---|
| 2009 | 312:419<br>(74%) | 83<br>(26.6%) | 229<br>(73.4%) | NA |
| 2011 | 237:378<br>(63%) | 57<br>(24.1%) | 180<br>(75.9%) | 92:378<br>(24%) |

## Analyses of Research Questions

To analyze the effect of multiple independent variables (1:1 initiative implementation, gender, and first-generation college student status) on the six dependent variables, two separate Multivariate Analyses of Variance (MANOVAs) were conducted. Multivariate techniques allow researchers to assess the effects of combinations of variables on more than one dependent variable at a time; following a significant multivariate effect, Univariate Analyses of Variance (ANOVA) were conducted to determine which items were statistically significant (Tabachnick & Fidell, 2013). Comparisons were considered to be statistically significant if the p-value for the comparison was equal to or less than .05; comparisons were considered marginally significant if the p-value for the comparison was between .06 and .10 (Tabachnick & Fidell, 2013).

*Research Question 1: For first-year undergraduates, what are the outcomes of student engagement before and after implementation of a 1:1 technology initiative? Do these outcomes depend on gender?*

To assess the effect of the 1:1 mobile computing initiative and gender on the six NSSE items, responses to the six NSSE items were subjected to a 2 (year: 2009 vs. 2011) X 2 (gender: male vs. female) between-groups MANOVA. Tests of the assumptions underlying these analyses (multivariate normality and linearity, homogeneity of variance-covariance matrices, and multicollinearity) indicated that these assumptions were not seriously violated in the analyses reported here.

**Effect of 1:1 Computing Technology Initiative on Academic Engagement**

Analysis suggested a significant multivariate main effect of implementation of the 1:1 initiative on the variables measuring academic engagement $F(6, 540) = 3.5$, $p = .002$; Wilks' Lamda = .96, partial eta squared = .04. For a complete breakdown of the multivariate effects for research question 1, see Table 2.

Table 2

*Multivariate Effects of 1:1 Technology Initiative and Gender on Academic Engagement.*

| Effect | Hotelling's Trace | F | $df_1$ | $df_2$ |
|---|---|---|---|---|
| 1:1 Initiative | .963 | 3.50* | 6 | 540 |
| Gender | .020 | 1.82 | 6 | 540 |
| 1:1 Initiative X Gender | .008 | .74 | 6 | 540 |

* $p < .01$

Table 2 demonstrates that there was no multivariate main effect of gender or gender X initiative interaction. As Table 3 illustrates below, when the results for the dependent variables were considered separately, the only difference to reach significance consisted in student responses as to whether they had used an electronic medium to discuss or complete an assignment for class. Specifically, respondents in 2011 ($M = 3.03$, $SD = .92$) did this significantly more than respondents in 2009 ($M = 2.67$, $SD = 1.06$) $F$(1,

545) = 14.55, $p < .001$. There were no other significant differences in student engagement as the result of the initiative (see Table 3).

Table 3

*Univariate Effects of 1:1 Initiative on Student Engagement*

| NSSE Item | | | | 2009 (Before 1:1 Initiative) N = 312 | 2011 (After 1:1 Initiative) N = 237 | *p-value* |
|---|---|---|---|---|---|---|
| | *df* | $df_{Error}$ | *F* | *M* (*SD*) | *M* (*SD*) | |
| Asked questions in class or contributed to class discussion | 1 | 545 | .079 | 3.17 (.79) | 3.12 (.82) | .99 |
| Made a class presentation | 1 | 545 | 1.60 | 2.88 (.80) | 2.95 (.82) | .207 |
| Worked with other students on projects during class | 1 | 545 | 1.30 | 2.65 (.80) | 2.51 (.77) | .253 |
| Worked with classmates outside of class to prepare class assignments | 1 | 545 | .376 | 2.74 (.80) | 2.55 (.81) | .54 |
| Used an electronic medium to discuss or complete an assignment | 1 | 545 | 14.55 | 2.67 (1.06) | 3.03 (.92) | < .001 |
| Used e-mail to communicate with an instructor | 1 | 545 | 1.04 | 3.47 (.69) | 3.52 (.69) | .307 |

Inspection of Table 3 indicates that the 1:1 initiative resulted in a significant increase in students using an electronic medium to discuss or complete an assignment. To put this finding into context, Figure 3 below illustrates the trend in responses to this item for the years 2005 - 2011. The effect of the 1:1 initiative can be seen in the increase in the slope between 2009 and 2011.

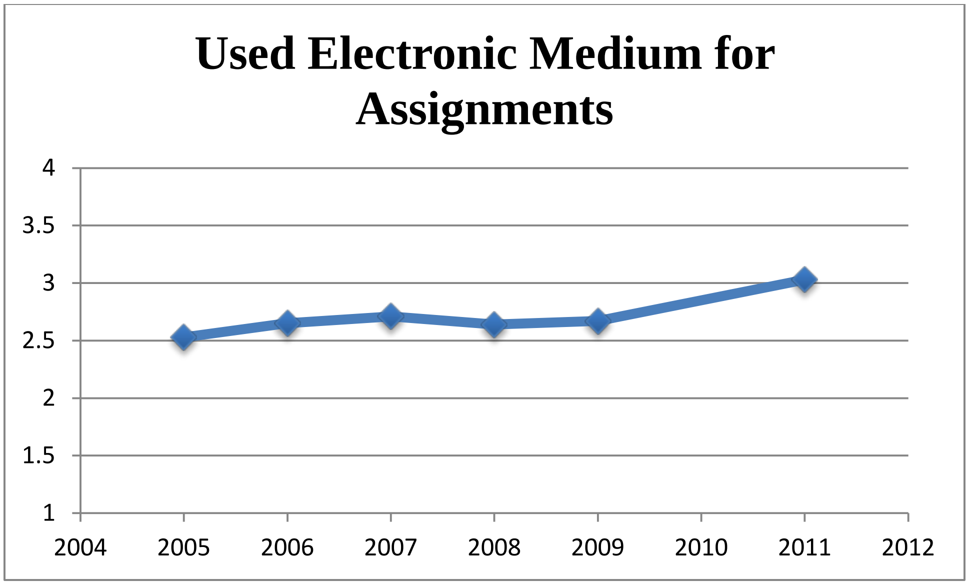


*Figure 3*. Trend in NSSE responses to this item across 2005-2011.

**Effect of Gender on Academic Engagement for Both Years**

Another goal of this first set of analyses was to investigate the effect of gender on student engagement. Analysis indicated a marginally significant effect of gender on academic engagement $F(6, 540) = 1.82$, $p = .093$, Wilks' Lamda = .98; partial eta squared = .02. When the results of the six NSSE questions were considered separately, there were differences in responses to the item that asked whether students worked with classmates outside of class to prepare for a class or assignment. Specifically, men ($M = 2.82$, $SD = .81$) indicated that they did this significantly more often than did women ($M = 2.66$, $SD = .81$), $F(1, 545) = 5.27$, $p = .022$. In addition, a marginally significant difference emerged in that men ($M = 2.82$, $SD = .81$) indicated that they worked with other students on projects during class more than women ($M = 2.66$, $SD = .81$), $F(1, 545) = 3.04$, $p = .08$. There were no other effects of gender on responses to the student engagement items (see Table 4).

Table 4

*Univariate Effects of Gender on Student Engagement*

| NSSE Item | *df* | $df_{Error}$ | *F* | Male (N = 140) | Female (N = 409) | *p-value* |
|---|---|---|---|---|---|---|
| | | | | *M* (*SD*) | *M* (*SD*) | |
| Asked questions in class or contributed to class discussion | 1 | 545 | .002 | 3.14 (.74) | 3.15 (.82) | .964 |
| Made a class presentation | 1 | 545 | .45 | 2.86 (.76) | 2.93 (.83) | .503 |
| Worked with other students on projects during class | 1 | 545 | 3.04 | 2.86 (.82) | 2.56 (.78) | .082 |
| Worked with classmates outside of class to prepare class assignments | 1 | 545 | 5.27 | 2.82 (.81) | 2.66 (.81) | .022 |
| Used an electronic medium to discuss or complete an assignment | 1 | 545 | .328 | 2.76 (1.07) | 2.84 (1.0) | .567 |
| Used e-mail to communicate with an instructor | 1 | 545 | .293 | 3.46 (.67) | 3.50 (.69) | .588 |

Inspection of Table 4 indicates that that in this sample, men more than women reported interacting with their peers about schoolwork, both in and out of class.

*Research Question 2: After implementation of a 1:1 technology initiative, what are the outcomes in levels of student engagement that depend on gender and first-generation status?*

Data for parental education was not available in 2009, and so responses to the six NSSE items in 2011 were subjected to a separate 2(gender: male versus female) X 2(first generation status: yes versus no) between groups MANOVA. Tests of the assumptions underlying these analyses (multivariate normality and linearity, homogeneity of variance-covariance matrices, and multicollinearity) indicated that these assumptions were not seriously violated in the analyses reported here.

**Effect of Gender in a 1:1 Environment on Academic Engagement**

As Table 5 below indicates, there was no multivariate main effect of gender or first-generation status, and in addition there was no multivariate interaction (see Table 5).

Table 5

*Multivariate Effects of Gender and First-Generation Status on Academic Engagement*

| Effect | Hotelling's Trace | F | $df_1$ | $df_2$ |
|---|---|---|---|---|
| Gender | .034 | 1.28 | 6 | 225 |
| First-generation Status | .021 | .78 | 6 | 225 |
| Gender X First-generation Status | .009 | .35 | 6 | 225 |

Table 6, below, presents the univariate results of gender on student engagement. As can be seen from the table, there was a marginally significant main effect of gender indicating that men ($M$ = 2.68, $SD$ = .81) were slightly more likely than women ($M$ = 2.46, $SD$ = .75) to report they worked outside of class with peers on assignments $F(1, 230) = 2.97$, $p = .09$. In addition, there was a significant main effect of gender on responses as to whether students had worked outside of class with peers to prepare assignments. Specifically, men ($M$ =2.88 , $SD$ = .85) indicated significantly higher responses to this item than did women ($M$ = 2.55, $SD$ = .82), $F(1, 230) = 6.07$, $p = .014$. (See Table 6).

Table 6

*Univariate Effects of Gender on Student Engagement (2011 data)*

| NSSE Item | *df* | $df_{Error}$ | *F* | Male (N = 140) | Female (N = 409) | *p-value* |
|---|---|---|---|---|---|---|
| | | | | *M* (*SD*) | *M* (*SD*) | |
| Asked questions in class or contributed to class discussion | 1 | 230 | .38 | 3.18 (.72) | 3.11 (.85) | .535 |
| Made a class presentation | 1 | 230 | .02 | 2.96 (.74) | 2.94 (.86) | .876 |
| Worked with other students on projects during class | 1 | 230 | 2.97 | 2.68 (.81) | 2.46 (.75) | .086 |
| Worked with classmates outside of class to prepare class assignments | 1 | 230 | 6.07 | 2.88 (.85) | 2.55 (.82) | .014 |
| Used an electronic medium to discuss or complete an assignment | 1 | 230 | .001 | 3.02 (1.0) | 3.03 (.90) | .978 |
| Used e-mail to communicate with an instructor | 1 | 230 | .155 | 3.52 (.69) | 3.51 (.70) | .694 |

These results should be interpreted carefully, because while they reproduce the pattern found with the analysis of research question one, the participants were the same (both were from the 2011 dataset). As was concluded regarding the results of research question one, these findings indicate that men are interacting with their peers about schoolwork more than women are.

**Effect of First-Generation College Status on Academic Engagement**

Table 7 illustrates the univariate effects of first-generation status on the student engagement items. As can be seen in the table, there was one marginally significant trend in responses as to whether students used e-mail to communicate with instructors. Specifically, first-generation students (*M* = 3.39, *SD* = .80) indicated that they did this less than non-first-generation students (*M* = 3.59, *SD* = .61), *F*(1, 230) = 3.0, *p* = .085 (see Table 7).

Table 7

*Univariate Effects of First-Generation Student Status on Student Engagement*

| NSSE Item | *df* | $df_{Error}$ | *F* | 1st Gen (N = 92) | Not 1st Gen (N = 142) | *p-value* |
|---|---|---|---|---|---|---|
| | | | | *M* (*SD*) | *M* (*SD*) | |
| Asked questions in class or contributed to class discussion | 1 | 230 | .245 | 3.1 (.80) | 3.14 (.84) | .621 |
| Made a class presentation | 1 | 230 | .914 | 2.92 (.83) | 2.96 (.83) | .340 |
| Worked with other students on projects during class | 1 | 230 | .120 | 2.58 (.80) | 2.46 (.75) | .729 |
| Worked with classmates outside of class to prepare class assignments | 1 | 230 | .014 | 2.67 (.87) | 2.60 (.82) | .907 |
| Used an electronic medium to discuss or complete an assignment | 1 | 230 | .202 | 2.98 (1.0) | 3.06 (.85) | .654 |
| Used e-mail to communicate with an instructor | 1 | 230 | 3.0 | 3.39 (.80) | 3.59 (.61) | .085 |

Table 7 indicates that there are no reliable effects of first-generation status on student engagement in this study.

## Summary

Overall, the analyses and results of this chapter involved academic engagement data collected within a private liberal arts university in western Pennsylvania from first-year college students in 2009 and 2011. In the Fall of 2010, the university implemented a 1:1 mobile technology initiative, which meant that every incoming student got an iPad and a MacBook for use in their coursework.

For this study, I analyzed the data from the sample with multivariate techniques, and follow-up analyses at the univariate level indicate that men more than women show increased engagement working with their peers more (both in class as well as outside of class), and that overall, the students sampled are using electronic mediums to turn in assignments significantly more following the 1:1 mobile computing initiative. In Chapter

Five, I will summarize the results and implications of the research, and from there I will make recommendations for future study.

# CHAPTER FIVE

## SUMMARY, DISCUSSION, AND RECOMMENDATIONS

The digital natives who sat in primary school classrooms a decade ago are now entering college as the Net Generation (James, 2011). This new class of first-year college students are not only tech-savvy, they are informed consumers of education with elevated expectations of curricular content and instructional methodology (Prensky, 2001). Simultaneously, multiple states have been cutting higher education budgets, which increases the pressure on administrators to make sound investments allowing their institutions to keep pace with new technology in a fiscally responsible manner (Hulsey, 2010).

One of the costliest proposals for satisfying the growing demand for classroom technology is the implementation of a 1:1 initiative (Boardman, 2012). Although much of the existing literature demonstrates increases in student engagement and classroom performance in a 1:1 environment, it is difficult to quantify whether these gains justify the cost (Li & Pow, 2011; Tamin et al., 2011; Weston & Bain, 2010). Therefore, this research provides an additional resource for administrators to make informed purchasing decisions.

In an effort to add clarity to the issue, this chapter will include three sections: (1) a review of the proposal, literature, and theoretical perspective; (2) a discussion of the research questions and summary of findings; and (3) an overview of limitations, implications, and recommendations for future research.

## Review of the Design, Literature, and Theoretical Perspective

The purpose of this study was to further support or refute previous findings on the effect of 1:1 technology implementations on student engagement in college classrooms. This information is intended to guide university administrators on the educational value of providing ubiquitous Internet access across all campus programs and facilities. The study was founded on the premise that increased access to education technology is requisite for technology use and that technology use is a fundamental pre-existing condition for studying the impact of said technology on student engagement (O'Dwyer, Russell, & Bebell, 2004). Hence, the opportunity to examine an extant data set in a 1:1 setting presented a rich environment to study the effect of education technology on student engagement.

To analyze the National Survey of Student Engagement (NSSE) data, I utilized an ex post facto design to provide quantitative analysis of the following research questions:

1. For first-year undergraduates, what are the outcomes in levels of student engagement before and after implementation of a 1:1 technology initiative? Do these outcomes depend on gender?
2. After implementation of a 1:1 technology initiative, what are the outcomes in levels of student engagement that depend on gender and first-generation status?

I chose the NSSE survey items for analysis from the academic and intellectual experiences grouping based on their perceived relevance to classroom technology and engagement (see Appendix A). Quantitative results for each research question were provided in Chapter Four and additional discussion surrounding the analysis of results will be provided in the next section of this chapter.

## Discussion of Findings

### Research Question 1

*Research Question 1: For first-year undergraduates, what are the outcomes of student engagement before and after implementation of a 1:1 technology initiative? Do these outcomes depend on gender?*

The first research question examined self-reported levels of student engagement through the NSSE of first-year undergraduate students before and after the implementation of a 1:1 technology initiative. As discussed in Chapter Two, the NSSE is a nationally normed measure of engagement employing five benchmarks: (1) Level of Academic Challenge, (2) Active and Collaborative Learning, (3) Student-Faculty Interaction, (4) Enriching Educational Experiences, and (5) Supportive Campus Environment (Kuh, 2003). Of the 100 survey items included in the NSSE, analysis was focused on the six Likert survey items listed in Figure 1 of Chapter Three as well as demographic information on the independent variables of gender and status as a first-generation college student displayed in Figure 2 of Chapter Three, due to their perceived relevance to the variables studied.

Initial analysis may suggest a 1:1 technology initiative results in a significant effect on student engagement. I identified survey item 1l as the driving force for the variation with the post-1:1 initiative data set, whereby students responded that they are more likely to use technology to discuss or complete an assignment: *Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment* (see Appendix A).

This is noteworthy from the standpoint that the measurement took place on a college campus, across the population, in a 1:1 technology environment where all incoming first-year students had access to the Internet through ubiquitous devices issued by the university. As outlined in Chapter One, the majority of existing research on 1:1 technology initiatives has taken place in a K-12 public school environment (Silvernail & Gritter, 2007).

Differences in age, usage patterns, and Internet access between K-12 and post-secondary learners may indicate that research results between these distinct environments could be fundamentally different. The Children's Internet Protection Act (CIPA) mandates that both primary and secondary public schools install Internet filters limiting access to information that would be readily available through college and university Intranets (Jaeger & Zheng, 2009). This filtering process could limit educational opportunities in K-12 public schools with many districts preferring to err on the side of caution when deciding the appropriate level of Internet access for students (Kilfoye, 2013).

When comparing technology usage patterns between primary school students and first-year college students, the contrast would call into question the validity and applicability of K-12 findings at the post-secondary level. Further highlighting the importance of conducting ongoing research at the university level in order to provide quantifiable data representing gains in student engagement on campuses implementing a 1:1 technology initiative. However, by and large the results of the current study conducted at the post-secondary level reflected findings consistent with the aforementioned research in K-12 environments.

All of the research examined in Chapter Two occurring at the post-secondary level was limited to a subset of the university population; typically by department or program (Allsopp, Kyger, & Lovin, 2007). By restricting studies to individual majors, researchers have been pre-selecting campus subgroups with narrower demographic, psychographic, and academic backgrounds than would be found across the entire university population.

Although the research has demonstrated significant correlations between the introduction of ubiquitous technology and increases in student engagement, the question of causation remains unanswered. Was the increased engagement based solely on the availability of digital devices and Internet access, or is this finding indicative of deeper methodological integration by faculty? As discussed in the literature review, 1:1 a technology environment where all students have access to their own device not only increases the likelihood of use by instructors, but also facilitates improved pedagogical integration as well (Cuban, 2001; Russell et al., 2004). Price (2011) indicated that without sufficient access to technology, effective pedagogical integration will not be achievable. Universities seeking significant increases in engagement and the corresponding improvements in academic achievement may consider the universal provision of compatible digital devices a prerequisite and therefore justifiable expense (Stephens, 2012).

However, Culp et al. (2003) suggested that synthesis of twenty years of policy reports pointed to the overarching institutional ecology as the main factor for technological integration to result in measureable academic gains. A fertile learning ecology requires commitment, focus, and substantial resources in order to influence faculty attitudes about technology use in a positive manner (Coburn, 2004). Several of the studies reviewed by Culp et al. considered ongoing professional development as the most important factor for both curricular and methodological integration of classroom technology (Culp et al., 2003)

Part two of the initial research question examined whether the NSSE outcomes were further influenced by the gender of the respondents. In the percentage of male respondents, I found a significant difference demonstrating increased levels of engagement in comparison to female respondents in their group. This finding was unexpected based on the emerging trend of gender-agnostic technology and an active movement to promote female participation in STEM (Science, Technology, Engineering, Mathematics) related fields (Arroyo et al., 2013). Consequently, the data would instead support the position of Wit, Heerwegh, and Verhoeven (2012) who believe a digital technology bias favoring males continues to pervade our classrooms. Also, the digital divide regarding technology careers continues to point toward an ongoing gender bias favoring males (Laroya, 2014). As with many discriminatory and exclusionary practices, the gap continues to exist long after the bias is no longer prevalent.

The survey question associated with the increase in male engagement with technology does not indicate the manner, type, or reason the technology was used but does provide several examples of utilizing technology to communicate: *Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment* (see Appendix A)

As discussed in the literature review, research indicates students do not differentiate between face-to-face communication and digital communication; the latter is merely a different methodology for sending a message (Joiner, 2005). This could be significant if the majority of faculty are designing assignments requiring one-way communication, such as posting an answer to a discussion question as opposed to two-way communication, which is more engaging to female learners (Herring, 1996).

Additionally, the digital technology of communication media continues to be portrayed as masculine, potentially deterring female learners from fully embracing these modes as conduits of learning (Cheryan, Davies, Plaut, & Steele, 2009). Females are often “dismissive” in regard to their technology skills, and many consider technological proficiency as unfeminine (Yau & Cheng, 2012).

**Research Question 2**

*After implementation of a 1:1 technology initiative, what are the outcomes in levels of student engagement that depend on gender and first-generation status?*

The second research question focused on student engagement outcomes influenced by gender and first-generation college student status among undergraduate first-year students post-implementation of a 1:1 technology initiative. I selected gender as a variable due to a perceived technology bias positing that male students have a higher propensity for technology use and a greater likelihood of pursuing careers in STEM-related fields (Wit, Heerwegh, & Verhoeven, 2012). As indicated in the previous chapter, data analysis of the 2011 NSSE respondents uncovered no effects of status as a first-generation student on engagement post-implementation of a 1:1 technology initiative. However, a similar gender effect was discovered reproducing the pattern of males engaging with their peers outside of class on assignments more so than did their female counterparts. It should be noted that the respondents are also the same participants from the analysis in question one (i.e., both were from the 2011 dataset).

The second variable examined in question two, status as a first-generation college student, was chosen based on findings in the literature review demonstrating increased enrollments and higher attrition rates of first-generation students when compared with students who had one or more parents participate in post-secondary education. It is noteworthy that this subset of the university population—identified in previous studies as less engaged (Lohfink and Paulsen, 2005) and at-risk (Jehangir, 2009)—showed no significant difference in levels of engagement when compared with first-year students who had one or more parents attend college. Davis (2010) posited that a deep lack of familiarity with the college experience is the most critical characteristic to examine concerning the higher attrition rates of first-generation students. Hopkins (2011) echoed these sentiments, stating that first-generation college students experience culture shock upon entering a foreign environment with unspoken rules and a variety of cultural norms.

In order to better serve this growing category of student population, Bradbury and Mather (2009) have challenged educators to explore why first-generation college students succeed or fail. Could this question be answered in part by demonstrating equivalent levels of engagement when equitable levels of technology are provided for all incoming first-year students? Discussion of three terms introduced in Chapter Two—digital divide, digital equity, and the participation gap—offer valuable insights when attempting to formulate an answer.

Morse (2004) contended the digital divide results from the inequitable distribution of information technology and Internet access based on characteristics such as ethnicity, income, and geographic location. And according to Bui (2002), first-generation college students have a higher likelihood of coming from a lower socioeconomic background and having a non-white ethnicity.

Digital equity has been defined as “every student, regardless of socioeconomic status (SES), language, race, geography, physical restrictions, cultural background, gender, or other attributes historically associated with inequities, [having] equitable access to advanced technologies, communication and information resources, and the learning experiences they provide” (Solomon et al., 2003, p. xiii). DiMaggio & Hargittai (2001) would also include the quality and quantity of Internet access as an attribute of digital equity. And Long (2008) expanded on the issue of Internet access by introducing the term “participation gap” to describe individuals lacking broadband Internet connections and computers at home, resulting in less opportunity for the acquisition of digital literacy skills.

Considering these findings regarding first-generation students en masse, a population segment identified as less engaged in college life, and generally lacking equitable technology resources, enters a 1:1 environment and demonstrates levels of engagement in line with the overall university population of first-year students. The findings may represent a relationship between the introduction of the 1:1 initiative and increases in engagement of first-generation students.

## Overview of Limitations, Implications, and Recommendations

### Limitations

The study was limited by the relatively small number of respondents self-reporting data at a single, private university. This geographically confined, context-specific data cannot be generalizeable across the broad spectrum of colleges and universities currently operating in the United States. The validity and reliability of self-reported data can suffer from respondents falsifying information or inaccurately responding to survey questions. (Pike, 1995). The two data collection points were three and five years prior to the date of the study. With the recent emphasis on women in STEM-related fields and the continued advances in technology, student and faculty expectations and integrations of technology in education may be significantly different today than they were in 2009. Also, the two-year gap between pre-implementation and post-implementation creates a disparity in the amount of professional development for faculty and depth of pedagogical integration in curriculum between groups. Due to changes in the NSSE survey instrument, the most recent NSSE data (2013) were not considered valid for the purposes of the research. Also, the decision by the university to collect data only every other year may further dilute the efficacy of the findings.

A multitude of uncontrolled variables exist, including but not limited to changes in faculty, curriculum, demographic make-up of first-year students, instructional methodology, and pedagogical integration. Therefore, the study is considered quasi-experimental and I was unable to assign any causal outcomes to the findings. Furthermore, because I chose to examine secondary data, the survey questions utilized were not specifically designed for the purposes of this study.

## Implications

The research questions were intended to provide additional information for consideration when college and university officials are evaluating the potential academic return on investing in a 1:1 technology initiative. In light of this, I also sought to examine unique variables in order to highlight the need for future evaluation or identify the variables studied as having a negligible impact on student engagement in a 1:1 learning environment. Findings from this investigation have implications for the value of 1:1 initiatives at the post-secondary level to increase engagement and retention of first-generation college students and for recommendations for future research in the areas of student engagement and education technology.

The results of this research inform the study of student engagement in a technology-rich learning environment with both specific and potentially broader implications. From an institutional standpoint, administrators and faculty can evaluate types of technology integration fostering student engagement. Furthermore, the university is not merely concerned with engaging students in the learning process but also with the overall impact increased levels of classroom engagement could have on raising academic performance and lowering attrition rates.

Kuh (2003) defines student engagement as the amount of time and effort students put into their studies and other educationally purposeful activities, and believes this constitutes one of two basic indicators of a quality college learning environment. The second indicator examines how universities allocate resources and design curriculums to support student involvement in the aforementioned educationally purposeful activities.

The results of this study provide evidence supporting the proposition that a provision of equitable technological resources will help alleviate disparities in engagement between continuing-generation and first-generation college students. Multiple studies have linked increased student engagement to increased academic performance (Bain, 2004; Beatty, Gerace, & Dufresne, 2006; Walberg, 1986).

Furthermore, Tinto (1997) found that students engaged in the learning process feel less isolated in regard to the overall college experience. This increase in academic achievement coupled with decreased levels of isolation could help alleviate the disproportionately high rate of attrition amongst first-generation college students.

Another important implication of the results came from the examination of gender as an independent variable, showing a greater propensity for male students to utilize technology to communicate for educationally purposeful activities. This may imply the need for faculty to reexamine strategies for incorporating technology in a manner requiring both report talk, which is favored by males, and rapport talk, shown to be the preferred method for female learners to communicate (Hayes, 2000; Tannen,1994). By thoughtful incorporation of activities geared toward peer collaboration and discussion facilitated through the use of technology, female learners may subsequently be more likely to engage in the use of technology as a learning support.

**Recommendations for Future Research**

The aim of this study was to provide a basis for ongoing research on larger university campuses across the United States and perhaps internationally. As mentioned previously in the limitations section of the study, there exists a multitude of variables that could impact student engagement and, subsequently, academic achievement. Systematically identifying and examining these variables could help form consensus between contemporary academicians who fall on opposite ends of the spectrum when discussing the benefits of 1:1 technology initiatives. Furthermore, the incorporation of a secondary or tertiary survey tool would provide increased statistical validity and additional support of findings.

Specifically, based on the research, I recommend the following three opportunities to build on the existing study in order to justify continued, increased, or decreased spending (or a cessation of spending) on 1:1 technology initiatives at the university level.

1. A quantitative survey tool designed expressly for the research.
2. Ethnicity and socioeconomic status as viable variables.
3. An analysis of professional development, faculty attitude, and pedagogical integration.

The remainder of this section will serve as a catalyst for modification of the current study, integrating one or more of the aforementioned recommendations.

**Quantitative survey tool designed expressly for the research.** The NSSE was initially designed to address the lack of third-party organizations and governmental agencies accurately reporting on the quality of education being provided identified by The Pew Charitable Trusts in 1998. The survey is made available to freshmen and seniors who self-report data in the latter portion of their Spring semester and was specifically developed to evaluate undergraduate pedagogical practice and overall student satisfaction, and to measure student engagement in the educational process (Kuh, 2002).

By designing a unique survey instrument, future researchers would have the opportunity to collect data on a more frequent basis and across all four years of a student's undergraduate education instead of only the first and final year. This could help eliminate favorable reporting of technology use based on the "cool" factor generated by first-year students receiving a new device (Fischman, 2011).

**Utilize ethnicity and socioeconomic status as potential variables.** One of the findings worthy of further investigation involved a potential correlation between the introduction of the 1:1 initiative and increased engagement of first-generation students. Lohfink and Paulsen (2005) described first-generation college students enrolling at four-year colleges as more likely to have a non-white ethnicity and to come from lower socioeconomic backgrounds. By collecting and analyzing data on each variable independently, it may be possible not only for future researchers to identify if this effect can be replicated, but also to uncover variance based on ethnicity and socioeconomic status.

**Analysis of professional development, faculty attitude, and pedagogical integration.** Twenty-first century instruction is synonymous with fluidity. If modes of communication are evolving, then so too must educators adapt to the new literacy context (Sweeny, 2010). In order to keep pace with this rapid development of new technologies, the cost and impact of ongoing professional development should be part of the decision-making process. Professional development has been identified as the key element for successfully integrating technology into instructional practice (Lawless & Pelligrino, 2007) . Although professional development has been demonstrated to change faculty attitude toward technology (Overbaugh & Lu, 2008), the prevailing university culture regarding technology use sets the stage for any meaningful in-service training (Inan & Lowther, 2010). For future research, the question of *how* and *why* technology is being utilized should take precedence over *if* technology is being utilized.

## Summary

The rate of technological innovation has created an environment of unprecedented opportunity for educators to reach large numbers of college students in ways previously viewed as impractical. However, the expense of keeping pace with the latest must-have digital devices has also generated a scenario where missteps in purchasing could have long-lasting financial implications for colleges and universities already struggling to maintain costs and enrollments.

The available data from the research results generally indicate increases in both student engagement and classroom performance when examining the effects of implementing a 1:1 technology initiative. The application of the data is limited by the following factors: (a) the small and geographically confined, context-specific sample; (b) the self-reported nature of the data; and (c) a multitude of uncontrolled variables preventing an inference of causal correlations from the results. In order to help minimize the effect of these limitations, I recommend three strategies for future researchers: (1) Focus on examining data collected at the university level, (2) study what types of instructional methodology and pedagogical integration correlate with higher levels of engagement in a 1:1 environment, and (3) utilize a quantitative survey tool designed expressly for this research.

The findings from this study support previous findings demonstrating increased student engagement in a technology-rich environment. Specifically, I identified the NSSE survey item 1l (see Appendix A) as the main dependent variable resulting in reported increases in student engagement by respondents post-1:1 initiative. Another noteworthy finding proved to be the significant difference of male respondents reporting increased engagement, in comparison with female respondents within the same dataset. It would be advisable for universities investing in a 1:1 initiative to examine how their faculty is utilizing technology as a means of communication. Expressly, do the curriculums and individual assignments encourage both report talk, which is favored by males, and rapport talk, shown to be the preferred method for female learners to communicate (Hayes, 2000; Tannen, 1994)?

The results of examining the third independent variable, status as a first-generation college student, may have yielded the most significant findings in that there was no significant difference in engagement between this at-risk student population and their continuing-generation peers when measured in a 1:1 environment. Bradbury and Mather (2009) have challenged educators to further examine why first-generation college students are at higher risk for attrition. One potential answer is the inequitable distribution of education technology, or lack of digital equity—a deficiency which is effectively minimized in a 1:1 learning environment.

Although the examination of gender and status as a first-generation college student did not yield any causal correlations, findings may aid university administrators in their purchasing decisions surrounding future investments in classroom technology and also guide pedagogical practices and instructional methodologies geared toward engaging students in classroom activities. The specific independent variables measured should provide direction on the need to differentiate student engagement methodologies based on gender and status as a first-generation college student.

Educators must continue to evaluate, quantitatively and qualitatively, both the tools and the pedagogical processes we are using to reach today's college student and, beyond that, the next generation filling our classrooms. Only through ongoing research and continuous critical examination of our educational product can institutions of higher learning capitalize on the wealth of knowledge now available through the Internet.

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APPENDIX A

National Survey of Student Engagement Questions

<u>Very Often / Often / Sometimes / Never</u>

1a Asked questions in class or contributed to class discussions

1b Made a class presentation

1g Worked with other students on projects during class

1h Worked with classmates outside of class to prepare class assignments

1l Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment

1m Used email to communicate with an instructor

16 Your sex: Male - Female

27 What is the highest level of education that your parent(s) completed?

(Mark one box per mother and one box per father)

Did not finish high school

Graduated from high school

Attended college but did not complete degree

Completed an associate's degree (A.A, A.S., etc.)

Completed a bachelor's degree (B.A., B.S., etc.)

Completed a master's degree (M.A., M.S., etc.)

Completed a doctoral degree (Ph.D., J.D., M.D., etc.)