An Investigation into the Relationship between Technology and Academic Achievement among First-Year Engineering Students

Dissertation

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ABSTRACT

In order to increase the number of American STEM degree recipients, it is important for academics to develop ways to improve students' interest, retention, and success in fields like engineering. The purpose of this study was to understand the relationship between first-year engineering students' (FYES) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement (i.e., grades). This investigation focused on the specific types and uses of educational technology by FYES, while also analyzing differences by race/ethnicity and gender.

Previously, scholars have employed a broad definition of technology to describe hardware such as cell phones and computers or software for word processing and web-based applications. Such definitions have been used to understand how collegians, instructors, and professionals interact with technology. In the present study, educational technology signified specific computer and information technology such as computer hardware (e.g., desktops, laptops), computer software (e.g., Microsoft Word/Excel, MATLAB, SolidWorks), electronic devices (e.g., cellphones, tablets, E-readers), and the Internet (e.g., websites, course management systems). Rogers' (1995) technology adoption theory was chosen for the current study as it related well to the present research questions.

A multi-step approach (i.e., descriptive statistics, independent samples *t*-tests, hierarchical linear regression) was used to analyze survey data from nearly 500 students. Results from the present study determined there were significant racial/ethnic differences in FYES' perceived usefulness as well as frequency and nature of use of technology. There were also significant gender differences in FYES' perceived knowledge and usefulness of technology. Furthermore, FYES' background characteristics significantly predicted their final course grades in the second of two *Fundamentals of Engineering* courses. Findings have important implications for practice, research, and theory surrounding FYES and educational technology.

DEDICATION

To my mother Karen, my sister Ashley, and a host of family/friends who have always supported my academic pursuits and dreams.

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PUBLICATIONS

Strayhorn, T. L., **Long, L. L., III,** Williams, M. S., Dorimé-Williams, M. L., & Tillman-Kelly, D. L. (2014). Measuring the educational benefits of diversity in engineering education: A multi-institutional survey analysis of women and underrepresented minorities. Proceedings from *2014 American Society of Engineering Education* (*ASEE) Annual Conference and Exposition.* Indianapolis, IN.

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Justification of the Study

Statement of the Problem: Lack of American STEM Degree Recipients

STEM statistics. Increasing the number of Americans who graduate with a degree in science, technology, engineering and mathematics (STEM) is of compelling national interest as the world is becoming more technologically-dependent (National Science Board [NSB], 2006; President's Council of Advisors on Science and Technology [PCAST], 2012, 2010). Currently, more than 18 million students are enrolled at institutions of higher education with over 10.5 million enrolled at 4-year schools (National Science Foundation [NSF], 2013b). However, only 38.4% of freshmen at 4-year institutions intend to major in a science and engineering (S&E) discipline, with 10.3% indicating an interest in engineering. Of those who intend to major in any STEM field, less than 40% actually graduate with a degree in the field (PCAST, 2012). As a result, about 525,000 U.S. collegians earned an S&E Bachelor's degree in 2010, with nearly 74,400 in engineering (NSF, 2013b). By comparison, more than 1,140,000 American students obtained a 4-year degree in non-S&E areas.

STEM diversity. Besides a low interest among freshmen and an overall retention rate of less than 40% in STEM, other factors point to the disparity between the number of S&E and non-S&E degree recipients. For instance, STEM fields have traditionally struggled to recruit and retain women and racial/ethnic minorities (Center for Institutional Data Exchange and Analysis [CIDEA], 2000). Historically underrepresented racial/ethnic minorities (URMs) – Blacks[1], Hispanics, and Native Americans – represent less than 18% of Bachelor's degree recipients in S&E even though they make up approximately 37% of the college population (National Center for Educational Statistics [NCES], 2011; NSF, 2013b). In addition, women account for about 50% of 4-year degrees in S&E even though they constitute roughly 67% of all collegians. Numbers are even more alarming in specific fields like engineering where URMs collectively earn just 13% of Bachelor's degrees and women are only awarded around 18% of undergraduate diplomas (NSF, 2013b). Certainly, efforts can be made to increase student interest and success in STEM fields like engineering. This will result in a more racially/ethnically diverse student population. Then, educational benefits can accrue to undergraduates who interact with diverse peers and perspectives (Strayhorn, Long, Williams, Dorimé-Williams, & Tillman-Kelly, 2014).

Why the Problem is Important: U.S. Workforce, Global Competitiveness, and Grand Challenges

U.S. workforce. So, why is it important to increase the number of American STEM graduates? Recent reports indicate that the U.S. needs more skilled workers in scientific and technology-based careers to occupy positions in its progressively technical workforce (NSB, 2006; PCAST, 2012, 2010; U.S. Department of Labor, 2007; U.S. News, 2012). For instance, in 2012, the President's Council of Advisors on Science and

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[1] The terms 'Black' and 'African American' are used interchangeably throughout this manuscript, referring to individuals who trace their ancestral origins to groups of the African Diaspora, including West Indians, Africans, Caribbeans, and Haitians, to name a few.

Technology (PCAST) called for approximately 1 million more STEM graduates over the next decade in order to meet economic forecasts for the nation.

Global competitiveness. U.S. leaders also aim to improve the nation's global competitiveness by increasing the number of skilled S&E workers. For example, recent reports reveal that the U.S. ranks 27th among developed countries in the proportion of undergraduates who earn a S&E Bachelor's degree, and 47th among developed countries in the quality of math and science education (Education at a Glance, 2010; Sala-i-Martín, Bilbao-Osorio, Blanke, Crotti, Hanouz, Geiger & Ko, 2012). In addition, the U.S. ranks 14th in availability of the latest technologies and in business absorption of technology, despite having the largest market size (Sala-i-Martín et al., 2012).

Grand challenges. An increase in STEM graduates can help the U.S. tackle emerging challenges of the 21st century (National Academy of Engineers [NAE], 2004). As technology continues to rapidly change and greatly impact people's lives, the world will become more globally connected. Therefore, the country must develop individuals who can solve complex real-world problems in order to provide people with access to things like clean water, improved medicines, and revitalized urban infrastructure.

Interested parties. The U.S. government, leading corporations, and non-profit institutions are all concerned with the preparation of engineers and other STEM students. Government agencies like the National Science Foundation (NSF), with an annual budget of $7 billion, provide substantial funding to support S&E while supplying students, researchers and practitioners with necessary technological tools and equipment

(Associated Press [AP], 2013; Evans, 2013; NSF, 2013a). Other organizations like the Accreditation Board for Engineering and Technology (ABET) and the National Academy of Engineers (NAE) provide information about expected student outcomes and skill sets (e.g., technical competence) in engineering (ABET, 2012; NAE, 2004). Furthermore, corporations such as The Chrysler Group, The Ford Motor Company, and Honda have become increasingly concerned with hiring engineering graduates as vehicles incorporate more high-tech designs (Seetharaman, 2013; Trop, 2013; Vlasic, 2013). Other companies like Caterpillar, General Motors, Northrop Grumman, and Siemens have been investing in secondary and post-secondary schools in an effort to provide students with access to professional mentors and cutting-edge technology (Burden, 2013; Kelley, 2013; Makinc, 2013; Roush, 2013). Overall, a diverse cross-section of groups has shown interest in increasing the number of American STEM graduates.

Approach to the Problem: Using Educational Technology to Improve Student Outcomes in STEM

In order to increase the number of American STEM degree recipients, academics must develop ways to improve students' interest, retention, and success in fields like engineering. In doing so, educators should focus on methods for improving curriculum, instruction, and the overall classroom environment. Additionally, students must be provided the skills they need to compete in an increasingly interconnected and technological world. As society changes there is a continual need for new devices, tools, and services. Therefore, what is represented as "technology" constantly changes. The underlying meaning of technology is fairly stable, but the term is employed differently across context and application. In society, a variety of technologies are used to provide people with things like food, healthcare, shelter, transportation, and entertainment. In educational settings, computers and other information technologies (C&IT) help individuals learn, teach, and communicate. Prior researchers have studied the use of educational technology as a way to improve student outcomes and skills (Dutton, Dutton, & Perry, 2001; Flowers, Pascarella, & Pierson, 2000; Green, Pinder-Grover, & Millunchick, 2012; Junco, Heiberger, & Loken, 2010; Kuh & Hu, 2001; Lloyd, Dean, & Cooper, 2007; Rutz, Eckart, Wade, Maltbie, Rafter, & Elkins, 2003).

Technology defined. It is helpful to understand what is meant by educational technology or technology in general before discussing its impact on students. Scholars, dictionaries, and professional societies have presented several broad definitions of technology. The National Academy of Engineering and National Research Council (2006) define technology as "any modification of the natural world made to fulfill human needs or desires." Alternatively, Bain (1937) defined technology as "all tools, machines, utensils, weapons, instruments, housing, clothing, communicating and transporting devices and the skills by which we produce and use them" (p. 860). Merriam-Webster Dictionary (2013) defines technology as "the practical application of knowledge especially in a particular area: engineering." More specifically, educational technology is "the systematic design and use of hardware and software to achieve specific objectives" (Ely, 1995, p. 5). A primary objective is student learning and development. For the purposes of this study, educational technology signified specific C&IT such as computer hardware (e.g., desktops, laptops), computer software (e.g., Microsoft Word/Excel, MATLAB, SolidWorks), electronic devices (e.g., cellphones, tablets, E-readers), and the Internet (e.g., websites, course management systems).

Literature review. Previous studies of educational technology have shown that college students believe it provides increased control of classroom activities, improved learning, greater educational involvement, cognitive/personal development, convenience, and connectedness with others (Dahlstrom, 2012; Flowers et al., 2000; Kuh & Hu, 2001; Kvavik, Caruso, & Morgan, 2004; Lloyd et al., 2007). However, students also report a preference for only a moderate amount of technology use in the classroom, a desire for instructors to use more open educational resources and gaming tools, a lack of confidence in their core software skills, and less comfort with more specialized forms of technology (Dahlstrom, 2012; Dahlstrom, de Boor, Grunwald, & Vockley, 2011; Kvavik & Caruso, 2005; Kvavik et al., 2004). There also are reported disparities in technological skill and use among various types of undergraduate students (Flowers & Zhang, 2003; Kuh & Hu, 2001; Lewis, Coursol, & Khan, 2001; Lloyd et al., 2007; Salaway & Caruso, 2007; Salaway, Katz, & Caruso, 2006). Examples of these differences are provided in the next section.

Undergraduates experience college differently depending on their major, class rank, gender, and race/ethnicity. So, it is useful to discuss such discrepancies before describing the targeted variables and population of this study. Students' chosen major impacts their experience through college as individuals in fields such as S&E complete specialized coursework and interact with tools like technology in a distinct way (Salaway & Caruso, 2007; Salaway et al., 2006). Class rank also matters. Prior studies have shown that freshmen use C&IT less frequently and interact with less specialized forms of technology when compared to seniors (Kuh & Hu, 2001). Furthermore, scholars have revealed that women and URMs face unique barriers (e.g., academic, social) to their success and ultimate degree completion in college (Strayhorn, 2008) especially in S&E disciplines (Bernold, Spurlin, & Anson, 2007; Besterfield-Sacre, Moreno, Shuman, & Atman, 2001; CIDEA, 2000; Good, Halpin, & Halpin, 2000; Johnson & Sheppard, 2002; May & Chubin, 2003; Strayhorn, Long, Kitchen, Williams, & Stentz, 2013).

Differences also exist across gender when comparing students' use and engagement with technology. Researchers have shown that females report lower confidence, later adoption, less frequent use of technology such as multimedia, lower use for academic purposes, and interaction with less advanced forms of technology than males (Kuh & Hu, 2001; Lewis et al., 2001; Lloyd et al., 2007; Smith & Caruso, 2010; Yau & Cheng, 2012). Similarly, differences occur across race/ethnicity. Of all racial/ethnic groups, American Indian/Alaska Native students are most likely to search the Internet for research or homework while White students use computers for academic work less often than non-Whites (Flowers & Zhang, 2003; Lloyd et al., 2007).

Gap in the Literature

Usually, scholars have employed a broad definition of technology to describe hardware such as cell phones and computers or software for word processing and web-based applications. Such definitions have been used to understand how collegians, instructors, and professionals interact with technology. Unlike previous analyses, the present study focused on the specific types of and ways that educational technology is used by first-year students in engineering.

Purpose of the Study

The purpose of the present study is to understand the relationship between first year engineering students' (FYES)[2] perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement. The term perceived is used to represent students' self-reported information about technology.

Theoretical Perspective

According to Rogers' (1995) theory, technology adoption occurs through a five-step innovation-decision process. The steps consists of, (a) knowledge, (b) persuasion, (c) decision, (d) implementation, and (e) confirmation. The first step, knowledge, takes place when an individual becomes aware of an innovation and begins to understand how it works. Step two, persuasion, occurs when someone develops a positive or negative perception of a technology. The third step, decision, happens when an individual chooses to adopt or reject an innovation. It is important to note that an individual can first adopt then later reject (i.e., discontinuance) or first reject then later adopt. Step four, implementation, occurs after someone adopts then begins to use a technology. The fifth step, confirmation, takes place when an individual seeks to reinforce their decision about

[2] The label 'first-year engineering students (FYES)' is used to refer to undergraduates of all class ranks that are enrolled in an introductory engineering course within a first-year engineering program.

an innovation (e.g., by receiving supportive messages). Based on Rogers' (1995) theory, it is important to understand why, how, and if individuals adopt technology. The innovation-decision process helps to explain the choices and actions that are made by people after being exposed to a technology. See Figure 1 for a visual representation of the process.

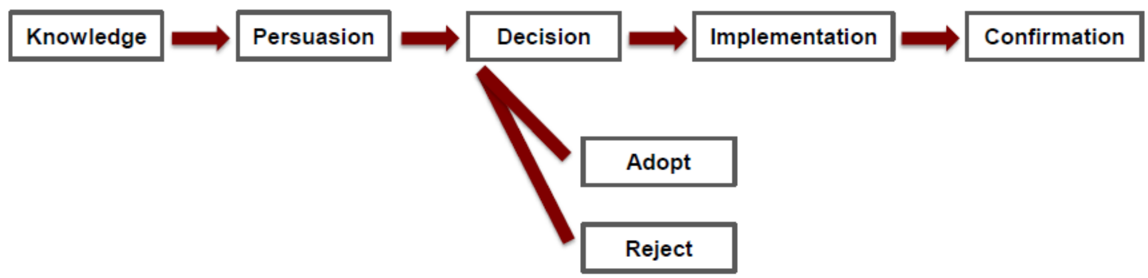

Figure 1.1: Recreation of Roger's (1995) Innovation-Decision Process

Research Population and Sample

The research population for the present study is undergraduates in engineering, with a particular focus on first-year students. These individuals were chosen because collegians tend to leave STEM during their freshman or sophomore year, with greater rates of departure among URMs (CIDEA, 2000). Also, due to variations across STEM disciplines, only engineering students were targeted (Salaway & Caruso, 2007; Salaway et al., 2006). By targeting this population, efforts can be made to increase engineering student satisfaction and success during the first year of college.

The research sample consisted of FYES enrolled at a large, public, research, 4-year, predominantly White institution (PWI) in the Midwest. The first-year engineering program (FEP) at the institution includes four (4) tracks: standard, scholars, honors and transfer courses. Only FYES within the standard track participated in the study. In the FEP, students are exposed to technological tools such as Microsoft (MS) Excel, MATLAB, SolidWorks, and microcontroller software. Students also participate in collaborative problem-solving and design-build projects while working in teams of four. In class, each student has access to an individual desktop computer. Outside of class, students have 24-hour access to a 64-seat computer lab. So, students are not required to own a computer but seating is very limited in the lab and less accessible to some individuals (e.g., commuters). Required software programs (i.e., MS Excel, MATLAB, SolidWorks, and microcontroller software) are free to students who own computers. The aforementioned characteristics are important to note since they may be very different from other institutions of higher education.

Research Questions

This study addressed the following research questions:

1. Are there differences in FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology by race/ethnicity and/or gender?
2. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their final course grades in two Fundamentals of Engineering courses?
    a. Does this relationship vary by race/ethnicity and/or gender?

3. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?

Definition of Terms

Computers and other information technologies (C&IT): modern technologies (e.g., computers, the Internet, cellphones) as described in research studies dating back to the 1990's.

EDUCAUSE Center for Applied Research (ECAR): a non-profit organization which collects information about student experiences with and attitudes toward educational technology; distributes a national survey on an annual basis.

First-year engineering program (FEP): introductory and prerequisite engineering courses at a large, public, research, 4-year, PWI in the Midwest; includes four (4) tracks: standard, scholars, honors and transfer courses; comprised of in-class instruction, hands-on labs, and team projects.

First-year engineering students (FYES): undergraduates of all class ranks that are enrolled in an introductory engineering course within a first-year engineering program.

National Survey of Student Engagement (NSSE): an annual survey that elicits self-report data on the extent to which students are engaged in educationally purposeful activities while focusing on desirable learning and personal development outcomes; designed by George Kuh (2001).

Perceived knowledge of technology: students' self-reported responses to survey items concerning their task-specific knowledge of technological tools such as word processors, spreadsheets, programming languages, CAD (computer-aided design) software, and microcontroller software.

Perceived usefulness of technology: students' self-reported responses to survey items concerning the importance of technology to their academic success and their agreement with numerous statements about the benefits of educational technology.

Perceived frequency and nature of use of technology: students' self-reported responses to survey items concerning their ownership of technology along with how often and in what ways they use specific technological software and hardware.

Science and engineering (S&E): educational fields and industries within the two disciplines; as defined by the National Science Foundation.

Science, technology, engineering and mathematics (STEM): educational fields and industries within the four disciplines; as defined by the National Science Foundation.

Underrepresented racial/ethnic minorities (URMs): racial/ethnic groups who have historically been underrepresented in higher education; Blacks, Hispanics, and Native Americans.

Significance of the Study

The results of the study have implications for practice, research, and theory. In terms of practice, the results of this study can provide faculty with information about students' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Such data can be used to improve curriculum, instruction, and the overall classroom environment. Staff members can use these findings to offer meaningful assistance to engineering students regarding relevant technological tools. This study is significant to college and university administrators too. Results from the investigation can be used by administrators when making decisions about the types of technology that should be purchased and accessible to first-year engineering students.

The present study is also significant for future research. This study focused exclusively on FYES' academic performance and perceptions of technology. Future studies might examine older/higher-ranking engineering students or non-engineering STEM majors. Such studies would expand on the available information about educational technology. For example, what kind of and how much knowledge do older/higher-ranking engineering students or non-engineering STEM majors possess regarding specific forms for technology? What are these students' positive and negative feelings about various kinds of technology? Furthermore, how often and in what ways do these students use certain technology?

Finally, the study is significant in terms of future theory. Existing theory on technology-based teaching and learning, such as technology adoption theory (Rogers, 1995), focus on how technology promotes student interactions with others and how an individual's characteristics are related to their willingness to use or adopt technology. The present study offers insight into how user characteristics (e.g., knowledge, attitudes, use of technology) are related to academic achievement.

Delimitations

As with all research, the present study has several delimitations. First, when focusing on the study's sample, all solicited participants were students from the same four-year public university. Furthermore, all participants were enrolled in the same introductory engineering courses. As a result, it was possible that students from this single institution and set of courses may differ in some important way from students at other colleges and universities. Therefore, results from this study may be unique to this institution.

Secondly, the chosen instrument for this study may limit the accuracy of the results. This analysis relied on a questionnaire which collects student self-reported data about technology. Self-reports are widely used in educational research despite a few challenges to their internal validity. They are generally considered valid if the information requested is known by the participants, if the questions are phrased clearly, and if the students deem the question worthy of a response (Pace, 1985).

Third, this study focused exclusively on engineering majors. STEM disciplines vary in several distinct ways. Students majoring in STEM fields take different coursework, outside of fundamental classes in math and science. As a result, students gain exposure to specialized curriculum and enroll in unique courses based on their class rank and specific major. Students also interact with discipline-specific educational equipment and technological tools. Consequently, discrepancies in students' use and knowledge of such equipment/tools arise across STEM fields. For instance, in prior studies, engineering students reported having higher use and skill than physical science majors with spreadsheet, computer programming, and discipline-specific software – such as Mathematica, AutoCAD, and STELLA (Salaway & Caruso, 2007; Smith, Salaway & Caruso, 2009). In order to avoid conflation of majors, this study focused specifically on FYES.

Despite the aforementioned delimitations, findings from this study add important insights to the extant literature on educational technology and first-year engineering students (FYES). Unlike previous analyses, the present study focused on the specific types of and ways that educational technology is used by first-year students in engineering. Results provide insight into FYES' perceived knowledge, usefulness, as well as frequency and nature of use of technology.

Organization of the Study

Reporting of the present study is structured around five chapters. Chapter One includes an introduction of the study, the purpose, research sample, research questions and the significance of the study. The second chapter contains a review of relevant literature on technology, first-year collegians, and underrepresented students. Chapter Three describes the methodology of the study, including a description of the data collection and analysis process. The fourth chapter presents the results of the investigation. Chapter Five provides a discussion of the results, coverage of the findings as they relate to prior literature, along with future implications for research, theory and practice.

CHAPTER 2: REVIEW OF LITERATURE

Outline

I. Introduction
    a. Relate lit. to purpose and research questions
II. Applicable Theory
    a. Technology Adoption Theory
    b. Engagement Theory
III. Overview of Lit.
    a. Student Ownership and Attitudes toward the Use of Technology (Background)
        i. Access to and Ownership
        ii. Attitudes toward the Use of Technology
    b. Student Perceptions Related to Technology (Independent Var.)
        i. Perceived Knowledge
        ii. Perceived Usefulness
        iii. Perceived Frequency and Nature of Use
    c. Student Outcomes from Engagement with Technology (Dependent Var.)
        i. Technology Use in Higher Education
            1. Positive Outcomes in Higher Education
            2. Negative Outcomes in Higher Education
        ii. Technology Use in Engineering Education
            1. Positive Outcomes in Higher Education
IV. Summary of Lit.

The purpose of this study was to understand the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement. Specifically, this study explored the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their (intermediate/final) grades in two *Fundamentals of Engineering* courses. The ways in which these relationships vary among FYES by race/ethnicity and gender were also determined.

The literature review conducted to frame this study has been organized into several sections. The first section is a review of relevant theory that guides this investigation. The second section includes an overview of research on access to, ownership of, and attitudes toward the use of technology among various collegiate populations at four-year institutions (i.e., all students, engineering students, and first-year students). The third section summarizes research on students' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. The fourth section further informs the present study by describing previous work on factors that influence student outcomes such as academic achievement (e.g., grades). The fifth and final section summarizes major themes drawn from the aforementioned literature.

Applicable Theory on Technology

As previously discussed, Rogers' (1995) technology adoption theory occurs through a five-step innovation-decision process. The steps consists of, (a) knowledge, (b) persuasion, (c) decision, (d) implementation, and (e) confirmation. Technology adoption starts when an individual becomes aware of an innovation. At this point, Rogers (1995) suggests, the participant can be classified as an "earlier knower" of the equipment (e.g., those with more formal education, higher social status) or a "later knower" (e.g., those with less formal education, lower social status). Then, based on one's level of uncertainty about an innovation's expected consequences, the person forms an opinion of the product that leads to a decision to accept or reject it. Once the technology is accepted, the individual uses it and searchers for reinforcement of their decision. As a professor of communication and journalism, Everett M. Rogers' (1995) theory has been previously used in a number of fields such as business management, marketing, communication, economics, public health, sociology, and engineering education.

Although Rogers' (1995) theory has roots and popularity outside of STEM, its focus on technology proved useful for the current investigation involving engineering students. To be clearer, the theory was chosen for the current study as it relates well to the present research questions involving FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Since various types of technology were required components of the FEP, students were evaluated on the ways in which they adopted the tools over time, rather than whether or not they adopted them at all.

Although Kearsley and Shneiderman's (1999) engagement theory was explored, its focus on student collaboration through technology use was beyond the scope of this study. A more individual-centered theory was desired. Furthermore, engagement theory's three components (i.e., relating, creating, donating) lend better support to studies of problem-solving activities. Thus, a theory which included factors such as student knowledge, opinions and habits was ultimately chosen.

Student Ownership and Attitudes toward the Use of Technology

Research on educational technology has only recently begun to emerge with most studies occurring over the past two decades. These investigations have primarily focused on student access to, ownership of, attitudes toward, and use of technology. As technological innovation has grown, researchers have expanded their focus from computers and the Internet to a variety of other C&IT. Investigations have taken place in the U.S. and abroad. Although the current study focused on American FYES, information concerning students and technology can still be learned from international work and later implemented around the globe. This section provides an overview of extant literature, beginning with all college students and then narrowing the focus to the student populations of interest in the present study (i.e., engineering and first-year students). Notable differences across race/ethnicity and gender are discussed.

Student Access to and Ownership of Technology

Prior research has indicated that most college students in contemporary Western societies have access to the Internet and modern technological devices such as computers. Kennedy, Judd, Churchward, Gray, and Krause (2008) conducted a single institutional analysis of over 2,000 Australian first-year students’ access to technology. They found that nearly all students have unrestricted access to a mobile phone (96.4%) and a desktop computer (89.5%) while a smaller number have access to broadband Internet (72.9%), a memory stick (72.5), and a laptop (63.2%). Kennedy et al. also determined that virtually no students lack access to some kind of computer (0.6%) or Internet connection (1.4%). In a multi-institutional investigation, Kvavik et al. (2004) examined roughly 4,400 American student's access to technology and discovered that nearly all participants (90%) have sufficient and reliable access to a computer and the Internet. Not only have scholars collected data on students' access to C&IT, but they have also investigated students' ownership of numerous technologies.

Recent reports indicate that technology ownership is on the rise among undergraduates. More specifically, ownership of portable devices such as laptops and smartphones has changed dramatically over the past decade. An EDUCAUSE Center for Applied Research (ECAR) study of 10,000 U.S. students at 184 colleges/universities – suggests many undergraduates own laptops (86%) and smartphones (62%), followed by desktops (33%), tablets (15%), and E-readers (12%) (Dahlstrom, 2012). An earlier ECAR report revealed that far less undergraduates own laptops (46.8%) and smartphones (1.1%) than desktops (62.8%) (Kvavik et al., 2004). When comparing students of different class rank/major, Kvavik et al. (2004) also found that freshmen are nearly twice as likely as seniors to own laptops. Furthermore, engineering students are more likely to own laptops than other majors. When examined by gender, researcher shows that females are more likely than males to own a cell phone and less likely to own a desktop (Kvavik et al., 2004).

Other scholars have collected information on student ownership of technology among various racial/ethnic groups. Lewis et al. (2001) conducted a study of more than

100 undergraduate students at a single institution comparing student ownership of C&IT across race/ethnicity. Evidence suggests that African Americans and Hispanics own computers at lower rates than Whites, Asians, and Pacific Islanders. In a similar vein, a study of nearly 500 Chinese and British students, explored student ownership of C&IT among specific racial/ethnic groups and found that Asian students own computers at lower rates than those from Europe (Li and Kirkup, 2007). In addition, Asian students with fewer previous experiences using computers and the Internet are less likely to own a computer or have adequate Internet access. The impact of such disparities in technology ownership on desired student outcomes (e.g., grades) has not been investigated.

Student Attitudes toward the Use of Technology

Previous studies have shown that students generally convey positive attitudes toward the use of C&IT. Ali and Elfessi (2004) examined undergraduates' views about C&IT use in a single institutional study of nearly 100 students. They found that students have positive attitudes in both virtual and conventional settings. For example, students agree with statements like "I enjoy using computers and internet technology" and "I feel comfortable using computers and Internet technology on my own" (p. 7). Atman and Nair (1996) studied approximately 100 freshman collegians at a single institution and learned that both engineering and non-engineering students think "science and technology solve problems more often than they create problems" (p. 317). Kennedy et al. (2008) also explored first-year students' attitudes toward technology. They found that the majority of students agree computers should be used to create documents (94.6%) and study (93.8%). Moreover, Kennedy et al. showed that students think the Web should be used to search for information (93.4%), manage enrollment services (83.9%), and access a learning portal (80.9%).

Prior ECAR studies have reviewed data on student attitudes about C&IT. For instance, Kvavik et al. (2004) investigated students' preference for technology use in the classroom and discovered that most students favor a moderate amount of technology usage. However, the researchers noticed differences by major with over two-thirds (2/3) of engineering and business students preferring an extensive amount of technology in their courses compared to those in other disciplines. In addition, seniors from engineering and business majors have a stronger preference for technology compared to freshmen. Moreover, Kvavik et al. (2004) learned that males (37%) have a slightly higher preference for extensive C&IT use in the classroom compared to females (27.7%). Other research reports similar findings across gender (Kvavik & Caruso, 2005; Salaway & Caruso, 2008; Smith & Caruso, 2010).

Other scholars have identified gender differences in students' attitudes toward the use of C&IT. Li and Kirkup (2007) explored student views toward C&IT and found that men display more positive feelings than women when asked if they "enjoy using the Internet" (p. 305). Work by Yau and Cheng (2012), involving over 200 Asian undergraduates, revealed that male collegians have more confidence in using technology for learning than do females. In terms of confidence and comfort with C&IT, other scholars found similar gender differences among first-year students (Lee, 2003; Schumacher & Morahan-Martin, 2001). Still, additional research is needed to determine if there is a relationship between student's attitudes toward technology and their expected outcomes (e.g., grades).

Student Perceptions Related to Technology

It was also necessary to review existing literature on student perceptions related to their interactions with technology. This section summarizes the literature on collegians' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology.

Students' Perceived Knowledge of Technology

Educational researchers have shown interest in understanding students' knowledge of basic technology. When exploring student understanding, scholars have interchangeably used the terms knowledge, experience, and skill to make sense of undergraduates' familiarity with and comprehension of technology. Dahlstrom (2012) examined students' perceived technological skills and found that only two-thirds (2/3) of participants believe they were adequately prepared to use required educational technology when they entered college. A similar ECAR study by Dahlstrom et al. (2011) included 3,000 undergraduates from more than 1,000 colleges/universities. The scholars determined that nearly half of students do not believe they have sufficient software skills to use tools such as programming languages (48%) and spreadsheets (41%). On the other hand, students feel they need the least improvement with word processing (15%) and college/university library websites (27%). These results are similar to findings from earlier ECAR studies that also showed students are most highly skilled in core (e.g., word processing) rather than specialized forms of technology (e.g., computer programming) but still lack confidence in their abilities (Kvavik & Caruso, 2005; Salaway & Caruso, 2008; Smith & Caruso, 2010).

Students' reported technological skills differ by major and class rank. For example, seniors, engineering students, and business majors rate their C&IT skills highest with tools such as presentation and spreadsheet software (Kvavik et al., 2004). Engineering students also have higher reported skills with graphics and webpage development compared to other majors (Kvavik & Caruso, 2005). So, there appears to be a correlation between students' required coursework and their technological skills.

When focusing on students' knowledge of technology, researchers have described differences by race/ethnicity and gender as well. Li and Kirkup (2007) explored students' perceived experience and skills with C&IT among specific racial/ethnic groups and learned that European students have more experience using the Internet than Asian students. Of all European participants, males report having used the Internet for a significantly longer time than females. Li and Kirkup also discussed that, when compared to females, males have stronger self-reported Internet skills for tasks such as using a search engine, keeping a record of sites, and downloading material.

Students' Perceived Usefulness of Technology

Additional dimensions of students' perceptions of technology have been explored. In terms of perceived usefulness of technology, Ali and Elfessi (2004) found students, on average, have a positive attitude towards the statement "I feel that Internet/Web technology will be useful for my learning" (p. 7). Dahlstrom (2012) investigated students' perceptions of the usefulness of technology too. She determined that over half of all participants believe they are "more actively involved in courses that use technology" and C&IT "helps them feel connected" to other students, their teachers, and their institutions (p. 10). Moreover, over two-thirds (2/3) of individuals believe technology "helps them achieve their academic outcomes," "prepares them for future educational plans" and "prepares them for the workforce" (p. 19). Prior studies have also revealed that a majority of students believe the most important devices to their academic success are laptops, followed by printers, thumb drives, and desktop computers (Dahlstrom, 2012; Dahlstrom et al., 2011).

Differences arose in students' perceived usefulness of technology by major and class rank. For example, engineering and business majors agree that technology use in classes "increases their understanding of complex concepts and provides more opportunity for practice and reinforcement" (Kvavik & Caruso, 2005, p. 64). When compared to non-engineering students, engineering majors are also more likely to agree that C&IT improves their learning, provides convenience, and causes them to be more engaged in courses (Salaway et al., 2006). Furthermore, seniors generally report higher levels of perceived usefulness when compared to freshmen in college (Kvavik & Caruso, 2005). To date, no extant research examines differences in perceived usefulness of technology across race/ethnicity and gender.

Students' Perceived Frequency/Nature of Use of Technology

In addition to participants' perceived knowledge and usefulness of technology, scholars have also explored the frequency and nature of students' use of technology. Using a sample of more than 18,300 undergraduates from 71 institutions, Kuh and Hu (2001) found that participants primarily use computers for basic tasks like writing a paper, sending an email to an instructor/classmate, or searching the Internet for course material. The scholars found that individuals are far less likely to use C&IT for more advanced tasks like developing a webpage or multimedia presentation. Kennedy et al. (2008) also explored first-year students' use of technology and found that freshmen use computers on a daily basis to play music (57.7%), write documents (31.4%), and study (24.5%). In addition, they determined that the majority of students (85%) use the Web on a daily or weekly basis to study, gather information, participate in leisure activities, send/receive email, and use instant messaging. Lastly, Kennedy et al. reported that very few students (24.9%) have ever used the Web to contribute to a wiki or read a news feed.

Research shows that there are differences in students' use of technology. For example, Lewis et al. (2001) studied college students' use of technology and discovered that men are more likely than women to use multimedia technology such as PowerPoint or Hyperstudio. Working with a sample of nearly 400 undergraduates at a single institution, Lloyd et al. (2001) also explored college students' technology use and showed that men are more likely to use computers for academic work and video game devices for entertainment purposes. Additional findings indicate that women use social tools such as Facebook, text messaging/talking features on cell phones, and blogs more frequently than men. Li and Kirkup (2007) investigated gender differences in C&IT use too and found that men are more likely to use email/chat rooms and play computer games than women. Kuh and Hu (2001) also determined that men use C&IT slightly more frequently and in more advanced forms (e.g., visual displays, data analysis, and multimedia presentations) than women. In addition, they found that seniors and participants majoring in mathematics/science fields use most C&IT more frequently than first-year students and non-STEM majors. Other scholars produced similar results when comparing students by major and class rank (Kvavik & Caruso, 2005; Salaway & Caruso, 2008; Smith & Caruso., 2010).

Still other studies have examined differences in C&IT use by race and ethnicity. For instance, Flowers and Zhang (2003) relied on data from over 45,000 undergraduates at approximately 1,000 institutions to examine the extent to which C&IT use in college differs by race/ethnicity. They found that American Indian/Alaska Native students are most likely to search the Internet for homework or research purposes. They determined that Asian students are the heaviest users of email (e.g., to communicate with instructors or fellow students) and computer programming languages too. Flowers and Zhang also found that, of any racial/ethnic group. Native Hawaiian/Pacific Islanders use electronic chat rooms and word processing/spreadsheet software the most. Lloyd et al. (2007) also examined differences in C&IT use by race/ethnicity. Their results indicate that non-White students not only watch TV, talk on cellphones, use instant messaging, and search the Internet more often than White students, but they also use computers for academic work more frequently.

Student Outcomes from Engagement with Technology

It is important to not only understand students' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology, but to also determine which student outcomes result from engagement with technology. With increasing technological advances and adoption, more attention has been paid to the influence of technology use on student outcomes. Prior research indicates that technology has a positive impact on various aspects of student learning and development in college (Dutton, Dutton, & Perry, 2001; Flowers et al., 2000; Green, Pinder-Grover, & Millunchick, 2012; Junco et al., 2010; Kuh & Hu, 2001; Lloyd et al., 2007; Rutz et al., 2003). Results from these studies have increased society's understanding about the role of technology in higher education. Specific fields within STEM, like engineering education, have profited from additional information about the influence of technology use on college students (Dutton et al., 2001; Green et al. 2012; Rutz et al., 2003). Details about selected investigations involving college students' technology use and related outcomes are discussed in the next section.

Technology Use in Higher Education

Positive outcomes in higher education. When looking at higher education as a whole, scholars have arrived at a number of positive findings about the influence of technology use on college students. For example, in a study of over 3,800 first-year undergraduates at 18 four-year and 5 two-year colleges/universities, researchers determined that computer use has positive effects on student development outcomes

(Flowers et al., 2000). Particularly, computer use has significant positive effects on two-year students' perceived reading comprehension and overall cognitive development. Additionally, the extent to which two-year students use computers for classroom assignments has significant positive effects on overall cognitive development. The extent to which first-year community college students' courses require them to learn how to use computers or word processors has a significant positive influence on critical thinking too. Student engagement in computer word processing has significant positive effects on first-year reading comprehension, with African Americans experiencing significantly greater benefits than other students. Finally, freshmen four-year students with the highest levels of overall precollege cognitive development have significant, positive first-year cognitive gains from email use.

Researchers have also learned that college students' use of C&IT is positively related to their learning and personal development (Kuh & Hu, 2001). More specifically, in a study of over 18,000 undergraduates at more than 70 four-year institutions, the analysis revealed that student gains in general education, personal development, science and technology, vocational preparation, and intellectual development are positively related to several C&IT activities. For instance, the study authors learned that using a computer or word processor to prepare papers has a significant positive net effect on students' perceived gains in intellectual development. On the other hand, using email to communicate with one's class has a significant positive net effect on perceived personal development. Using a computer to analyze data and making visual displays with a computer both have significant positive net effects on students' perceived gains in intellectual development along with students' perceived gains in science and technology. By comparison, using a computer tutorial to learn materials has significant positive net effects on students' perceived gains in vocational preparation along with science and technology. Searching the Internet for course material has significant positive net effects on students' perceived gains in intellectual development, vocational preparation, and personal development. Lastly, overall C&IT use is significantly and positively related to the amount of effort students devote to educationally purposeful activities, as defined by prior research (Kuh, 1995).

Other researchers have uncovered links between students' use of technology and their intellectual development too. In a study of over 700 students at a large, public, research university, Strayhorn (2006) found a modest, but statistically significant link between students' technology use and related learning outcomes. Specifically, students with higher reported levels of technology usage have significantly greater self-reported gains in college. Also, students who use technology for tasks such as searching the internet for course material and analyzing data with a computer report higher perceived gains in intellectual development.

Scholars have also determined that the extent and ways in which students use technology is positively related to their psychosocial development (Lloyd et al., 2007). For example, in a study of nearly 500 undergraduates at a large research institution in the Southeast, students who report higher levels of computer use for academics and email use have significantly higher levels of educational involvement. This positive relationship also holds true for students who frequently talked on a cell phone or used a personal digital assistant (PDA). Lloyd et al. (2007) believe students use these devices for some academic matters, thus increasing educational involvement.

Researchers have also found that using twitter for various types of academic and co-curricular discussions is positively related to student's academic and psychosocial development (Junco et al., 2010). In a study of 125 first-year students enrolled in multiple sections of a seminar course for pre-health professionals at a single institution, the authors found that students who take courses that use twitter have a significantly greater increase in engagement than those who take traditional courses. Also, through analysis of survey data which included select items from the National Survey of Student Engagement (NSSE), they revealed students have significantly higher semester grade point averages when taking courses that employ twitter compared to traditional courses. Hence, using twitter in educationally purposeful ways is beneficial for students.

Negative outcomes in higher education. Higher education scholars have also discovered a few negative findings about the influence of technology use on college students. For example, researchers determined that email use, among community college students, has significant negative effects on overall first-year cognitive development, reading comprehension, mathematics and critical thinking (Flowers et al., 2000). In this study, email use represented students' electronic interactions with faculty/peers. Furthermore, email use by Hispanic 4-year college students has significant negative effects on first-year reading comprehension. However, results from this study also showed that precollege cognitive development in four-year college students and high computer use among two-year students each reduce the negative effects of email use on overall first-year cognitive development.

Other higher education scholars revealed that students' perceived gains in general education, personal development, science and technology, vocational preparation, and intellectual development were negatively related to some C&IT activities (Kuh & Hu, 2001). For instance, using a computer or word processor to prepare papers has a significant negative net effect on students' perceived gains in science and technology. Conversely, using email to communicate with an instructor or other students, using a computer to analyze data, and making visual displays with a computer each have a significant net effect on students' perceived gains in general education. Retrieving off-campus library materials has a significant net effect on students' perceived gains in intellectual development, personal development, and vocational preparation, while developing a webpage and multimedia presentation has significant negative effects on students' perceived gains in science and technology along with personal development.

Higher education researchers have also revealed the negative effects of social media and leisure technology use on students' development (Junco, 2012; Lloyd et al., 2007). For example, the amount of time students use Facebook and watch DVDs are both negatively correlated with students' psychosocial development – specifically with regard to peer relationships (Lloyd et al., 2007). In addition, the amount of time students spend watching DVDs, using instant messaging, Facebook, an iPod or a Gameboy all have significant negative effects on their educational involvement. Other scholars found similar results concerning the negative effects of Facebook use on educational involvement (Junco, 2012).

Technology Use in Engineering Education

Positive outcomes in engineering education. When focusing on prior studies from engineering education, researchers have discovered several positive results concerning the influence of technology use on college students. A two-year study of over 200 students who enrolled in multiple sections of a fundamental engineering science course at a large, public, research, 4-year, PWI researchers revealed that the use of instructional technology improved student performance when compared to traditional teaching mechanisms (Rutz et al., 2003). In particular, the authors showed that students in courses with Web-assistance (i.e., through Web-based content/assessment), streaming media (i.e., via recorded presentations), and interactive videos (i.e., connecting a local and remote class) achieve significantly higher final course grades than students in courses with traditional lectures (i.e., using overheads, chalkboards, and whiteboards). The authors suggest the variation in student performance between the technology-assisted and traditional courses may be due to student interest and time on task.

Other engineering education researchers have found that students' academic achievement is positively influenced by technology-based course delivery. Take for instance one study consisting of approximately 300 students who enrolled in a computer programming class at a large public 4-year institution in the Southeast. From this investigation, scholars learned that students earn significantly higher exam and course grades when taking an online versus a traditional lecture version of the course (Dutton et al., 2001). This disparity in academic achievement was significant even after accounting for student maturity and effort. Yet, the difference in course grades becomes non-significant if the sample is divided between lifelong learners and undergraduates.

Engineering educators have also focused on other forms of instructional technology. Prior research has shown that screencasts (i.e., video of a computer screen output with real-time audio commentary) positively impacts student performance (Green et al., 2012). In a two-year study of nearly 400 undergraduate engineering students enrolled in a survey course at a large public university, investigators determined that students' screencast use was positively and significantly correlated with their final exam performance. Students' screencast use was also positively and significantly correlated with their final course grades.

Summary of Literature

In summary, scholars have shown that an overwhelming percentage of students (90%) have sufficient and reliable access to a computer and the Internet (Kennedy et al., 2008; Kvavik et al., 2004). The researchers reported that African Americans and Hispanics own computers at lower rates than Whites, Asians, and Pacific Islanders (Lewis et al., 2001). Also, Asian students own computers at lower rates than those from Europe (Li & Kirkup, 2007). So far, the impact of such disparities in technology ownership on desired student outcomes (e.g., grades) has not been investigated.

Previous studies have shown that students generally convey positive attitudes toward the use of C&IT (Ali and Elfessi, 2004; Atman and Nair, 1996; Kennedy et al., 2008; Kvavik et al., 2004). However, engineering/business majors, seniors, and males have more positive attitudes toward and increased knowledge of technology than their respective counterparts (Kvavik et al., 2004; Li & Kirkup, 2007; Yau & Cheng, 2012). Prior studies have also shown that freshmen and females use some C&IT less frequently than their classmates (Kuh & Hu, 2001; Lewis et al., 2001; Lloyd et al., 2007; Smith & Caruso, 2010; Yau & Cheng, 2012). Similarly, differences occur across race/ethnicity. Past studies concluded that American Indian/Alaska Native students are most likely to search the Internet for research or homework, while White students use computers for academic work less often than non-White students (Flowers & Zhang, 2003; Lloyd et al., 2007).

Prior research indicates that educational technology has a positive impact on various aspects of student learning and development in college (Dutton et al., 2001; Flowers et al., 2000; Green et al., 2012; Junco et al., 2010; Kuh & Hu, 2001; Lloyd et al., 2007; Rutz et al., 2003; Strayhorn, 2006). Students who use technology for academically purposeful activities experience higher levels of cognitive development, reading comprehension and critical thinking (Flowers et al., 2000). Student participation in educationally beneficial C&IT activities also leads to perceived gains in areas such as general education, personal development, science and technology, vocational preparation, and intellectual development (Kuh & Hu, 2001; Strayhorn, 2006). Also, students exhibit higher levels of educational involvement (Lloyd et al., 2007). Furthermore, academic uses of social media result in greater student engagement and academic achievement (Junco et al., 2010). Prior work has also shown that instructors' delivery and implementation of technology causes students to earn higher exam and course grades (Dutton et al., 2001; Green et al., 2012; Rutz et al., 2003).

Despite positive findings surrounding students' use of educational technology in higher education, gaps in our collective knowledge on this subject still exist. Technology has been changing at a rapid pace so it is important to continually measure its impact on students. Prior studies focused on many types of C&IT (e.g., computers, instructional technologies, social media) and various resulting student outcomes (e.g., cognitive development, educational involvement, academic achievement). Most studies have successfully answered how students engage with technology and what outcomes result from that engagement, but little is known about reasons why numerous activities or forms of C&IT produce such positive effects.

Additional student perceptions of technology have been explored. In terms of perceived usefulness of technology, Ali and Elfessi (2004) found many students agree with the statement "I feel that Internet/Web technology will be useful for my learning" (p. 7). Dahlstrom (2012) investigated students' perceptions of the usefulness of technology too. She determined that over half of all participants believe they are "more actively involved in courses that use technology" and C&IT "helps them feel connected" to other students, their teachers, and their institutions (p. 10). Moreover, over two-thirds (2/3) of individuals believe technology "helps them achieve their academic outcomes," "prepares them for future educational plans" and "prepares them for the workforce" (p.

19). Prior studies have also revealed that a majority of students believe the most important devices to their academic success are laptops, followed by printers, thumb drives, and desktop computers (Dahlstrom, 2012; Dahlstrom et al., 2011).

Differences arose in students' perceived usefulness of technology by major and class rank. For example, engineering and business majors agree that technology use in classes "increases their understanding of complex concepts and provides more opportunity for practice and reinforcement" (Kvavik & Caruso, 2005, p. 64). Engineering students are also more likely to agree that C&IT improves their learning, provides convenience, and causes them to be more engaged in courses (Salaway et al., 2006). Furthermore, seniors report higher levels of perceived usefulness when compared to freshmen (Kvavik & Caruso, 2005). More research is needed to understand any differences in perceived usefulness by race/ethnicity and/or gender.

Unlike previous analyses, the present study focused on the specific types of educational technology that are used by FYES. For the purposes of this study, educational technology signified specific C&IT such as computer hardware (e.g., desktops, laptops), computer software (e.g., MS Word/Excel, MATLAB, SolidWorks), electronic devices (e.g., cellphones, tablets, E-readers), and the Internet (e.g., websites, course management systems). More research is needed to bridge the gap between our understanding of student's perceptions and their actual academic performance. So, the aforementioned definition of technology was used to understand the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement. Additional research is needed that analyzes differences in ownership, knowledge and perceptions of technology by major, class rank, race/ethnicity and gender. The current study was designed to fill this gap in understanding.

CHAPTER 3: METHODOLOGY

Outline

I. Introduction
   a. Purpose of study and research questions/hypotheses
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   a. Population
   b. Participant criteria and justification of criteria
   c. Recruitment procedure
   d. Selection of sample
III. Instrumentation
   a. Description and overview
   b. Contents of each section
IV. Validity/Reliability or Accuracy of the Data
   a. Quantitative – validity and reliability
   b. Qualitative – accuracy of the data
V. Data Collection Procedures
   a. Collection process
VI. Data Analysis Procedures
   a. Form of the results
      i. Quantitative: example comparisons
      ii. Qualitative: groups that will be described & how the results will be presented
VII. Conclusion
   a. How data has produced results that answer research questions

The purpose of this study was to understand the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement. Specifically, I sought to answer the following questions:

1. Are there differences in FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology by race/ethnicity and/or gender?
2. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their final course grades in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?
3. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?

The methods used to address these questions are described in this chapter. The study's sample and instruments are discussed. In addition, validity, reliability, data collection, and data analysis procedures are addressed.

Research Population and Sample

The research population for the present study is undergraduates in engineering. This specific population was chosen for several reasons: (a) unique transition experiences of first-year students, (b) low student attrition rates in STEM, and (c) differences across STEM majors (CIDEA, 2000; Goldrick-Rab, 2007; Long, 2013; Salaway & Caruso, 2007; Salaway et al., 2006). While transitioning to college, first-year students face unique academic, social, and financial experiences (Goldrick-Rab, 2007; Long, 2013). In addition, collegians tend to leave STEM during their freshman or sophomore year, with greater rates among URMs (CIDEA, 2000). Furthermore, variations (e.g., coursework, technology use) exist across STEM disciplines (Salaway & Caruso, 2007; Salaway et al., 2006). By targeting this population, efforts can be made to increase engineering student satisfaction and success during the first year of college. As previously mentioned in Chapter One, the U.S.' workforce and global competitiveness can benefit from an increase in the number of American STEM graduates.

The research sample consisted of approximately 1,600 FYES enrolled at a large, public, research, 4-year, PWI in the Midwest. This sample was chosen due to the large number of eligible participants. Although the FEP at the institution includes four (4) tracks (i.e., standard, scholars, honors and transfer courses), only FYES within the standard track participated in the study. Potential participants were identified through their enrollment in the selected institutions' fundamental/introductory engineering courses. Each of the 16-week courses was designed to provide students with knowledge of fundamental engineering topics such as technical communication, problem solving, data collection/analysis, technical graphics, and the design process. The two-course sequence was a pre-requisite before students could take introductory courses for most engineering disciplines at the institution.

Students under the age of 18 were excluded from the study for two reasons. First, it was difficult to gain parental consent from these individuals. This was especially difficult for out-of-state students and parents. Second, results from prior research suggest that the experiences of students under the age of 18 may be qualitatively different from those who are 18 and over, especially when interacting with same-age peers (Pascarella & Terenzini, 2005). After excluding roughly 70 minors (i.e., less than 7% of willing participants), only students who were at least 18 years old at the beginning of the fall semester were included in this study.

It can be noted that 487 FYES, who enrolled in the standard track at the institution during the fall of 2013 and spring of 2014, agreed to participate in the study and were at least 18 years old. This yielded a response rate of roughly 30%. Of the 487 students, nearly 20% self-reported as being a female and about 7% identified as a URM (i.e., African Americans, Hispanics, and Native Americans). Roughly two-thirds (66%) were ranked as a freshman and almost all (89.3%) were an engineering pre-major. Additional demographic information for this sample is summarized below in Table 3.1.

Table 3.1
Description of samples

Variables	%	%	%	%	%
Academic	Aggregate (N=487)	Non-White (N=109)	White (N=345)	Female (N=98)	Male (N=389)
Admission classification					
New freshman	78.6	74.3	78.8	79.6	78.4
New advanced undergraduate 1 & 2*	4.1	5.5	3.5	5.1	3.9
New advanced undergraduate 3 & 4**	4.1	5.5	3.8	4.1	4.1
Continuing undergraduate	11.5	13.8	11.9	11.2	11.6
Old returning undergraduate	1.6	0.9	2.0	0	2.1
Class Rank					
Freshman	66.1	66.1	66.1	62.2	67.1
Sophomore	22.6	21.1	22.6	28.6	21.1
Junior	6.6	10.1	5.8	7.1	6.4
Senior	4.7	2.8	5.5	2.0	5.4
Pre-Major					
Has not declared a pre-major	6.4	4.6	7.5	6.1	6.4
Non-engineering pre-major	4.3	5.5	4.4	4.0	4.3
Engineering pre-major	89.3	89.9	88.1	89.8	89.2
Demographic					
Sex of student					
Male	79.9	72.5	82.0	0.0	100.0
Female	20.1	27.5	18.0	100.0	0.0
Race/Ethnicity					
African American/Black	2.7	11.9	0.0	4.1	2.3
American Indian/Alaska Native	0.6	2.8	0.0	1.0	0.5
Asian/Pacific Islander	6.6	29.4	0.0	10.2	5.7
Caucasian/White	70.8	0.0	100.0	63.3	72.8
Hispanic	3.3	14.7	0.0	3.1	3.3
International Student	9.2	41.3	0.0	12.2	8.5
Missing	6.8	0.0	0.0	6.1	6.9
Age of student					
18-19	85.0	78.9	86.1	90.8	83.5
20-23	10.3	14.7	9.6	8.2	10.8
24-29	3.5	4.6	3.2	0.0	4.4
30-39	1.0	0.9	1.2	0.0	1.3
40-55	0.2	0.9	0.0	1.0	0.0
First-generation status					
Not a first-generation student	85.2	81.7	87.2	87.8	84.6
First-generation student	14.8	18.3	12.8	12.2	15.4
Pell Grant					
Not a Pell Grant recipient	96.5	98.2	95.7	98.0	96.1
Pell Grant recipient	3.5	1.8	4.3	2.0	3.9

NOTE: * Transfer students at academic level 1 or 2
** Transfer students at academic level 3 or 4

Instrumentation

A quantitative approach was employed to meet the objectives of the present study. However, a pilot-version of a subsequent explanatory qualitative component was used to add depth and discuss the numerical results in Chapter Five.

Quantitative data was collected during two terms, autumn semester 2013 (AU13) and spring semester 2014 (SP14). A slightly different version of the 24-item questionnaire was administered each semester (See Appendix A for specific items). The survey was organized into three sections, perceived: (a) knowledge of technology, (b) usefulness of technology, as well as (c) frequency and nature of use of technology. The first two sections contained 10 items and the last section had 4 items. Specific questionnaire items were distributed using weekly journals (referred to as "quizzes") on the institution's course management system. The journals were an existing assignment within the two *Fundamentals of Engineering* courses. Figure 2, below, shows the period at which each part of the survey was administered during an academic term.

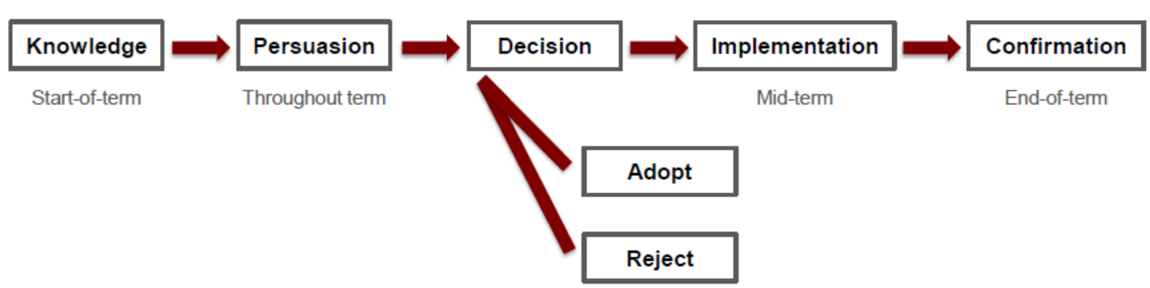

Figure 3.1: Data Collection for Survey Instrument

Qualitative data was collected once, after spring semester 2014 (See Appendix B for the interview protocol). A pilot-version of explanatory one-on-one interviews were conducted to discover detailed insights that may help to explain survey results. Therefore, interview excerpts are only included in the discussion within Chapter Five.

Part 1: Survey Instrument

The survey consisted of original questions and some modified items from the 2012 NSSE and 2011/2012 ECAR Study of Undergraduate Students and Technology Questionnaire. Permission was granted from both ECAR and NSSE (See Appendix C for actual documentation). The NSSE collected self-report data on the extent to which students are engaged in educationally purposeful activities while focusing on desirable learning and personal development outcomes (Kuh, 2001). On the other hand, the ECAR survey elicited information about student experiences with and attitudes toward educational technology (Dahlstrom et al., 2011; Dahlstrom, 2012).

The first section of the questionnaire explored students' perceived knowledge of C&IT. Five unique questions were included twice for a total of 10 items. Questions were created to prompt FYES about their task-specific knowledge of technological tools used in the course sequence such as word processors, spreadsheets, MATLAB, CAD (computer-aided design) programs, and microcontroller software. For instance, participants were asked "In terms of using a word processor (like MS Word) to perform tasks such as creating/formatting written documents, how would you rate your current knowledge?" Students used a 6-point scale from 0 (*no prior knowledge*) to 5 (*very high*) to rate their replies. The five (5) questions were given to students at the beginning and end of the semester for a total of 10 items about perceived knowledge.

Section Two of the questionnaire investigated students' perceived usefulness of C&IT. A total of 10 questions were developed. Five (5) questions from the 2012 ECAR Study of Undergraduate Students and Technology were adapted to prompt FYES about the importance of certain technological devices to their academic success. For example, participants were asked "Regardless of whether or not you own one, please rate how important desktop computers/laptops are to your academic success." Students used a 6-point scale from 0 (*not at all important*) to 5 (*very high*) to rate their responses. Five (5) questions were also adapted from the 2011 ECAR Study of Undergraduate Students and Technology to assess FYES' level of agreement with various statements about technology. For instance, participants were asked "To what extent do you agree with the statement 'Technology makes it easier to get help when I need it'?" Students used a 5-point scale from 0 (*strongly disagree*) to 4 (*strongly agree*) to rate their responses. The aforementioned items were given to students throughout the semester for a total of 10 items about perceived usefulness.

The last section of the questionnaire assessed students' perceived frequency and nature of use of C&IT. A total of 4 questions were established. Two (2) questions from the 2012 National Survey of Student Engagement (NSSE) were adapted to prompt FYES about the frequency of their use of C&IT for academic purposes. For instance, midway through the semester, participants were asked "During the current semester, about how often have you used email to communicate with an instructor or TA for this course?"

Students used a 4-point scale from 0 (*never*) to 3 (*very often*) to rate their use. In addition, two (2) unique questions were generated to learn about students' ownership of software and use of optional educational technologies. For example, midway through the term, participants were asked "During the current semester, about how often have you used the optional storage mediums (such as Dropbox, Box and Google Drive) that are described in the Student Resources Guide to complete course assignments?" Students used the same 4-point scale that was previously mentioned to rate their use.

Part 2: Explanatory Interviews

A subsequent pilot-version of an explanatory qualitative component was used to add depth to the quantitative study and discuss the numerical results. A constructivist research approach was taken. A constructivist perspective was taken because the researcher agrees that knowledge and the world are "socially constructed, complex, and ever changing" (Glesne, 1999, p. 5). In order to understand such constructed realities and different perceptions of technology, the researcher used interviews to interact and talk with participants.

Explanatory one-on-one semi-structured interviews were conducted with willing participants in a private room, located at the institution. Interviews lasted approximately 15-45 minutes and students had the right to withdrawal participation from the study at any point in time. Each interview was digitally recorded and later transcribed by a professional.

Interview techniques were used such as exploring what is said instead of probing, asking for concrete details, and using protocol cautiously (Seidman, 1998). The researcher also tried to build rapport with each interviewee by introducing oneself, making "small talk" before and after the interview, and creating an overall friendly atmosphere. It was anticipated that this would lead to more open and honest responses.

"Information rich" participants were selected using a purposeful sampling approach. Qualitative texts describe "information rich" participants as those who have a capacity to talk about their experiences in some detail, have experiences that align with the phenomenon under investigation (i.e. they identify as a FYES), and meet the specified sampling criteria. Student participation in the study was completely voluntary.

This approach yielded a total of four FYES. All of the individuals were male. Two were White and two were non-White. With a monetary incentive and more time it is anticipated that many more participants can be recruited in a future full-scale qualitative study.

Research Variables

This study's research variables were categorized into three domains: (a) control variables, (b) independent variables, and (c) dependent variables. In total, the investigation consisted of nine student background/control variables, fourteen independent variables, and five dependent variables. The control variables accounted for a series of student background and academic traits. The independent variables represented FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. The dependent variables consisted of FYES' software-specific and final course grades in introductory/fundamental engineering courses.

Control Variables

A college intervention or experience can produce varying benefits for students, depending on one's background characteristics (Pascarella & Terenzini, 2005). Thus, numerous academic and demographic traits were included as controls in the analysis. The control variables included student background characteristics (e.g., age, gender, race/ethnicity, Pell Grant recipient status, first-generation status) and academic traits (e.g., admission classification, class rank, pre-major designation). Participants' Pell Grant recipient status served as a proxy for socio-economic status. Based on the literature in Chapter Two, if not controlled for in the analysis, each of the aforementioned student characteristics may have influenced FYES' independent technology-related measures and dependent grades.

Independent Variables

The independent variables in this analysis represented FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. The three categories were guided by Rogers' (1995) theory of technology adoption. The five-step innovation-decision process consists of, (a) knowledge, (b) persuasion, (c) decision, (d) implementation, and (e) confirmation. This process helps to explain the views and actions of people after being exposed to a technology.

Participants' perceived knowledge of specific technological tools was operationalized using three (3) independent variables, which came from 5 individual survey items. Response options ranged from 0 (*no prior knowledge*) to 5 (*very high*). The survey items prompted FYES about their task-specific knowledge of technological tools such as word processors, spreadsheets, MATLAB, CAD programs, and microcontroller software. Such tools are typically used in introductory/fundamental engineering courses.

It was important to explore students' perceived knowledge of these technologies for several reasons. Some students do not believe they have sufficient software skills with tools such as programming languages and spreadsheets (Dahlstrom et al., 2011). On the other hand, students feel they need the least improvement with word processing software (Dahlstrom et al., 2011). However, using tools such as word processors in courses has a positive effect on undergraduates' perceived critical thinking skills and intellectual development (Flowers et al., 2000; Kuh & Hu, 2001).

Students' perceived usefulness of technology was characterized by seven (7) independent variables, which came from 10 separate survey items. Five of the questions were adapted from the 2012 ECAR Study of Undergraduate Students and Technology to prompt FYES about the importance of certain technological devices to their academic success. Response options ranged from 0 (*not at all important*) to 5 (*very high*). The remaining five (5) questions were adapted from the 2011 ECAR Study of Undergraduate Students and Technology to assess FYES' level of agreement with various statements about technology. Response options ranged from 0 (*strongly disagree*) to 4 (*strongly agree*). The above items were included in the study because it was helpful to determine how participants' positive/negative views concerning the usefulness of technology influence their academic success.

Participants' perceived frequency and nature of use of technology included four variables, which represented four discrete survey items. Two of the items were adapted from the 2012 National Survey of Student Engagement (NSSE) to prompt FYES about the frequency of their use of C&IT for academic purposes. In addition, two unique questions were generated to learn about students' ownership of software and use of optional educational technologies. Response options ranged from 0 (*never*) to 3 (*very often*). These variables provided information about the way in which students' use of technology impacts their course grades.

Dependent Variables

The dependent variables consisted of students' three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) and their two final course grades (i.e., during AU13 and SP14) in introductory/fundamental engineering courses. In other words, when controlling for the aforementioned background characteristics and academic traits, students' grades could be predicted based on their perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Table 3.2 below provides a description of all control, independent, and dependent variables.

Table 3.2
Description of variables

Variables	Scale	Values
Controls		
Age 18-19	Nominal; Dichotomous	0 = Older than 19; 1 = Age 18-19
Admission: New Freshman	Nominal; Dichotomous	0 = Non-Freshman; 1 = Freshman
Rank: Freshman	Nominal; Dichotomous	0 = Non-Freshman; 1 = Freshman
Pre-Major: Engineering	Nominal; Dichotomous	0 = Non-Engineering; 1 = Engineering
Gender: Female	Nominal; Dichotomous	0 = Male; 1 = Female
Ethnicity: White	Nominal; Dichotomous	0 = Non-White; 1 = White
Pell Grant Recipient	Nominal; Dichotomous	0 = Non-Recipient; 1 = Pell Grant
First Generation Student	Nominal; Dichotomous	0 = Not First-Gen.; 1 = First-Generation
HS Rank	Ratio; Continuous	0 – 100
Independent Variables (AU13)		
Δ Perceived Knowledge 1: Word Processors	Ordinal; Non-dichotomous	0=No prior knowledge; 5=Very high
Δ Perceived Knowledge 2: Spreadsheet software	Ordinal; Non-dichotomous	0=No prior knowledge; 5=Very high
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	Ordinal; Non-dichotomous	0=No prior knowledge; 5=Very high
Perceived Usefulness 1: Easier to Get Help When Needed	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 3: Makes Learning More Fun	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 4: Importance of Desktops/Laptops	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 5: Importance of Tablets/iPads	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 6: Importance of E-readers	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 7: Importance of Smartphones/Cellphones	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Frequency of Use 1: Electronic Medium for Coursework	Ordinal; Non-dichotomous	0=Never; 3=Very often
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	Ordinal; Non-dichotomous	0=Never; 3=Very often
Perceived Frequency of Use 3: Storage Medium	Ordinal; Non-dichotomous	0=Never; 3=Very often
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	Ordinal; Non-dichotomous	0=Never; 3=Very often

Continued

Table 3.2 continued

Variables	Scale	Values
Independent Variables (SP14)		
Δ Perceived Knowledge 1: Word processors	Ordinal; Non-dichotomous	0=No prior knowledge; 5=Very high
Δ Perceived Knowledge 2: Spreadsheet software	Ordinal; Non-dichotomous	0=No prior knowledge; 5=Very high
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	Ordinal; Non-dichotomous	0=No prior knowledge; 5=Very high
Perceived Usefulness 1: More Actively Involved in Courses	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 2: More Connected & Achieve Academic Outcomes	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 3: Makes Learning More Fun	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 4: Importance of Desktops/Laptops	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 5: Importance of Tablets/iPads	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 6: Importance of E-readers	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Usefulness 7: Importance of Smartphones/Cellphones	Ordinal; Non-dichotomous	0=Strongly disagree; 4=Strongly agree
Perceived Frequency of Use 1: Electronic Medium for Coursework	Ordinal; Non-dichotomous	0=Never; 3=Very often
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	Ordinal; Non-dichotomous	0=Never; 3=Very often
Perceived Frequency of Use 3: Storage Medium	Ordinal; Non-dichotomous	0=Never; 3=Very often
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	Ordinal; Non-dichotomous	0=Never; 3=Very often
Dependent Variables		
Final Course Grade AU13	Ratio; Continuous	0-100
Mean MS Excel Grade AU13	Ratio; Continuous	0-100
Mean MATLAB Grade AU13	Ratio; Continuous	0-100
Final Course Grade SP14	Ratio; Continuous	0-100
Mean SolidWorks Grade SP14	Ratio; Continuous	0-100

Validity and Reliability

Validity is "an integrated evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores or other modes of assessment" (Messick, 1989, p. 5). For the purposes of this study, a literature review, group of first-year engineering instructors, and panel of experts were used to establish face and content validity. This process was necessary to ensure that the assessment tool covered concepts related to the subject, with the appropriate coverage of the topic (Ding, Chabay, Sherwood & Beichner, 2006). The dissertation examination committee for this study served as the primary panel of experts. In addition, the FEP director and two experienced FEP Graduate Teaching Associates (GTAs) at the selected institution also reviewed and approved of the survey questions.

As previously stated, this study relied on student self-reports. This data is generally considered valid if the requested information is known by the participants, if the questions are phrased clearly, and if the students believe the question is worthy of a response (Pace, 1985). A panel of experts was used to make sure the information would be known to participants and the questions were phrased clearly. Students deemed questions worthy of a response since they were embedded within the curriculum of their fundamental/introductory engineering courses.

Since some items were borrowed or adapted from the NSSE and ECAR questionnaires it was important to discuss the validity and reliability of each survey tool.

To establish content validity, the NSSE relies on a panel of experts and uses student self-report data (Kuh, 2009). In terms of construct validity, NSSE has a reported reliability of 0.70 or higher for deep learning which includes higher-order, integrative, and reflective learning items (NSSE, 2010a). Reliability values close to or above 0.70 are generally considered acceptable in statistical analysis (Nunnaly, 1978). In terms of response process validity, NSSE used cognitive interviews and focus groups to determine that the survey was valid for students of different races/ethnicities (NSSE, 2010b). ECAR has not published information on the validity or reliability of its questionnaires.

Since the present study relied on a newly constructed assessment tool, a panel of experts was used to evaluate its validity. When evaluating the adequacy of the overall survey for each semester, one dissertation committee member, Dr. Terrell L. Strayhorn, stated "overall, the survey appears well-constructed for the purposes of the study; adequate for assessing students' experiences with technology and perceived outcomes." Another committee member, Dr. Lin Ding, indicated "the survey covers important aspects of student views about technology." When describing the survey's ability to answer the specified research questions, Dr. Strayhorn explained "on face value, the survey appears adequate for providing information to answer the study's research questions. Most items are well constructed, using expected response options, score ranges, and quantifiable responses." Furthermore, Dr. Ding said "assuming that the research methods and data analysis approaches are properly designed and implemented, the survey instrument can be useful for answering the research questions."

In addition to evaluating validity, a reliability analysis was conducted for the AU13 ($\alpha = 0.49$) and SP14 ($\alpha = 0.77$) questionnaires. So, the SP14 survey items were more reliable than those used during AU13. When referring to Table 3.2, it should be noted that the items which measured students' perceived usefulness of technology differed between the AU13 and SP14 questionnaires. This variation may explain the change in reliability between the two questionnaires.

Perceived Knowledge of Technology

I hypothesized that some of the original items concerning students' perceived knowledge of technology formed a coherent subset or factor. After conducting a principal component factor analysis on the AU13 data, I determined that three of the five items loaded onto one factor. This accounted for 64% of the variance among items collected at each point in time. A subsequent reliability analysis produced a moderately acceptable value for items collected in the beginning of the term ($\alpha = 0.68$) and an adequate number for those gathered at the end ($\alpha = 0.70$). Ultimately, a variable called "Perceived Knowledge 3 (AU13): MATLAB, CAD, MCC" was created by computing the difference between the two aforementioned factors. Within this variable name, CAD stands for computer-aided design programs and MCC represents microcontroller software.

Similarly, a factor analysis was also conducted on the SP14 data, which was collected at the end of the term. I confirmed that the same three items concerning students' perceived knowledge of technology loaded onto one factor. This accounted for 63% of the variance among items. A succeeding reliability analysis produced an acceptable value ($\alpha = 0.70$). Finally, a variable called “Perceived Knowledge 3 (SP14): MATLAB, CAD, MCC” was generated by computing the difference between the SP14 factor and the one representing data from the end of AU13.

Perceived Usefulness of Technology

I also hypothesized that some of the original items concerning students’ perceived usefulness of technology formed a factor. After conducting a factor analysis on the AU13 data, which was collected once during the term, I determined that four of the ten items loaded onto one factor. This accounted for 62% of the variance among items. A subsequent reliability analysis produced an acceptable value ($\alpha = 0.79$). Ultimately, a variable called “Perceived Usefulness 2 (AU13): Improves Work, Essential for College & Worthwhile” was created from the factor analysis.

Likewise, a factor analysis was also conducted on the SP14 data, which was collected once during the term. I confirmed that the same four items concerning students’ perceived usefulness of technology loaded onto one factor. This accounted for 60% of the variance among items. A follow-up reliability analysis produced an acceptable value ($\alpha = 0.78$). So, a variable called “Perceived Usefulness 2 (SP14): Improves Work, Essential for College & Worthwhile” was generated from the factor analysis.

Data Collection

FYES taking at least one of two possible fundamental/introductory courses at a large, public, research, 4-year, PWI in the Midwest had an opportunity to complete the questionnaire that was developed for this study. Questionnaire items were administered using weekly journals (referred to as “quizzes”) on the institution’s course management system. Journals are an existing assignment within the two *Fundamentals of Engineering* courses. Students accessed the electronic survey items through a link on their course’s management page and offered consent if they were willing to participate in the investigation. An email was sent to students after their completion of the two *Fundamentals of Engineering* courses in an effort to recruit individuals for one-on-one interviews. Willing interview participants were asked to review a copy of the consent document and sign it. Permission was granted from the institution’s Institutional Review Board (IRB) concerning the questionnaire and interviews. (See Appendix D for actual documentation).

Students’ self-reported demographic information (e.g., race/ethnicity, class rank, major), which is collected by the University, was used in conjunction with the survey responses. Student identity data and survey/interview responses were placed on a secure University server. Students’ ID number linked them to their survey data and pseudonyms linked them to interview recordings. Their personally identifiable information was located in a separate file from their survey responses. Data was stored electronically on a secure network drive within the university’s servers and a protected course management site. Only the investigators and co-investigators had access to the personally identifiable data.

Data Analysis

Part 1: Survey Data

Survey data was retrieved from the institution's course management system and saved in MS Excel, a spreadsheet software application. MATLAB, a programming language and numerical computing environment, was used to configure the data into a useable form for statistical analysis. Data was then input into SPSS, a statistical package for the social sciences. Analysis proceeded in three stages. First, descriptive statistics were computed to describe both the sample of students and their responses to survey items. Second, independent *t*-tests were used to measure differences in student grades by age (i.e., 18-19 or older than 19), admission classification (i.e., first year or not first year), class rank (i.e., freshman or non-freshman), pre-major designation (i.e., engineering and non-engineering), race/ethnicity (i.e., White and non-White), gender, Pell Grant recipient status, and first-generation status. For independent samples *t*-tests, assumptions about equal variances were assessed using Levene's test of variance equality. Third, hierarchical linear regression was used to identify technology-based predictors of first-year engineering students' academic success (i.e., grades). To intensify the rigor of this analysis, a series of background traits (e.g., age, gender, ethnicity, Pell Grant recipient status, first-generation status) and academic variables (e.g., admission classification, class rank, pre-major designation) were controlled in the model. Prior research has shown that several of these factors are important when estimating the "net effect" of college on students (Kuh, 2003). A more detailed description of the quantitative methods will be described in Chapter 4.

Part 2: Explanatory Interview Data

Every interview was digitally recorded and later transcribed by a professional. To analyze the interview data, the researcher deeply analyzed and admitted self-biases which could inadvertently affect the findings. Then, each transcript was indexed and annotated (Nespor, "Indexing," n.d.). Indexing provided the researcher with a way to quickly find information in the data set, since qualitative studies typically contain many words. By indexing the interviews, descriptors (e.g., numbers, letters) or simple terms were assigned to various sections of each transcript. Then, using the index, an initial set of patterns was identified within each interview transcript. After indexing took place, the researcher was able to read through the material and make notes on the pages (i.e., annotate). Next, the data was thought through in cases, contextualized, and matched to patterns through interactions/conversations with other qualitative researchers. Several strategies were employed to establish credibility: peer debriefing (i.e., researcher talked with a colleague regularly for the purpose of exploring implicit aspects of the study), triangulation of data sources (e.g., interviews, questionnaire), and member checking (i.e., asking a participant to review her/his transcript for accuracy and completeness). A more detailed description of the explanatory qualitative data will be discussed in Chapter 5.

CHAPTER 4: RESULTS

Outline

I. Introduction
   a. Purpose of study and research questions/hypotheses
II. Statistical Results
   a. Research Question 1
   b. Research Question 2
   c. Research Question 3

The purpose of this study is to understand the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement. Specifically, I am seeking to answer the following questions:

1. Are there differences in FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology by race/ethnicity and/or gender?
2. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their final course grades in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?
3. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?

A multi-step approach was used to analyze data and answer the above research questions. First, descriptive statistics were computed to describe both the sample of participants and their responses to survey items. Next, independent samples *t*-tests were used to answer the first research question by measuring differences in students' final course grades across demographic categories (e.g., race/ethnicity, gender, class rank, etc.). Bivariate correlations were then employed. Last, hierarchical linear regression analyses were conducted to address the remaining two research questions by testing technology-based predictors of FYES' academic success (i.e., grades). The results of the aforementioned analyses are described in this chapter.

Descriptive Statistics

Independent Variables

The independent variables of this study represented FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Recall from Chapter Three and Tables 3.3-3.4, there were a total of 14 variables. Each term, participants' perceived knowledge of technology was characterized by three independent variables, which came from five individual survey items. Essentially, three individual survey items were combined into one independent variable, while the other two survey items were each represented as a single independent variable. Participants' perceived usefulness of technology was characterized by seven independent variables, which came from 10 individual survey items. Lastly, students' perceived frequency and nature of use of technology was characterized by four independent variables, which came from four individual survey items.

Perceived knowledge. The first independent variable (i.e., Δ Perceived Knowledge 1: Word processors) was computed as the difference from beginning to end of term in students' mean perceived knowledge of word processors. For the aggregate sample, individuals began AU13 with a mean perceived knowledge of word processors that was 3.98 (*SD* = 0.77) and ended the term with a mean value of 3.96 (*SD* = 0.82). So, students rated their knowledge of word processors as approximately 4 (*high*) at the beginning and end of the term, using a scale from 0 (*no prior knowledge*) to 5 (*very high*). This change/difference led to a mean value of -0.02 (SD = 1.06) during AU13. By comparison, the value was 0.10 (SD = 0.76) during SP14.

Independent variable number two (i.e., Δ Perceived Knowledge 2: Spreadsheet software) was computed as the difference from beginning to end of term in FYES' mean perceived knowledge of spreadsheet software. In the aggregate sample, this difference was 0.81 (SD = 1.23) during AU13 and 0.12 (SD = 0.81) during SP14. Therefore, students ranked their knowledge of spreadsheet software near 3 (*moderate*) at the beginning of the term but close to 4 (*high*) by the end of the semester.

The third independent variable (i.e., Δ Perceived Knowledge 3: MATLAB, CAD, MCC) was computed as the difference from beginning to end of term in FYES' mean perceived knowledge of MATLAB, CAD software and microcontrollers. In the aggregate sample, the mean difference was 1.51 (SD = 1.30) during AU13 and 1.19 (SD = 1.19) during SP14. So, initially students' perceived knowledge ranged from 0 (*no knowledge*) to slightly above 1 (*very low*). By the end of the term, students' perceived knowledge was between 2 (*low*) and 3 (*moderate*).

Perceived usefulness. Another set of independent variables represented FYES' perceived usefulness of technology. During AU13, independent variable number four (i.e., Perceived Usefulness 1: Easier to Get Help When Needed) was computed as students' mean perception that technology makes it easier to get help when needed. For the aggregate sample, the mean rating was 3.25 (SD = 0.82), using a scale from 0 (*strongly disagree*) to 4 (*strongly agree*). Recall that a slightly different version of the questionnaire was administered each semester. So, during SP14, independent variable number four (i.e., Perceived Usefulness 1: More Actively Involved in Courses) was instead computed as students' mean perception that they are more actively involved in courses that use technology. For the aggregate sample, this rating was 2.80 (*SD* = 0.85).

During AU13, the fifth independent variable (i.e., Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile) was computed as participants' mean perception that technology improves the quality of their work and is essential for college and worthwhile. In the aggregate sample, the mean rating was 3.28 (*SD* = 0.62). During SP14, the fifth independent variable (i.e., Perceived Usefulness 2: More Connected & Achieve Academic Outcomes) was instead computed as participants' mean perception that technology makes them more connected to others and helps them achieve their academic outcomes. In the aggregate sample, the mean rating was 2.95 (*SD* = 0.62). Average scores around 3 (*agree*), for independent variable number four and five, indicate that individuals in the aggregate sample have positive perceptions about the usefulness of technology. They agree technology (a) makes it easier to get help when needed, (b) causes them to be more involved in courses, (c) improves the quality of their work, is essential for college and worthwhile, and (d) helps them achieve their academic outcomes.

Independent variable number six (i.e., Perceived Usefulness 3: Makes Learning More Fun) was computed as students' mean perception that technology makes learning more fun. In the aggregate sample, the mean rating was 2.80 (*SD* = 0.85) during AU13 and 2.94 (*SD* = 0.85) during SP14. For these values, which round to 3 (*agree*), participants in the aggregate sample think technology makes learning more fun. Furthermore, students display increased or more positive perceptions between semesters.

The seventh independent variable (i.e., Perceived Usefulness 4: Importance of Desktops/Laptops) was computed as students' mean perception of the importance of desktops/laptops to their academic success. For the aggregate sample, the mean rating was 3.45 (*SD* = 1.75) during AU13 and 2.55 (*SD* = 1.65) during SP14. So, during the academic year, participants in the aggregate sample's responses concerning the importance of desktops/laptops to their academic success decreased from over 3 (*moderate*) to above 2 (*low*).

Independent variable number eight (i.e., Perceived Usefulness 5: Importance of Tablets/iPads) was computed as FYES' mean perception of the importance of tablets/iPads to their academic success. In the aggregate sample, the mean rating was 1.69 (*SD* = 1.50) during AU13 and 1.43 (*SD* = 1.44) during SP14. In other words, students' feelings toward the importance of tablets/iPads to their academic success were consistently between 2 (*low*) and 1 (*very low*).

The ninth independent variable (i.e., Perceived Usefulness 6: Importance of E-readers) was computed as students' mean perception of the importance of e-readers to their academic success. For the aggregate sample, the mean rating was 2.25 (*SD* = 1.79) during AU13 and 2.99 (*SD* = 1.50) during SP14. Therefore, participants' feelings towards the importance of e-readers to their academic success increased from around 2 (*low*) to 3 (*moderate*).

Independent variable number ten (i.e., Perceived Usefulness 7: Importance of Smartphones/Cellphones) was computed as students' mean perception of the importance of smartphones/cellphones to their academic success. For the aggregate sample, the mean rating was 3.59 (*SD* = 1.14) during AU13 and 3.63 (*SD* = 0.93) during SP14. Therefore, during both terms, individuals in the aggregate sample agreed that smartphones/cellphones are between a 3 (*moderate*) to 4 (*high*) in terms of the devices' importance to their academic success.

Perceived frequency and nature of use. The last set of independent variables accounted for FYES' perceived frequency and nature of use of technology. Therefore, the eleventh independent variable (i.e., Perceived Frequency of Use 1: Electronic Medium for Coursework) was computed as participants' mean perception about how frequently they used an electronic medium for a course assignment. In the aggregate sample, the mean rating was 1.69 (*SD* = 1.00) during AU13 and 1.90 (*SD* = 0.94) during SP14, using a scale from 0 (*never*) to 3 (*very often*). Hence, individuals in the aggregate sample report values increasingly close to 2, meaning they often use an electronic medium for a course assignment.

Independent variable number twelve (i.e., Perceived Frequency of Use 2: Email to Communicate with TA/Instructor) was computed as participants' mean perception about how frequently they used email to communicate with a TA/instructor. For the aggregate sample, the mean rating was 1.10 (*SD* = 0.84) during AU13 and 1.01 (*SD* = 0.81) during SP14. Thus, students in the aggregate sample chose categories decreasingly close to 1, indicating they sometimes use email to communicate with a TA/instructor.

The thirteenth independent variable (i.e., Perceived Frequency of Use 3: Storage Medium) was computed as students' mean perception about how frequently they used a storage medium. In the aggregate sample, the mean rating was 1.30 (*SD* = 1.00) during

AU13 and 1.53 (*SD* = 1.11) during SP14. In this case, participants in the aggregate sample had a rating that increased from over 1 (*sometimes*) toward 2 (*often*), in terms of how frequently they use a storage medium.

Independent variable number fourteen (i.e., Perceived Frequency of Use 4: Text/Email Notifications from Course Management System) was computed as participants' mean perception about how frequently they used text/email notification features from the institution's course management system. For the aggregate sample, the mean rating was 0.78 (*SD* = 1.03) during AU13 and 0.77 (*SD* = 1.02) during SP14. Therefore, members of the aggregate sample report a value near 1 (*sometimes*) each term when stating how frequently they use text/email notification features from the institution's course management system.

Dependent Variables

The dependent variables in this analysis were students' final course grades and their three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) in two *Fundamentals of Engineering* courses. During AU13, students in the aggregate sample's mean final course grades were 87.86 (*SD* = 6.93) while their mean software-specific grades were 84.45 (*SD* = 13.83) for MS Excel and 86.31 (*SD* = 11.64) for MATLAB. By comparison, for all AU13 participants and non-participants, students' mean final course grades were 86.13 (*SD* = 9.97) while their mean software-specific grades were 84.15 (*SD* = 14.62) for MS Excel and 83.34 (*SD* = 16.43) for MATLAB. So, the sample was representative of the overall research population.

During SP14, participants in the aggregate sample's mean final course grades were 90.87 (*SD* = 6.44) whereas their mean software-specific grades were 89.09 (*SD* = 16.33) for SolidWorks. By comparison, for the all SP14 participants and non-participants, students' mean final course grades were 90.71 (*SD* = 6.09) while their mean SolidWorks grades were 88.82 (*SD* = 15.51). Again, the sample was representative of the overall research population. Tables 4.1 and 4.2 contain more descriptive statistics for the aggregate, non-White, White, female, and male samples.

Table 4.1
Means and standard deviations for variables by race/ethnicity

Variables	Aggregate Sample (*N*=487) *M*	*SD*	Non-white (*N*=109) *M*	*SD*	White (*N*=345) *M*	*SD*
Controls						
Age 18-19	0.85	0.36	0.79	0.41	0.86	0.35
Admission: New Freshman	0.79	0.41	0.74	0.44	0.79	0.41
Rank: Freshman	0.66	0.47	0.66	0.48	0.66	0.47
Pre-Major: Engineering	0.89	0.31	0.90	0.30	0.88	0.32
Gender: Female	0.20	0.40	0.28	0.45	0.18	0.39
Ethnicity: White	0.76	0.43	0.00	0.00	1.00	0.00
Pell Grant Recipient	0.03	0.18	0.02	0.14	0.04	0.20
First Generation Student	0.15	0.36	0.18	0.39	0.13	0.33
HS Rank	84.91	13.37	84.87	12.67	84.90	13.47
Independent Variables (AU13)						
Δ Perceived Knowledge 1: Word processors	-0.02	1.06	-0.06	1.15	-0.02	1.06
Δ Perceived Knowledge 2: Spreadsheet software	0.81	1.23	0.62	1.29	0.81	1.23
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	1.51	1.30	1.52	1.23	1.51	1.30
Perceived Usefulness 1: Easier to Get Help When Needed	3.25	0.82	3.13	0.76	3.25	0.82
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	3.28	0.62	3.23	0.60	3.28	0.62
Perceived Usefulness 3: Makes Learning More Fun	2.80	0.85	2.96	0.81	2.80	0.85
Perceived Usefulness 4: Importance of Desktops/Laptops	3.45	1.75	2.98	1.85	3.45	1.75
Perceived Usefulness 5: Importance of Tablets/iPads	1.69	1.50	1.62	1.50	1.69	1.50
Perceived Usefulness 6: Importance of E-readers	2.25	1.79	2.66	1.72	2.25	1.79
Perceived Usefulness 7: Importance of Smartphones/Cellphones	3.59	1.14	3.69	1.03	3.59	1.14
Perceived Frequency of Use 1: Electronic Medium for Coursework	1.69	1.00	1.62	0.98	1.70	1.00
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	1.10	0.84	1.17	0.90	1.08	0.82
Perceived Frequency of Use 3: Storage Medium	1.30	1.00	1.53	1.08	1.25	0.99

Continued

Table 4.1 continued

Variables	Aggregate (*N*=487) *M*	*SD*	Non-white (*N*=109) *M*	*SD*	White (N=345) *M*	*SD*
<u>Independent Variables (AU13)</u>						
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.78	1.03	0.90	1.14	0.79	1.01
<u>Independent Variables (SP14)</u>						
Δ Perceived Knowledge 1: Word processors	0.10	0.76	0.18	1.11	0.10	0.76
Δ Perceived Knowledge 2: Spreadsheet software	0.12	0.81	0.24	1.18	0.12	0.81
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	1.19	1.19	1.43	1.25	1.19	1.19
Perceived Usefulness 1: More Actively Involved in Courses	2.80	0.85	2.89	0.83	2.80	0.85
Perceived Usefulness 2: More Connected & Achieve Academic Outcomes	2.95	0.62	3.01	0.64	2.95	0.62
Perceived Usefulness 3: Makes Learning More Fun	2.94	0.85	2.90	0.79	2.94	0.85
Perceived Usefulness 4: Importance of Desktops/Laptops	2.55	1.65	3.08	1.38	2.55	1.65
Perceived Usefulness 5: Importance of Tablets/iPads	1.43	1.44	2.30	1.59	1.43	1.44
Perceived Usefulness 6: Importance of E-readers	2.99	1.50	3.35	1.32	2.99	1.50
Perceived Usefulness 7: Importance of Smartphones/Cellphones	3.63	0.93	3.69	0.81	3.63	0.93
Perceived Frequency of Use 1: Electronic Medium for Coursework	1.90	0.94	1.89	0.84	1.92	0.96
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	1.01	0.81	1.22	0.89	0.94	0.78
Perceived Frequency of Use 3: Storage Medium	1.53	1.11	1.72	1.02	1.47	1.13
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.77	1.02	1.21	1.08	0.64	0.96
<u>Dependent Variables</u>						
Final Course Grade AU13	87.86	6.93	87.65	6.48	87.89	7.13
Mean MS Excel Grade AU13	84.45	13.83	84.60	13.09	84.73	13.20
Mean MATLAB Grade AU13	86.31	11.64	86.20	10.56	86.30	12.06
Final Course Grade SP14	90.87	6.44	90.12	8.10	91.06	5.87
Mean SolidWorks Grade SP14	89.09	16.33	86.36	18.08	89.79	15.87

Table 4.2
Means and standard deviations for variables by gender

Variables	Aggregate Sample (*N*=487) *M*	*SD*	Female (*N*=98) *M*	*SD*	Male (*N*=389) *M*	*SD*
Controls						
Age 18-19	0.85	0.36	0.91	0.29	0.84	0.37
Admission: New Freshman	0.79	0.41	0.80	0.41	0.78	0.41
Rank: Freshman	0.66	0.47	0.62	0.49	0.67	0.47
Pre-Major: Engineering	0.89	0.31	0.90	0.30	0.89	0.31
Gender: Female	0.20	0.40	1.00	0.00	0.00	0.00
Ethnicity: White	0.76	0.43	0.67	0.47	0.78	0.41
Pell Grant Recipient	0.03	0.18	0.02	0.14	0.04	0.19
First Generation Student	0.15	0.36	0.12	0.33	0.15	0.36
HS Rank	84.91	13.37	87.31	10.61	84.27	13.95
Independent Variables (AU13)						
Δ Perceived Knowledge 1: Word processors	-0.02	1.06	0.02	1.05	-0.03	1.07
Δ Perceived Knowledge 2: Spreadsheet software	0.81	1.23	0.87	1.33	0.80	1.20
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	1.51	1.30	1.36	1.43	1.55	1.27
Perceived Usefulness 1: Easier to Get Help When Needed	3.25	0.82	3.23	0.79	3.26	0.83
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	3.28	0.62	3.22	0.55	3.30	0.64
Perceived Usefulness 3: Makes Learning More Fun	2.80	0.85	2.90	0.90	2.77	0.84
Perceived Usefulness 4: Importance of Desktops/Laptops	3.45	1.75	3.26	1.82	3.50	1.72
Perceived Usefulness 5: Importance of Tablets/iPads	1.69	1.50	1.58	1.41	1.72	1.52
Perceived Usefulness 6: Importance of E-readers	2.25	1.79	2.24	1.74	2.26	1.80
Perceived Usefulness 7: Importance of Smartphones/Cellphones	3.59	1.14	3.39	1.26	3.64	1.10
Perceived Frequency of Use 1: Electronic Medium for Coursework	1.69	1.00	1.75	0.93	1.67	1.01
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	1.10	0.84	1.07	0.88	1.11	0.83
Perceived Frequency of Use 3: Storage Medium	1.30	1.00	1.25	0.93	1.32	1.02

Continued

Table 4.2 continued

Variables	Aggregate (*N*=487) *M*	*SD*	Non-white (*N*=109) *M*	*SD*	White (N=345) *M*	*SD*
Independent Variables (AU13)						
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.78	1.03	0.65	0.97	0.82	1.05
Independent Variables (SP14)						
Δ Perceived Knowledge 1: Word processors	0.10	0.76	0.53	0.89	0.17	1.10
Δ Perceived Knowledge 2: Spreadsheet software	0.12	0.81	0.23	1.07	0.07	1.14
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	1.19	1.19	1.19	1.06	1.19	1.23
Perceived Usefulness 1: More Actively Involved in Courses	2.80	0.85	2.61	0.81	2.85	0.85
Perceived Usefulness 2: More Connected & Achieve Academic Outcomes	2.95	0.62	3.00	0.57	2.93	0.64
Perceived Usefulness 3: Makes Learning More Fun	2.94	0.85	2.88	0.81	2.96	0.86
Perceived Usefulness 4: Importance of Desktops/Laptops	2.55	1.65	2.65	1.70	2.52	1.63
Perceived Usefulness 5: Importance of Tablets/iPads	1.43	1.44	1.29	1.34	1.47	1.46
Perceived Usefulness 6: Importance of E-readers	2.99	1.50	2.97	1.58	2.99	1.47
Perceived Usefulness 7: Importance of Smartphones/Cellphones	3.63	0.93	3.62	0.90	3.63	0.93
Perceived Frequency of Use 1: Electronic Medium for Coursework	1.90	0.94	1.96	1.00	1.88	0.93
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	1.01	0.81	1.05	0.76	1.00	0.83
Perceived Frequency of Use 3: Storage Medium	1.53	1.11	1.57	1.11	1.52	1.11
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.77	1.02	0.73	1.03	0.78	1.02
Dependent Variables						
Final Course Grade AU13	87.86	6.93	88.30	6.28	87.75	7.08
Mean MS Excel Grade AU13	84.45	13.83	83.83	14.79	84.60	13.59
Mean MATLAB Grade AU13	86.31	11.64	86.24	11.90	86.33	11.59
Final Course Grade SP14	90.87	6.44	90.70	7.67	90.91	6.10
Mean SolidWorks Grade SP14	89.09	16.33	89.53	15.62	88.98	16.52

Research Question 1: Differences by Race/Ethnicity and Gender

To explore group mean differences among FYES, 56 independent samples *t*-tests were conducted to evaluate the relationship between students' race/ethnicity and gender and their perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. The *t*-tests analyzed student responses to survey items during the first and second semesters of the academic year (i.e., AU13 and SP14). To make comparisons between groups, participants were placed into two separate ethnicity/race categories (i.e., non-White and White) and two gender categories (i.e., female and male). Levene's test was used to check for equality of variance. When the assumption of equal variances could not be assumed, Welch's (1947) *t*-test statistic was used. Statistically significant values were discovered when comparing groups' perceived knowledge, usefulness, as well as their frequency and nature of use of technology. In the following paragraphs, these findings are discussed based on race/ethnicity and gender.

In terms of race/ethnicity, several statistically significant results were found regarding students' perceived usefulness of technology. During AU13, White students (M = 3.45, SD = 1.75) rated desktops/laptops as more important to their academic success than non-White students (M = 2.98, SD = 1.85); the mean difference was statistically significant, $t(400)$= -2.92, p <0.01, assuming equal variances. Also, during AU13, non-White students (M = 2.66, SD = 1.72) rated e-Readers as more important to their academic success than White students (M = 2.25, SD = 1.80); the mean difference was statistically significant, $t(400)$=2.56, p<0.05, assuming equal variances.

During SP14, significant differences by race/ethnicity were produced for similar variables that accessed students' perceived usefulness of technology. For desktops/laptops, non-White students (M = 3.08, SD = 1.38) rated the devices as more important to their academic success than White students (M = 2.55, SD = 1.65); the mean difference was statistically significant, $t(168)=3.59$, $p<0.001$, not assuming equal variances. Similar results were discovered during SP14 for tablets/iPads and e-readers. Non-White students (M = 2.30, SD = 1.59) rated tablets/iPads as more important to their academic success than White students (M = 1.43, SD = 1.44); the mean difference was statistically significant, $t(123)=5.59$, $p<0.001$, not assuming equal variances. Non-White students (M = 3.35, SD = 1.32) also rated e-readers as more important to their academic success than White students (M = 2.99, SD = 1.50); the mean difference was statistically significant, $t(388)=2.45$, $p<0.05$, assuming equal variances.

In terms of race/ethnicity, several statistically significant results were also found surrounding students' perceived frequency and nature of use of technology. During AU13, non-White students (M = 1.62, SD = 0.98) reported using storage mediums more frequently than White students (M = 1.70, SD = 1.00); the mean difference was statistically significant, $t(335)=2.13$, $p<0.05$, assuming equal variances.

During SP14, non-White students (M = 1.22, SD = 0.89) reported using email to communicate with TAs/Instructors more frequently than White students (M = 0.94, SD = 0.78); the mean difference was statistically significant, $t(165)=3.00$, $p<0.01$, not assuming equal variances. Also during SP14, non-White students (M = 1.21, SD = 1.08) reported using text/email notifications from the institution's course management system more frequently than White students (*M* = 0.64, *SD* = 0.96); the mean difference was statistically significant, $t(405)=4.95$, $p<0.001$, assuming equal variances.

Two statistically significant results were found in terms of gender. Differences were determined surrounding female/male students' perceived knowledge and usefulness of technology. During SP14, female students (*M* = 0.53, *SD* = 0.89) reported a greater change from beginning to end of the semester in their perceived knowledge of word processors than male students (*M* = 0.17, *SD* = 1.10); the mean difference was statistically significant, $t(341)= -2.53$, $p<0.05$, assuming equal variances. Also, during SP14, male students (*M* = 2.85, *SD* = 0.85) reported that they become more actively involved in courses that use technology than female students (*M* = 2.61, *SD* = 0.81); the mean difference was statistically significant, $t(454)=2.43$, $p<0.05$, assuming equal variances.

To summarize, there are differences in students' perceived usefulness as well as frequency and nature of use of technology by race/ethnicity. In terms of perceived usefulness of technology, non-White students rate iPads/tablets and e-readers as more important to their academic success than White students. White students initially rate desktops/laptops as more important to their academic success than non-White students but the reverse is true by the second semester. In terms of perceived frequency and nature of use of technology, non-White students report using email to communicate with TAs/Instructors and text/email notifications from the institution's course management system more frequently than White students. Differences also exist in students' perceived knowledge and usefulness of technology by gender. Female students report a greater change from beginning to end of the semester in their perceived knowledge of word processors than male students. In terms of perceived usefulness of technology, male students report that they become more actively involved in courses that use technology than female students. Tables 4.3 and 4.4 provide a tabular summary of the results.

Table 4.3
Results from t-tests for variables by race/ethnicity

Term	Independent Variable	Non-White (*N=109*) M	Non-White (*N=109*) SD	White (*N=345*) M	White (*N=345*) SD
SP14	Usefulness of e-Readers $t(388)=2.45$, $p<0.05$	**3.35**	**1.32**	2.99	1.50
SP14	Usefulness of desktops/laptops $t(168)=3.59$, $p<0.001$	**3.08**	**1.38**	2.55	1.65
AU13	Usefulness of e-Readers $t(400)=2.56$, $p<0.05$	**2.66**	**1.72**	2.25	1.79
SP14	Usefulness of tablets/iPads $t(123)=5.59$, $p<0.001$	**2.30**	**1.59**	1.43	1.44
AU13	Frequency of using storage mediums $t(388)=2.45$, $p<0.05$	**1.62**	**0.98**	1.70	1.00
SP14	Frequency of using email to communicate with TAs/Instructors; $t(165)=3.00$, $p<0.01$	**1.22**	**0.89**	0.94	0.78
SP14	Frequency of using text/email notifications from course management system; $t(405)=4.95$, $p<0.001$	**1.21**	**1.08**	0.64	0.96
AU13	Usefulness of desktops/laptops $t(400)= -2.92$, $p <0.01$	2.98	1.85	**3.45**	**1.75**

Table 4.4
Results from t-tests for variables by gender

Term	Independent Variable	Non-White (*N=109*) M	Non-White (*N=109*) SD	White (*N=345*) M	White (*N=345*) SD
SP14	Δ Perceived knowledge of word processors $t(341)= -2.53$, $p <0.05$	**0.53**	**0.89**	0.17	1.10
SP14	Usefulness: More actively involved in courses that use technology; $t(454)=2.43$, $p<0.05$	2.61	0.81	**2.85**	**0.85**

Research Question 2: Technology and Final Course Grades

Ten bivariate correlations and ten hierarchical linear regression analyses were conducted to answer the second research question. The tests were run to examine the extent to which FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in two *Fundamentals of Engineering* courses. Differences were also explored by race/ethnicity and gender. So, two regressions – using students' final course grades from each of the two *Fundamentals of Engineering* courses – were conducted on the aggregate, non-White, White, female and male samples.

Bivariate Correlation Results

Prior to analyzing results from the regression models, multicollinearity diagnostics were run to ensure that predictor or independent variables were not highly correlated (Cohen, Cohen, West & Aiken, 2003). If multicollinearity does not exist, values for the Pearson correlation should be less than 0.8, numbers for the variance of inflation factors (VIF) should not exceed 10, and tolerances should be greater than 0.10 (Cohen et al., 2003). All correlations between independent variables, VIF values and tolerances were within acceptable limits.

Bivariate correlations were calculated to determine the magnitude and direction of the relationship between the study's independent and dependent variables. Recall, the independent variables of this study represented FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. There were a total of 14 variables. The dependent variables consisted of students' three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) and their final course grades (i.e., during AU13 and SP14) in two introductory/fundamental engineering courses.

Aggregate sample. For the aggregate (N=487) sample, none of the technology-related independent variables were significantly correlated with FYES' AU13 final course grades. However, students' perception about the extent to which technology makes learning more fun was statistically significantly related (r=0.12, p<0.05) to their SP14 final course grades. In addition, students' perceived frequency of email use for communication with a TA/instructor was statistically significantly related (r= -0.11, p<0.05) to their SP14 final course grades. Tables 4.3 – 4.4 provide more detailed correlation results for the aggregate sample.

Table 4.5

Correlations between AU13 independent variables and final course grades for aggregate sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.06	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.00	0.48**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.01	0.16**	0.28**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.02	0.03	0.02	-0.09	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.03	-0.02	-0.09	-0.05	-0.02	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.02	-0.07	0.10*	-0.01	0.09	0.10	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.00	-0.04	-0.02	0.02	-0.07	-0.01	-0.07	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	0.03	-0.01	-0.03	0.03	-0.04	-0.00	0.06	0.35**	1.00						

Continued

Table 4.5 continued

Perceived Usefulness 6: Importance of E-readers	-0.01	-0.02	-0.02	-0.01	0.02	0.01	0.03	-0.46**	0.29**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.04	0.02	0.09	0.02	0.03	0.01	0.08	0.03	0.18**	0.13**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.01	-0.07	0.07	-0.01	-0.02	-0.01	0.03	-0.05	-0.03	0.02	0.02	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.09	-0.12*	0.03	0.01	0.02	0.01	-0.00	-0.10*	0.03	0.08	0.04	0.13**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.08	0.03	-0.02	-0.08	-0.07	0.01	0.01	0.01	0.00	0.00	0.05	0.02	0.01	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.06	0.12*	-0.05	-0.01	0.05	0.04	0.02	-0.03	-0.08	-0.06	0.03	0.05	-0.05	-0.16**	1.00

NOTE: *$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 4.6

Correlations between SP14 independent variables and final course grades for aggregate sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.00	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.03	0.59**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.06	0.27**	0.36**	1.00											
Perceived Usefulness 1: More Actively Involved in Courses	0.01	0.07	0.09	0.09	1.00										
Perceived Usefulness 2: More Connected & Achieve Academic Outcomes	0.05	0.15**	0.12*	0.07	0.51**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.12*	0.16**	0.12*	0.00	0.46**	0.50**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.02	0.00	0.02	0.09	0.17**	0.13*	0.13*	1.00							

Continued

Table 4.6 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.09	-0.00	0.01	0.14*	0.20**	0.11*	0.03	0.54**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.03	0.05	0.04	0.10	0.18**	0.24**	0.12*	-0.12*	0.19**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.06	0.03	0.00	0.00	0.05	0.10*	-0.02	0.04	0.11*	0.14**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.05	0.08	0.06	0.04	0.17**	0.17**	0.15**	0.09	0.10*	0.16**	0.08	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.11*	-0.01	0.10	0.15**	0.15**	0.12*	0.05	0.17**	0.23**	0.19**	-0.01	0.17**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.09	-0.04	0.01	-0.03	0.17**	0.20**	0.14**	0.18**	0.11*	0.12*	-0.07	0.17**	0.22**	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.08	0.03	0.05	0.08	0.20**	0.18**	0.14**	0.14**	0.27**	0.27**	0.13*	0.12*	0.27**	0.20**	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Non-white sample. For the non-White (*N*=109) sample, none of the technology-related independent variables were significantly correlated with the FYES' AU13 final course grades. However, non-White students' perception about the importance of tablets/iPads to their academic success was statistically significantly related (r= -0.25, p<0.05) to their final course grades during SP14. Tables 4.5 – 4.6 provide more detailed correlation results for the non-White sample.

Table 4. 7

Correlations between AU13 independent variables and final course grades for non-White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.02	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.11	0.57**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.11	0.24*	0.23*	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.09	0.04	0.04	-0.12	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.09	0.04	-0.13	-0.09	-0.18	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.06	-0.14	0.06	-0.04	0.02	-0.02	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.08	-0.19	-0.07	0.07	-0.36**	-0.02	-0.02	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	-0.06	-0.15	-0.17	-0.01	-0.24*	0.03	-0.08	0.47**	1.00						

Continued

Table 4.7 continued

Perceived Usefulness 6: Importance of E-readers	-0.04	-0.04	0.02	-0.08	0.11	0.09	-0.12	-0.43**	0.27**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.04	0.02	-0.05	-0.07	-0.07	-0.02	0.07	0.06	0.19	-0.01	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.16	-0.11	0.03	-0.02	0.07	-0.03	-0.15	-0.11	0.04	-0.01	-0.09	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.02	-0.19	-0.06	-0.09	-0.01	0.05	-0.07	-0.13	-0.02	0.10	-0.04	0.29**	1.00		
Perceived Frequency of Use 3: Storage Medium	0.12	0.12	0.05	0.21	-0.22	-0.16	-0.16	0.09	-0.01	-0.11	0.07	-0.02	-0.19	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.05	0.24*	0.01	0.07	0.19	0.00	-0.14	-0.07	-0.03	-0.03	0.15	0.05	-0.00	0.22	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.8

Correlations between SP14 independent variables and final course grades for non-White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.12	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.04	0.58**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.06	0.31**	0.35**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.02	0.24*	0.28*	0.09	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.04	0.21	0.31*	0.25*	0.47**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	-0.00	0.10	0.16	0.14	0.25*	0.31**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.05	-0.06	0.16	0.24	0.15	0.29**	0.13	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	-0.25*	-0.03	0.01	0.23	0.18	0.06	0.08	0.61**	1.00						

Continued

Table 4.8 continued

Perceived Usefulness 6: Importance of E-readers	-0.15	0.11	0.20	0.02	0.01	0.15	0.01	0.10	0.36**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.02	0.15	0.25	0.07	0.03	0.06	-0.27*	0.18	0.22*	0.26*	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.00	0.34**	0.34**	0.03	0.16	0.32**	0.09	0.15	0.08	0.28**	0.29**	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.17	-0.01	0.17	0.02	0.25*	0.16	0.03	0.27*	0.35**	0.10	0.10	0.18	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.01	-0.02	-0.03	-0.14	0.04	0.13	0.13	0.17	0.04	0.08	0.01	0.27**	0.17	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.14	0.07	0.02	0.10	0.27**	0.23*	0.34**	0.34**	0.53**	0.41**	-0.05	0.30**	0.44**	0.26**	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

White sample. For the White (N=345) sample, students' perceived frequency of using email for communication with a TA/instructor in the class was statistically significantly related (r= -0.12, p<0.05) to their AU13 final course grades. Also, White students' perceived frequency of using a storage medium to complete an assignment was statistically significantly related (r= -0.13, p<0.05) to their AU13 final course grades.

During the second semester, students' perception about the extent to which technology makes learning more fun was statistically significantly related (r=0.16, p<0.01) to their SP14 final course grades. Tables 4.7 – 4.8 provide more detailed correlation results for the White sample.

Table 4.9

Correlations between AU13 independent variables and final course grades for White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.07	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.00	0.41**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.07	0.12*	0.28**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.01	0.03	0.04	-0.07	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.01	-0.04	-0.13*	-0.03	0.03	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.01	-0.03	0.16**	-0.00	0.10	0.16**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.03	0.00	-0.01	0.00	-0.05	-0.02	-0.05	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	0.08	0.01	-0.01	0.02	0.04	-0.01	0.13*	0.33**	1.00						

Continued

Table 4.9 continued

Perceived Usefulness 6: Importance of E-readers	0.01	-0.01	-0.02	-0.00	0.04	0.02	0.05	-0.44**	0.28**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.03	0.03	0.14*	0.06	0.05	0.02	0.05	0.04	0.19**	0.16**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.03	-0.06	0.08	0.00	-0.04	-0.01	0.08	-0.03	-0.06	0.02	0.04	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.12*	-0.09	0.07	0.05	0.05	-0.02	0.03	-0.08	0.05	0.06	0.09	0.05	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.13*	-0.01	-0.03	-0.17*	-0.02	0.05	0.03	0.03	0.01	0.00	0.04	0.03	0.06	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.08	0.07	-0.07	-0.00	0.01	0.04	0.02	0.00	-0.09	-0.09	-0.04	0.03	-0.08	0.11	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.10

Correlations between SP14 independent variables and final course grades for White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.02	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.11	0.59**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.11	0.24*	0.23*	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.09	0.04	0.04	-0.12	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.09	0.04	-0.13	-0.09	-0.18	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.06	-0.14	0.06	-0.04	0.02	-0.02	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.08	-0.19	-0.07	0.07	-0.36**	-0.02	-0.02	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	-0.06	-0.15	-0.17	-0.01	-0.24*	0.03	-0.08	0.47**	1.00						

Continued

Table 4.10 continued

Perceived Usefulness 6: Importance of E-readers	-0.04	-0.04	0.02	-0.08	0.11	0.09	-0.12	-0.43**	0.27**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.04	0.02	-0.05	-0.07	-0.07	-0.02	0.07	0.06	0.19	-0.01	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.16	-0.11	0.03	-0.02	0.07	-0.03	-0.15	-0.11	0.04	-0.01	-0.09	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.02	-0.19	-0.06	-0.09	-0.01	0.05	-0.07	-0.13	-0.02	0.10	-0.04	0.29**	1.00		
Perceived Frequency of Use 3: Storage Medium	0.12	0.12	0.05	0.21	-0.22	-0.16	-0.16	0.09	-0.01	-0.11	0.07	-0.02	-0.19	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.05	0.24*	0.01	0.07	0.19	0.00	-0.14	-0.07	-0.03	-0.03	0.15	0.05	-0.00	0.22	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Female sample. For the female (*N*=98) sample, none of the technology-related independent variables were significantly correlated with the FYES' AU13 or SP14 final course grades. Tables 4.9 – 4.10 provide more detailed correlation results for the female sample.

Table 4.11

Correlations between AU13 independent variables and final course grades for female sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.08	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.13	0.34**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.03	0.24*	0.39**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.04	-0.10	-0.01	-0.22	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.03	-0.20	-0.22	-0.06	0.07	1.00									
Perceived Usefulness 3: Makes Learning More Fun	-0.09	-0.17	0.12	-0.02	0.21	0.09	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.08	-0.04	-0.13	-0.04	-0.18	0.04	-0.08	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	-0.15	-0.09	-0.19	-0.03	-0.11	-0.05	0.00	0.33**	1.00						

Continued

Table 4.11 continued

Perceived Usefulness 6: Importance of E-readers	-0.00	-0.04	-0.08	-0.12	0.10	0.10	0.05	-0.53**	0.20	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.14	0.03	0.23*	0.01	0.19	-0.15	0.15	-0.13	0.22*	0.09	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.09	0.02	-0.02	-0.03	-0.10	0.12	-0.14	-0.07	0.09	0.28*	0.03	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.11	-0.25*	-0.01	-0.24*	0.02	-0.06	0.06	-0.04	0.08	0.14	0.02	0.08	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.04	0.06	-0.15	-0.19	0.01	0.18	0.01	0.01	-0.06	-0.05	0.06	0.04	-0.04	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.18	0.25*	-0.10	-0.08	0.02	0.05	-0.12	-0.07	-0.11	0.04	-0.07	0.20	-0.01	0.37**	1.00

NOTE: *$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 4.12

Correlations between SP14 independent variables and final course grades for female sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.06	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.09	0.47**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.15	0.08	0.15	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.03	-0.13	0.05	0.06	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.05	0.19	0.14	-0.19	0.37**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.04	0.15	0.18	-0.09	0.43**	0.49**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.01	0.01	-0.10	-0.13	0.01	0.14	0.08	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	-0.16	-0.05	-0.05	-0.04	0.15	0.12	0.06	0.45**	1.00						

Continued

Table 4.12 continued

Perceived Usefulness 6: Importance of E-readers	-0.09	-0.02	0.10	0.00	0.10	0.13	0.08	-0.27**	0.30**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	0.07	-0.06	0.06	-0.01	-0.14	0.06	-0.14	0.03	0.08	0.09	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.04	0.02	-0.03	-0.06	0.03	0.10	0.13	0.00	0.03	0.09	0.03	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.20	-0.02	-0.08	0.04	0.06	-0.01	0.06	0.16	0.16	-0.01	-0.11	0.04	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.05	0.10	-0.02	0.14	0.19	0.20	0.20	0.29**	0.11	0.01	0.01	0.22*	0.17	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.10	-0.04	0.02	0.09	0.17	0.12	0.30**	0.13	0.35**	0.27*	0.06	0.02	0.06	0.27*	1.00

NOTE: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Male sample. For the male (N=389) sample, none of the technology-related independent variables were significantly correlated with the FYES' AU13 final course grades. During the second semester, students' perceived knowledge of MATLAB, CAD and microcontroller software was statistically significantly related (r= -0.13, p<0.05) to their SP14 final course grades. Furthermore, students' perception about the extent to which technology makes learning more fun was statistically significantly related (r=0.15, p<0.01) to their SP14 final course grades. Tables 4.11 – 4.12 provide more detailed correlation results for the male sample.

Table 4.13

Correlations between AU13 independent variables and final course grades for male sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.10	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.05	0.52**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.03	0.14*	0.24**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.03	0.06	0.02	-0.05	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.03	0.02	-0.06	-0.05	-0.04	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.05	-0.05	0.10	-0.01	0.06	0.10	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.02	-0.04	0.02	0.03	-0.04	-0.02	-0.06	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	0.07	0.01	0.02	0.04	-0.02	0.00	0.08	0.35**	1.00						

Continued

Table 4.13 continued

Perceived Usefulness 6: Importance of E-readers	-0.02	-0.01	0.00	0.02	-0.00	-0.01	0.03	-0.44**	0.31**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.01	0.03	0.04	0.02	-0.01	0.05	0.06	0.08	0.17**	0.14*	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.01	-0.09	0.09	-0.01	-0.00	-0.03	0.07	-0.04	-0.06	-0.04	0.02	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.09	-0.08	0.04	0.09	0.02	0.03	-0.02	-0.13*	0.01	0.07	0.04	0.14**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.09	0.02	0.03	-0.05	-0.09	-0.03	0.01	0.01	0.02	0.01	0.04	0.02	0.02	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.04	0.09	-0.03	0.01	0.05	0.03	0.06	-0.03	-0.07	-0.09	0.05	0.02	-0.06	0.11	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4. 14

Correlations between SP14 independent variables and final course grades for male sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Final Course Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.01	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.07	0.62**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.13*	0.31**	0.41**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.02	0.14*	0.12	0.11	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.04	0.14*	0.11	0.12	0.55**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.15**	0.17**	0.11	0.03	0.46**	0.51**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.03	-0.01	0.04	0.14*	0.22**	0.12*	0.14*	1.00							
Perceived Usefulness 5: Importance of Tablets/iPads	-0.07	0.02	0.03	0.18**	0.20**	0.12*	0.02	0.57**	1.00						

Continued

Table 4.14 continued

Perceived Usefulness 6: Importance of E-readers	-0.01	0.06	0.02	0.12	0.19**	0.27**	0.12*	-0.07	0.16**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.10	0.05	-0.01	0.00	0.10	0.12*	0.02	0.05	0.12*	0.15**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.05	0.07	0.08	0.06	0.21**	0.19*	0.16**	0.12*	0.12*	0.18**	0.10	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.09	-0.01	0.13*	0.17**	0.17**	0.14**	0.04	0.18**	0.26**	0.24**	0.01	0.20**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.11	-0.08	0.01	-0.06	0.17**	0.19**	0.12*	0.15*	0.11	0.15**	-0.10	0.16**	0.23**	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.08	0.05	0.06	0.08	0.20**	0.19**	0.09	0.14*	0.25**	0.28**	0.15*	0.14**	0.32**	0.19**	1.00

NOTE: *$p<0.05$, **$p<0.01$, ***$p<0.001$

Summary. A couple of technology-related independent variables were significantly correlated with White FYES' AU13 final course grades. For the White sample, students' perceptions about their frequency of using (a) email for communication with a TA/instructor, and (b) a storage medium to complete an assignment were statistically significant but negatively related to their AU13 final course grades.

Several technology-related independent variables were also significantly correlated with FYES' SP14 final course grades from the aggregate, non-White, White and male samples. For the aggregate sample, students' perception about a) the extent to which technology makes learning more fun and b) their frequency of email use for communication with a TA/instructor were both statistically significantly related to their SP14 final course grades. The former was positively correlated while the latter was negatively correlated with students' SP14 final course grades. On the other hand, non-White students' perception about the importance of tablets/iPads to their academic success was statistically significant but negatively related to their SP14 final course grades. By comparison, White students' perception about the extent to which technology makes learning more fun was positively, statistically significantly related to their SP14 final course grades. Finally, male students' (a) perceived knowledge of MATLAB, CAD and microcontroller software, and (b) perception about the extent to which technology makes learning more fun were both statistically significantly related to their SP14 final course grades. The former was negatively correlated while the latter was positively correlated with students' SP14 final course grades.

Hierarchical Linear Regression Results

Aggregate sample. Using the aggregate sample, the first regression analysis included students' survey data and final course grades from the first semester of the academic year (i.e., AU13). Potentially confounding variables such as age, gender, ethnicity/race, admission classification, class rank, pre-major, Pell Grant and first-generation status were controlled for in the first block (i.e., model 1) of the regression test. Multiple independent variables representing FYES' (N=487) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between FYES' background characteristics and technology-related measures and their final course grades during AU13, $F(23, 164) = 1.00$, $p = 0.47$, $R = 0.38$, $R^2 = 0.14$, adjusted $R^2 = 0.00$.

Again using the aggregate sample, a second hierarchical linear regression analysis was conducted to examine the extent to which FYES' (N=487) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in SP14 during the second of two *Fundamentals of Engineering* courses. Potentially confounding variables were again entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis.

In model 1, participants' background traits proved to be statistically significant predictors of their SP14 final course grades in the second of two *Fundamentals of Engineering* courses, $F(9, 198) = 2.34$, $p < 0.05$, $R = 0.36$, $R^2 = 0.13$, adjusted $R^2 = 0.02$. Hence, FYES' background traits accounted for 13% of the variance in their SP14 final course grades. When holding all other background traits constant, students who receive a Pell grant earned final course grades during SP14 that are 6.20 points higher than those who did not receive such financial aid. In addition, when holding all other background traits constant, students who are first-generation college undergraduates earn final course grades during SP14 that are 2.34 points lower than those who did not receive such financial aid. Lastly, when holding all other background traits constant, for every one point increase in students' H.S. class rank, their final course grades during SP14 increase by 0.07 points. In model 2, findings reveal no statistically significant relationship between FYES' background characteristics and technology-related measures and their final course grades during SP14, $F(23, 198) = 1.16$, $p = 0.29$, $R = 0.36$, $R^2 = 0.13$, adjusted $R^2 = 0.02$. Tables 4.13 and 4.14 contain more detailed hierarchical linear regression results.

Table 4. 15

Regression results for final grades (AU13), aggregate sample (N=487)

Variables	Model 1 *B*	Model 1 *SE*	Model 1 *β*	Model 1 *t*	Model 2 *B*	Model 2 *SE*	Model 2 *β*	Model 2 *t*
Constant	87.98	3.85		22.88***	89.52	6.30		14.21***
Age 18-19	0.76	2.52	0.03	0.30	0.66	2.61	0.03	0.25
Admission: New Freshman	-1.44	2.42	-0.08	-0.59	-0.93	2.51	-0.05	-0.37
Rank: Freshman	0.47	1.60	0.03	0.29	-0.38	1.69	-0.03	-0.22
Pre-Major: Engineering	-1.14	1.95	-0.06	-0.59	-0.61	2.03	-0.03	-0.30
Gender: Female	0.95	1.18	0.06	0.81	0.92	1.22	0.06	0.75
Ethnicity: White	1.95	1.22	0.13	1.60	1.36	1.27	0.09	1.08
Pell Grant Recipient	-7.16	3.31	-0.19	-2.16**	-6.20	3.44	-0.17	-1.80
First Generation Student	0.54	1.37	0.03	0.40	1.07	1.48	0.06	0.72
HS Rank	-0.01	0.04	-0.01	-0.11	0.01	0.04	0.03	0.33
Δ Perceived Knowledge 1: Word processors					-0.71	0.56	-0.12	-1.27
Δ Perceived Knowledge 2: Spreadsheet software					0.43	0.54	0.08	0.80
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.21	0.46	-0.04	-0.45
Perceived Usefulness 1: Easier to Get Help When Needed					-0.26	0.61	-0.04	-0.43
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					-0.20	1.10	-0.02	-0.18
Perceived Usefulness 3: Makes Learning More Fun					-0.20	0.62	-0.03	-0.32
Perceived Usefulness 4: Importance of Desktops/Laptops					0.03	0.39	0.01	0.07
Perceived Usefulness 5: Importance of Tablets/iPads					0.33	0.42	0.08	0.80
Perceived Usefulness 6: Importance of E-readers					-0.29	0.37	-0.08	-0.79

Continued

Table 4.15 continued

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.30	0.48	-0.05	-0.62
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.79	0.56	0.12	1.40
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-1.04	0.69	-0.13	-1.50
Perceived Frequency of Use 3: Storage Medium					-0.70	0.51	-0.11	-1.36
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.98	0.52	0.16	1.87
R	0.23				0.38			
R^2	0.05				0.14			
Adj. R^2	-0.00				0.00			
ΔR^2	0.05				0.09			
Model	$F(9, 164) = 0.99$, $p = 0.45$				$F(23, 164) = 1.00$, $p = 0.47$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4. 16

Regression results for final grades (SP14), aggregate sample (N=487)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	85.85	2.70		31.8^{***}	86.72	3.63		23.90^{***}
Age 18-19	0.17	1.98	0.01	0.08	0.30	2.11	0.02	0.14
Admission: New Freshman	1.03	1.67	0.08	0.62	1.13	1.74	0.08	0.65
Rank: Freshman	0.00	0.93	0.00	0.00	0.11	0.97	0.01	0.12
Pre-Major: Engineering	-0.26	1.40	-0.02	-0.19	-0.42	1.52	-0.03	-0.28
Gender: Female	-1.41	0.77	-0.13	-1.84	-1.47	0.85	-0.13	-1.73
Ethnicity: White	-0.54	0.86	-0.04	-0.63	-0.51	0.92	-0.04	-0.55
Pell Grant Recipient	6.20	2.26	0.24	2.75^{**}	6.78	2.46	0.26	2.76^{**}
First Generation Student	-2.34	0.90	-0.18	-2.59^{*}	-2.55	0.97	-0.20	-2.63^{**}
HS Rank	0.07	0.03	0.17	2.22^{*}	0.06	0.03	0.16	1.99^{*}
Δ Perceived Knowledge 1: Word processors					-0.17	0.42	-0.04	-0.40
Δ Perceived Knowledge 2: Spreadsheet software					-0.05	0.40	-0.01	-0.12
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					0.02	0.32	0.00	0.05
Perceived Usefulness 1: Easier to Get Help When Needed					-0.46	0.58	-0.08	-0.78
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.26	0.72	0.03	0.36
Perceived Usefulness 3: Makes Learning More Fun					-0.16	0.55	-0.03	-0.29
Perceived Usefulness 4: Importance of Desktops/Laptops					0.00	0.29	0.00	0.01
Perceived Usefulness 5: Importance of Tablets/iPads					0.31	0.35	0.09	0.88
Perceived Usefulness 6: Importance of E-readers					-0.21	0.27	-0.07	-0.78

Continued

Table 4.16 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					0.27	0.41	0.05	0.67
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.20	0.38	-0.04	-0.53
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.48	0.48	-0.08	-0.99
Perceived Frequency of Use 3: Storage Medium					0.05	0.33	0.01	0.15
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.12	0.40	0.02	0.29
R	0.32				0.36			
R^2	0.10				0.13			
Adj. R^2	0.06				0.02			
ΔR^2	0.10				0.03			
Model	$F(9, 198) = 2.34, p = 0.02$				$F(23, 198) = 1.16, p = 0.29$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Non-white sample. Using the non-White sample, a third regression analysis was run to examine the extent to which FYES' (N=109) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in the first semester of the academic year (i.e., AU13). Potentially confounding variables were entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between non-White FYES' background characteristics and technology-related measures and their final course grades during AU13, $F(22, 36) = 0.84$, $p = 0.65$, $R = 0.75$, $R^2 = 0.57$, adjusted $R^2 = -0.11$.

Once more using the non-White sample, a fourth regression analysis was run to examine the extent to which FYES' (N=109) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in SP14 during the second of two *Fundamentals of Engineering* courses. Potentially confounding variables were again entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Findings reveal no statistically significant relationship between non-White FYES' background traits and technology-related measures and their final course grades during SP14, $F(22, 36) = 0.54$,

$p = 0.91$, $R = 0.68$, $R^2 = 0.46$, adjusted $R^2 = -0.39$. Tables 4.15 and 4.16 contain more detailed hierarchical linear regression results for the non-White sample.

Table 4.17

Regression results for final grades (AU13), non-White sample (N=109)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*B*	*t*
Constant	73.03	13.89		5.26^{***}	49.77	29.27		1.70
Age 18-19	8.62	9.02	0.33	0.96	1.05	11.43	0.04	0.09
Admission: New Freshman	6.22	11.58	0.30	0.54	1.95	14.71	0.09	0.13
Rank: Freshman	-2.70	4.69	-0.16	-0.58	-7.11	6.66	-0.43	-1.07
Pre-Major: Engineering	-8.01	13.05	-0.42	-0.61	-1.83	15.50	-0.10	-0.12
Gender: Female	0.10	2.98	0.01	0.03	1.97	4.05	0.12	0.49
Pell Grant Recipient	-5.19	11.35	-0.12	-0.46	-4.18	15.13	-0.10	-0.28
First Generation Student	3.22	3.57	0.19	0.90	4.95	4.71	0.29	1.05
HS Rank	0.10	0.15	0.13	0.67	0.15	0.18	0.20	0.85
Δ Perceived Knowledge 1: Word processors					-2.73	2.41	-0.45	-1.13
Δ Perceived Knowledge 2: Spreadsheet software					2.54	2.03	0.41	1.25
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-2.69	2.03	-0.44	-1.32
Perceived Usefulness 1: Easier to Get Help When Needed					2.63	3.46	0.27	0.76
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					4.96	4.55	0.31	1.09
Perceived Usefulness 3: Makes Learning More Fun					0.26	1.91	0.04	0.14
Perceived Usefulness 4: Importance of Desktops/Laptops					0.42	1.93	0.10	0.22
Perceived Usefulness 5: Importance of Tablets/iPads					-0.53	2.13	-0.11	-0.25
Perceived Usefulness 6: Importance of E-readers					-0.57	1.77	-0.14	-0.32

Continued

Table 4.17 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.27	1.99	-0.03	-0.13
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.62	2.21	0.09	0.28
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					0.96	1.90	0.12	0.51
Perceived Frequency of Use 3: Storage Medium					0.98	1.58	0.15	0.62
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.82	1.78	0.27	1.02
R	0.36				0.75			
R^2	0.13				0.57			
Adj. R^2	-0.12				-0.11			
ΔR^2	0.13				0.44			
Model	$F(8, 36) = 0.53$, $p = 0.83$				$F(22, 36) = 0.84$, $p = 0.65$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.18

Regression results for final grades (SP14), non-White sample (N=109)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	73.03	13.89		5.26***	49.77	29.27		1.70***
Age 18-19	8.62	9.02	0.33	0.96	1.05	11.43	0.04	0.09
Admission: New Freshman	6.22	11.58	0.30	0.54	1.95	14.71	0.09	0.13
Rank: Freshman	-2.70	4.69	-0.16	-0.58	-7.11	6.66	-0.43	-1.07
Pre-Major: Engineering	-8.01	13.05	-0.42	-0.61	-1.83	15.50	-0.10	-0.12
Gender: Female	0.10	2.98	0.01	0.03	1.97	4.05	0.12	0.49
Pell Grant Recipient	-5.19	11.35	-0.12	-0.46	-4.18	15.13	-0.10	-0.28
First Generation Student	3.22	3.57	0.19	0.90	4.95	4.71	0.29	1.05
HS Rank	0.10	0.15	0.13	0.67	0.15	0.18	0.20	0.85
Δ Perceived Knowledge 1: Word processors					-2.73	2.41	-0.45	-1.13
Δ Perceived Knowledge 2: Spreadsheet software					2.54	2.03	0.41	1.25
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-2.69	2.03	-0.44	-1.32
Perceived Usefulness 1: Easier to Get Help When Needed					2.63	3.46	0.27	0.76
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					4.96	4.55	0.31	1.09
Perceived Usefulness 3: Makes Learning More Fun					0.26	1.91	0.04	0.14
Perceived Usefulness 4: Importance of Desktops/Laptops					0.42	1.91	0.10	0.22
Perceived Usefulness 5: Importance of Tablets/iPads					-0.53	1.93	-0.11	-0.25
Perceived Usefulness 6: Importance of E-readers					-0.57	2.13	-0.14	-0.32

Continued

Table 4.18 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.27	1.77	-0.03	-0.13
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.62	1.99	0.09	0.28
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					0.96	1.90	0.12	0.51
Perceived Frequency of Use 3: Storage Medium					0.98	1.58	0.15	0.62
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.82	1.78	0.27	1.02
R	0.36				0.68			
R^2	0.13				0.46			
Adj. R^2	-0.12				-0.39			
ΔR^2	0.13				0.33			
Model	$F(8, 36) = 0.52$, $p = 0.83$				$F(22, 36) = 0.54$, $p = 0.91$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

White sample. Using the White sample, a fifth regression analysis was run to examine the extent to which FYES' (N=345) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in the first semester of the academic year (i.e., AU13). Potentially confounding variables were entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between White FYES' background characteristics and technology-related measures and their final course grades during AU13, $F(22, 127) = 0.99$, $p = 0.49$, $R = 0.41$, $R^2 = 0.17$, adjusted $R^2 = -0.00$.

Again using the White sample, a sixth regression analysis was run to examine the extent to which FYES' (N=345) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in SP14 during the second of two *Fundamentals of Engineering* courses. Potentially confounding variables were again entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis.

In model 1, White participants' background traits proved to be statistically significant predictors of their SP14 final course grades in the second of two *Fundamentals of Engineering* courses, $F(8, 161) = 2.36$, $p < 0.05$, $R = 0.33$, $R^2 = 0.11$, adjusted $R^2 = 0.06$. Hence, FYES' background traits accounted for 11% of the variance in their SP14 final course grades. When holding all other background traits constant, White female students earn final course grades during SP14 that are 1.82 points lower than White males. In addition, when holding all other background traits constant, White students who receive a Pell grant earn final course grades during SP14 that are 6.94 points higher than those who did not receive such financial aid. Lastly, when holding all other background traits constant, for every one point increase in White students' H.S. class rank, their final course grades during SP14 increase by 0.08 points. In model 2, findings reveal no statistically significant relationship between White FYES' background characteristics and technology-related measures and their final course grades during SP14, $F(22, 161) = 1.27$, $p = 0.21$, $R = 0.41$, $R^2 = 0.17$, adjusted $R^2 = 0.04$. Tables 4.17 and 4.18 contain more detailed hierarchical linear regression results for the White sample.

Table 4.19

Regression results for final grades (AU13), White sample (N=345)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	91.49	3.90		23.46***	97.28	6.41		15.17***
Age 18-19	1.17	2.88	0.05	0.41	0.04	3.07	0.00	0.01
Admission: New Freshman	-2.33	2.62	-0.14	-0.89	-0.75	2.75	-0.05	-0.27
Rank: Freshman	1.43	1.72	0.11	0.83	1.15	1.88	0.09	0.61
Pre-Major: Engineering	-1.28	2.02	-0.07	-0.64	-0.59	2.10	-0.03	-0.28
Gender: Female	1.29	1.30	0.09	0.99	0.97	1.36	0.07	0.71
Pell Grant Recipient	-6.63	3.50	-0.19	-1.90	-3.07	3.72	-0.09	-0.82
First Generation Student	-0.73	1.57	-0.04	-0.47	-0.81	1.69	-0.05	-0.48
HS Rank	-0.02	0.04	-0.06	-0.57	-0.02	0.05	-0.05	-0.53
Δ Perceived Knowledge 1: Word processors					-0.22	0.61	-0.04	-0.36
Δ Perceived Knowledge 2: Spreadsheet software					-0.25	0.59	-0.05	-0.43
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					0.43	0.53	0.08	0.81
Perceived Usefulness 1: Easier to Get Help When Needed					-0.36	0.64	-0.05	-0.57
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					-1.04	1.17	-0.09	-0.89
Perceived Usefulness 3: Makes Learning More Fun					-0.22	0.70	-0.03	-0.31
Perceived Usefulness 4: Importance of Desktops/Laptops					-0.10	0.44	-0.03	-0.22
Perceived Usefulness 5: Importance of Tablets/iPads					0.64	0.44	0.16	1.45
Perceived Usefulness 6: Importance of E-readers					-0.34	0.40	-0.10	-0.84

Continued

Table 4.19 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					0.05	0.53	0.10	0.10
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.16	0.64	-0.03	-0.25
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-1.45	0.79	-0.17	-1.84
Perceived Frequency of Use 3: Storage Medium					-0.72	0.60	-0.12	-1.21
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.12	0.58	0.18	1.92
R	0.23				0.41			
R^2	0.05				0.17			
Adj. R^2	-0.01				-0.00			
ΔR^2	0.05				0.12			
Model	$F(8, 127) = 0.80$, $p = 0.60$				$F(22, 127) = 0.99$, $p = 0.49$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.20

Regression results for final grades (SP14), White sample (N=345)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	84.46	3.15		26.82***	85.21	3.94		21.64***
Age 18-19	0.44	2.36	0.02	0.19	0.48	2.63	0.02	0.18
Admission: New Freshman	1.03	1.77	0.07	0.59	1.32	1.84	0.10	0.72
Rank: Freshman	-0.22	1.01	-0.02	-0.21	-0.15	1.05	-0.01	-0.14
Pre-Major: Engineering	-0.40	1.51	-0.03	-0.27	-0.62	1.63	-0.04	-0.38
Gender: Female	-1.82	0.86	-0.16	-2.11*	-2.21	0.98	-0.20	-2.27
Pell Grant Recipient	6.94	2.59	0.27	2.68**	7.50	2.86	0.29	2.62
First Generation Student	-1.85	1.07	-0.13	-1.72	-1.91	1.15	-0.14	-1.66
HS Rank	0.08	0.03	0.19	2.20*	0.07	0.04	0.16	1.72
Δ Perceived Knowledge 1: Word processors					-0.34	0.48	-0.07	-0.70
Δ Perceived Knowledge 2: Spreadsheet software					0.13	0.45	0.03	0.29
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					0.21	0.38	0.05	0.56
Perceived Usefulness 1: Easier to Get Help When Needed					-1.19	0.66	-0.19	-1.80
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					1.02	0.84	0.12	1.22
Perceived Usefulness 3: Makes Learning More Fun					0.06	0.64	0.01	0.10
Perceived Usefulness 4: Importance of Desktops/Laptops					0.13	0.32	0.05	0.40
Perceived Usefulness 5: Importance of Tablets/iPads					0.28	0.40	0.08	0.72
Perceived Usefulness 6: Importance of E-readers					-0.01	0.31	-0.00	-0.05

Continued

Table 4.20 continued

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					0.12	0.45	0.02	0.26
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.28	0.42	-0.06	-0.67
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.73	0.54	-0.12	-1.36
Perceived Frequency of Use 3: Storage Medium					0.12	0.37	0.03	0.33
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.06	0.43	0.01	0.13
R	0.33				0.41			
R^2	0.11				0.17			
Adj. R^2	0.06				0.04			
ΔR^2	0.11				0.12			
Model	$F(8, 161) = 2.36, p = 0.02$				$F(22, 161) = 1.27, p = 0.21$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Female sample. Using the female sample, a seventh regression analysis was run to examine the extent to which FYES' (N=98) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in the first semester of the academic year (i.e., AU13). Potentially confounding variables were entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between female FYES' background characteristics and technology-related measures and their final course grades during AU13, $F(22, 40) = 1.44$, $p = 0.22$, $R = 0.80$, $R^2 = 0.64$, adjusted $R^2 = 0.19$.

Once more using the female sample, an eighth regression analysis was run to examine the extent to which FYES' (N=98) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in SP14 during the second of two *Fundamentals of Engineering* courses. Potentially confounding variables were again entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Interestingly, in model 2, the age variable dropped out and was excluded from the analysis. This happened because variables with very low tolerance can cause computational problems and add little information to a model (Stockburger, 1998). So, such variables are excluded instead.

In model 2, results reveal no statistically significant relationship between female FYES' background characteristics and technology-related measures and their final course grades during SP14, $F(21, 49) = 0.97$, $p = 0.53$, $R = 0.65$, $R^2 = 0.42$, adjusted $R^2 = -0.02$. Tables 4.19 and 4.20 contain more detailed hierarchical linear regression results for the female sample.

Table 4.21

Regression results for final grades (AU13), female sample (N=98)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	94.53	9.25		10.22^{***}	95.51	12.79		7.47^{***}
Age 18-19	-4.65	5.74	-0.20	-0.81	-9.80	6.09	-0.43	-1.61
Admission: New Freshman	2.94	3.46	0.23	0.85	1.96	3.72	0.16	0.53
Rank: Freshman	-1.28	2.33	-0.12	-0.55	-1.35	2.85	-0.13	-0.48
Pre-Major: Engineering	-1.84	2.68	-0.14	-0.69	-0.80	2.84	-0.06	-0.28
Ethnicity: White	2.46	1.85	0.21	1.33	-0.63	2.60	-0.06	-0.24
Pell Grant Recipient	-14.73	7.02	-0.46	-2.10	-17.19	8.20	-0.53	-2.10
First Generation Student	-1.36	2.35	-0.10	-0.58	-3.90	2.69	-0.28	-1.45
HS Rank	-0.03	0.10	-0.06	-0.32	0.10	0.13	0.21	0.83
Δ Perceived Knowledge 1: Word processors					-1.07	1.09	-0.21	-0.98
Δ Perceived Knowledge 2: Spreadsheet software					0.45	0.85	0.11	0.52
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					1.30	0.79	0.34	1.65
Perceived Usefulness 1: Easier to Get Help When Needed					-1.01	1.25	-0.18	-0.81
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					-1.78	1.63	-0.20	-1.09
Perceived Usefulness 3: Makes Learning More Fun					0.13	0.86	0.02	0.15
Perceived Usefulness 4: Importance of Desktops/Laptops					0.54	0.79	0.19	0.68
Perceived Usefulness 5: Importance of Tablets/iPads					-0.87	0.70	-0.25	-1.26
Perceived Usefulness 6: Importance of E-readers					0.51	0.72	0.19	0.72

Continued

Table 4.21 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-1.23	1.00	-0.29	-1.23
Perceived Frequency of Use 1: Electronic Medium for Coursework					1.63	0.92	0.32	1.78
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					0.06	1.10	0.01	0.05
Perceived Frequency of Use 3: Storage Medium					-0.04	1.09	-0.01	-0.04
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					2.07	1.02	0.36	2.03
R	0.47				0.80			
R^2	0.22				0.64			
Adj. R^2	0.03				0.19			
ΔR^2	0.22				0.42			
Model	$F(8, 40) = 1.14$, $p = 0.37$				$F(22, 40) = 1.44$, $p = 0.22$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.22

Regression results for final grades (SP14), female sample (N=98)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*B*	*t*
Constant	82.91	7.66		10.82***	78.61	12.18		6.45***
Admission: New Freshman	0.67	3.75	0.04	0.18	4.73	4.70	0.28	1.01
Rank: Freshman	0.32	2.33	0.03	0.14	0.12	2.55	0.01	0.05
Pre-Major: Engineering	-2.21	3.29	-0.12	-0.67	-6.93	3.77	-0.39	-1.84
Ethnicity: White	-2.09	2.30	-0.14	-0.91	-1.15	2.74	-0.08	-0.42
Pell Grant Recipient	7.22	5.42	0.24	1.33	14.97	6.86	0.50	2.18*
First Generation Student	0.61	2.55	0.04	0.24	1.31	2.99	0.08	0.44
HS Rank	0.11	0.08	0.23	1.44	0.04	0.11	0.07	0.31
Δ Perceived Knowledge 1: Word processors					-1.88	1.26	-0.31	-1.49
Δ Perceived Knowledge 2: Spreadsheet software					-0.18	1.01	-0.03	-0.18
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					1.25	1.13	0.22	1.11
Perceived Usefulness 1: Easier to Get Help When Needed					0.40	1.93	0.05	0.21
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					2.35	2.30	0.21	1.02
Perceived Usefulness 3: Makes Learning More Fun					1.32	1.39	0.21	0.95
Perceived Usefulness 4: Importance of Desktops/Laptops					-1.04	0.94	-0.30	-1.11
Perceived Usefulness 5: Importance of Tablets/iPads					-0.56	1.21	-0.12	-0.46
Perceived Usefulness 6: Importance of E-readers					-1.35	0.94	-0.35	-1.44
Perceived Usefulness 7: Importance of Smartphones/Cellphones					2.25	1.29	0.35	1.74

Continued

Table 4.22 continued

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.49	1.10	-0.08	-0.44
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-2.61	1.42	-0.34	-1.84
Perceived Frequency of Use 3: Storage Medium					0.27	0.96	0.05	0.28
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.19	1.03	0.21	1.15
R	0.32				0.65			
R^2	0.10				0.42			
Adj. R^2	-0.05				-0.02			
ΔR^2	0.10				0.32			
Model	$F(7, 49) = 0.68, p = 0.69$				$F(21, 49) = 0.97, p = 0.53$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Male sample. Using the male sample, a ninth regression analysis was run to examine the extent to which FYES' (N=389) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in the first semester of the academic year (i.e., AU13). Potentially confounding variables were entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between male FYES' background characteristics and technology-related measures and their final course grades during AU13, $F(22, 123) = 0.87$, $p = 0.63$, $R = 0.40$, $R^2 = 0.16$, adjusted $R^2 = -0.02$.

Again using the male sample, a tenth regression analysis was run to examine the extent to which FYES' (N=389) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their final course grades in SP14 during the second of two *Fundamentals of Engineering* courses. Potentially confounding variables were again entered into the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis.

In model 1, male participants' background traits proved to be statistically significant predictors of their SP14 final course grades in the second of two *Fundamentals of Engineering* courses, $F(8, 148) = 2.60$, $p < 0.05$, $R = 0.36$, $R^2 = 0.13$, adjusted $R^2 = 0.08$. Hence, male students' background traits accounted for 13% of the variance in their SP14 final course grades. When holding all other background traits constant, male students who receive a Pell grant earn final course grades during SP14 that are 6.25 points higher than those who did not receive such financial aid. Furthermore, when holding all other background traits constant, first-generation male students earn final course grades during SP14 that are 3.06 points lower than those who did not receive such financial aid. In model 2, results reveal no statistically significant relationship between male FYES' background characteristics and technology-related measures and their final course grades during SP14, $F(22, 148) = 1.41$, $p = 0.12$, $R = 0.44$, $R^2 = 0.20$, adjusted $R^2 = 0.06$. Tables 4.21 and 4.22 contain more detailed hierarchical linear regression results for the male sample.

Table 4.23

Regression results for final grades (AU13), male sample (N=389)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	87.19	4.48		19.48***	85.46	7.81		10.94***
Age 18-19	1.23	3.20	0.05	0.38	0.78	3.39	0.03	0.23
Admission: New Freshman	-4.24	3.29	-0.22	-1.29	-3.69	3.54	-0.19	-1.04
Rank: Freshman	1.51	2.07	0.10	0.73	0.21	2.19	0.01	0.10
Pre-Major: Engineering	0.01	2.88	0.00	0.00	1.78	3.19	0.08	0.56
Ethnicity: White	1.67	1.54	0.10	1.09	1.08	1.61	0.07	0.67
Pell Grant Recipient	-7.00	4.02	-0.18	-1.74	-5.56	4.21	-0.14	-1.32
First Generation Student	1.34	1.70	0.08	0.79	3.04	1.98	0.17	1.53
HS Rank	0.01	0.05	0.02	0.15	0.03	0.05	0.07	0.66
Δ Perceived Knowledge 1: Word processors					-0.96	0.76	-0.15	-1.27
Δ Perceived Knowledge 2: Spreadsheet software					1.13	0.77	0.19	1.47
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.59	0.61	-0.10	-0.97
Perceived Usefulness 1: Easier to Get Help When Needed					-0.09	0.78	-0.01	-0.11
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.15	1.42	0.01	0.10
Perceived Usefulness 3: Makes Learning More Fun					-0.20	0.81	-0.03	-0.24
Perceived Usefulness 4: Importance of Desktops/Laptops					-0.02	0.50	-0.01	-0.04
Perceived Usefulness 5: Importance of Tablets/iPads					0.66	0.53	0.15	1.26
Perceived Usefulness 6: Importance of E-readers					-0.57	0.48	-0.15	-1.20

Continued

Table 4.23 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					0.03	0.65	0.01	0.05
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.54	0.70	0.08	0.77
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-1.34	0.97	-0.14	-1.38
Perceived Frequency of Use 3: Storage Medium					-0.62	0.64	-0.09	-0.96
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.89	0.64	0.14	1.40
R	0.22				0.40			
R^2	0.05				0.16			
Adj. R^2	-0.02				-0.02			
ΔR^2	0.05				0.11			
Model	$F(8, 123) = 0.70$, $p = 0.69$				$F(22, 123) = 0.87$, $p = 0.63$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4. 24

Hierarchical linear regression results for final grades (SP14), male sample (N=389)

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	86.75	2.67		32.53***	88.61	3.70		23.97***
Age 18-19	-0.49	1.93	-0.03	-0.25	-1.14	2.06	-0.07	-0.55
Admission: New Freshman	1.90	1.85	0.16	1.03	2.25	1.95	0.19	1.16
Rank: Freshman	-0.30	1.01	-0.03	-0.30	-0.45	1.06	-0.05	-0.42
Pre-Major: Engineering	0.26	1.53	0.02	0.17	0.44	1.72	0.03	0.26
Ethnicity: White	-0.16	0.90	-0.02	-0.18	0.18	0.97	0.02	0.19
Pell Grant Recipient	6.25	2.24	0.26	2.79**	7.41	2.46	0.31	3.01**
First Generation Student	-3.06	0.93	-0.27	-3.30**	-3.26	0.98	-0.29	-3.34**
HS Rank	0.05	0.03	0.14	1.58	0.06	0.03	0.18	1.89
Δ Perceived Knowledge 1: Word processors					0.06	0.46	0.01	0.13
Δ Perceived Knowledge 2: Spreadsheet software					-0.12	0.44	-0.03	-0.28
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.41	0.33	-0.12	-1.25
Perceived Usefulness 1: Easier to Get Help When Needed					-0.87	0.61	-0.16	-1.42
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.28	0.74	0.04	0.37
Perceived Usefulness 3: Makes Learning More Fun					-0.53	0.60	-0.09	-0.87
Perceived Usefulness 4: Importance of Desktops/Laptops					0.03	0.31	0.01	0.09
Perceived Usefulness 5: Importance of Tablets/iPads					0.55	0.37	0.19	1.47
Perceived Usefulness 6: Importance of E-readers					0.02	0.29	0.01	0.08

Continued

Table 4.24 continued

Variables	Model 1 *B*	Model 1 *SE*	Model 1 *β*	Model 1 *t*	Model 2 *B*	Model 2 *SE*	Model 2 *β*	Model 2 *t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.05	0.41	-0.01	-0.13
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.01	0.41	-0.00	-0.01
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					0.16	0.51	0.03	0.32
Perceived Frequency of Use 3: Storage Medium					-0.16	0.34	-0.04	-0.47
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					-0.06	0.43	-0.01	-0.14
R	0.36				0.44			
R^2	0.13				0.20			
Adj. R^2	0.08				0.06			
ΔR^2	0.13				0.07			
Model	$F(8, 148) = 2.60, p = 0.01$				$F(22, 148) = 1.41, p = 0.12$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Summary. Overall, results from this section indicate that FYES' technology-related variables are not significant predictors of their final course grades in two *Fundamentals of Engineering* courses. However, students' background characteristics significantly predict their final course grades in the second course. There are differences by race/ethnicity and gender. Specifically, FYES' background traits – Pell grant recipient status, first-generation status, and H.S. class rank – are statistically significant predictors of their SP14 final course grades in the second of two *Fundamentals of Engineering* courses. Also, White students' background traits – gender, Pell grant recipient status, and H.S. class rank – are statistically significant predictors of their SP14 final course grades. Finally, male participants' background traits – Pell Grant recipient status and first-generation status – are statistically significant predictors of their SP14 final course grades.

Research Question 3: Technology and Software-Specific Grades

To answer the third research question, fifteen bivariate correlations and fifteen hierarchical linear regression analyses were conducted. The analyses were used to examine the extent to which FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology could predict their three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) in AU13 and SP14. Differences were also explored by race/ethnicity and gender.

Bivariate Correlation Results

Prior to running each analysis, multicollinearity diagnostics revealed that all correlations between independent variables, VIF values and tolerances were within acceptable limits.

Aggregate sample. For the aggregate (N=487) sample, none of the technology-related independent variables were significantly correlated with the FYES' mean Excel grades during AU13. However, students' perceived frequency of using text/email notifications from the course management system was statistically significantly related (r= 0.11, p<0.05) to their mean MATLAB grades during AU13. In addition, students' perception about the extent to which technology makes learning more fun was statistically significantly related (r=0.14, p<0.01) to the FYES' mean SolidWorks grades during SP14. Furthermore, students' perception about the importance of smartphones/cellphones to their academic success was statistically significantly related (r= -0.10, p<0.05) to their mean SolidWorks grades during SP14. Tables 4.23 – 4.25 provide more detailed correlation results for the aggregate sample.

Table 4.25

Correlations between AU13 independent variables and mean Excel grades for aggregate sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean Excel Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.08	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.06	0.48**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.02	0.16**	0.28**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.04	0.03	0.02	-0.09	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.00	-0.02	-0.09	-0.05	-0.02	1.00									
Perceived Usefulness 3: Makes Learning More Fun	-0.01	-0.07	0.10*	-0.01	0.09	0.10	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.01	-0.04	-0.02	0.02	-0.07	-0.01	-0.07	1.00							

Continued

Table 4.25 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.00	-0.01	-0.03	0.03	-0.04	-0.00	0.06	0.35**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.02	-0.02	-0.02	-0.01	0.02	0.01	0.03	-0.46**	0.29**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.04	0.02	0.09	0.02	0.03	0.01	0.08	0.03	0.18**	0.13**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.01	-0.07	0.07	-0.01	-0.02	-0.01	0.03	-0.05	-0.03	0.02	0.02	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.06	-0.12*	0.03	0.01	0.02	0.01	-0.00	-0.10*	0.03	0.08	0.04	0.13**	1.00		
Perceived Frequency of Use 3: Storage Medium	0.09	0.03	-0.02	-0.08	-0.07	0.01	0.01	0.01	0.00	0.00	0.05	0.02	0.01	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.09	0.12*	-0.05	-0.01	0.05	0.04	0.02	-0.03	-0.08	-0.06	0.03	0.05	-0.05	0.16**	1.00

NOTE: *$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 4.26

Correlations between AU13 independent variables and mean MATLAB grades for aggregate sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean MATLAB Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.06	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.02	0.48^{**}	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.02	0.16^{**}	0.28^{**}	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.08	0.03	0.02	0.11	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.01	-0.02	-0.09	-0.05	-0.02	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.01	-0.07	0.10^{*}	-0.01	0.09	0.10	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.00	-0.04	-0.02	0.02	-0.07	-0.10	-0.07	1.00							

Continued

Table 4.26 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.01	-0.01	-0.03	0.03	-0.04	-0.00	0.06	0.35**	1.00						
Perceived Usefulness 6: Importance of E-readers	0.04	-0.02	-0.02	-0.01	0.02	0.01	0.03	-0.46**	0.29**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.09	0.02	0.09	0.02	0.03	0.01	0.08	0.03	0.18**	0.13**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.04	-0.07	0.07	-0.01	-0.02	-0.01	0.03	-0.05	-0.03	0.02	0.02	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.06	-0.12*	0.03	0.01	0.02	0.01	-0.00	-0.10*	0.03	0.08	0.04	0.13**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.06	0.03	-0.02	-0.08	-0.07	0.01	0.01	0.01	0.00	0.00	0.05	0.02	0.01	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.11*	0.12*	-0.05	-0.01	0.05	0.04	0.02	-0.03	-0.08	-0.06	0.03	0.05	-0.05	0.16**	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4. 27

Correlations between SP14 independent variables and mean SolidWorks grades for aggregate sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean SolidWorks Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.01	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.04	0.59**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.07	0.27**	0.36**	1.00											
Perceived Usefulness 1: More Actively Involved in Courses	-0.02	0.07	0.09	0.09	1.00										
Perceived Usefulness 2: More Connected & Achieve Academic Outcomes	0.01	0.15**	0.12*	0.07	0.51**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.14**	0.16**	0.12*	0.00	0.46**	0.50**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.01	0.00	0.02	0.09	0.17**	0.13*	0.13*	1.00							

Continued

Table 4.27 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.07	-0.00	0.01	0.14*	0.20**	0.11*	0.03	0.54**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.05	0.05	0.04	0.10	0.18**	0.24**	0.12*	-0.12*	0.19**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.10*	0.03	0.00	0.00	0.05	0.10*	-0.02	0.04	0.11*	0.14**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.03	0.08	0.06	0.04	0.17**	0.17**	0.15**	0.09	0.10*	0.16**	0.08	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.08	-0.01	0.10	0.15**	0.15**	0.12*	0.05	0.17**	0.23**	0.19**	-0.01	0.17**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.03	-0.04	0.01	-0.03	0.17**	0.20**	0.14**	0.18**	0.11*	0.12*	-0.07	0.17**	0.22**	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.06	0.03	0.05	0.08	0.20**	0.18**	0.14**	0.14**	0.27**	0.27**	0.13*	0.12*	0.27**	0.20**	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Non-white sample. For the non-White (*N*=109) sample, students' perceived knowledge of word processors was statistically significantly related (r= -0.26, p<0.05) to their mean Excel grades during AU13. Conversely, none of the technology-related independent variables were significantly correlated with the FYES' mean MATLAB grades during AU13. Lastly, non-White students' perceived frequency of email use for communication with a TA/instructor was statistically significantly related (r= -0.21, p<0.05) to their mean SolidWorks grades during SP14. Tables 4.26 – 4.28 provide more detailed correlation results for the non-White sample.

Table 4.28

Correlations between AU13 independent variables and mean Excel grades for non-White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean Excel Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.26*	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.14	0.57**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.08	0.24*	0.23*	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.06	0.04	0.04	-0.12	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.07	0.04	-0.13	-0.09	-0.18	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.04	-0.14	0.06	-0.04	0.02	-0.02	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.03	-0.19	-0.07	0.07	-0.36**	-0.02	-0.02	1.00							

Continued

Table 4.28 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.08	-0.15	-0.17	-0.01	-0.24*	0.03	-0.08	0.47**	1.00						
Perceived Usefulness 6: Importance of E-readers	0.04	-0.04	0.02	-0.08	0.11	0.09	-0.12	-0.43**	0.27**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	0.02	0.02	-0.05	-0.07	-0.07	-0.02	0.07	0.06	0.19	-0.01	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.10	-0.11	0.03	-0.02	0.07	-0.03	-0.15	-0.11	0.04	-0.01	-0.09	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.04	-0.19	-0.06	-0.09	-0.01	0.05	-0.07	-0.13	-0.02	0.10	-0.04	0.29**	1.00		
Perceived Frequency of Use 3: Storage Medium	0.16	0.12	0.05	0.21	-0.22	-0.16	-0.16	0.09	-0.01	-0.11	0.07	-0.02	-0.19	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.11	0.24*	0.01	0.07	0.19	0.00	-0.14	-0.07	-0.03	-0.03	0.15	0.05	-0.00	0.22	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.29
Correlations between AU13 independent variables and mean MATLAB grades for non-White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean MATLAB Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.11	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.06	0.57**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.19	0.24*	0.23*	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.18	0.04	0.04	-0.12	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.04	0.04	-0.13	-0.09	-0.18	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.01	-0.14	0.06	-0.04	0.02	-0.02	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.13	-0.19	-0.07	0.07	-0.36**	-0.02	-0.02	1.00							

Continued

Table 4.29 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.04	-0.15	-0.17	-0.01	-0.24*	0.03	-0.08	0.47**	1.00						
Perceived Usefulness 6: Importance of E-readers	0.08	-0.04	0.02	-0.08	0.11	0.09	-0.12	-0.43**	0.27**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.02	0.02	-0.05	-0.07	-0.07	-0.02	0.07	0.06	0.19	-0.01	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.09	-0.11	0.03	-0.02	0.07	-0.03	-0.15	-0.11	0.04	-0.01	-0.09	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.01	-0.19	-0.06	-0.09	-0.01	0.05	-0.07	-0.13	-0.02	0.10	-0.04	0.29**	1.00		
Perceived Frequency of Use 3: Storage Medium	0.04	0.12	0.05	0.21	-0.22	-0.16	-0.16	0.09	-0.01	-0.11	0.07	-0.02	-0.19	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.01	0.24*	0.01	0.07	0.19	0.00	-0.14	-0.07	-0.03	-0.03	0.15	0.05	-0.00	0.22	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.30

Correlations between SP14 independent variables and mean SolidWorks grades for non-White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean SolidWorks Grade SP14	1.00														
Independent Variables															
∆ Perceived Knowledge 1: Word processors	-0.22	1.00													
∆ Perceived Knowledge 2: Spreadsheet software	-0.18	0.58**	1.00												
∆ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.14	0.31**	0.35**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.04	0.24*	0.28*	0.09	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.00	0.21	0.31*	0.25*	0.47**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	1.21	0.10	0.16	0.14	0.25*	0.31**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.02	-0.06	0.16	0.24	0.15	0.29**	0.13	1.00							

Continued

Table 4.30 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.18	-0.03	0.01	0.23	0.18	0.06	0.08	0.61**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.12	0.11	0.20	0.02	0.01	0.15	0.01	0.10	0.36**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.10	0.15	0.25	0.07	0.03	0.06	-0.27*	0.18	0.22*	0.26*	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.07	0.34**	0.34**	0.03	0.16	0.32**	0.09	0.15	0.08	0.28**	0.29**	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.21*	-0.01	0.17	0.02	0.25*	0.16	0.03	0.27*	0.35**	0.10	0.10	0.18	1.00		
Perceived Frequency of Use 3: Storage Medium	0.08	-0.02	-0.03	-0.14	0.04	0.13	0.13	0.17	0.04	0.08	0.01	0.27**	0.17	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.08	0.07	0.02	0.10	0.27**	0.23*	0.34**	0.34**	0.53**	0.41**	-0.05	0.30**	0.44**	0.26**	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

White sample. For the White (N=345) sample, none of the technology-related independent variables were significantly correlated with the FYES' mean Excel or MATLAB grades during AU13. However, White students' perceived frequency of using text/email notifications from the course management system was statistically significantly related (r= 0.15, p<0.05) to their mean MATLAB grades during AU13. Also, White participants perception about the extent to which technology makes learning more fun was statistically significantly related (r=0.14, p<0.05) to their mean SolidWorks grades during SP14. Tables 4.29 – 4.31 provide more detailed correlation results for the White sample.

Table 4.31

Correlations between AU13 independent variables and mean Excel grades for White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean Excel Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.04	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.01	0.41**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.02	0.12*	0.23*	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.00	0.03	0.04	-0.07	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.05	-0.04	-0.13*	-0.03	0.03	1.00									
Perceived Usefulness 3: Makes Learning More Fun	-0.03	-0.03	0.16**	-0.00	0.10	0.16**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.04	0.00	-0.01	0.00	-0.05	-0.02	-0.05	1.00							

Continued

Table 4.31 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.01	0.01	-0.01	0.02	0.04	-0.01	0.13^{*}	0.33^{**}	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.04	-0.01	-0.02	-0.00	0.04	0.02	0.05	-0.44^{**}	0.28^{**}	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.03	0.03	0.14^{*}	0.06	0.05	0.02	0.05	0.04	0.19^{**}	0.16^{**}	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.07	-0.06	0.08	0.00	-0.04	-0.01	0.08	-0.03	-0.06	0.02	0.04	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.09	-0.09	0.07	0.05	0.05	-0.02	0.03	-0.08	0.05	0.06	0.09	0.05	1.00		
Perceived Frequency of Use 3: Storage Medium	0.06	-0.01	-0.03	-0.17^{*}	-0.02	0.05	0.03	0.03	0.01	0.00	0.04	0.03	0.06	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.10	0.07	-0.07	-0.00	0.01	0.04	0.02	0.00	-0.09	-0.09	-0.04	0.03	-0.08	0.11	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.32

Correlations between AU13 independent variables and mean MATLAB grades for White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean MATLAB Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.04	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.03	0.41**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.06	0.12*	0.28**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.05	0.03	0.04	-0.07	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.01	-0.04	-0.13*	-0.03	0.03	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.01	-0.03	0.16**	-0.00	0.10	0.16**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.04	0.00	-0.01	0.00	-0.05	-0.02	-0.05	1.00							

Continued

Table 4.32 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.04	0.01	-0.01	0.02	0.04	-0.01	0.13*	0.33**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.01	-0.01	-0.02	-0.00	0.04	0.02	0.05	-0.44**	0.28**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.11	0.03	0.14*	0.06	0.05	0.02	0.05	0.04	0.19**	0.16**	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.06	-0.06	0.08	0.00	-0.04	-0.01	0.08	-0.03	-0.06	0.02	0.04	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.08	-0.09	0.07	0.05	0.05	-0.02	0.03	-0.08	0.05	0.06	0.09	0.05	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.07	-0.01	-0.03	-0.17*	-0.02	0.05	0.03	0.03	0.01	0.00	0.04	0.03	0.06	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.15*	0.07	-0.07	-0.00	0.01	0.04	0.02	0.00	-0.09	-0.09	-0.04	0.03	-0.08	0.11	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.33

Correlations between SP14 independent variables and mean SolidWorks grades for White sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean SolidWorks Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.09	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.02	0.58**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.02	0.25**	0.36**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.01	0.02	0.02	0.10	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.03	0.18**	0.10	0.04	0.52**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.14*	0.21**	0.14*	-0.02	0.52**	0.54**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.01	0.02	-0.03	0.06	0.17**	0.09	0.15*	1.00							

Continued

Table 4.33 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.01	0.02	-0.03	0.05	0.20**	0.13*	0.04	0.52**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.00	0.04	-0.00	0.10	0.22**	0.26**	0.17**	-0.17**	0.10	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.08	0.03	-0.03	-0.00	0.05	0.11	0.04	0.04	0.08	0.07	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.01	0.02	0.03	0.05	0.19**	0.14*	0.22**	0.10	0.10	0.13*	0.03	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.02	0.00	0.08	0.17**	0.11*	0.11	0.06	0.15*	0.14*	0.22**	-0.05	0.16**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.04	-0.03	0.01	0.03	0.19**	0.20**	0.15*	0.16**	0.10	0.13*	-0.10	0.15**	0.23**	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.00	0.05	0.07	0.05	0.16**	0.16**	0.12*	0.05	0.12	0.22**	0.16**	0.07	0.16**	0.14*	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Female sample. For the female (N=98) sample, students' perceived knowledge of spreadsheet software was statistically significantly related (r= -0.23, p<0.05) to their mean Excel grades during AU13. Female students' perceived knowledge of spreadsheet software was also statistically significantly related (r= -0.22, p<0.05) to their mean MATLAB grades during AU13. In addition, students' perceived knowledge of MATLAB, CAD and microcontrollers was statistically significantly related (r= 0.24, p<0.05) to their mean SolidWorks grades during SP14. Moreover, female students' perceived frequency of email use for communication with a TA/instructor was statistically significantly related (r= -0.28, p<0.01) to their mean SolidWorks grades during SP14. Tables 4.32 – 4.34 provide more detailed correlation results for the female sample.

Table 4. 34

Correlations between AU13 independent variables and mean Excel grades for female sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean Excel Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.04	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.23*	0.34**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.01	0.24*	0.39**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.02	-0.10	-0.01	-0.22	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.14	-0.20	-0.22	-0.06	0.07	1.00									
Perceived Usefulness 3: Makes Learning More Fun	-0.10	-0.17	0.12	-0.02	0.21	0.09	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.04	-0.04	-0.13	-0.04	-0.18	0.04	-0.08	1.00							

Continued

Table 4.34 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.07	-0.09	-0.19	-0.03	-0.11	-0.05	0.00	0.33**	1.00						
Perceived Usefulness 6: Importance of E-readers	0.14	-0.04	-0.08	-0.12	0.10	0.10	0.05	-0.53**	0.20	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.20	0.03	0.23*	0.01	0.19	-0.15	0.15	-0.13	0.22*	0.09	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.12	0.02	-0.02	-0.03	-0.10	0.12	-0.14	-0.07	0.08	0.28*	0.03	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.17	-0.25*	-0.01	-0.24*	0.02	-0.06	0.06	-0.04	0.08	0.14	0.02	0.08	1.00		
Perceived Frequency of Use 3: Storage Medium	0.15	0.06	-0.15	-0.19	0.01	0.18	0.01	0.01	-0.06	-0.05	0.06	0.04	-0.04	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.09	0.25*	-0.10	-0.08	0.02	0.05	-0.12	-0.07	-0.11	0.04	-0.07	0.20	-0.01	0.37**	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.35

Correlations between AU13 independent variables and mean MATLAB grades for female sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean MATLAB Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.03	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.22*	0.34**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.01	0.24*	0.39**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.03	-0.10	-0.01	-0.22	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.02	-0.20	-0.22	-0.06	0.07	1.00									
Perceived Usefulness 3: Makes Learning More Fun	-0.12	-0.17	0.12	-0.02	0.21	0.09	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.02	-0.04	-0.13	-0.04	-0.18	0.04	-0.08	1.00							

Continued

Table 4.35 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.12	-0.09	-0.19	-0.03	-0.11	-0.05	0.00	0.33^{**}	1.00						
Perceived Usefulness 6: Importance of E-readers	0.05	-0.04	-0.08	-0.12	0.10	0.10	0.05	-0.53^{**}	0.20	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.16	0.03	0.23^{*}	0.01	0.19	-0.15	0.15	-0.13	0.22^{*}	0.09	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.08	0.02	-0.02	-0.03	-0.10	0.12	-0.14	-0.07	0.09	0.28^{*}	0.03	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.14	-0.25^{*}	-0.01	-0.24^{*}	0.02	-0.06	0.06	-0.04	0.08	0.14	0.02	0.08	1.00		
Perceived Frequency of Use 3: Storage Medium	0.03	0.06	-0.15	-0.19	0.01	0.18	0.01	0.01	-0.06	-0.05	0.06	0.04	-0.04	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.21	0.25^{*}	-0.10	-0.08	0.02	0.05	-0.12	-0.07	-0.11	0.04	-0.07	0.20	-0.01	0.37^{**}	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.36

Correlations between SP14 independent variables and mean SolidWorks grades for female sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean SolidWorks Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	0.16	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.13	0.47**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.24*	0.08	0.15	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	-0.12	-0.13	0.05	0.06	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	0.15	0.19	0.14	-0.19	0.37**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.10	0.15	0.18	-0.09	0.43**	0.49**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.02	0.01	-0.10	-0.13	0.01	0.14	0.08	1.00							

Continued

Table 4.36 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.03	-0.05	-0.05	-0.04	0.15	0.12	0.06	0.45**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.11	-0.02	0.10	0.00	0.10	0.13	0.08	-0.27**	0.30**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	0.13	-0.06	0.06	-0.01	-0.14	0.06	-0.14	0.03	0.08	0.09	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.04	0.02	-0.03	-0.06	0.03	0.10	0.13	0.00	0.03	0.09	0.03	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.28**	-0.02	-0.08	0.04	0.06	-0.01	0.06	0.16	0.16	-0.01	-0.11	0.04	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.01	0.10	-0.02	0.14	0.19	0.20	0.20	0.29**	0.11	0.01	0.01	0.22*	0.17	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.01	-0.04	0.02	0.09	0.17	0.12	0.30**	0.13	0.35**	0.27*	0.06	0.02	0.06	0.27*	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Male sample. For the male (N=389) sample, none of the technology-related independent variables were significantly correlated with the FYES' mean Excel or MATLAB grades during AU13. However, male students' perceived knowledge of MATLAB, CAD and microcontrollers was statistically significantly related (r= 0.24, p<0.05) to their mean SolidWorks grades during SP14. Also, male students' students' perception about the extent to which technology makes learning more fun was statistically significantly related (r=0.15, p<0.01) to their mean SolidWorks grades during SP14. Furthermore, male students' perception about the importance of smartphones/cellphones to their academic success was statistically significantly related (r= -0.10, p<0.05) to their mean SolidWorks grades during SP14. Tables 4.35 – 4.37 provide more detailed correlation results for the male sample.

Table 4.37

Correlations between AU13 independent variables and mean Excel grades for male sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean Excel Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.09	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.00	0.52**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.03	0.14*	0.24**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.05	0.06	0.02	-0.05	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.04	0.02	-0.06	-0.05	-0.04	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.02	-0.05	0.10	-0.01	0.06	0.10	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.03	-0.04	0.02	0.03	-0.04	-0.02	-0.06	1.00							

Continued

Table 4.37 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.02	0.01	0.02	0.04	-0.02	0.00	0.08	0.35^{**}	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.06	-0.01	0.00	0.02	-0.00	-0.01	0.03	-0.44^{**}	0.31^{**}	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	0.01	0.03	0.04	0.02	-0.01	0.05	0.06	0.08	0.17^{**}	0.14^{*}	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	0.02	-0.09	0.09	-0.01	-0.00	-0.03	0.07	-0.04	-0.06	-0.04	0.02	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.03	-0.08	0.04	0.09	0.02	0.03	-0.02	-0.13^{*}	0.01	0.07	0.04	0.14^{**}	1.00		
Perceived Frequency of Use 3: Storage Medium	0.08	0.02	0.03	-0.05	-0.09	-0.03	0.01	0.01	0.02	0.01	0.04	0.02	0.02	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.09	0.09	-0.03	0.01	0.05	0.03	0.06	-0.03	-0.07	-0.09	0.05	0.02	-0.06	0.11	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.38

Correlations between AU13 independent variables and mean MATLAB grades for male sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean MATLAB Grade AU13	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.08	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	0.05	0.52**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	0.03	0.14*	0.24**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.10	0.06	0.02	-0.05	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.01	0.02	-0.06	-0.05	-0.04	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.05	-0.05	0.10	-0.01	0.06	0.10	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	0.01	-0.04	0.02	0.03	-0.04	-0.02	-0.06	1.00							

Continued

Table 4.38 continued

Perceived Usefulness 5: Importance of Tablets/iPads	0.04	0.01	0.02	0.04	-0.02	0.00	0.08	0.35**	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.01	-0.01	0.00	0.02	-0.00	-0.01	0.03	-0.44**	0.31**	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.06	0.03	0.04	0.02	-0.01	0.05	0.06	0.08	0.17**	0.14*	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.03	-0.09	0.09	-0.01	-0.00	-0.03	0.07	-0.04	-0.06	-0.04	0.02	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.04	-0.08	0.04	0.09	0.02	0.03	-0.02	-0.13*	0.01	0.07	0.04	0.14**	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.08	0.02	0.03	-0.05	-0.09	-0.03	0.01	0.01	0.02	0.01	0.04	0.02	0.02	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	0.08	0.09	-0.03	0.01	0.05	0.03	0.06	-0.03	-0.07	-0.09	0.05	0.02	-0.06	0.11	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.39

Correlations between SP14 independent variables and mean SolidWorks grades for male sample

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent Variables															
Mean SolidWorks Grade SP14	1.00														
Independent Variables															
Δ Perceived Knowledge 1: Word processors	-0.03	1.00													
Δ Perceived Knowledge 2: Spreadsheet software	-0.08	0.62**	1.00												
Δ Perceived Knowledge 3: MATLAB, CAD, MCC	-0.14*	0.32**	0.41**	1.00											
Perceived Usefulness 1: Easier to Get Help When Needed	0.01	0.14*	0.12	0.11	1.00										
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile	-0.02	0.14*	0.11	0.12	0.55**	1.00									
Perceived Usefulness 3: Makes Learning More Fun	0.15**	0.17**	0.11	0.03	0.46**	0.51**	1.00								
Perceived Usefulness 4: Importance of Desktops/Laptops	-0.02	-0.01	0.04	0.14*	0.22**	0.12*	0.14*	1.00							

Continued

Table 4.39 continued

Perceived Usefulness 5: Importance of Tablets/iPads	-0.08	0.02	0.03	0.18^{**}	0.20^{**}	0.12^{*}	0.02	0.57^{**}	1.00						
Perceived Usefulness 6: Importance of E-readers	-0.04	0.06	0.02	0.12	0.19^{**}	0.27^{**}	0.12^{*}	-0.07	0.16^{**}	1.00					
Perceived Usefulness 7: Importance of Smartphones/Cellphones	-0.15^{**}	0.05	-0.01	0.00	0.10	0.12^{*}	0.02	0.05	0.12^{*}	0.15^{**}	1.00				
Perceived Frequency of Use 1: Electronic Medium for Coursework	-0.04	0.07	0.08	0.06	0.21^{**}	0.19^{**}	0.16^{**}	0.12^{*}	0.12^{*}	0.18^{*}	0.10	1.00			
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor	-0.03	-0.01	0.13^{*}	0.17^{**}	0.17^{**}	0.14^{**}	0.04	0.18^{**}	0.26^{**}	0.24^{**}	0.01	0.20^{**}	1.00		
Perceived Frequency of Use 3: Storage Medium	-0.04	-0.08	0.01	-0.06	0.17^{**}	0.19^{**}	0.12^{*}	0.15^{*}	0.11	0.15^{**}	-0.10	0.16^{**}	0.23^{**}	1.00	
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System	-0.08	0.05	0.06	0.08	0.20^{**}	0.19^{**}	0.09	0.14^{*}	0.25^{**}	0.28^{**}	0.15^{*}	0.14^{**}	0.32^{**}	0.19^{**}	1.00

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Hierarchical Linear Regression Results

Aggregate sample. The first regression analysis involved students' survey data and mean MS Excel grades from the first semester of the academic year (i.e., AU13). Potentially confounding variables such as age, gender, ethnicity/race, admission classification, class rank, pre-major, Pell Grant and first-generation status were controlled for in the first block (i.e., model 1) of the regression test. Multiple independent variables representing FYES' (N=487) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between FYES' background characteristics and technology-related measures and their mean MS Excel grades during AU13, $F(23, 164) = 1.20$, $p = 0.26$, $R = 0.40$, $R^2 = 0.16$, adjusted $R^2 = 0.03$.

The second regression analysis involved students' survey data and mean MATLAB grades from the first semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between FYES' background characteristics and technology-related measures and their mean MATLAB grades during AU13, $F(23, 164) = 1.10$, $p = 0.35$, $R = 0.39$, $R^2 = 0.15$, adjusted $R^2 = 0.01$.

The third regression analysis included students' survey data and mean SolidWorks grades from the second semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis.

In model 1, participants' background traits proved to be statistically significant predictors of their mean SolidWorks grades in the second of two *Fundamentals of Engineering* courses, $F(9, 198) = 2.22$, $p < 0.05$, $R = 0.31$, $R^2 = 0.10$, adjusted $R^2 = 0.05$. Hence, FYES' background traits accounted for 10% of the variance in their mean SolidWorks grades during SP14. When holding all other background traits constant, for every one point increase in students' H.S. class rank, their mean SolidWorks grades during SP14 increase by 0.26 points. In model 2, results reveal no statistically significant relationship between FYES' background characteristics and technology-related measures and their mean SolidWorks grades during SP14, $F(23, 198) = 1.36$, $p = 0.14$, $R = 0.39$, $R^2 = 0.15$, adjusted $R^2 = 0.04$. Tables 4.38 - 4.40 contain more detailed hierarchical linear regression results for the aggregate sample.

Table 4.40

Regression results for mean MS Excel grades, aggregate sample (N=487)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	77.96	7.75		10.06	72.02	12.81		5.62***
Age 18-19	7.46	5.08	0.14	1.47	8.75	5.31	0.17	1.65
Admission: New Freshman	-2.09	4.87	-0.06	-0.43	-1.18	5.09	-0.03	-0.23
Rank: Freshman	0.58	3.22	0.02	0.18	-0.60	3.44	-0.02	-0.17
Pre-Major: Engineering	-0.85	3.94	-0.02	-0.22	0.01	4.13	0.00	0.00
Gender: Female	-2.77	2.38	-0.09	-1.16	-2.55	2.48	-0.08	-1.03
Ethnicity: White	3.04	2.45	0.10	1.24	2.10	2.58	0.07	0.82
Pell Grant Recipient	-17.64	6.68	-0.23	-2.64**	-17.40	7.00	-0.23	-2.49*
First Generation Student	2.06	2.75	0.06	0.75	2.34	3.01	0.07	0.78
HS Rank	-0.01	0.08	-0.01	-0.16	0.02	0.09	0.02	0.21
Δ Perceived Knowledge 1: Word processors					-0.73	1.14	-0.06	-0.64
Δ Perceived Knowledge 2: Spreadsheet software					0.20	1.09	0.02	0.18
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.61	0.94	-0.06	-0.64
Perceived Usefulness 1: Easier to Get Help When Needed					-0.84	1.24	-0.06	-0.68
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					1.81	2.23	0.07	0.81
Perceived Usefulness 3: Makes Learning More Fun					-0.95	1.25	-0.06	-0.76
Perceived Usefulness 4: Importance of Desktops/Laptops					0.72	0.80	0.10	0.91
Perceived Usefulness 5: Importance of Tablets/iPads					0.71	0.85	0.08	0.84
Perceived Usefulness 6: Importance of E-readers					-0.12	0.75	-0.02	-0.16

Continued

Table 4.40 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.33	0.97	-0.03	-0.34
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.18	1.15	0.01	0.16
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-1.98	1.40	-0.12	-1.41
Perceived Frequency of Use 3: Storage Medium					0.90	1.04	0.07	0.86
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.94	1.07	0.07	0.88
R	0.31				0.40			
R^2	0.10				0.16			
Adj. R^2	0.04				0.03			
ΔR^2	0.10				0.07			
Model	$F(9, 164) = 1.81, p = 0.07$				$F(23, 164) = 1.20, p = 0.26$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.41

Hierarchical linear regression results for mean MATLAB grades, aggregate sample (N = 487)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	84.63	6.00		14.11	85.36	9.84		8.68
Age 18-19	5.35	3.93	0.13	1.36	5.42	4.08	0.13	1.33
Admission: New Freshman	-0.37	3.77	-0.01	-0.10	1.43	3.91	0.05	0.37
Rank: Freshman	-1.86	2.49	-0.08	-0.75	-2.75	2.64	-0.12	-1.04
Pre-Major: Engineering	-1.65	3.05	-0.06	-0.54	-1.47	3.17	-0.05	-0.46
Gender: Female	0.24	1.84	0.01	0.13	-0.07	1.90	-0.00	-0.04
Ethnicity: White	2.01	1.90	0.08	1.06	1.10	1.98	0.05	0.56
Pell Grant Recipient	-12.03	5.17	-0.20	-2.33*	-11.51	5.38	-0.20	-2.14
First Generation Student	1.90	2.13	0.07	0.89	2.92	2.31	0.11	1.26
HS Rank	-0.02	0.06	-0.02	-0.23	0.00	0.07	0.00	0.02
Δ Perceived Knowledge 1: Word processors					-0.65	0.88	-0.07	-0.74
Δ Perceived Knowledge 2: Spreadsheet software					0.51	0.84	0.06	0.62
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.19	0.73	-0.02	-0.26
Perceived Usefulness 1: Easier to Get Help When Needed					-0.21	0.95	-0.02	-0.22
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.79	1.71	0.04	0.46
Perceived Usefulness 3: Makes Learning More Fun					-0.59	0.96	-0.05	-0.61
Perceived Usefulness 4: Importance of Desktops/Laptops					0.92	0.61	0.16	1.50
Perceived Usefulness 5: Importance of Tablets/iPads					-0.22	0.65	-0.03	-0.34
Perceived Usefulness 6: Importance of E-readers					0.55	0.58	0.10	0.95

Continued

Table 4.41 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-1.70	0.75	-0.19	-2.28
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.11	0.88	-0.01	-0.13
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.70	1.08	-0.05	-0.65
Perceived Frequency of Use 3: Storage Medium					-0.77	0.80	-0.08	-0.96
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.51	0.82	0.15	1.84
R	0.26				0.39			
R^2	0.07				0.15			
Adj. R^2	0.02				0.01			
ΔR^2	0.07				0.08			
Model	$F(9, 164) = 1.28$, $p = 0.25$				$F(23, 164) = 1.10$, $p = 0.35$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.42

Hierarchical linear regression results for mean SolidWorks grades, aggregate sample (N = 487)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*B*	*t*
Constant	73.21	6.70		10.93***	73.16	8.87		8.25***
Age 18-19	-6.35	4.90	-0.14	-1.30	-7.49	5.15	-0.16	-1.46
Admission: New Freshman	4.45	4.13	0.13	1.08	5.62	4.25	0.17	1.32
Rank: Freshman	-1.57	2.31	-0.06	-0.68	-1.59	2.36	-0.06	-0.67
Pre-Major: Engineering	0.47	3.46	0.01	0.14	0.37	3.71	0.01	0.10
Gender: Female	-3.37	1.90	-0.12	-1.77	-4.32	2.07	-0.16	-2.08*
Ethnicity: White	-0.04	2.13	-0.00	-0.02	-0.51	2.26	-0.02	-0.23
Pell Grant Recipient	5.58	5.60	0.09	1.00	6.75	6.01	0.11	1.12
First Generation Student	-2.02	2.24	-0.06	-0.90	-2.30	2.37	-0.07	-0.97
HS Rank	0.26	0.07	0.27	3.53**	0.23	0.08	0.24	2.95**
Δ Perceived Knowledge 1: Word processors					-0.48	1.02	-0.04	-0.47
Δ Perceived Knowledge 2: Spreadsheet software					-0.04	0.97	-0.00	-0.05
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.04	0.79	-0.00	-0.06
Perceived Usefulness 1: Easier to Get Help When Needed					-3.10	1.43	-0.21	-2.17*
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					2.46	1.76	0.13	1.40
Perceived Usefulness 3: Makes Learning More Fun					0.65	1.33	0.04	0.49
Perceived Usefulness 4: Importance of Desktops/Laptops					-0.16	0.72	-0.02	-0.22
Perceived Usefulness 5: Importance of Tablets/iPads					0.32	0.86	0.04	0.38
Perceived Usefulness 6: Importance of E-readers					-0.51	0.67	-0.06	-0.75

Continued

Table 4.42 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					1.43	0.99	0.11	1.45
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.17	0.93	-0.01	-0.18
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.61	1.18	-0.04	-0.51
Perceived Frequency of Use 3: Storage Medium					-0.04	0.80	-0.00	-0.05
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					-0.27	0.98	-0.02	-0.28
R	0.31				0.39			
R^2	0.10				0.15			
Adj. R^2	0.05				0.04			
ΔR^2	0.10				0.06			
Model	$F(9, 198) = 2.22, p = 0.02$				$F(23, 198) = 1.36, p = 0.14$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Non-white sample. The fourth regression analysis involved non-White students' survey data and mean MS Excel grades from the first semester of the academic year (i.e., AU13). Potentially confounding variables such as age, gender, ethnicity/race, admission classification, class rank, pre-major, Pell Grant and first-generation status were controlled for in the first block (i.e., model 1) of the regression test. Multiple independent variables representing FYES' (N=109) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between non-White FYES' background characteristics and technology-related measures and their mean MS Excel grades during AU13, $F(22, 36) = 1.23$, $p = 0.35$, $R = 0.81$, $R^2 = 0.66$, adjusted $R^2 = 0.12$.

The fifth regression analysis involved non-White students' survey data and mean MATLAB grades from the first semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' (N=109) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Findings reveal no statistically significant relationship between non-White FYES' background characteristics and technology-related measures and their mean MATLAB grades during AU13, $F(22, 36) = 0.84$, $p = 0.65$, $R = 0.76$, $R^2 = 0.57$, adjusted $R^2 = -0.11$.

The sixth regression analysis included non-White students' survey data and mean SolidWorks grades from the second semester of the academic year (i.e., SP14).

Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' (N=109) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between non-White FYES' background characteristics and technology-related measures and their mean SolidWorks grades during SP14, $F(22, 36) = 0.74$, $p = 0.75$, $R = 0.73$, $R^2 = 0.54$, adjusted $R^2 = -0.19$. Tables 4.41 - 4.43 contain more detailed hierarchical linear regression results for the non-White sample.

Table 4.43

Regression results for mean MS Excel grades, non-White sample (N=109)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	78.66	29.54		2.66*	23.14	54.37		0.43
Age 18-19	16.67	19.18	0.31	0.87	15.90	21.23	0.29	0.75
Admission: New Freshman	25.66	24.63	0.59	1.04	19.48	27.33	0.45	0.71
Rank: Freshman	6.21	9.98	0.18	0.62	8.10	12.37	0.23	0.66
Pre-Major: Engineering	-29.19	27.74	-0.73	-1.05	-39.05	28.79	-0.97	-1.36
Gender: Female	-0.22	6.34	-0.01	-0.03	-0.67	7.52	-0.02	-0.09
Pell Grant Recipient	3.56	24.13	0.04	0.15	-0.46	28.11	-0.01	-0.02
First Generation Student	4.89	7.59	0.14	0.64	3.47	8.75	0.10	0.40
HS Rank	-0.19	0.31	-0.12	-0.62	-0.23	0.34	-0.15	-0.69
Δ Perceived Knowledge 1: Word processors					-0.12	4.47	-0.01	-0.03
Δ Perceived Knowledge 2: Spreadsheet software					-2.41	3.77	-0.19	-0.64
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-7.16	3.78	-0.57	-1.90
Perceived Usefulness 1: Easier to Get Help When Needed					4.03	6.43	0.20	0.63
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					8.51	8.45	0.25	1.01
Perceived Usefulness 3: Makes Learning More Fun					5.06	3.55	0.33	1.43
Perceived Usefulness 4: Importance of Desktops/Laptops					5.71	3.59	0.67	1.59
Perceived Usefulness 5: Importance of Tablets/iPads					-5.49	3.96	-0.56	-1.39
Perceived Usefulness 6: Importance of E-readers					5.08	3.29	0.60	1.55

Continued

Table 4.43 continued

Variables	Model 1 *B*	*SE*	*β*	*t*	Model 2 *B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.99	3.70	-0.06	-0.27
Perceived Frequency of Use 1: Electronic Medium for Coursework					3.18	4.10	0.21	0.78
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-3.53	3.52	-0.21	-1.04
Perceived Frequency of Use 3: Storage Medium					5.70	2.94	0.42	1.94
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					4.04	3.32	0.28	1.22
R	0.32				0.81			
R^2	0.10				0.66			
Adj. R^2	-0.16				0.12			
ΔR^2	0.10				0.56			
Model	$F(8, 36) = 0.39, p = 0.92$				$F(22, 36) = 1.23, p = 0.35$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.44

Regression results for mean MATLAB grades, non-White sample (N=109)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	65.81	19.62		3.35**	58.50	44.36		1.32
Age 18-19	13.25	12.74	0.34	1.04	0.91	17.32	0.02	0.05
Admission: New Freshman	11.84	16.36	0.38	0.72	-1.08	22.30	-0.03	-0.05
Rank: Freshman	-7.45	6.63	-0.30	-1.13	-9.35	10.09	-0.37	-0.93
Pre-Major: Engineering	-8.85	18.43	-0.30	-0.48	-2.13	23.48	-0.07	-0.09
Gender: Female	-3.80	4.21	-0.16	-0.90	-5.59	6.13	-0.23	-0.91
Pell Grant Recipient	-15.72	16.03	-0.24	-0.98	-13.48	22.93	-0.20	-0.59
First Generation Student	6.53	5.04	0.25	1.30	9.19	7.14	0.35	1.29
HS Rank	0.12	0.21	0.10	0.57	0.04	0.27	0.03	0.14
Δ Perceived Knowledge 1: Word processors					-2.71	3.65	-0.29	-0.74
Δ Perceived Knowledge 2: Spreadsheet software					2.10	3.08	0.22	0.68
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-5.65	3.08	-0.61	-1.83
Perceived Usefulness 1: Easier to Get Help When Needed					5.81	5.25	0.39	1.11
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					3.96	6.89	0.16	0.57
Perceived Usefulness 3: Makes Learning More Fun					-0.08	2.89	-0.01	-0.03
Perceived Usefulness 4: Importance of Desktops/Laptops					1.98	2.93	0.32	0.68
Perceived Usefulness 5: Importance of Tablets/iPads					-3.00	3.23	-0.42	-0.93
Perceived Usefulness 6: Importance of E-readers					3.17	2.68	0.51	1.18

Continued

Table 4.44 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.65	3.01	-0.06	-0.22
Perceived Frequency of Use 1: Electronic Medium for Coursework					-1.16	3.34	-0.11	-0.35
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					0.75	2.87	0.06	0.26
Perceived Frequency of Use 3: Storage Medium					1.58	2.40	0.16	0.66
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.52	2.70	0.05	0.19
R	0.50				0.76			
R^2	0.25				0.57			
Adj. R^2	0.03				-0.11			
ΔR^2	0.25				0.32			
Model	$F(8, 36) = 1.15, p = 0.36$				$F(22, 36) = 0.84, p = 0.65$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.45

Regression results for mean SolidWorks grades, non-White sample (N=109)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	94.92	12.32		7.70***	84.81	26.62		3.19**
Age 18-19	19.29	9.65	-0.66	-2.00	-14.39	12.76	-0.49	-1.13
Admission: New Freshman	24.9	15.67	1.01	1.59	35.85	20.04	1.45	1.79
Rank: Freshman	-3.46	6.05	-0.16	-0.57	-0.98	8.18	-0.05	-0.12
Pre-Major: Engineering	-8.32	12.07	-0.31	-0.69	-31.61	17.22	-1.19	-1.84
Gender: Female	-0.22	3.92	-0.01	-0.06	-1.50	4.86	-0.07	-0.31
Pell Grant Recipient	1.34	12.19	0.02	0.11	-1.43	14.51	-0.03	-0.10
First Generation Student	-3.63	3.82	-0.18	-0.95	-2.08	5.15	-0.10	-0.40
HS Rank	0.04	0.13	0.05	0.27	0.01	0.18	0.02	0.06
Δ Perceived Knowledge 1: Word processors					1.50	2.56	0.18	0.59
Δ Perceived Knowledge 2: Spreadsheet software					-6.87	3.06	-0.86	-2.24*
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					1.18	2.14	0.16	0.55
Perceived Usefulness 1: Easier to Get Help When Needed					1.82	4.24	0.15	0.43
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					3.09	4.13	0.21	0.75
Perceived Usefulness 3: Makes Learning More Fun					-0.38	3.37	-0.03	-0.11
Perceived Usefulness 4: Importance of Desktops/Laptops					0.64	2.57	0.10	0.25
Perceived Usefulness 5: Importance of Tablets/iPads					-1.64	3.10	-0.30	-0.53
Perceived Usefulness 6: Importance of E-readers					-0.40	1.90	-0.06	-0.21

Continued

Table 4.45 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					1.69	3.41	0.14	0.49
Perceived Frequency of Use 1: Electronic Medium for Coursework					-1.73	3.36	-0.16	-0.52
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					1.15	4.21	0.11	0.27
Perceived Frequency of Use 3: Storage Medium					0.58	2.36	0.07	0.24
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.15	4.28	0.13	0.27
R	0.43				0.73			
R^2	0.18				0.54			
Adj. R^2	-0.05				-0.19			
ΔR^2	0.18				0.35			
Model	$F(8, 36) = 0.79$, $p = 0.62$				$F(22, 36) = 0.74$, $p = 0.75$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

White sample. The seventh regression analysis involved White students' survey data and mean MS Excel grades from the first semester of the academic year (i.e., AU13). Potentially confounding variables such as age, gender, ethnicity/race, admission classification, class rank, pre-major, Pell Grant and first-generation status were controlled for in the first block (i.e., model 1) of the regression test. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis.

In model 1, White participants' background traits proved to be statistically significant predictors of their mean Excel grades during AU13, $F(8, 127) = 2.14$, $p < 0.05$, $R = 0.35$, $R^2 = 0.13$, adjusted $R^2 = 0.07$. Hence, White students' background traits accounted for 13% of the variance in their mean Excel grades during AU13. When holding all other background traits constant, White students who receive a Pell grant earn mean Excel grades during AU13 that are 20.76 points lower than those who did not receive such financial aid. In model 2, results reveal no statistically significant relationship between White FYES' background characteristics and technology-related measures and their mean MS Excel grades during AU13, $F(22, 127) = 1.20$, $p = 0.27$, $R = 0.45$, $R^2 = 0.20$, adjusted $R^2 = 0.03$.

The eighth regression analysis involved White students' survey data and mean MATLAB grades from the first semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Findings reveal no statistically significant relationship between White FYES' background characteristics and technology-related measures and their mean MATLAB grades during AU13, $F(22, 127) = 1.17$, $p = 0.30$, $R = 0.44$, $R^2 = 0.20$, adjusted $R^2 = 0.03$.

The ninth regression analysis included White students' survey data and mean SolidWorks grades from the second semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis.

In model 1, White participants' background traits proved to be statistically significant predictors of their mean SolidWorks grades during SP14, $F(8, 161) = 2.32$, $p < 0.05$, $R = 0.33$, $R^2 = 0.11$, adjusted $R^2 = 0.06$. Hence, White students' background traits accounted for 11% of the variance in their mean SolidWorks grades during SP14. When holding all other background traits constant, for every one point increase in White students' H.S. class rank, their mean SolidWorks grades during SP14 increase by 0.32 points. In model 2, results reveal no statistically significant relationship between White FYES' background characteristics and technology-related measures and their mean SolidWorks grades during SP14, $F(22, 161) = 1.48$, $p = 0.09$, $R = 0.44$, $R^2 = 0.19$, adjusted $R^2 = 0.06$. Tables 4.44 -4.46 contain more detailed hierarchical linear regression results for the White sample.

Table 4. 46

Regression results for mean MS Excel grades, White sample (N=345)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	79.91	7.71		10.37***	84.86	12.96		6.55***
Age 18-19	10.50	5.69	0.20	1.84	9.98	6.21	0.19	1.61
Admission: New Freshman	-4.67	5.17	-0.14	-0.90	-2.12	5.57	-0.06	-0.38
Rank: Freshman	0.38	3.40	0.01	0.11	-0.27	3.80	-0.01	-0.07
Pre-Major: Engineering	-0.13	3.99	-0.00	-0.03	0.69	4.24	0.02	0.16
Gender: Female	-3.17	2.57	-0.11	-1.24	-3.50	2.75	-0.12	-1.27
Pell Grant Recipient	-20.76	6.92	-0.29	-3.00**	-17.62	7.52	-0.24	-2.34*
First Generation Student	-0.11	3.09	-0.00	-0.04	0.12	3.42	0.00	0.04
HS Rank	-0.01	0.08	-0.01	-0.10	0.01	0.09	0.01	0.07
Δ Perceived Knowledge 1: Word processors					0.20	1.24	0.02	0.16
Δ Perceived Knowledge 2: Spreadsheet software					-0.11	1.19	-0.01	-0.09
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.01	1.07	-0.00	-0.01
Perceived Usefulness 1: Easier to Get Help When Needed					-0.79	1.30	-0.06	-0.60
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.29	2.37	0.01	0.12
Perceived Usefulness 3: Makes Learning More Fun					-2.05	1.41	-0.14	-1.45
Perceived Usefulness 4: Importance of Desktops/Laptops					0.62	0.88	0.09	0.71
Perceived Usefulness 5: Importance of Tablets/iPads					1.10	0.89	0.13	1.23
Perceived Usefulness 6: Importance of E-readers					-0.29	0.82	-0.04	-0.36

Continued

Table 4.46 continued

Variables	Model 1 *B*	Model 1 *SE*	Model 1 *β*	Model 1 *t*	Model 2 *B*	Model 2 *SE*	Model 2 *β*	Model 2 *t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-0.49	1.08	-0.05	-0.45
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.79	1.29	-0.06	-0.61
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-1.39	1.59	-0.08	-0.87
Perceived Frequency of Use 3: Storage Medium					0.03	1.21	0.00	0.03
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					0.46	1.17	0.04	0.40
R	0.35				0.45			
R^2	0.13				0.20			
Adj. R^2	0.07				0.03			
ΔR^2	0.13				0.08			
Model	$F(8, 127) = 2.14$, $p = 0.04$				$F(22, 127) = 1.20$, $p = 0.27$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.47

Regression results for mean MATLAB grades, White sample (N=345)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	88.89	6.20		14.35***	92.66	10.11		9.16***
Age 18-19	7.31	4.58	0.18	1.60	4.67	4.84	0.12	0.96
Admission: New Freshman	-2.94	4.16	-0.11	-0.71	1.52	4.34	0.06	0.35
Rank: Freshman	0.07	2.73	0.00	0.02	-0.48	2.97	-0.02	-0.16
Pre-Major: Engineering	-2.26	3.21	-0.08	-0.73	-1.83	3.31	-0.06	-0.55
Gender: Female	1.73	2.07	0.08	0.84	0.85	2.15	0.04	0.39
Pell Grant Recipient	-10.49	5.56	-0.19	-1.89	-6.68	5.87	-0.12	-1.14
First Generation Student	-0.43	2.49	-0.02	-0.17	0.37	2.67	0.01	0.14
HS Rank	-0.05	0.07	-0.07	-0.69	-0.05	0.07	-0.07	-0.63
Δ Perceived Knowledge 1: Word processors					0.11	0.97	0.01	0.12
Δ Perceived Knowledge 2: Spreadsheet software					-0.27	0.93	-0.03	-0.29
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					0.72	0.83	0.09	0.87
Perceived Usefulness 1: Easier to Get Help When Needed					-0.66	1.02	-0.06	-0.65
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.01	1.85	0.00	0.00
Perceived Usefulness 3: Makes Learning More Fun					-0.60	1.10	-0.05	-0.54
Perceived Usefulness 4: Importance of Desktops/Laptops					0.98	0.69	0.18	1.43
Perceived Usefulness 5: Importance of Tablets/iPads					0.24	0.69	0.04	0.34
Perceived Usefulness 6: Importance of E-readers					0.24	0.64	0.04	0.37

Continued

Table 4.47 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-1.19	0.84	-0.14	-1.42
Perceived Frequency of Use 1: Electronic Medium for Coursework					-1.33	1.01	-0.13	-1.32
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.81	1.24	-0.06	-0.65
Perceived Frequency of Use 3: Storage Medium					-0.64	0.94	-0.06	-0.68
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					2.04	0.91	0.21	2.24^{*}
R	0.26				0.44			
R^2	0.07				0.20			
Adj. R^2	0.00				0.03			
ΔR^2	0.07				0.13			
Model	$F(8, 127) = 1.06$, $p = 0.40$				$F(22, 127) = 1.17$, $p = 0.30$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.48

Regression results for mean SolidWorks grades, White sample (N=345)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	67.69	8.00		8.46***	68.44	9.86		6.94***
Age 18-19	-4.19	5.99	-0.08	-0.70	-5.49	6.58	-0.11	-0.84
Admission: New Freshman	3.42	4.49	0.10	0.76	5.76	4.61	0.16	1.25
Rank: Freshman	-1.85	2.57	-0.07	-0.72	-2.17	2.62	-0.08	-0.83
Pre-Major: Engineering	-0.19	3.85	-0.01	-0.05	-0.42	4.07	-0.01	-0.10
Gender: Female	-3.93	2.18	-0.14	-1.80	-5.74	2.44	-0.20	-2.35*
Pell Grant Recipient	7.41	6.58	0.11	1.13	9.67	7.16	0.15	1.35
First Generation Student	-1.25	2.73	-0.04	-0.46	-1.11	2.88	-0.03	-0.39
HS Rank	0.32	0.09	0.31	3.64***	0.27	0.10	0.26	2.85**
Δ Perceived Knowledge 1: Word processors					-0.78	1.21	-0.06	-0.64
Δ Perceived Knowledge 2: Spreadsheet software					1.00	1.12	0.09	0.89
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.03	0.94	-0.00	-0.03
Perceived Usefulness 1: Easier to Get Help When Needed					-4.69	1.66	-0.30	-2.83**
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					2.24	2.09	0.11	1.07
Perceived Usefulness 3: Makes Learning More Fun					1.99	1.60	0.13	1.24
Perceived Usefulness 4: Importance of Desktops/Laptops					0.04	0.81	0.01	0.06
Perceived Usefulness 5: Importance of Tablets/iPads					-0.06	0.99	-0.01	-0.06
Perceived Usefulness 6: Importance of E-readers					-0.04	0.78	-0.01	-0.05

Continued

Table 4.48 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					1.39	1.13	0.11	1.23
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.03	1.04	0.00	0.03
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.80	1.35	-0.05	-0.60
Perceived Frequency of Use 3: Storage Medium					-0.04	0.93	-0.00	-0.04
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					-0.70	1.08	-0.06	-0.64
R	0.33				0.44			
R^2	0.11				0.19			
Adj. R^2	0.06				0.06			
ΔR^2	0.11				0.08			
Model	$F(8, 161) = 2.32$, $p = 0.02$				$F(22, 161) = 1.48$, $p = 0.09$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Female sample. The tenth regression analysis involved female students' survey data and mean MS Excel grades from the first semester of the academic year (i.e., AU13). Potentially confounding variables such as age, gender, ethnicity/race, admission classification, class rank, pre-major, Pell Grant and first-generation status were controlled for in the first block (i.e., model 1) of the regression test. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. In model 1, female participants' background traits proved to be statistically significant predictors of their mean Excel grade during AU13, $F(8, 40) = 3.03$, $p < 0.05$, $R = 0.66$, $R^2 = 0.43$, adjusted $R^2 = 0.29$. So, female students' background traits account for 43% of the variance in their mean Excel grades during the first of two *Fundamentals of Engineering* courses. When holding all other background traits constant, students who receive a Pell grant earn mean Excel grades during AU13 that are 67.4 points lower than those who did not receive such financial aid. However, in model 2, results reveal no statistically significant relationship between female FYES' background characteristics and technology-related measures and their mean Excel grade during AU13, $F(22, 40) = 1.22$, $p = 0.34$, $R = 0.77$, $R^2 = 0.60$, adjusted $R^2 = 0.11$.

The eleventh regression analysis involved female students' survey data and mean MATLAB grades from the first semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Findings reveal no statistically significant relationship between female FYES' background characteristics and technology-related measures and their mean MATLAB grades during AU13, $F(22, 40) = 1.10$, $p = 0.42$, $R = 0.76$, $R^2 = 0.57$, adjusted $R^2 = 0.05$.

The twelfth regression analysis included female students' survey data and mean SolidWorks grades from the second semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. In model 2, the age variable dropped out and was excluded from the analysis to avoid computational problems and because it added little information to the model (Stockburger, 1998).

In model 1, female participants' background traits proved to be statistically significant predictors of their mean SolidWorks grades during SP14, $F(7, 49) = 2.71$, $p < 0.05$, $R = 0.56$, $R^2 = 0.31$, adjusted $R^2 = 0.20$. So, female students' background traits account for 31% of the variance in their mean SolidWorks grades during the second of two *Fundamentals of Engineering* courses. When holding all other background traits constant, for every one point increase in female students' H.S. class rank, their mean SolidWorks grades during SP14 increase by 0.78 points. However, in model 2, results reveal no statistically significant relationship between female FYES' background characteristics and technology-related measures and their mean SolidWorks grades during SP14, $F(21, 49) = 1.68$, $p = 0.10$, $R = 0.75$, $R^2 = 0.56$, adjusted $R^2 = 0.23$. Tables 4.47 - 4.49 contain more detailed hierarchical linear regression results for the female sample.

Table 4.49

Regression results for mean MS Excel grades, female sample (N=98)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	84.16	23.41		3.60***	83.95	39.82		2.11*
Age 18-19	-3.20	14.53	-0.05	-0.22	-5.19	18.94	-0.08	-0.27
Admission: New Freshman	-0.56	8.75	-0.02	-0.06	-0.58	11.57	-0.02	-0.05
Rank: Freshman	-1.79	5.90	-0.06	-0.30	-3.24	8.86	-0.11	-0.37
Pre-Major: Engineering	7.35	6.78	0.19	1.09	6.96	8.83	0.18	0.79
Ethnicity: White	2.73	4.68	0.08	0.58	1.10	8.10	0.03	0.14
Pell Grant Recipient	-67.40	17.76	-0.71	-3.80**	-65.60	25.52	-0.69	-2.57*
First Generation Student	-3.28	5.94	-0.08	-0.55	-4.46	8.38	-0.11	-0.53
HS Rank	-0.05	0.24	-0.03	-0.20	0.19	0.39	0.13	0.48
Δ Perceived Knowledge 1: Word processors					0.18	3.41	0.01	0.05
Δ Perceived Knowledge 2: Spreadsheet software					1.16	2.65	0.10	0.44
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					0.20	2.45	0.02	0.08
Perceived Usefulness 1: Easier to Get Help When Needed					-1.84	3.88	-0.11	-0.47
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.28	5.07	0.01	0.06
Perceived Usefulness 3: Makes Learning More Fun					-1.25	2.68	-0.08	-0.47
Perceived Usefulness 4: Importance of Desktops/Laptops					1.03	2.45	0.12	0.42
Perceived Usefulness 5: Importance of Tablets/iPads					-2.65	2.16	-0.25	-1.22
Perceived Usefulness 6: Importance of E-readers					2.46	2.22	0.30	1.11

Continued

Table 4.49 continued

Variables	Model 1 *B*	Model 1 *SE*	Model 1 *β*	Model 1 *t*	Model 2 *B*	Model 2 *SE*	Model 2 *β*	Model 2 *t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-3.72	3.12	-0.30	-1.20
Perceived Frequency of Use 1: Electronic Medium for Coursework					-2.46	2.86	-0.16	-0.86
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					1.24	3.41	0.08	0.36
Perceived Frequency of Use 3: Storage Medium					0.82	3.39	0.05	0.24
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.03	3.17	0.06	0.33
R	0.66				0.77			
R^2	0.43				0.60			
Adj. R^2	0.29				0.11			
ΔR^2	0.43				0.17			
Model	$F(8, 40) = 3.03$, $p = 0.01$				$F(22, 40) = 1.22$, $p = 0.34$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.50

Regression results for mean MATLAB grades, female sample (N=98)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	87.94	18.52		4.75^{***}	80.34	28.84		2.79^{*}
Age 18-19	7.35	11.49	0.15	0.64	3.03	13.72	0.06	0.22
Admission: New Freshman	1.52	6.92	0.06	0.22	-0.87	8.38	-0.03	-0.10
Rank: Freshman	0.02	4.67	0.00	0.00	0.45	6.42	0.02	0.07
Pre-Major: Engineering	0.01	5.36	0.00	0.00	2.60	6.39	0.10	0.41
Ethnicity: White	6.81	3.70	0.28	1.84	2.38	5.87	0.10	0.41
Pell Grant Recipient	-24.32	14.05	-0.36	-1.73	-26.57	18.48	-0.40	-1.44
First Generation Student	0.42	4.70	0.01	0.09	-2.42	6.07	-0.08	-0.40
HS Rank	-0.16	0.19	-0.15	-0.81	0.02	0.29	0.02	0.06
Δ Perceived Knowledge 1: Word processors					-2.83	2.47	-0.27	-1.15
Δ Perceived Knowledge 2: Spreadsheet software					-0.05	1.92	-0.01	-0.03
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					2.01	1.78	0.25	1.13
Perceived Usefulness 1: Easier to Get Help When Needed					-0.34	2.81	-0.03	-0.12
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					-0.69	3.67	-0.04	-0.19
Perceived Usefulness 3: Makes Learning More Fun					-0.61	1.94	-0.06	-0.31
Perceived Usefulness 4: Importance of Desktops/Laptops					0.79	1.78	0.13	0.45
Perceived Usefulness 5: Importance of Tablets/iPads					-2.33	1.57	-0.31	-1.49
Perceived Usefulness 6: Importance of E-readers					1.85	1.61	0.32	1.15

Continued

Table 4.50 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-1.59	2.26	-0.18	-0.70
Perceived Frequency of Use 1: Electronic Medium for Coursework					1.05	2.07	0.10	0.51
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					0.19	2.47	0.02	0.08
Perceived Frequency of Use 3: Storage Medium					0.93	2.46	0.08	0.38
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					3.32	2.29	0.28	1.45
R	0.53				0.76			
R^2	0.28				0.57			
Adj. R^2	0.10				0.05			
ΔR^2	0.28				0.29			
Model	$F(8, 40) = 1.55$, $p = 0.18$				$F(22, 40) = 1.10$, $p = 0.42$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.51

Regression results for SolidWorks grades, female sample (N=98)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	18.94	18.07		1.05	5.13	28.65		0.18
Admission: New Freshman	1.10	8.85	0.02	0.12	11.94	11.06	0.26	1.08
Rank: Freshman	-2.49	5.50	-0.07	-0.45	-2.44	5.99	-0.07	-0.41
Pre-Major: Engineering	3.82	7.77	0.08	0.49	-6.21	8.87	-0.13	-0.70
Ethnicity: White	-1.86	5.42	-0.05	-0.34	0.97	6.45	0.02	0.15
Pell Grant Recipient	16.77	12.78	0.21	1.31	29.82	16.13	0.37	1.85
First Generation Student	4.52	6.02	0.10	0.75	3.89	7.02	0.09	0.55
HS Rank	0.78	0.19	0.58	4.17***	0.64	0.27	0.48	2.39*
Δ Perceived Knowledge 1: Word processors					-1.56	2.97	-0.10	-0.53
Δ Perceived Knowledge 2: Spreadsheet software					-0.26	2.37	-0.02	-0.11
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					3.61	2.66	0.23	1.36
Perceived Usefulness 1: Easier to Get Help When Needed					-1.87	4.54	-0.08	-0.41
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					9.52	5.42	0.32	1.76
Perceived Usefulness 3: Makes Learning More Fun					2.09	3.28	0.12	0.64
Perceived Usefulness 4: Importance of Desktops/Laptops					-2.32	2.20	-0.25	-1.05
Perceived Usefulness 5: Importance of Tablets/iPads					-1.43	2.84	-0.11	-0.50
Perceived Usefulness 6: Importance of E-readers					-2.24	2.22	-0.22	-1.01
Perceived Usefulness 7: Importance of Smartphones/Cellphones					2.23	3.04	0.13	0.73

Continued

Table 4.51 continued

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.90	2.58	-0.06	-0.35
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-6.30	3.34	-0.30	-1.88
Perceived Frequency of Use 3: Storage Medium					1.09	2.26	0.08	0.48
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					2.66	2.42	0.17	1.10
R	0.56				0.75			
R^2	0.31				0.56			
Adj. R^2	0.20				0.23			
ΔR^2	0.31				0.25			
Model	$F(7, 49) = 2.71$, $p = 0.02$				$F(21, 49) = 1.68$, $p = 0.10$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Male sample. The thirteenth regression analysis involved male students' survey data and mean MS Excel grades from the first semester of the academic year (i.e., AU13). Potentially confounding variables such as age, gender, ethnicity/race, admission classification, class rank, pre-major, Pell Grant and first-generation status were controlled for in the first block (i.e., model 1) of the regression test. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between male FYES' background characteristics and technology-related measures and their mean male MS Excel grades during AU13, $F(22, 123) = 1.14$, $p = 0.32$, $R = 0.45$, $R^2 = 0.20$, adjusted $R^2 = 0.02$.

The fourteenth regression analysis involved male students' survey data and mean MATLAB grades from the first semester of the academic year (i.e., SP14). Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Findings reveal no statistically significant relationship between male FYES' background characteristics and technology-related measures and their mean MATLAB grades during AU13, $F(22, 123) = 0.73$, $p = 0.80$, $R = 0.37$, $R^2 = 0.14$, adjusted $R^2 = -0.05$.

A final regression analysis included male students' survey data and mean SolidWorks grades from the second semester of the academic year (i.e., SP14).

Potentially confounding variables were again controlled for in the first block (i.e., model 1) of the regression analysis. Multiple independent variables representing FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology were entered into the second block (i.e., model 2) of the regression analysis. Results reveal no statistically significant relationship between male FYES' background characteristics and technology-related measures and their mean SolidWorks grades during SP14, $F(22, 148) = 1.05$, $p = 0.42$, $R = 0.39$, $R^2 = 0.15$, adjusted $R^2 = 0.01$. Tables 4.50 - 4.52 contain more detailed hierarchical linear regression results for the male sample.

Table 4.52
Regression results for mean MS Excel grades, male sample (N=389)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	77.54	8.30		9.34***	54.00	14.16		3.81***
Age 18-19	7.01	5.93	0.14	1.18	6.97	6.14	0.14	1.14
Admission: New Freshman	-3.10	6.10	-0.09	-0.51	-1.92	6.41	-0.05	-0.30
Rank: Freshman	1.47	3.83	0.05	0.38	-1.13	3.97	-0.04	-0.29
Pre-Major: Engineering	-1.52	5.34	-0.04	-0.29	1.84	5.78	0.05	0.32
Ethnicity: White	3.58	2.85	0.12	1.26	2.50	2.91	0.08	0.86
Pell Grant Recipient	-9.36	7.46	-0.13	-1.26	-8.41	7.64	-0.12	-1.10
First Generation Student	2.50	3.15	0.08	0.79	5.03	3.60	0.15	1.40
HS Rank	-0.00	0.09	-0.00	-0.04	0.07	0.09	0.08	0.75
Δ Perceived Knowledge 1: Word processors					-1.54	1.37	-0.13	-1.13
Δ Perceived Knowledge 2: Spreadsheet software					1.60	1.39	0.14	1.15
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-1.40	1.11	-0.13	-1.27
Perceived Usefulness 1: Easier to Get Help When Needed					-0.25	1.41	-0.02	-0.18
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					3.17	2.58	0.12	1.23
Perceived Usefulness 3: Makes Learning More Fun					-0.59	1.47	-0.04	-0.40
Perceived Usefulness 4: Importance of Desktops/Laptops					0.60	0.92	0.09	0.66
Perceived Usefulness 5: Importance of Tablets/iPads					1.25	0.95	0.15	1.31
Perceived Usefulness 6: Importance of E-readers					-1.02	0.86	-0.15	-1.19

Continued

Table 4.52 continued

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					1.37	1.18	0.12	1.16
Perceived Frequency of Use 1: Electronic Medium for Coursework					0.81	1.27	0.06	0.64
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-2.04	1.76	-0.12	-1.16
Perceived Frequency of Use 3: Storage Medium					0.92	1.17	0.08	0.79
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.42	1.16	0.12	1.23
R	0.22				0.45			
R^2	0.05				0.20			
Adj. R^2	-0.02				0.02			
ΔR^2	0.05				0.15			
Model	$F(8, 123) = 0.76$, $p = 0.64$				$F(22, 123) = 1.14$, $p = 0.32$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.53

Regression results for mean MATLAB grades, male sample (N=389)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	85.09	6.58		12.93***	85.62	11.63		7.36***
Age 18-19	5.68	4.71	0.15	1.21	5.47	5.04	0.14	1.09
Admission: New Freshman	-1.84	4.84	-0.07	-0.38	0.05	5.27	0.00	0.01
Rank: Freshman	-2.80	3.04	-0.12	-0.92	-3.41	3.26	-0.15	-1.05
Pre-Major: Engineering	-1.25	4.23	-0.04	-0.30	-0.05	4.75	-0.00	-0.01
Ethnicity: White	0.50	2.26	0.02	0.22	-0.25	2.39	-0.01	-0.11
Pell Grant Recipient	-10.18	5.92	-0.18	-1.72	-8.19	6.27	-0.14	-1.31
First Generation Student	1.79	2.50	0.07	0.72	3.55	2.95	0.14	1.20
HS Rank	0.01	0.07	0.01	0.12	0.01	0.08	0.01	0.07
Δ Perceived Knowledge 1: Word processors					-0.70	1.12	-0.08	-0.62
Δ Perceived Knowledge 2: Spreadsheet software					1.21	1.14	0.14	1.06
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-0.96	0.91	-0.11	-1.06
Perceived Usefulness 1: Easier to Get Help When Needed					-0.25	1.16	-0.02	-0.21
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.91	2.12	0.04	0.43
Perceived Usefulness 3: Makes Learning More Fun					-0.56	1.21	-0.05	-0.47
Perceived Usefulness 4: Importance of Desktops/Laptops					0.82	0.75	0.15	1.09
Perceived Usefulness 5: Importance of Tablets/iPads					0.52	0.78	0.08	0.66
Perceived Usefulness 6: Importance of E-readers					-0.05	0.71	-0.01	-0.07

Continued

Table 4.53 continued

Variables	Model 1				Model 2			
	B	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					-1.08	0.97	-0.12	-1.11
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.51	1.04	-0.05	-0.49
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					-0.07	1.44	-0.01	-0.05
Perceived Frequency of Use 3: Storage Medium					-1.28	0.96	-0.13	-1.34
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					1.19	0.95	0.13	1.26
R	0.21				0.37			
R^2	0.05				0.14			
Adj. R^2	-0.02				-0.05			
ΔR^2	0.05				0.09			
Model	$F(8, 123) = 0.69$, $p = 0.70$				$F(22, 123) = 0.73$, $p = 0.80$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Table 4.54

Regression results for mean SolidWorks grades, male sample (N=389)

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Constant	85.72	6.38		13.44^{***}	86.58	8.82		9.82^{***}
Age 18-19	-5.80	4.61	-0.16	-1.26	-7.66	4.91	-0.21	-1.56
Admission: New Freshman	7.91	4.44	0.28	1.78	7.07	4.65	0.25	1.52
Rank: Freshman	-1.12	2.42	-0.05	-0.46	-1.23	2.52	-0.05	-0.49
Pre-Major: Engineering	-1.74	3.65	-0.06	-0.48	0.38	4.11	0.01	0.09
Ethnicity: White	0.22	2.14	0.01	0.10	0.32	2.31	0.01	0.14
Pell Grant Recipient	8.43	5.36	0.15	1.57	9.07	5.87	0.16	1.55
First Generation Student	-4.34	2.22	-0.16	-1.95	-4.19	2.33	-0.16	-1.80
HS Rank	0.09	0.07	0.11	1.22	0.10	0.08	0.12	1.22
Δ Perceived Knowledge 1: Word processors					-0.53	1.10	-0.06	-0.48
Δ Perceived Knowledge 2: Spreadsheet software					-0.04	1.04	-0.00	-0.04
Δ Perceived Knowledge 3: MATLAB, CAD, MCC					-1.06	0.78	-0.13	-1.36
Perceived Usefulness 1: Easier to Get Help When Needed					-2.62	1.46	-0.21	-1.80
Perceived Usefulness 2: Improves Work, Essential for College & Worthwhile					0.99	1.77	0.06	0.56
Perceived Usefulness 3: Makes Learning More Fun					0.05	1.44	0.00	0.04
Perceived Usefulness 4: Importance of Desktops/Laptops					0.52	0.73	0.09	0.71
Perceived Usefulness 5: Importance of Tablets/iPads					0.03	0.89	0.01	0.03
Perceived Usefulness 6: Importance of E-readers					0.07	0.68	0.01	0.10

Continued

Table 4.54 continued

	Model 1				Model 2			
Variables	*B*	*SE*	*β*	*t*	*B*	*SE*	*β*	*t*
Perceived Usefulness 7: Importance of Smartphones/Cellphones					1.04	0.99	0.09	1.06
Perceived Frequency of Use 1: Electronic Medium for Coursework					-0.40	0.99	-0.04	-0.40
Perceived Frequency of Use 2: Email to Communicate with TA/Instructor					1.19	1.21	0.10	0.99
Perceived Frequency of Use 3: Storage Medium					-0.26	0.82	-0.03	-0.32
Perceived Frequency of Use 4: Text/Email Notifications from Course Management System					-0.94	1.03	-0.09	-0.91
R	0.28				0.39			
R^2	0.08				0.15			
Adj. R^2	0.03				0.01			
ΔR^2	0.08				0.08			
Model	$F(8, 148) = 1.47, p = 0.17$				$F(22, 148) = 1.05, p = 0.42$			

NOTE: $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

Summary. Overall, results from this section indicate that FYES' technology-related variables are not significant predictors of their mean software-specific grades in two *Fundamentals of Engineering* courses. However, students' background characteristics significantly predict their mean software-specific grades in the two courses. There are differences by race/ethnicity and gender. Specifically, FYES' background traits – such as H.S. class rank – are statistically significant predictors of their mean SolidWorks grades in the second of two *Fundamentals of Engineering* courses. Also, White students' background traits – Pell grant recipient status and H.S. class rank – are statistically significant predictors of their mean Excel and SolidWorks grades in AU13 and SP14. Finally, female participants' background traits – like H.S. class rank – are statistically significant predictors of their mean SolidWorks grades in SP14.

CHAPTER 5: DISCUSSION

Outline

I. Introduction
   a. Recall purpose of study and research questions/hypotheses
II. Discussion
   a. Research Question 1
   b. Research Question 2
   c. Research Question 3
III. Relate to Lit.
IV. Implications
   a. Practice
   b. Research
   c. Theory
V. Limitations
VI. Conclusions

The purpose of this study was to understand the relationship between first-year engineering students' (FYES) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement (i.e., grades). This investigation focused on the specific types and uses of educational technology by FYES, while also analyzing differences by race/ethnicity and gender. Previously, scholars have employed a broad definition of technology to describe hardware such as cell phones and computers or software for word processing and web-based applications. Such definitions have been used to understand how collegians, instructors, and professionals interact with technology.

In the present study, educational technology signified specific computer and information technology (C&IT) such as computer hardware (e.g., desktops, laptops), computer software (e.g., Microsoft Word/Excel, MATLAB, SolidWorks), electronic devices (e.g., cellphones, tablets, E-readers), and the Internet (e.g., websites, course management systems). Rogers' (1995) technology adoption theory was chosen for the current study as it related well to the present research questions involving FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Several of the aforementioned types of technology are required components of the first-year engineering program (FEP) where the present study took place. So, students were evaluated on the ways in which they adopted the tools over time, rather than whether or not they adopted them at all.

Specifically, the present investigation addressed the following research questions:

1. Are there differences in FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology by race/ethnicity and/or gender?
2. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their final course grades in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?
3. What is the relationship between FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their three software-specific grades (i.e., MS Excel, MATLAB, SolidWorks) in two *Fundamentals of Engineering* courses?
    a. Does this relationship vary by race/ethnicity and/or gender?

Independent samples *t*-tests were used to answer the first research question by measuring differences in students' perceptions of technology across demographic categories (e.g., race/ethnicity, gender, class rank, etc.). Bivariate correlations and hierarchical linear regression analyses were conducted to address the second and third research questions by seeking to identify relationships between technology-based variables and FYES' academic success (i.e., grades).

This final chapter includes a discussion of the study's findings. This section also contains coverage of the results as they relate to prior literature along with future implications for research, theory and practice.

Discussion

Research Question 1: Discussion

The first research question examined differences in FYES' perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology by race/ethnicity and gender. Independent samples *t*-tests were used to assess if statistically significant differences exist between non-White and White along with male and female FYES.

There were no significant racial/ethnic differences in FYES' perceived knowledge of technology. It appears that FYES experienced approximately the same change, from beginning to end of each term, in their perceived knowledge of word processors, spreadsheet software, along with MATLAB/CAD/microcontroller software. As may be expected, initially participants' mean perceived knowledge was highest for word processors while it was lowest for MATLAB/CAD/microcontroller software. During a pilot interview with a FYES named Daniel, he provided additional insight on students' perceived knowledge of technology by saying, "I only ever used like Microsoft Word, PowerPoint, and Excel. Very limited Excel. There was like no SolidWorks or MATLAB for sure back before college. Basically, just limited to like internet use and word processing stuff." During another interview with a FYES named Adam, he provided further explanation of students' perceived knowledge by stating "I had no prior coding experience [with MATLAB]. However, I'd soon learn that MATLAB almost has its own language or at least to my understanding. So, you don't need any prior knowledge to learn MATLAB." Therefore, during the two semesters, students experienced the greatest gain in their mean perceived knowledge of MATLAB/CAD/microcontroller software and the least improvement in their mean perceived knowledge of word processors. This appears to be due to a lack of prior experience with programming software like MATLAB or 3-D graphics tools like SolidWorks.

Findings indicated there were significant racial/ethnic differences in FYES' perceived usefulness as well as frequency and nature of use of technology. In terms of perceived usefulness of technology, non-White FYES rated desktops/laptops as being significantly more important to their second-semester academic success than White students. Interestingly, the reverse was true during the first semester, with White participants rating such devices higher. Results also revealed non-White FYES rate iPads/tablets and E-readers as being significantly more important to their second-semester academic success than their White peers. So, by the second semester, non-White FYES valued using several electronic devices (i.e., iPads/tablets, E-readers, and desktops/laptops) for academic achievement more than their White peers.

Interestingly, although no significant racial/ethnic differences existed in FYES' perceptions about the importance of smartphones/cellphones, the devices were rated as most important to all participants' academic success. Daniel explained his perception about the importance of smartphones/cellphones when revealing that "having a smartphone has been very important to me…getting me around campus…being able to use… [my smartphone] as a quick reference...that's been a big thing." Another FYES named John described the importance of his cellphone when stating "my phone is the only piece of technology I carry around at all times. My laptop is rather heavy so I usually leave that back at my dorm…my cell phone is what I use to keep me on track…I have notifications…I have the Google Calendar.” Thus, the mobile and lightweight nature of smartphones/cellphones may cause students to rely on them for quick access to information.

In terms of perceived frequency and nature of use of technology, during the first semester, non-White students reported using storage mediums (such as Dropbox, Box and Google Drive) more frequently than White students. During the second semester, non-White students reported using text/email notifications from the institution’s course management system more frequently than White students. The same was true for FYES’ use of email to communicate with TAs/Instructors. Daniel, who is White, elaborated on students’ perceived frequency and nature of use of technology by expressing that “generally how responsive the respective TA would be [influenced how frequently I used email to communicate with TAs/Instructors].” So, it’s possible that students’ expectations and perceptions of their TAs/Instructors ability to quickly reply to email impacted their frequency of use. Perhaps this differed across race/ethnicity.

Significant gender differences also existed in students’ perceptions of technology. There were variations in female and male FYES’ perceived knowledge and usefulness of technology. From beginning to end of the second semester, female students reported a significantly greater change in their perceived knowledge of word processors than male students. In terms of perceived usefulness of technology, there was a significant difference in male and female students’ level of agreement that they become significantly more actively involved in courses that use technology. Even though males had a higher level of agreement during the second semester than females, the difference between the two groups was only 0.24 on a 5-point scale. Daniel described his perceived usefulness of technology by saying “Technology makes it easier [to be involved in a course] because you can get a hold of a professor easier.” Adam also discussed his perceived usefulness of technology by indicating that “when working in a group it was very important to use technology. If one of the members in one of my groups, over the past year, was opposed to using one of the technologies I mentioned earlier [such as Google Docs, text messaging, phone calls, and email], then we would not have been very successful.” Hence, it appears that technology allows students to get more involved in group activities and to communicate more easily with faculty/peers but the rate may vary across gender.

Research Question 2: Discussion

The second research question explored the extent to which FYES’ final course grades in two *Fundamentals of Engineering* courses could be predicted by their perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Differences were analyzed by race/ethnicity and gender. Results indicated that FYES’ technology-related variables were not significant predictors of their final course grades in the two *Fundamentals of Engineering* courses.

Despite non-significant findings concerning technology-related variables, FYES’ background characteristics significantly predicted their final course grades in the second course. Specifically, FYES’ background traits – such as Pell grant recipient status, first-generation status, and H.S. class rank – were statistically significant predictors of their final grades in the second course. For the aggregate sample, Pell grant recipient status and H.S. class rank were positive, significant predictors while first-generation status is a negative, significant predictor. Overall, FYES' background traits accounted for 13% of the variance in their final course grades during the second of two *Fundamentals of Engineering* courses.

In terms of race/ethnicity, White students' background traits – like gender, Pell grant recipient status, and H.S. class rank – were statistically significant predictors of their final course grades in the second course. Pell grant recipient status and H.S. class rank were positive, significant predictors while gender was a negative, significant predictor. Overall, White FYES' background traits accounted for 11% of the variance in their final course grades during the second of two *Fundamentals of Engineering* courses.

In terms of gender, male participants' background traits – such as Pell Grant recipient status and first-generation status – were statistically significant predictors of their final course grades in the second course. Pell grant recipient status was a positive, significant predictor while first-generation status is a negative, significant predictor. Overall, male FYES' background traits accounted for 13% of the variance in their final course grades during the second of two *Fundamentals of Engineering* courses.

Research Question 3: Discussion

The third research question explored the extent to which FYES' mean software-specific grades in two *Fundamentals of Engineering* courses could be predicted by their perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology. Differences were analyzed by race/ethnicity and gender. Results indicated that FYES' technology-related variables were not significant predictors of their mean software-specific grades in the two *Fundamentals of Engineering* courses.

Regardless of the non-significant findings related to technology-related variables, FYES' background characteristics significantly predicted their mean software-specific grades in the two courses. Specifically, FYES' background traits – such as H.S. class rank – were statistically significant predictors of their mean SolidWorks grades in the second of two *Fundamentals of Engineering* courses. For the aggregate sample, students' H.S. class rank was a positive, significant predictor. Overall, FYES' background traits accounted for 10% of the variance in their mean SolidWorks grades during the second of two *Fundamentals of Engineering* courses.

In terms of race/ethnicity, White students' background traits – like Pell grant recipient status and H.S. class rank – were statistically significant predictors of their mean Excel and SolidWorks grades during the first and second semester. Pell grant recipient status was a negative, significant predictor of mean Excel grades while H.S. class rank was a positive, significant predictor of mean SolidWorks grades. Overall, White FYES' background traits accounted for 13% of the variance in their mean Excel grades during the first course and 11% of the variance in their mean SolidWorks grades during the second of two *Fundamentals of Engineering* courses.

In terms of gender, female participants' background traits – H.S. class rank – were statistically significant predictors of their mean SolidWorks grades during the second semester. Female students' H.S. class rank was a positive, significant predictor. Overall, female FYES' background traits accounted for 31% of the variance in their mean SolidWorks grades during the second of two *Fundamentals of Engineering* courses.

Summary

Collectively, the results of this study suggest several key points. First, there were significant racial/ethnic differences in FYES' perceived usefulness as well as frequency and nature of use of technology. For example, at the beginning of the first semester, White FYES rated desktops/laptops as being significantly more important to their academic success than non-White students. In this study, African Americans and Hispanics represented over one-fourth (26.6%) of the non-White sample. So, the initial difference between non-White and White participants' perceptions of desktops/laptops could be due to the fact that African Americans and Hispanics own computers at lower rates than Whites (Lewis et al., 2001). One could hypothesize that students who have open access to a technological device might be more familiar with the tool, use it more often, and therefore believe it is more important to his/her academic success than those who do not own them.

During the first semester, non-White students also reported using storage mediums (such as Dropbox, Box and Google Drive) more frequently than White students.

By the second semester, non-White FYES valued using several electronic devices (i.e., iPads/tablets, E-readers, and desktops/laptops) for academic achievement more than their White peers. It's possible that required academic use of desktops/laptops could cause some FYES (e.g., non-White students) to have more positive perceptions of the devices over time while others (e.g., White students) could begin to view them more negatively. It's also conceivable that non-White participants have had more positive prior experiences with iPads/tablets and E-readers causing them to regard the devices more highly than their White counterparts. Furthermore, this difference between non-White and White FYES' perceived usefulness of technology could be a result of the ways in which the electronic devices are used. For example, recall from Chapter Two, non-White students use instant messaging, search the internet, and use computers for academic work more frequently than their White peers (Lloyd et al., 2007).

During the second semester, non-White students also reported using email significantly more frequently to communicate with TAs/Instructors than White students. The same was true for use of text/email notifications from the institution's course management system. In this investigation, Asian/Pacific Islander students represented close to thirty percent (29.4%) of the non-White sample. Therefore, more frequent email use by non-White students may be due to the fact that Asian students are the heaviest users of email to communicate with instructors or fellow students (Flowers and Zhang, 2003).

Second, there were significant gender differences in FYES' perceived knowledge and usefulness of technology. For instance, from beginning to end of the second semester, female students reported a significantly greater change in their perceived knowledge of word processors than male students. Also, male students had a significantly higher level of agreement that they become significantly more actively involved in courses that use technology than females. Disparities in male and female students' perceived knowledge and usefulness of technology may exists because females report lower confidence, later adoption, and less use of technology for academic purposes than males (Lloyd et al., 2007; Smith & Caruso, 2010; Yau & Cheng, 2012). These differences could also be due to the fact that technology allows students to customize their learning environment based on one's preferences and needs (Johri & Olds, 2014). Perhaps individuals from similar genders or racial/ethnic groups also have comparable technological preferences.

Third, FYES' background characteristics significantly predicted their final course grades in the second of two *Fundamentals of Engineering* courses. FYES' background characteristics also significantly predicted their mean software-specific grades in *Fundamentals of Engineering* courses. Students' high school class rank was one background trait that proved to be significant. Research suggests that regardless of the school attended, cumulative high school grade point average (GPA) is the best overall predictor of student performance in college (Atkinson & Geiser, 2009). Therefore, students' high school class rank may have been a statistically significant predictor due to its dependence on one's GPA. Participants' Pell Grant recipient status, which served as an approximation of one's socio-economic level, was another background trait that was significant. This is important since individuals with more formal education and higher socioeconomic status can be classified as “earlier knowers” of a specific technology while those with less schooling and a lower income would be considered “later knowers” (Rogers, 1995). Hence, students’ socio-economic status can affect the point at which they learn how to describe and use new devices.

Relationship of the Findings to Prior Research

Findings from this study add important insights to the extant literature on educational technology and first-year engineering students (FYES). Some results support or extend existing research while others contest past work.

In terms of students’ perceived knowledge of technology, prior investigations have revealed that students are most highly skilled in core rather than specialized forms of technology (Dahlstrom et al., 2011; Kvavik & Caruso, 2005; Salaway & Caruso, 2008; Smith & Caruso, 2010). For example, students feel they need the least improvement with word processing but lack sufficient software skills with tools such as programming languages (Dahlstrom et al., 2011). Results from the present study support these claims. Initially, all FYES’ mean perceived knowledge was highest for word processors while it was lowest for MATLAB/CAD/microcontroller software. Therefore, as Kennedy et al. (2008) stated, “first-year students are highly tech-savy. However, when one moves beyond entrenched technologies and tools (e.g., computers, mobile phones, and email), the patterns of access and use of a range of technologies show considerable variation” (p. 108).

Previous researchers have also shown that there are differences in students' perceived knowledge of technology by race/ethnicity and gender (Li & Kirkup, 2007). The present study found no significant racial/ethnic differences in students' perceived knowledge of technology. However, the current investigation did find variations in female and male FYES' perceived knowledge of word processors. This study revealed that female students experience a significantly greater change in their perceived knowledge of word processors than male students.

In terms of students' perceived usefulness of technology, past studies have revealed that a majority of students believe the most important devices to their academic success are laptops, followed by printers, thumb drives, and desktop computers (Dahlstrom, 2012; Dahlstrom et al., 2011). Nevertheless, the extant literature has not explored differences in students' perceived usefulness of technology by race/ethnicity or gender. In the current investigation, significant differences existed in FYES' perceived usefulness of technology by race/ethnicity and gender. For instance, non-White FYES valued using several electronic devices (i.e., iPads/tablets, E-readers, and desktops/laptops) for academic achievement more than their White peers. In addition, female students reported a significantly greater change in their perceived knowledge of word processors than male students. There was also a significant difference in male and female students' level of agreement that they become significantly more actively involved in courses that use technology, with males indicating a higher level of agreement than females. These significant differences extend our knowledge surrounding students' perceptions of technology.

In terms of students' perceived frequency and nature of use of technology, scholars have found differences by race/ethnicity and gender. For example, Flowers and Zhang (2003) determined that Asian students are the heaviest users of email (i.e., to communicate with instructors or fellow students) and Native Hawaiian/Pacific Islanders use electronic chat rooms the most. Lloyd et al. (2007) also examined differences in C&IT use by race/ethnicity. Their results indicate that non-White students use instant messaging more often than White students. Similar to previous findings, in the present investigation, non-White students reported using email significantly more frequently to communicate with TAs/Instructors than White students. The same was true for FYES' use of text/email notifications from the institution's course management system.

Researchers have also examined differences in C&IT use by gender. Li and Kirkup (2007) investigated variances in students' use of C&IT and found that men are more likely to use email than women. Lloyd et al. (2001) also explored college students' technology use and showed that women use text messaging/talking features on cell phones and blogs more frequently than men. Yet, in the present study no significant gender differences were found in how often FYES used an electronic medium (e.g., listserv, chat group, Internet, instant messaging) to discuss or complete a course assignment. Furthermore, no gender differences were found in how often FYES used email to communicate with an instructor/TA or how frequently they used an optional text/email notification feature from the course management system.

Implications

Implications for Practice

Findings from this study have several practical implications. Results provide insight into FYES' perceived knowledge, usefulness, as well as frequency and nature of use of technology. Therefore, university faculty members can use this new information when teaching FYES and integrating technology into their classrooms. When teaching, faculty can create syllabi and lesson plans that utilize FYES' existing knowledge of word processors but develop their software skills with specialized tools such as programming languages. College professors can also find ways for students to use smartphones/cellphones for educational purposes since the devices were rated as most important to participants' academic success. When integrating technology into their classrooms, instructors should recognize that FYES have different perceptions of technology by race/ethnicity and gender. Therefore, FYES should be given opportunities to use multiple technological devices to complete course assignments since participants value using electronic devices (i.e., iPads/tablets, E-readers, and desktops/laptops) at varying levels. Administrators can also use information from the present investigation when making programmatic changes and technological purchases.

Implications for Future Research

Findings from the present study have implications for future research. This study focused exclusively on FYES' academic performance and perceptions of technology. However, students' perceived knowledge and usefulness of technology differ by major and class rank (Kvavik & Caruso, 2005; Kvavik et al., 2004; Salaway et al., 2006). For example, seniors, engineering students, and business majors rate their C&IT skills highest with tools such as presentation and spreadsheet software (Kvavik et al., 2004). In addition, engineering students are also more likely to agree that C&IT improves their learning, provides convenience, and causes them to be more engaged in courses (Salaway et al., 2006). Furthermore, seniors report higher levels of perceived usefulness of technology when compared to freshmen (Kvavik & Caruso, 2005). So, future studies might first examine older/higher-ranking engineering students or non-engineering STEM majors.

Second, future investigations can be expanded to other schools. The present investigation took place at a single institution. Hence, the study could be replicated at other large, public, research, 4-year, PWIs in the Midwest. In addition, a similar research approach can be used at different types of schools (i.e., private or 2-year). Such studies would expand on the available information about educational technology. They would also allow researchers to have more accurate finds and stronger interventions.

Third, future work could include larger and more racially diverse samples. A larger sample would allow the research to conduct a full qualitative or mixed-methods analysis. This would also allow the researcher to disaggregate findings among individual non-White racial/ethnic groups (i.e., Blacks, Hispanics, Asians, etc.). Previous studies have found differences in terms of individual racial/ethnic groups' perceptions of technology but the present investigation was unable to make such comparisons.

Therefore, future work could focus on just Black, Hispanic or Asian students' perceptions of technology.

Implications for Theory

Present theory makes little mention of any differences along race/ethnicity or gender. However, results from the present study determined there were significant racial/ethnic differences in FYES' perceived usefulness as well as frequency and nature of use of technology. There were also significant gender differences in FYES' perceived knowledge and usefulness of technology. Furthermore, FYES' background characteristics significantly predicted their final course grades in the second of two *Fundamentals of Engineering* courses. These outcomes have important implications for theory. Findings from the present study add to Rogers' (1995) theory, which states that technology adoption occurs through a five-step innovation-decision process. It is evident that different students adopt and use technology in various ways. Future theory can delve deeper into such differences when focusing on students and technology.

Limitations

This study, like all others, has limitations. It is important to consider them when analyzing and implementing findings. First, the study involved participants from a single institution. The participants also took the same *Fundamentals of Engineering* courses. This could unintentionally influence participants' responses to survey questions about one's courses or college. For example, students were asked about their level of agreement about the statement 'Technology makes me feel more connected to what's going on at the college/university.'" In addition, individuals were probed about their level of agreement with the statement 'I get more actively involved in courses that use technology.'" Consequently, it is possible that the students from this single institution and set of courses may differ in some important way from students at other colleges and universities. This could limit the generalizability of findings.

Second, the study relied on a questionnaire that collects student self-report data. As previously mentioned in Chapter Three, self-reports are considered valid and widely used in educational research. Nonetheless, one must still trust that students can accurately convey information regarding their knowledge or frequency of use regarding a specific type of technology.

Third, the use of students' class rank may have influenced the results in unexpected ways. As previously mentioned, high school GPA is the strongest predictor of students' college performance (Atkinson & Geiser, 2009). However, in this study, class rank was used as a representation of one's academic performance in high school. It is possible that some students attended very competitive schools which could have caused them to have a lower class rank. The size of one's cohort could also have had an unknown effect on one's class rank. Furthermore, it is important to note that data on class rank was not available for all students. When taking the aforementioned into consideration, some students' college performance may have been more or less accurately predicted by the use of class rank.

Fourth, the use of students' Pell Grant recipient status as a proxy for socio-economic status may have limited the generalizability of the results. For instance, within this study's sample, it's possible that some students who met the award's criteria for financial need were not aware of the grant or did not choose to apply. So, findings related to individuals' Pell Grant status may not fully represent student differences based on income-level.

Conclusion

The purpose of this study was to understand the relationship between first-year engineering students' (FYES) perceived (a) knowledge, (b) usefulness, as well as (c) frequency and nature of use of technology and their academic achievement (i.e., grades). Unlike previous analyses, the present study focused on the specific types of and ways that educational technology is used by FYES. In the present study, educational technology signified specific computer and information technology (C&IT) such as computer hardware (e.g., desktops, laptops), computer software (e.g., Microsoft Word/Excel, MATLAB, SolidWorks), electronic devices (e.g., cellphones, tablets, E-readers), and the Internet (e.g., websites, course management systems).

A multi-step approach (i.e., descriptive statistics, independent samples *t*-tests, hierarchical linear regression) was used to analyze survey data from nearly 500 students. Results from the present study determined there were significant racial/ethnic differences in FYES' perceived usefulness as well as frequency and nature of use of technology. There were also significant gender differences in FYES' perceived knowledge and usefulness of technology. Furthermore, FYES' background characteristics significantly predicted their final course grades in the second of two *Fundamentals of Engineering* courses. Findings have important implications for practice, research, and theory surrounding FYES and educational technology.

Current undergraduates are often classified as being "digital natives." Nonetheless, findings from the present study indicate that students' perceived knowledge, usefulness, as well as frequency and nature of use of technology varies by race/ethnicity and/or gender. So, college faculty and staff should take such variations into consideration when constructing curriculum and seeking to create a positive learning environment.

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APPENDIX A: Student Questionnaires

Questionnaire – Autumn Semester 2013 (AU13)

The following survey items were distributed to first-year engineering students taking *Fundamentals of Engineering* courses. The items were administered using weekly quizzes/journals (which were an existing component of the course). Students answered the questions during the AU13 semester. Reference numbers were added next to questionnaire items which have been adapted or used from an existing survey. In addition, university supplied information on student demographics (gender, race/ethnicity, major, rank, etc.) was used.

Perceived Knowledge

Start-of-Term: Pre-Knowledge

1. In terms of using a word processor (like MS Word) to perform tasks such as creating/formatting written documents, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High
2. In terms of using spreadsheet software (like MS Excel) to perform tasks such as analyzing/plotting data, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High
3. In terms of using MATLAB to perform tasks such as creating computer programs and analyzing/plotting data, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

Questionnaire – Autumn Semester 2013 (AU13)

4. In terms of using CAD software (like SolidWorks) to perform task such as creating/modifying 3-D parts, assemblies and drawings, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

5. In terms of using microcontroller software (like Arduino) to program an automatically controlled device, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

End-of-Term: New Knowledge

6. In terms of using a word processor (like MS Word) to perform tasks such as creating/formatting written documents, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

7. In terms of using spreadsheet software (like MS Excel) to perform tasks such as analyzing/plotting data, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

Questionnaire – Autumn Semester 2013 (AU13)

8. In terms of using MATLAB to perform tasks such as creating computer programs and analyzing/plotting data, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

9. In terms of using CAD software (like SolidWorks) to perform task such as creating/modifying 3-D parts, assemblies and drawings, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

10. In terms of using microcontroller software (like Arduino) to program an automatically controlled device, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

Perceived Usefulness

Throughout Term

11. Regardless of whether or not you own one, please rate how important desktop computers/laptops are to your academic success. [2]

    - 0 = Not at all important
    - 1 = Very low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very high

Questionnaire – Autumn Semester 2013 (AU13)

12. Regardless of whether or not you own one, please rate how important tablets/iPads are to your academic success. [2]

- 0 = Not at all important
- 1 = Very low
- 2 = Low
- 3 = Moderate
- 4 = High
- 5 = Very high

13. Regardless of whether or not you own one, please rate how important E-readers are to your academic success. [2]

- 0 = Not at all important
- 1 = Very low
- 2 = Low
- 3 = Moderate
- 4 = High
- 5 = Very high

14. Regardless of whether or not you own one, please rate how important smartphones/cellphones are to your academic success. [2]

- 0 = Not at all important
- 1 = Very low
- 2 = Low
- 3 = Moderate
- 4 = High
- 5 = Very high

15. To what extent do you agree with the statement "Technology makes it easier to get help when I need it"? [1]

- 0 = Strongly disagree
- 1 = Somewhat disagree
- 2 = Neither agree nor disagree
- 3 = Agree
- 4 = Strongly agree

16. To what extent do you agree with the statement "Technology makes learning more fun"? [1]
- 0 = Strongly disagree
- 1 = Somewhat disagree
- 2 = Neither agree nor disagree
- 3 = Agree
- 4 = Strongly agree

<u>Questionnaire – Autumn Semester 2013 (AU13)</u>

17. To what extent do you agree with the statement "Technology helps me do my work faster"? [1]

    - 0 = Strongly disagree
    - 1 = Somewhat disagree
    - 2 = Neither agree nor disagree
    - 3 = Agree
    - 4 = Strongly agree

18. To what extent do you agree with the statement "Technology allows me to produce higher quality work"? [1]

    - 0 = Strongly disagree
    - 1 = Somewhat disagree
    - 2 = Neither agree nor disagree
    - 3 = Agree
    - 4 = Strongly agree

19. To what extent do you agree with the statement "Technology is an essential part of the college experience"? [1]

    - 0 = Strongly disagree
    - 1 = Somewhat disagree
    - 2 = Neither agree nor disagree
    - 3 = Agree
    - 4 = Strongly agree

20. To what extent do you agree with the statement "Technology, when used well, is worth the investment"? [1]

    - 0 = Strongly disagree
    - 1 = Somewhat disagree
    - 2 = Neither agree nor disagree
    - 3 = Agree
    - 4 = Strongly agree

Perceived Frequency and Nature of Use of Technology

Mid-Term: Software usage

21. During the current semester, about how often have you used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment for this course? [3]

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

Questionnaire – Autumn Semester 2013 (AU13)

22. During the current semester, about how often have you used email to communicate with an instructor or TA for this course? [3]

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

23. During the current semester, about how often have you used the optional storage mediums (such as Dropbox, Box and Google Drive) that are described in the Student Resources Guide to complete course assignments?

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

24. During the current semester, about how often have you used the optional Text/Email Notification features from the course management system that are described in the Student Resources Guide to complete course assignments?

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

References for Questionnaire

[1] *ECAR Study of Undergraduate Students and Technology, 2011*. Retrieved from http://www.educause.edu/library/resources/ecar-national-study-undergraduate-students-and-information-technology-2011%E2%80%94survey-questionnaire

[2] *ECAR Study of Undergraduate Students and Technology, 2012*. Retrieved from http://www.educause.edu/library/resources/ecar-study-undergraduate-students-and-information-technology-2012

[3] *The National Survey of Student Engagement (NSSE) 2012*. Retrieved from http://nsse.iub.edu/html/survey_instruments.cfm

Questionnaire – Spring Semester 2014 (SP14)

The following survey items were distributed to first-year engineering students taking *Fundamentals of Engineering* courses. The items were administered using weekly quizzes/journals (which were an existing component of the course). Students answered the questions during the SP14 semester. Reference numbers were added next to questionnaire items which have been adapted or used from an existing survey. In addition, university supplied information on student demographics (gender, race/ethnicity, major, rank, etc.) was used.

Perceived Knowledge

Start-of-Term: Pre-Knowledge

1. In terms of using a word processor (like MS Word) to perform tasks such as creating/formatting written documents, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High
2. In terms of using spreadsheet software (like MS Excel) to perform tasks such as analyzing/plotting data, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High
3. In terms of using MATLAB to perform tasks such as creating computer programs and analyzing/plotting data, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

Questionnaire – Spring Semester 2014 (SP14)

4. In terms of using CAD software (like SolidWorks) to perform task such as creating/modifying 3-D parts, assemblies and drawings, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

5. In terms of using microcontroller software (like Arduino) to program an automatically controlled device, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

End-of-Term: New Knowledge

6. In terms of using a word processor (like MS Word) to perform tasks such as creating/formatting written documents, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

7. In terms of using spreadsheet software (like MS Excel) to perform tasks such as analyzing/plotting data, how would you rate your current knowledge?
    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

Questionnaire – Spring Semester 2014 (SP14)

8. In terms of using MATLAB to perform tasks such as creating computer programs and analyzing/plotting data, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

9. In terms of using CAD software (like SolidWorks) to perform task such as creating/modifying 3-D parts, assemblies and drawings, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

10. In terms of using microcontroller software (like Arduino) to program an automatically controlled device, how would you rate your current knowledge?

    - 0 = No Prior Knowledge
    - 1 = Very Low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very High

Perceived Usefulness

Throughout term

11. Regardless of whether or not you own one, please rate how important desktop computers/laptops are to your academic success. [2]

    - 0 = Not at all important
    - 1 = Very low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
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Questionnaire – Spring Semester 2014 (SP14)

12. Regardless of whether or not you own one, please rate how important tablets/iPads are to your academic success. [2]

    - 0 = Not at all important
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13. Regardless of whether or not you own one, please rate how important E-readers are to your academic success. [2]

    - 0 = Not at all important
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    - 3 = Moderate
    - 4 = High
    - 5 = Very high

14. Regardless of whether or not you own one, please rate how important smartphones/cellphones are to your academic success. [2]

    - 0 = Not at all important
    - 1 = Very low
    - 2 = Low
    - 3 = Moderate
    - 4 = High
    - 5 = Very high

15. To what extent do you agree with the statement "I get more actively involved in courses that use technology"? [2]

    - 0 = Strongly disagree
    - 1 = Somewhat disagree
    - 2 = Neither agree nor disagree
    - 3 = Agree
    - 4 = Strongly agree

16. To what extent do you agree with the statement "Technology makes me feel more connected to what's going on at the college/university"? [2]

    - 0 = Strongly disagree
    - 1 = Somewhat disagree
    - 2 = Neither agree nor disagree
    - 3 = Agree
    - 4 = Strongly agree

Questionnaire – Spring Semester 2014 (SP14)

17. To what extent do you agree with the statement "Technology makes me feel connected to professors"? [2]

    a. 0 = Strongly disagree
    b. 1 = Somewhat disagree
    c. 2 = Neither agree nor disagree
    d. 3 = Agree
    e. 4 = Strongly agree

18. To what extent do you agree with the statement "Technology makes me feel connected to other students"? [2]

    a. 0 = Strongly disagree
    b. 1 = Somewhat disagree
    c. 2 = Neither agree nor disagree
    d. 3 = Agree
    e. 4 = Strongly agree

19. To what extent do you agree with the statement "Technology helps me achieve my academic outcomes"? [2]

    a. 0 = Strongly disagree
    b. 1 = Somewhat disagree
    c. 2 = Neither agree nor disagree
    d. 3 = Agree
    e. 4 = Strongly agree

20. To what extent do you agree with the statement "Technology elevates the level of teaching"? [1]

    a. 0 = Strongly disagree
    b. 1 = Somewhat disagree
    c. 2 = Neither agree nor disagree
    d. 3 = Agree
    e. 4 = Strongly agree

Perceived Frequency and Nature of Use of Technology

Mid-Term: Software usage

21. During the current semester, about how often have you used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment for this course? [3]

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

Questionnaire – Spring Semester 2014 (SP14)

22. During the current semester, about how often have you used email to communicate with an instructor or TA for this course? [3]

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

23. During the current semester, about how often have you used the optional storage mediums (such as Dropbox, Box and Google Drive) that are described in the Student Resources Guide to complete course assignments?

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

24. During the current semester, about how often have you used the optional Text/Email Notification features from the course management system that are described in the Student Resources Guide to complete course assignments?

    - 0 = Never
    - 1 = Sometimes
    - 2 = Often
    - 3 = Very Often

References for Questionnaire

[1] *ECAR Study of Undergraduate Students and Technology, 2011*. Retrieved from http://www.educause.edu/library/resources/ecar-national-study-undergraduate-students-and-information-technology-2011%E2%80%94survey-questionnaire

[2] *ECAR Study of Undergraduate Students and Technology, 2012*. Retrieved from http://www.educause.edu/library/resources/ecar-study-undergraduate-students-and-information-technology-2012

[3] *The National Survey of Student Engagement (NSSE) 2012*. Retrieved from http://nsse.iub.edu/html/survey_instruments.cfm

APPENDIX B: Interview Protocol

Interview Protocol

The following are semi-structured interview questions based on the proposed study:

1) I am interested in hearing about your previous use of technology. Can you please describe what forms of technology you had access to at home while growing up? How about at school?
    a. Probe: What type of computers did you have access to and use? What type of computer software (e.g., MS Office, MATLAB, SolidWorks) did you have access to and use?
2) I am interested in hearing about your use of technology as a FYES. Can you please describe what forms of technology you use for academic purposes and why?
    a. Probe: Are you required to use them or doing so voluntarily?
    b. Probe: What about for non-academic purposes?
3) Can you also describe how frequently and in what ways you use technology for academic purposes?
    a. Probe: In terms of using an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment for FYES courses, what impacted the frequency with which you used the technology?
    b. Probe: In terms of using email to communicate with an instructor or TA for FYES courses, what impacted the frequency with which you used the technology?
    c. Probe: In terms of using optional Text/Email Notification features from the course management system to complete assignments for FYES courses, what impacted the frequency with which you used the technology?
4) Can you please describe your level of academic success in engineering thus far?
    a. Probe: How has the use of technology in courses impacted your academic success in them?
5) I am interested in learning more about your perceptions of technology. Can you please describe what forms of technology have been important to your academic success thus far and why?
    a. Probe: How important have desktops/laptops been to your academic success and why?
    b. Probe: How important have e-Readers been to your academic success and why?
    c. Probe: How important have tablets/iPads been to your academic success and why?
6) Can you please describe your typical level of involvement in engineering courses?
    a. Probe: Does your willingness to get involved in courses change when technology is used?
7) Is there anything else that you would like to share that we haven't discussed already?

APPENDIX C: Permission to Use Existing Survey Items

RE: Permission to use ECAR Survey Items - Mozilla Firefox

https://pod51034.outlook.com/owa/#viewmodel=ReadMessageItem&ItemID=AAMkAGQ1MDgzMzIzLTgwYzgtNDI0Yy1hY2QzLWYxMGNhOWI4NzkxZQBGAAAAAABko5UF

RE: Permission to use ECAR Survey Items

DELETE REPLY REPLY ALL FORWARD

mark as unread

Eden Dahlstrom <edahlstrom@educause.edu>

Tue 7/2/2013 10:14 AM

To: Leroy Long;

Cc: Kate McTurk <kmcturk@educause.edu>;

• You replied on 10/23/2013 11:26 AM.

Leroy,

I'm pleased to hear that you are interested in using the ECAR student technology studies as a resource for your dissertation. The CC by-nc-nd nature of our survey instruments provides us with the opportunity to waive the "no derivative works" clause, and we do so willingly with the following conditions:

1. Provide appropriate attribution to ECAR by citing us as the source of the original questions
2. Share with us the most interesting findings that result from your project

You may access the most recent survey (2013) or any of the past survey instruments from our project landing page: http://www.educause.edu/ecar/about-ecar/ecar-annual-study-students-and-it. Note that OSU participated in the 2013 project, so if your dissertation research is focusing on Buckeyes, there may already be an existing dataset for you to use. I'm happy to put you in contact with the survey administrator at OSU if you'd like to discuss the options with him.

-Eden

Eden Dahlstrom Senior Research Analyst

Data, Research, and Analytics

EDUCAUSE

Uncommon Thinking for the Common Good

1150 18th Street, NW, Suite 900 Washington, DC 20036

direct: 303.939.0330 | mobile: 530.903.2305 | educause.edu

From: Leroy Long [mailto:long.914@buckeyemail.osu.edu]
Sent: Friday, June 28, 2013 1:44 PM
To: ECAR
Subject: Permission to use ECAR Survey Items

To whom it may concern,

Hi, I am currently in the planning phase for a potential dissertation project. Therefore, I would like to know what steps I would need to take in order to use or adapt portions of the ECAR National Study of Undergraduate Students and Information Technology Questionnaire when providing a survey to my research participants.

RE: Permission to use NSSE Survey Items - Mozilla Firefox

https://pod51034.outlook.com/owa/#viewmodel=ReadMessageItem&ItemID=AAMkAGQ1MDgzMzIzLTgwYzgtNDI0Yy1hY2QzLWYxMGNhOWI4NzkxZQBGAAAAAABko5UF

RE: Permission to use NSSE Survey Items

DELETE REPLY REPLY ALL FORWARD ...

mark as unread

Lambert, Amber Desiree <adlamber@indiana.edu>
Fri 8/9/2013 5:26 PM

To: Long, Leroy L.;
Cc: Gustafson, Robert <gustafson.4@osu.edu>;

- To help protect your privacy, some content in this message has been blocked. To re-enable the blocked features, click here.
- To always show content from this sender, click here.
- You replied on 8/12/2013 2:28 PM.

Leroy,

We don't need an agreement for two questions. You have our permission to use those two items.

Good luck with your research.

Amber

From: Long, Leroy L. [mailto:long.914@buckeyemail.osu.edu]
Sent: Thursday, August 08, 2013 5:10 PM
To: Lambert, Amber Desiree
Cc: Gustafson, Robert
Subject: RE: Permission to use NSSE Survey Items

Hi Amber,

1) Yes, I only wish to use two items from the NSSE survey.

2) My dissertation project should be completed within 2 years, but the first-year engineering program uses journal questions to prompt students on various topics each semester. So, they may have a longer desired use for the items if interesting data is collected. Dr. Gustafson, the PI for the study who is "cc'd" on this message, informed me that OSU would not be administering the NSSE survey for 3 years.

The Ohio State University
Leroy Long
PhD Student: STEM (Engineering) Education
Graduate Teaching Associate: First-Year Engineering Program

The Ohio State University
Office: 342 Hitchcock Hall, Columbus, OH 43210
Phone: 614-292-7923

APPENDIX D: Approval to Conduct the Study

THE OHIO STATE UNIVERSITY

Behavioral and Social Sciences Institutional Review Board

Office of Responsible Research Practices
300 Research Administration Building
1960 Kenny Road
Columbus, OH 43210-1063

Phone (614) 688-8457
Fax (614) 688-0366
www.orrp.osu.edu

September 13, 2013

Protocol Number:	**2013B0358**
Protocol Title:	**EDUCATIONAL STUDIES IN THE FIRST-YEAR ENGINEERING PROGRAM, Kathleen Harper, John Merrill, Richard Freuler, Engineering Education Innovation Center**
Type of Review:	Initial Review—Expedited
IRB Staff Contact:	Michael Donovan Phone: 614-292-6950 Email: donovan.6@osu.edu

Dear Dr. Harper,

The Behavioral and Social Sciences IRB **APPROVED BY EXPEDITED REVIEW** the above referenced research. The Board was able to provide expedited approval under 45 CFR 46.110(b)(1) because the research meets the applicability criteria and one or more categories of research eligible for expedited review, as indicated below.

Date of IRB Approval:	**September 10, 2013**
Date of IRB Approval Expiration:	**September 10, 2014**
Expedited Review Category:	**7**

In addition; the research was approved for a waiver of documentation of the consent process.

If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB-approved consent form and process must be used. Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

This approval is valid for **one year** from the date of IRB review when approval is granted or modifications are required. The approval will no longer be in effect on the date listed above as the IRB expiration date. A Continuing Review application must be approved within this interval to avoid expiration of IRB approval and cessation of all research activities. A final report must be provided to the IRB and all records relating to the research (including signed consent forms) must be retained and available for audit for at least 3 years after the research has ended.

It is the responsibility of all investigators and research staff to promptly report to the IRB any serious, unexpected and related adverse events and potential unanticipated problems involving risks to subjects or others.

This approval is issued under The Ohio State University's OHRP Federalwide Assurance #00006378. All forms and procedures can be found on the ORRP website – www.orrp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.

Michael Edwards, PhD, Chair, Behavioral and Social Sciences Institutional Review Board

Association for the Accreditation of Human Research Protection Programs, Inc. — Full Accreditation

hs-017-06 Exp Approval New CR
Version 05/18/10

Behavioral and Social Sciences Institutional Review Board

Office of Responsible Research Practices
300 Research Administration Building
1960 Kenny Road
Columbus, OH 43210-1063

Phone (614) 688-8457
Fax (614) 688-0366
www.orrp.osu.edu

December 27, 2013

Protocol Number:	**2013B0358**
Protocol Title:	**EDUCATIONAL STUDIES IN THE FIRST-YEAR ENGINEERING PROGRAM, Kathleen Harper, Richard Freuler, John Merrill, Introduction to Engineering**
	Request to amend the protocol dated September 24, 2013--Add 200 participants (new maximum 2700), add Leroy Long III and Deborah Grzybowski as key personnel, add Studies 3, 4 and 5, add instruments (Inverted Felder Inventory, Inverted MSLQ V2, Inverted Questionnaires, Technology Study Questionnaire)
Type of Review:	Amendment #01—Expedited
Approval Date:	**December 24, 2013**
IRB Staff Contact:	Kellie Hall Phone: 614-292-0569 Email: hall.1451@osu.edu

Dear Dr. Harper,

The Behavioral and Social Sciences IRB **APPROVED** the above referenced research.

Note that if applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB-approved consent form and process must be used. Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

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This approval is issued under The Ohio State University's OHRP Federalwide Assurance #00006378. All forms and procedures can be found on the ORRP website – www.orrp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.

Michael Edwards, PhD, Chair
Behavioral and Social Sciences Institutional Review Board

hs-017-03 Approval Amend
Version 05/18/10

Behavioral and Social Sciences Institutional Review Board

Office of Responsible Research Practices
300 Research Administration Building
1960 Kenny Road
Columbus, OH 43210-1063

Phone (614) 688-8457
Fax (614) 688-0366
www.orrp.osu.edu

May 21, 2014

Protocol Number:	**2013B0358**
Protocol Title:	**EDUCATIONAL STUDIES IN THE FIRST-YEAR ENGINEERING PROGRAM, Kathleen Harper, Richard Frueler, John Merrill, Engineering**
	Request to amend the research dated April 8, 2014--Revise study 3 to include interview and add corresponding materials (consent form,interview guide), add study 7 (notebook assignment) and corresponding materials (recruitment email and reminder email, online consent form), revise research protocol accordingly
Type of Review:	Amendment #03- Expedited
Approval Date:	May 21, 2014
IRB Staff Contact:	Michael Donovan Phone: 614-292-6950 Email: donovan.6@osu.edu

Dear Dr. Harper,

The Behavioral and Social Sciences IRB **APPROVED** the above referenced research.

Note that if applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB-approved consent form and process must be used. Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

It is the responsibility of all investigators and research staff to promptly report to the IRB any serious, unexpected and related adverse events and potential unanticipated problems involving risks to subjects or others.

This approval is issued under The Ohio State University's OHRP Federalwide Assurance #00006378. All forms and procedures can be found on the ORRP website – www.orrp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.

Michael Edwards, PhD, Chair, Behavioral and Social Sciences Institutional Review Board

hs-017-03 Approval Amend
Version 05/18/10