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Evaluating multiple factors that can be used as skill predictors in software proficiency

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Evaluating multiple factors that can be used as skill predictors in software proficiency

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business at Virginia Commonwealth University

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Abstract

EVALUATING MULTIPLE FACTORS THAT CAN BE USED AS SKILL PREDICTORS IN SOFTWARE PROFICIENCY

By Stephen Larson, PhD

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business at Virginia Commonwealth University

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Major Director: Dr. Peter Aiken, Associate Professor, Information Systems Department

In this ubiquitous computing society, most students are required to be proficient in computer skills to compete in today’s global job market. These computer skills usually include skills in business productivity applications. Assessing those skills is normally accomplished by hands-on skills exams, which can become onerous and costly. This study explored whether a combination of a computer self-efficacy (CSE) survey, cognitive questions, and skill-based questions could indeed be a valid alternative to a hands-on skills exam. The findings of this study indicate some types of questions may be better predictors of performance on the hands-on skills exam, and some combinations of survey items and questions may be viable alternatives to hands-on skills exams. As a result of this research, schools and companies could adapt these indirect and direct assessments to their situation to perform their own study or assess the skills of their students/employees.
Chapter 1: Research Overview

This chapter will present an introduction to the research being undertaken. First the background, reason and motivation for the study will be discussed. This is followed by a description of the research that has already been done in this area. It concludes with a look ahead to the anticipated results.

1.1 Background

The purpose of schools of business is to prepare students for workplace success. One of the challenges in Information Systems (IS) education is ensuring students have the skills necessary to be successful in the workplace. Skills with business productivity software have been of particular interest, with most of that focus on the student ability to appropriately apply Microsoft Excel to business challenges (Johnson et al. 2006; Gibbs 2009; Grant et al. 2009). To accomplish this, schools must either certify existing competence or ensure students attain the requisite level of competence prior to taking dependent courses or securing employment.

Unfortunately, varying education and access to technology cause students to arrive at business schools with disparate levels of competence and confidence in their capabilities. To ensure students have a minimum level of competence, many schools typically require students to demonstrate competency in certain software programs, either by passing an introductory software skills course or by “testing out” of the course.

Effective assessment of student software skills permits instructors to spend less class time teaching how to accomplish tasks and more time teaching how to interpret the results. When students possess the necessary software competence, instructors can focus on teaching the advanced business topics more effectively.
Unfortunately, the faculty and staff do not possess a complete picture of the competence level of every student. Recent experiences at the school under study indicate deficiencies associated with the present method of assessing the students’ software skills. Incorrect assessment inhibits effective use of contact hours, and results in students not being able to complete assignments, students needing extra help on assignments, and students completing assignments wrong. Research has provided evidence that the average software skill level is insufficient (Case et al. 2004). Schools are motivated to discover a method of ascertaining software competence that is neither costly nor onerous to administer.

This study investigated whether student self-assessment in the form of computer self-efficacy surveys can be a valid predictor of actual competence in business productivity software. Several studies in the educational literature examined students’ use of computers at home. These confirmed that the domestic computing environment has a positive effect on students’ general computer competence (see for example Mumtaz, 2001; Papert, 1980, 1993; Selwyn, 1998; Shoffner, 1990; Subrahmanyam, Greenfield, Kraut, & Gross, 2001). In a number of states, middle school and high school students are issued laptop computers to help them develop competence using computers. Access to a computer with its accompanying software lets the students avail themselves of the opportunity to gain computing experience and develop skills with software.

Hasan (2003) found that eight different types of computer experiences – word processing, spreadsheets, databases, operating systems, graphics, computer games, programming languages and telecommunications – have a positive and significant correlation with computer self-efficacy, and thereby confidence with computers. Unfortunately, however, confidence does not
necessarily lead to competence. Instead there appears to be some concern that confidence may negatively affect competence (Smith 2004; Gibbs and McLennan 2008).

Confidence and competence are widely different outcomes of computing experience. The results of a study by Case et al. “suggests that the majority of students enrolling in university-level introductory computing courses do not possess a sufficient prior knowledge or experience base to warrant removal of such courses from the curriculum,” even when these students had completed multiple computing courses in high school (Case et al. 2004). The students report that they have computing experience, but the experience is not with business productivity software (Boud 1989; Boud and Falchikov 1989). Other studies agree that students do not appear to be learning business productivity software as part of their education (see Gibbs and McLennan 2008; Stone, et al, 2006; Perez and Murray, 2006; etc.).

1.2 Context and motivation

Business schools face frustrations with the varying level of computer skills among incoming students. This is not unexpected, as the typical student is not the same as in the past. Today’s undergraduate student could be either a new high school graduate or a 45 year old with 25 years of experience owning his or her own business. Complicating this is the addition of international students enrolling in US business schools, whose education may or may not have included training on business productivity software. (The studied business school’s student body currently includes 8% international students.) Hence, the students in any particular class may have had no experience with business productivity software to 20 or so years of experience with the software. Thus when faced with an assignment for which expertise in a software program is required, the instructor often must teach to the lowest level of skill.
Students also experience frustrations. Those with expertise in a software program feel that valuable class time is being spent learning to use the software instead of learning how to analyze and interpret the results. Conversely, students with less or no expertise may feel overwhelmed by an assignment which requires software skills beyond their level.

This study occurred in the school of business in a large southeastern university. Much like other schools and colleges of business, the university business school requires that all students have a certain level of expertise in business productivity software such as word processing, spreadsheets, and presentation software before proceeding with upper-level courses.

The school currently allows the students to make their own determination of their computer training needs. It effectively asks a simple question to determine whether a student has the requisite skills in business productivity software. The question (paraphrased) is: “Do you know Microsoft Word, Excel, and Powerpoint well enough to take the upper-level courses?” An affirmative answer allows the student to bypass the one credit, online, self-paced course for each software program; a negative answer requires the student to take the class as a prerequisite to upper-level courses. A score of 80% or better in the class is required. More than two thirds of the students answer in the affirmative. Unlike Case et al. (2004), whose program allowed students to attempt to “test out” of a course by achieving an acceptable score on a 100-item computer literacy assessment test, there is no option to test out of the software skills courses.

Some schools opt to test the students to determine if they need to take the software training classes. Given current budget pressures this proved to be cost-prohibitive at the school under study, and more than likely at other schools. (Even if the cost of the test was passed on to the students, the administrative cost of the test was unable to be borne by the school.)
Evidence overwhelmingly suggests that many of the students who do not take the classes do not possess the requisite skills, and thus require training or risk being unable to take full advantage of their business school experience. This provided the general motivating requirements to develop a computer self-efficacy (CSE) scale/screening tool: 1) that will be easy to implement, (such as an online survey); 2) has a low cost of administration (current assessment tools have a per test cost); and 3) gives reliable results (the screening tool needs to be a valid predictor of actual competence).

1.3 Framework and Model

- Previous research has measured CSE and competence by administering a self-report survey and a pencil and paper test (Marcolin et al. 2000; Merhout et al. 2008). Marcolin’s (2000) study on assessing user competence followed the framework shown in Figure 1. It shows that the self-report measure assessed the students’ perceived cognitive and affective scores, which were then measured against a pencil and paper test. They define cognitive, skill-based, and affective as follows:
- Cognitive outcomes refer to the descriptive knowledge users have about what a technology is and how to use it.
- Skill-based outcomes are associated with the move from verbal knowledge to compilation. Users “develop their ability to generalize procedures to novel tasks, and to speed up performance by moving beyond the step-by-step processes first learned and into more fluid and efficient processes.”
- Affective outcomes are generally concerned with users’ attitudes and values.
For their study, Marcolin, et al. chose to use a self-report and a multiple choice test, since “hands-on testing is typically reserved for skill-based assessments of competence,” and it is dependent not only on task domain skill but also computer domain skill and is quite difficult to employ (Marcolin et al. 2000).

At the conclusion of a longitudinal study by Smith (2004) in which student self-efficacy and performance were measured before and after instruction, it was recommended that Marcolin’s (2000) study be extended to include measurements of computer self-efficacy, software knowledge, and task performance. This study endeavors to meet this call for research by validating the affective or self-report measures with cognitive and skills-based questions, as well as incorporating hands-on measures, and determining whether self-report measures are valid alternatives for hands-on skills exams. Self-report measures abound in the literature (for example Blili et al. 1998; Cheney and Nelson 1988; Harrison and Rainer 1992; Nelson and Cheney 1987; Nelson 1991; Rainer and Harrison 1993; Schroeder and Kletke 1990; Winter et al. 1992; Hakkarainen et al., 2000; Karsent & Roth, 1998; Nurjahan, Lim, Foong, Yeong, & Ware, 2000; Stoner, 1999; van Braak, 2004).
Pencil and paper tests are mostly multiple choice and open-ended questions about what can be done and how. They have generally avoided addressing task accomplishment. These assessments measure cognitive knowledge of the domain (for example, Merhout, et al 2008; Ballentine, et al 2007; Falchikov and Boud 1989).

Skill-based assessments are abundant in the training literature (Olfman and Bostrom 1990; Webster and Martocchio 1993; Compeau and Higgins 1995). Trainers believe that a hands-on test is the true method to measure competence. Though uncommon, hands-on assessment measures have been used in IS (Lamberti and Wallace 1990; Suh and Jenkins 1992). Observer assessment measures (i.e., ratings of skill by independent observers) were common in early literature on user competence (Rockart and Flannery 1983; Panko 1988; Cotterman and Kumar 1989; Hurt 1990; Miriani and King 1994), but have not been found in more recent literature.

A review of the IS literature revealed no studies to date that have used a hands-on skills exam to validate whether a CSE survey could be a valid predictor of competence. This study examines that possibility. Marcolin’s (2000) work will serve as the study’s framework. This research will extend Marcolin’s (2000) work in two important and useful ways:

1) This study incorporates the cognitive and skill-based questions into the assessment pool;

2) It assesses user competence with a hands-on skills exam (a direct measure of skills) to validate the CSE survey results.

Figure 2 shows the evolution of Marcolin’s (2000) framework, with the shaded areas representing this research. It shows that the self-report measure will consist of affective questions (computer self-efficacy), and the paper and pencil test will measure the cognitive and skill-based knowledge and skills. These will be validated by the hands-on, skill-based test.
1.4 Significance

Corporate America considers competency in business productivity software to be necessary for success and a desirable skill for employees to have (see Johnson, Bartholomew, et al. 2006; Murray, Sherburn et al. 2007; Strover, 2003; etc.). Murray, et al. (2007) identified “computer and information technology proficiencies that are perceived to be critical among employees in ten corporations in the discrete manufacturing industry.” They found that skills with business productivity applications are not “just desirable but needed by all employees,” and that those skills are the most important of all computer skills. A vice president at a credit card company stated that business school graduates looking to work in a finance company should have skills in spreadsheets (MS Excel) up to and including pivot tables (Larson 2010). Regrettably, many workers develop their software skills and expertise on the job (Kelly and Shepard 2004), which slows the attainment of job productivity.

Technology-enhanced curricula is required to keep abreast of industry practice (AACSB 2002), and the acquisition of software skills has largely been placed in business education.
programs (Tesch et al. 2003). The significance of this study is that it will examine a potential improvement to the process of getting business school students the necessary business productivity software skills in college.

Figure 3 shows how the survey will incorporate a computer self-efficacy measure in the form of affective questions, and include cognitive and skill-based questions. These will then be validated by a hands-on skills exam. In several experiments in the study, investigators found that before a hands-on experience with a task, consumers are overconfident about their initial mastery of the task; after performing the task, the overconfidence was replaced by self-doubt (Billeter et al. 2011).

![Research Model](image)

**Figure 3. Research model**

### 1.5 Research Question

Given the time and cost that could be saved by using student self-assessment (using a CSE survey) rather than a vendor-supplied hands-on skills exam, it was decided to address the
following research question: *Can a CSE self-report survey be developed to be a valid predictor of actual competence as measured by a hands-on skills based assessment?*

To answer the research question, the data resulting from surveys and hands-on skills exams were analyzed in light of the hypotheses. This determined not only whether a CSE survey could be a valid predictor of actual competence, but in light of the hands-on skills exam results, whether a cognitive assessment, skill-based assessment, or a combination thereof is the better predictor of IS skill competence. Comparisons were used to determine the best predictor of actual competence.

This chapter has presented a research introduction, the study background, and motivation and anticipated outcomes.

**1.6 Outline of Chapters**

Chapter 2 presents the literature review covering the state of research concerning indirect assessment of IS skills in the form of computer self-efficacy surveys and the direct assessment of IS skills. It illustrates the need to extend research to include not only computer self-efficacy / indirect assessment and direct assessment, but to link the former using the latter.

Chapter 3 presents the research design. It will include the nature of the study, the demographics of the target population, the details of the computer self-efficacy survey and its accompanying direct assessment measures and hands-on skills exam. The data collection (pilot study and subsequent data collections) will be outlined, followed by the research question and consequent hypotheses. The chapter closes with a discussion of the processes and procedures that will be followed to develop the direct and indirect assessment measures.

Chapter 4 describes the empirical work done in this research and provides an analysis of the data. The main analysis was conducted and the model tested and analyzed in a manner
consistent with this type of study. Normality and missing data will be addressed, and leading indicators of goodness of fit, correlations, etc. will be reported.

Finally, chapter 5 concludes the discussions generated in the previous chapters, and outlines the results, implications, and conclusions. A summary of the dissertation contributions are presented, along with its limitations. Additionally, chapter 5 provides directions for future research.
Chapter 2: Literature Review

2.1 Introduction

This chapter presents the argument to extend the research to include not only computer self-efficacy vis-à-vis indirect assessment and direct assessment, but also to link the two by validating the former with the latter. It presents a review the existing IS literature on direct versus indirect assessment of IT skills. Relevant Information Systems research articles have been included from the following journals:

| MIS Quarterly | Information Systems Research |
| Journal of Management Information Systems | European Journal of Information Systems |
| Decision Support Systems | Information Systems Journal |
| Journal of Strategic Information Systems | Decision Support Systems |
| IEEE Transactions | Information Management |
| Journal of Information Technology | ACM Transactions |
| Journal of the Association of Information Systems | Journal of Information Systems Education |

In addition, journals in other fields such as education and training were also searched and found to contain relevant information. The self-efficacy site run by Emory University provides a thorough background on self-efficacy, including materials on Professor Albert Bandura and other prominent self-efficacy scholars, self-efficacy and social cognitive theory, self-efficacy instruments and measures, etc. (Emory 2011).

The review includes computer self-efficacy (CSE) surveys and hands-on skills exams, each a subset of IT skills assessment. More detail is presented, outlining the frustrations and challenges faced by business schools with respect to IS skills assessment. This is followed by an overview of direct and indirect assessments of IT skills, including CSE surveys and hands-on skill exams. The literature review identified two categories of findings: Assessment of IS Skills,
and Self-Efficacy. Assessment of IS Skills includes direct and indirect assessment; Self-Efficacy includes computer self-efficacy.

2.2 Direct and Indirect Assessment: Definitions

2.2.1 Direct Assessment

Direct assessments require that students demonstrate mastery of topics or skills using actual work completed by students. This requirement can be accomplished by using papers, presentations, speeches, graded assessment items such as True/False, short answer, multiple choice, or hands-on skills exams (Price and Randall 2008); one school uses a “6-day, comprehensive, cross functional integrative exercise” (McKell et al. 2008).

For this research, the following definition of “direct assessment” will be used: a direct assessment is an assessment in which the participant must demonstrate mastery of topics or skill via actual task completed or by graded assessment measures such as an exam.

2.2.2 Indirect Assessment

Conversely, indirect assessments gather opinions of perceived knowledge or the quality and quantity of learning that takes place (Martell & Calderon, 2005). Techniques for gathering data by using indirect assessment include focus groups, exit interviews, third-party observations, and self-assessment surveys.

For this research, the following definition of “indirect assessment” will be used: an indirect assessment is an assessment in which a participant completes an assessment regarding his or her perceived knowledge of a topic or skill set.
2.3 Review of IS Skills Assessment Literature

Presently, skills with business productivity software is essential for employment. “Employers demand graduates who are prepared to leverage technology in a scalable fashion to advance the firms’ strategies and operations” (Grant et al. 2009). The accurate assessment of those skills is crucial to ensure employees have the skills necessary to accomplish their assigned tasks.

For decades software vendors have attempted to accurately assess skills. Makers of backend office software, vendors of networking equipment and utilities, and makers of hardware, such as servers, backup devices, etc. have all used assessment measures such as multiple choice questions, structured response questions, and the like. Other attempts included adaptive testing, and presently the trend appears to be skill-based or task-oriented assessments.

For example, 15 years ago a person taking a certification exam for a server operating system was required to take an adaptive test in which several topics were presented. The first question for each topic was considered of medium difficulty. If the test taker got the question right, a more difficult question was presented next; a right answer resulted in a change of topic as the test taker was deemed to have sufficient knowledge in that topic area. A wrong answer resulted in 3 or more extra questions, until the testing system determined whether the test taker had sufficient knowledge in the topic. This process was repeated for each topic area of the exam. Thus the test taker could experience exam times ranging from very short, with only 2-3 questions for each topic, to very long, with up to 10 questions per topic.

A decade ago a person taking an assessment to attain certification for popular networking devices only had to answer an exam with 100 multiple choice and fill-in-the-blank questions. The test taker could review each question (which was rather nice for the test taker, as subsequent
questions often gave clues to the right answer for previous questions) and thus the competence may not have been accurately measured. The vendor then had the test taker perform a hands-on skill-based exam in which tasks must be performed. This method is considered to measure not only the cognitive knowledge of the networking device’s operating system, but also the skill required to configure the device; together these were necessary to obtain a certification for the device.

A common type of indirect assessment or measure is the self-report survey. In the literature related to this study, self-assessment has been used extensively assess computer knowledge and skills among students (Karsent and Roth 1998; Stoner 1999; Hakkarainen et al. 2000; Nurjahan et al. 2000; van Braak 2004). Other self-report surveys in which CSE was explored or used to study other phenomena can be found in Table 1 at the end of this chapter.

2.3.1 Self-Efficacy

The basis for computer self-efficacy theory is general self-efficacy theory. Due to the large number of publications on the subject, Albert Bandura is known as the “father of self-efficacy”. He found that individuals create and develop self-perceptions of capability that become instrumental to the goals they pursue and to the control they are able to exercise over their environments. He established:

1. self-efficacy is an individual's perceived ability to perform a specific behavior;
2. self-efficacy is a significant predictor of performance of that behavior; and
3. self-efficacy expectations determine an individual's decision to engage in a behavior, and the amount of effort to be expended and the degree of persistence at the task (Bandura 1977; Bandura 1986).

These perceptions of self-efficacy are developed in response to four main sources of influence (see Figure 4): 1) mastery experiences (actually performing a behavior); 2) vicarious
experiences (seeing another person perform a behavior); 3) social or verbal persuasion (persuasions by others that they possess the capabilities to master given activities); and 4) emotional arousal (people tend to rely on their emotional states in judging their capabilities). Of these four sources of influence or information, performance or mastery is thought to exert the strongest influence on self-efficacy expectations (Bandura 1994).

![Diagram](image)

**Figure 4. Four main sources of influence on perceptions of self-efficacy**

Bandura and Cervone (1986) suggested that self-efficacy is a critical factor for the motivational and learning processes that govern task performance (Bandura and Cervone 1986). Self-efficacy has also been used to predict the level of performance using IT (Grant, et al 2009). Moores and Chang (2009) showed that the psychological literature suggests that self-efficacy can lead to overconfidence and reduce performance over time. In a field study they found that self-efficacy was positively and significantly related to performance. Unfortunately, however, they also discovered that overconfidence leads to a significant negative relationship between self-efficacy and subsequent performance.
In summary, there are several self-efficacy works that show that it has a positive relationship to performance. Endeavoring to determine a person’s self-efficacy level of task performance concerning computers, computer experience or expertise in software applications gave rise to surveys that could be used to measure the construct of computer self-efficacy (CSE).

2.3.2 Computer Self-Efficacy (CSE) Construct

The CSE construct has gone through extensive research and discussion within the literature (see Table 1). Indeed, Gist (1987) and Gist and Mitchell (1992) provide thorough reviews of CSE literature, followed by Marakas’ (2007) detailed examination of the varieties of measures for CSE. As mentioned previously, Emory University’s CSE site also contains a thorough discussion. Highlights of this topic are presented below.

In 1998, Marakas et al. discussed the CSE construct and developed a research framework. Their model (Figure 5) “displays the multifaceted and reciprocal nature of the CSE-Performance relationship as well as the wide variety of known antecedent and consequent variables associated with the formation of CSE perceptions” (Marakas et al. 1998).
Figure 5 Multifaceted Model of Specific Computer Self-Efficacy

(Marakas, Yi et al. 1998) <redrawn for clarity>

This study will validate and extend Marakas et al’s model by validating a number of the antecedents and consequent variables between specific CSE and specific computer performance.

In addition, CSE has broader implications for IS research. While not addressed specifically in this dissertation, these might include:

- Training of employees in technology-related tasks
- Adoption of new technology
• Confidence with which IS projects are approached

These and other items will be addressed in more detail in directions for future research.

2.3.3 General CSE versus Task-Specific CSE

The literature is replete with research regarding general CSE versus task-specific or domain-specific CSE. Subsequent discussion presents a comparison of the two. Marakas et al. delineate between general CSE and task-specific CSE: general CSE “refers to an individual’s judgment of efficacy across multiple computer application domains,” while task-specific CSE “refers to an individual’s perception of efficacy in performing specific computer-related tasks within the domain of general computing” (Marakas et al. 1998).

General CSE is a product of a lifetime of related experiences, and can be thought of as a weighted collection of all CSEs accumulated over time (Marakas et al. 2007). General CSE is not appropriate for estimating efficacy at the task or application level – attempting to measure accordingly will result in a lower explained variance with regard to predicting task performance.

Task-specific CSE (Marakas et al. 1998), also referred to as domain-specific CSE, software-specific CSE, or application-specific CSE (Johnson 2005; Johnson et al. 2008), focuses on the task domain under study.

Hasan describes task-specific CSE as a judgment of efficacy in performing a defined computing task using a specific computer application (Hasan 2006). As such, the measure should reflect the task-relevant specificity level. For example, a measure developed for studying a subject’s perception of his or her ability to use statistical analysis software would not be appropriate for testing said subject’s ability to perform statistical analyses using a spreadsheet.

Examples of task-specific CSE could be measures for word processing, spreadsheets, or databases, each with their own unique measure (Dishaw et al. 2002). Interested readers are
encouraged to review Marakas, Yi, and Johnson (1998) and Marakas, Johnson, and Clay (2007) for more detailed and in-depth examinations of the computer self-efficacy construct.

2.3.4 CSE Surveys

The first CSE survey was a self-developed measure (Marakas et al. 1998). To date, more than 300 studies have focused on the CSE construct, or have been developed, adapted, or reused as a CSE measure. (Please see Table 1 at the end of this chapter for a more comprehensive listing.)

As illustrated in Table 1, CSE surveys have been used in a variety of disciplines; for example education (Brown et al. 1989; Delcourt and Kinzie 1993), and healthcare (Henderson et al. 1993). Among the information systems studies, researchers have studied CSE as it relates to Social Cognitive Theory; creative self-efficacy; learning, education, training, and/or literacy; the Unified Theory of Acceptance and Use of Technology (UTAUT); End User Computing (EUC) Acceptance; the Technology Acceptance Model (TAM); attitudes towards computer usage, gender; new technologies and innovations; adopting new technologies; perceived ease of use (EOU); computer anxiety or frustration; ERP usage or intentions to use ERP; mobile computing self-efficacy (MCSE), and several other topics.

2.3.5 The accuracy of self-report measures or assessments

There is some debate about self-assessment accuracy levels in the information systems field. Boud and Falchikov (1989) found that numerous research studies reported significant leniency bias among self-assessment subjects. One study found that “despite the prevalent use of self-report data in empirical studies, there is a widespread belief among researchers that there are severe threats to its validity which serve to weaken the intended substantive inferences to be drawn from such data” (Chan 2009) Despite being asked to “asseverate to testify with veracity”
without prevarication (Larson 2005) while filling out the measure or survey, participants are wont to overestimate their abilities when filling in self-efficacy survey questions, and many believe that faking or feigning competency is rampant (Chan 2009). Price and Randall (2008) found that “[s]tudents were not able to accurately perceive their knowledge level.” The results of the indirect assessment (knowledge survey) of perceived knowledge did not correlate with students’ actual knowledge (Price and Randall 2008).

Merritt and Smith, et al. (2005) studied the reliability of self-reported computer literacy. The survey subjects first completed a questionnaire concerning their computer literacy and were asked to rate their level of competency with various software applications and computer hardware. Following the survey, subjects then completed an objective measure of computer literacy, which included questions to test the subjects’ knowledge of applications and hands-on performance items. The results give “an indication that self-reported computer literacy is not reliable.”

A similar study “revealed discrepancies between students’ self-efficacy beliefs regarding their level of computer knowledge and skills and students’ demonstrated abilities using Word, Excel, Powerpoint, and Access” (Guy and Lownes-Jackson 2010). Case et al. (2004) found no predictive relationship between student perceptions of their proficiency with productivity software applications and the scores on the assessment test. Like many other direct assessments, the “items on the assessment test were written in textbook-independent language designed to assess the students’ understanding of basic concepts rather than the specialized ways in which these might be addressed in different textbooks” (Case et al. 2004).

A contrasting study found that a self-assessment is a valid proxy for direct assessments in certain situations, and that there is a high correlation between self-assessment and direct
assessment results for highly technical outcomes (Anderson et al. 2010). Likewise, the more able and more experienced a student, the more accurate self-assessment becomes (Boud and Falchikov 1989; van Vliet et al. 1994; Mowl and Pain 1995; Longhurst and Norton 1997; Orsmond et al. 1997; Sullivan and Hall 1997; McCourt Larres et al. 2003; Gravill et al. 2006). Anderson, et al found that students accurately perceived their ability for technical learning outcomes; there was a high correlation between self-assessment and direct assessments for a highly technical learning objective (Anderson et al. 2010).

Thus the literature suggests that while generally self-report assessments are unreliable, in certain cases the results can be trusted. Additionally, the tendency to over-estimate skills, knowledge, and ability appears to be more pronounced among less able and less experienced students. The findings of this study will be used to suggest some improvements that could be made in self-report assessments.

The psychology of why students overestimate their abilities or whether they consciously or subconsciously falsify answers or feign competence is not within the purview of this study; the overestimation of abilities by participants is an accepted assumption.

2.4 Review of Hands-on Skills Assessment Literature

Hands-on skill or performance assessments have appeared less frequently in the IS literature. This might be due to cognitive assessments being the dominant approach and cognitive assessments of competence are usually done with multiple-choice, open-ended, structured-response, or fill-in-the-blank questions (Marcolin et al. 2000). Another reason might be that compared to multiple-choice assessments, hands-on skill assessments are much more difficult and costly to administer and score. Whereas multiple choice assessments can use bubble-type answer sheets and be automatically scored, hands-on assessments must either be
hand-graded or use costly simulation software that can take time to create. Nevertheless, there are a few examples in the IS literature. Compeau and Higgins (1995) used hands-on assessment of subjects’ knowledge of the software packages Lotus 123 and Wordperfect, after training. Lamberti and Wallace (1990) used a hands-on assessment to determine the impact of task uncertainty on performance. Suh and Jenkins (1992) assessed data retrieval and query correctness performance on a database (see also Olfman and Bostrom 1990).

Hands-on is usually used for testing of skills, training and education, and simulations (Elbadawi et al. 2010; Greenberg and Schneider 2010; Lazarony and Driscoll 2011; Lyons 2011; Mayer et al. 2011), and is widely used in industry. Vendors of hardware and software certify skill levels through various hands-on exams in which the test-taker must accomplish tasks using the hardware or software under examination. Temporary staffing agencies utilize hands-on skills testing to verify skills with software packages before assigning personnel to customer sites. These hands-on exams are domain-specific, and multiple exams are used to certify different skill levels.

**Summary**

In this chapter the research literature regarding direct and indirect assessments, including self-report surveys and hands-on skill exams, has been discussed. To summarize, this literature review has shown that assessment of IS skills has evolved over the years, utilizing both direct and indirect assessments. Moreover, indirect assessments in the form of self-report surveys have a number of accuracy weaknesses. No study has developed a method to overcome those weaknesses. CSE is a major part of indirect assessments, and the CSE construct has also evolved. This study addresses the research gaps by validating a self-report survey with a hands-on skills exam. Further, this study re-measures the participants’ self-report CSE ratings after the
hands-on skills exam to discover any change in perception of their capabilities with regard to performing specific tasks in MS Excel.

Table 1 lists studies with a focus on the CSE construct, that have used CSE to explore or study other phenomena, or that have developed, adapted, or re-used a CSE measure.

Table 1: Uses of CSE and Related Scales

<table>
<thead>
<tr>
<th>Uses of CSE and related scales</th>
<th>References</th>
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<tbody>
<tr>
<td>CSE and Social Cognitive Theory</td>
<td>(Venkatesh et al. 2003; Hsu et al. 2004; Kuo et al. 2004; Chiu et al. 2006; Lam and Lee 2006; Liaw et al. 2006; Looney et al. 2006; McFarland and Hamilton 2006; Shih 2006; Hsu et al. 2007; Lu and Hsiao 2007; Lin and Huang 2008; Santhanarn et al. 2008; Shih 2008; Soh and Subramanian 2008; Lu and Hsiao 2009)</td>
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<tr>
<td>CSE and creative self-efficacy</td>
<td>(Yang and Cheng 2009)</td>
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<tr>
<td>CSE and learning / education / training / literacy</td>
<td>(Wang et al. 2009), (Abdrbo et al. 2009), (Yuen and Ma 2008), (Tung and Chang 2008), (Tung and Chang 2008), (Wang 2007), (van Braak and Tearle 2007), (Markauskaite 2007), (Lim et al. 2007), (Liaw et al. 2007), (Lee et al. 2007), (Koseoglu et al. 2007), (Huang et al. 2007), (Bayirtepe and Tuzun 2007), (Bates and Khasawneh 2007), (Stephens 2006), (Ong and Lai 2006), (Mills et al. 2006), (Liaw et al. 2006), (Lee 2006), (Koh 2006)</td>
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<tr>
<td>CSE and End User Computing (EUC) Acceptance</td>
<td>(Harris 1999; Vandenbosch 1999; Wu et al. 2007)</td>
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<td>Uses of CSE and related scales</td>
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<tr>
<td>CSE and attitudes towards computer usage</td>
<td>(Morris et al. 2009), (Shih 2006), (Pare et al. 2006), (Liaw et al. 2006)</td>
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<td>CSE and gender</td>
<td>(Lu and Hsiao 2009), (Askar and Davenport 2009), (Wang and Wang 2008), (Kuo et al. 2007), (Imhof et al. 2007), (Ong and Lai 2006), (Ng 2006)</td>
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<td>CSE and new technologies / innovations; adopting new technologies</td>
<td>(Junglas et al. 2009), (Ernstmann et al. 2009), (Yuen and Ma 2008), (Venkatesh et al. 2008), (Yeow et al. 2007), (Mathieu et al. 2007), (Lee et al. 2007), (Compeau et al. 2007), (Yi et al. 2006), (Yang et al. 2006), (Lin 2006), (Lam and Lee 2006), (Hovorka and Larsen 2006), (Hasan 2006)</td>
</tr>
<tr>
<td>How CSE affects the use of computers</td>
<td>(Isman and Celikli 2009), (Shih 2006), (Pare et al. 2006), (Ng 2006)</td>
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<td>Uses of CSE and related scales</td>
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<tr>
<td>CSE and perceived ease of use (EOU)</td>
<td>(Venkatesh and Davis 1996; Agarwal and Karahanna 2000; Davis and Wiedenbeck 2001; Hong et al. 2001; Patrick 2001; Seyal et al. 2002; Thong et al. 2002; Hu et al. 2003; Wang et al. 2003; Wang 2003; Li et al. 2004; Seyal and Pijpers 2004; Avlonitis and Panagopoulos 2005; Hasan 2006; Lee 2006; Lin 2006; Lin 2006; Ong and Lai 2006; Lee et al. 2007; Wu et al. 2007; Chang and Tung 2008; Kim and Forsythe 2008; Nov and Ye 2008; Roca and Gagne 2008; Siracuse and Sowell 2008; Teo et al. 2008; Teo et al. 2008; Tung and Chang 2008; Yuen and Ma 2008; Fakun 2009; Lee and Kim 2009)</td>
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<tr>
<td>CSE and age</td>
<td>(Locke et al. 1984; Anandarajan et al. 2000; Pearson et al. 2002; Mirchandani and Lederer 2004; Lam and Lee 2006; Bunz et al. 2007; Lee et al. 2007; Poon 2008; Wang and Shih 2009; Wang et al. 2009)</td>
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<tr>
<td>CSE and ERP usage or intentions to use ERP</td>
<td>(Lim et al. 2005; Shih 2006; Kwahk and Lee 2008; Scott 2008; Wang et al. 2008; Chou and Chen 2009)</td>
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<td>Uses of CSE and related scales</td>
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<td>mobile computing self-efficacy (MCSE), including mobile phones, PDAs, etc.</td>
<td>(Lee 2003; Teo and Pok 2003; Luarn and Lin 2005; Wang et al. 2006; Huang et al. 2007; Kwon et al. 2007; Lee et al. 2007; Lee et al. 2007; Mort and Drennan 2007; Seo et al. 2007; Wang 2007; Wu et al. 2007; Dickinger et al. 2008; Kang et al. 2008; Mahatanankoon and O'Sullivan 2008; Poon 2008; Srivastava and Rangarajan 2008; van Biljon and Kotze 2008; Wang and Wang 2008; Junglas et al. 2009; Wang et al. 2009)</td>
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<tr>
<td>CSE and the IS Continuance (ISC) model</td>
<td>(Wang et al. 2008), (Savaya et al. 2006)</td>
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<tr>
<td>CSE and online / internet stuff</td>
<td>(Wang and Wang 2008), (Turel et al. 2008), (Wang and Liao 2008), (Tung and Chang 2008), (Tung and Chang 2008), (Whitty and McLaughlin 2007), (Lu and Hsiao 2007), (Lin 2007), (Kwon et al. 2007), (Kim et al. 2007), (Chiu and Wan 2007), (Bunz et al. 2007), (Bates and Khasawneh 2007), (Torkzadeh et al. 2006), (Looney et al. 2006), (Lin 2006), (Lam and Lee 2006), (Hong 2006), (Galletta et al. 2006), (Featherman et al. 2006), (Dimitrova and Chen 2006),</td>
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<tr>
<td>CSE and knowledge sharing</td>
<td>(Chiu et al. 2006), (Kuo and Young 2008), (Kuo and Young 2008)</td>
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<tr>
<td>CSE and Attribution Theory</td>
<td>(Thatcher et al. 2008)</td>
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<tr>
<td>CSE scale and related scales</td>
<td>(Marakas et al. 2007), (Stephens 2006), (Kurbanoglu et al. 2006), (Bandura 2006)</td>
</tr>
<tr>
<td>CSE and computer collective efficacy</td>
<td>(Hsu et al. 2007), (Hardin et al. 2007), (Fuller et al. 2006)</td>
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Chapter 3: Research Design

This chapter presents the research method. The chapter describes the demographics of the target population. It next presents an overview of the computer self-efficacy survey and its accompanying direct assessment measures and hands-on skills exam. The next section outlines the study; that is, how the survey type was chosen, and the multiple choice questions and hands-on skill exam. A discussion of the research question and ensuing hypotheses is followed by a description of the data collection.

3.1 Demographics of study population

The target population was School of Business students. The studied business school has several departments and majors: Accounting; Economics; Finance, Insurance and Real Estate; Information Systems; Management; and Marketing. The race/ethnicity and major demographics within the student body of the school of business can be seen in Figure 6. This combination of majors and ethnicities provide a good mix of students with differing abilities with Excel.

As all school of business students must pass an Introduction to Information Systems course prior to graduation, the students from several sections of this course were invited to participate. Study participants received extra credit for participating in this research.
3.2 CSE Survey and Hands-on Skills Exam

The study used a self-report survey, which included demographic questions, affective (CSE) questions, and cognitive/skill- and task-based questions.
The survey was administered online immediately preceding the hands-on skills exams. This denied the students time to potentially prepare for the hands-on skills exam. Microsoft Excel was chosen as the task domain because Microsoft Office is the standard business productivity suite for the school of business where the study was conducted.

Because Simon, et al. found that cognitive ability failed to be a good predictor of performance (Simon et al. 1996), it was decided to validate the CSE rating with not only cognitive questions, but also a hands-on skills exam. This is important because while the survey will help determine if the students can “talk the talk,” the hands-on skills exam will determine if they can “walk the walk.” Rogers (2006) noted, “as evidence of student learning, indirect methods are not as strong as direct measures because assumptions must be made about what exactly the self-report means.”

The results of the study by Price and Randall (2008) indicate that self-reporting is unreliable. Eighty-five percent of students showed no significant relationship between their perceived knowledge and their actual knowledge of a subject. The inability of the students to identify their knowledge level implies that to accurately measure competence, direct measures should be employed; thus the indirect measure (survey) will be followed by a direct measure (hands-on skills exam).

The hands-on skills exam was provided through a grant-in-kind from a private company. The company is a provider of online software training and testing, and provided free test codes to allow study participants to take the hands-on skills test. The score on the hands-on skills exam will help determine which question type(s) in the self-report survey prove(s) to be the better predictor of competence.
3.2.1 The CSE survey

When faced with a new CSE research question, the researcher must make a decision about whether to reuse or adapt an existing measure or scale, or create a new measure or scale. The common practice of researchers is to use a well-known validated scale to measure the construct in question. Using a scale that is well-known in the literature seems to add credibility to one's research – a new scale is not being introduced, and it further validates the original work.

Marakas, et al. (2007) found that the "reuse of long-standing instruments to measure CSE may not be the most effective approach to the study of the construct," especially in a volatile domain such as computers. Boudreau, Gefen, and Straub (2001) point out that the practice of reuse has been interpreted by some to mean that "use of previously validated instruments is a superior practice to revalidating and/or creating new measures for constructs,” but they are quick to point out that “[n]othing could be further from the truth.”

Marakas et al. (1998) state further that "an existing measure of CSE must be given substantial and careful consideration when weighing the costs and benefits of adopting the existing measure against the development of a measure more targeted to the task or application under study.” Their study results also suggests a framework for CSE measure development proposed by Marakas et al. (1998) that can be used as an effective guide for researchers to follow when developing new CSE measures, presented as follows:

- All questions must focus on the subject’s perceived ability to perform a specific task without regard to outcome expectations or derived benefits.
- All questions must elicit estimations of ability within a task-specific rather than a general context.
- Specific questions must avoid ability assessments that include cross domain or general-domain skills.
• The level of analysis (LOA) of the requested estimation of perceived ability must agree with the level of analysis of the task and subsequent performance measure.

• The ordering of questions must avoid inappropriate or unnecessary anchoring with regard to perceived rather than actual increasing levels of task difficulty or complexity.

A factor to consider when choosing a method for measuring efficacy beliefs is the context being studied (Bandura 1997; Marakas et al. 1998), in essence, how specifically the efficacy beliefs match the domain of interest (Hardin et al. 2007). Measures that more closely match the context have been shown to be the best predictors of performance (Bandura, 1997; Hardin et al., 2006; Johnson & Marakas, 2000). Subsequently, general measures of CSE are predictive of general computer performance (Compeau and Higgins, 1995), whereas application-specific CSE measures are more predictive of application-specific computer performance (Johnson and Marakas, 2000).

“Efficacy items should accurately reflect the construct. Self-efficacy is concerned with perceived capability. The items should be phrased in terms of can do rather than will do. Can is a judgment of capability; will is a statement of intention” (Bandura 2006). Marakas et al. found that "if the intention is to closely isolate the CSE construct for the purpose of explaining the maximum amount of variance in one or more dependent variables, it is likely that a new measure of CSE, constructed to be closely aligned to the task or application under study, may need to be developed from scratch rather than adopted for reuse from a previously published measure” (Marakas et al. 2007).

One goal of the current study is to determine whether the self-perceived proficiency (computer self-efficacy) is a good predictor of actual performance on a hands-on skills exam (Grant et al. 2009). As previously stated by Bandura, “self-efficacy is concerned with perceived
capability (Bandura 2006). Thus the CSE survey in this study is a newly constructed measure that, in addition to demographical information, endeavors to capture the students’ self-perceived proficiency, cognitive knowledge, and task- and skill-based knowledge in spreadsheet tasks using Excel. Based on the framework and these recommendations, the CSE survey was constructed that asked pertinent questions about the participants’ perceived ability to perform tasks in Excel.

The survey consists of four major sections. The first section of the survey is designed to capture demographical information about the participants. The second section is designed to capture students’ access to and experience with computers in general. The third section is designed to ascertain the students’ perceived knowledge and experience with Excel experience using a 5-point Likert scale. The fourth section contains affective (CSE) questions concerning the participants’ perceived skills with Excel, and cognitive/skill-based Excel specific questions. The survey is presented in Appendix 4.

3.2.2 Cognitive and Skill-based Questions

Several of the cognitive and skill-based questions are aligned with the affective (CSE) questions and tasks on the hands-on skill exam. This allowed for finer granularity for analyses – the CSE ranking, cognitive, and skill-based questions could each be compared with the hands-on exam performance.

The cognitive and skill-based questions are in multiple-choice format (Ballantine et al. 2007). Each question has four possible answers, one correct and 3 incorrect or deflector answers. Multiple-choice tests provide easy analysis and reward only precision, thus no reward is given for partial knowledge (Hibberd 1996).
3.2.3 The Hands-on Skills Exam

Various computer applications training and assessment tools exist in the market today (e.g. MyIT Lab, SimNet, etc.). All of these tools assess a range of skills in computer applications. While all of the vendors’ exams were usable, a few of the vendors only gave a pass/fail grade on the skills exam. The skills exam was given using SAM 2007 available from Course Technology’s Cengage Learning series. SAM 2007 is a skills assessment tool that offers skills assessment in the Microsoft Office suite in a simulated environment. Fifty skill assessment tasks within Excel were chosen. The task list was reviewed by faculty members for appropriateness. During the skills-exam, the tasks were presented randomly to students to avoid inappropriate or unnecessary anchoring with regard to perceived rather than actual increasing levels of task difficulty or complexity. Students could skip questions and/or end the exam at any point.

Tasks were categorized as general, basic, and intermediate. The three categories are defined as follows:

- **General tasks** are tasks common to most of the applications within the Microsoft Office suite, such as changing the color of text or changing the paper orientation. These types of tasks also follow the same processes. “For example, those learning word processing might proceed from the knowledge that applying bold formatting to text can be accomplished by highlighting the text and then selecting “bold” from a menu or toolbar, and that applying underline is accomplished the same way” (Marcolin et al. 2000). An example general task might be “Center the text in the selected cells.”

- **Basic tasks** are tasks that are considered basic or beginning skills within Excel, such as summing a column of numbers. These types of tasks have virtually no equivalent in other software programs, yet are used often within the software program. An
example basic task might be “Remove the worksheet "OFFICES" from the workbook.”

- **Intermediate tasks** are tasks such as editing a chart or setting the print area of a spreadsheet. Intermediate tasks are not generally used on a regular basis, and tend to require a few repetitions before the commands are stored in the user’s memory for later recall. An example intermediate task might be “Automatically arrange the selected rows so that each item in the first column will appear in alphabetical order.”

Many of the tasks aligned with the questions of the CSE survey and the cognitive questions to facilitate finer granularity for analyses; for example, comparing the CSE ranking for printing with the printing tasks on the exam. For a list of the 50 tasks and a sample screenshot of a task, please see Appendix 5.

### 3.3 Research Question and Hypotheses

The goal of the present study is to provide insight on the use of direct versus indirect techniques as means of assessing competence, with the hope that these findings can be used as input to developing a screening tool that will help evaluate whether students need training in business productivity software. Given the time and cost that could be saved by using student self-assessment in IS program readiness, and given the uncertainty about the accuracy of student self-assessment, it was decided to address the following research question: Is a CSE self-report survey a valid predictor of actual competence as measured by a hands-on skills based assessment?

Based on the literature review and the goal of the study, the following hypotheses were developed:

H1) Participants who rate themselves higher on a CSE survey should also have a higher score on the hands-on skills exam.
H2) Participants with more computing experience will have a higher score on hands-on skills exam.
   a) Participants with more experience with the software package being used in the study will have a higher score on the hands-on skills exam.
   b) Participants with more experience with the particular software version being used in the hands-on skill exam will have a higher score on the hands-on skills exam.

H3) A combination of indirect and direct assessments is a valid alternative to a hands-on skills test.
   a) A combination of CSE survey and cognitive questions is a valid alternative to a hands-on skills test.
   b) A combination of CSE survey and skill-based questions is a valid alternative to a hands-on skills test.
   c) A combination of cognitive questions and skill-based questions is a valid alternative to a hands-on skills test.
   d) A combination of CSE survey, cognitive questions, and skill-based questions is a valid alternative to a hands-on skills test.

These hypotheses are summarized as Figure 7 and are presented individually below.
The results of a study by Shih (2008) found that self-efficacy is a strong and positive antecedent of competence. “Through inefficacious thought… people distress and depress themselves and constrain and impair their level of functioning” (Wood and Bandura 1989), which suggests that the lower the self-reported CSE score, the lower the score expected on the hands-on skill exam. Compeau and Higgins (1995) hypothesized that “[i]ndividuals with high computer self-efficacy will score higher than those with low computer self-efficacy on measures of performance.” Likewise, it is hypothesized that people with a higher CSE score will have higher scores on the hands-on skills exam:

**H1: A higher CSE self-rating should lead to a higher score on the hands-on skills exam**

Several studies found that computing experience at home contributed positively to computer competence – the more domestic computing experience a person has, the more competence should be observed (Mumtaz, 2001; Papert, 1980, 1993; Selwyn, 1998; Shoffner, 1990; Subrahmanyam, Greenfield, Kraut, & Gross, 2001). Hence it is hypothesized that people with more computing experience should do better on the cognitive portion of the survey and on the hands-on exam:

**H2: Computing experience has a positive relationship to the score on the cognitive portion of the survey and hands-on skills exam**

Specific types of computer experience have a unique influence on CSE beliefs; some types of experience with computers have a stronger and more significant effect on CSE beliefs
than others (Hasan 2003). For this reason, it is hypothesized that people with Excel experience will have a higher CSE score and a higher score on cognitive portion of the survey and hands-on skills exam than people whose experience is with a different spreadsheet program:

**H2a: Experience with a software package has a positive relationship to the score on the CSE survey and on the cognitive and hands-on skills exams.**

Software package version matters. Past performance also tends to have a positive effect on CSE. Locke, et al. found that “self-efficacy was more strongly related to past performance than to future performance” (Locke et al. 1984). There are several versions of Excel currently in use today; the version used in the hands-on exam is version 2007. Excel for Windows versions 2007 and 2010 and Excel for MAC version 2011 use a ribbon that is unlike the menus and task bars of previous versions. Thus it is hypothesized that people with past experience with Excel for Windows 2007 and/or 2010 or Excel for MAC 2011 will have a higher score on the multiple-choice or hands-on skills exams than those whose past experience only includes version 2003 or previous:

**H2b: Experience with the software version being used in the exams has a positive relationship to the score on the multiple choice or hands-on skills exam.**

Evans and Simkin (1989) found that no single set of variables, be it demographical, behavioral, cognitive, etc., dominated the others as a “best” set of predictors of performance. Rather, they found that several factors may be useful in forecasting computer proficiency. Hence, it is anticipated that the study will be able to compare the following to determine which variable or combination of variables provides the best predictor of actual competence:
H3: A combination of indirect and direct assessments is a valid alternative to a hands-on skills test.

Hypothesis 3 will be tested via the following sub-hypotheses.

H3a: A combination of CSE survey and cognitive questions is a valid alternative to a hands-on skills test.

H3b: A combination of CSE survey and skill-based questions is a valid alternative to a hands-on skills test.

H3c: A combination of cognitive questions and skill-based questions is a valid alternative to a hands-on skills test.

H3d: A combination of CSE survey, cognitive questions, and skill-based questions is a valid alternative to a hands-on skills test.

This study will adapt and extend Marakas’ (2007) Multifaceted Model of Specific Computer Self-Efficacy (see Figure 5). Specifically the relationship between “specific computer self-efficacy” and “specific computer performance.” will also be re-evaluated.

This study will likewise evaluate whether specific cognitive knowledge is a predictor of specific computer performance. In summary, Figure 8 shows the abbreviated model we will study. It shows the anticipated relationships between

- Specific cognitive knowledge and specific computer self-efficacy
- Specific computer self-efficacy and specific computer performance
- Specific computer performance and prior (post) success or failure
- Prior (post) success or failure and specific computer self-efficacy
3.4 Data collection

The data collection fulfilled two goals. The first goal is for a program assessment. A member of the curriculum committee wanted to find out whether an introductory course on Excel should be a prerequisite for upper-division business courses. The second goal is to help accomplish this research.

The requisite subjects were obtained by coordinating with two faculty members, one in charge of the introductory software courses and one on the school of business curriculum committee. It was decided to run a pilot study during the Summer 2010 semester, and subsequent studies over the Fall 2010 and Spring 2011 semesters.

The pilot study was used to fine-tune the CSE survey questions to more accurately measure the skills and determine which demographic questions were appropriate. Processes and measures from previous studies were used in order to determine where they could be adapted and/or enhanced in order to discover the most appropriate measures.

The subsequent studies were conducted three times across the two terms in order to increase the diversity of student populations. The studies were also conducted at different times.
within the terms – one at the beginning of the term, one just after midterm exams, and one near the end of the term – to avoid timing biases.

As an incentive to take the survey and exam, students were assigned extra credit points for participation. The collected data was recorded and verified manually in an Excel spreadsheet, and later exported to SPSS for analyses.

**Pilot Study (Summer 2010)**

The pilot study was conducted with 74 students. The students had a week in which to take the CSE survey. This was done at their leisure and a time of their choosing. Following the survey, the students gathered in a computer lab to take the hands-on skills exam consisting of 50 tasks using Excel.

Following the pilot study, it was determined that additional demographical information was needed. The results also showed that more detailed questions about the students’ CSE concerning Excel were necessary. Those changes were made for the next data collection. Specifically, questions were added to discover the students’ Excel experience, which version of Excel the students are most comfortable with, which Operating System they used, etc.

The pilot study also showed that students expected the hands-on skills exam to be more realistic and true to life. When faced with a task to accomplish, they expected to be able to have more than one try to get the correct answer. The pilot study did not allow for multiple tries on task accomplishment.

**First study (Fall 2010)**

The first study took place in two separate computer labs to accommodate a high number of expected participants. The 128 students who participated took the skills exam directly after
the CSE survey. The study occurred during the second half of the academic term, shortly after midterm exams.

Additional demographic questions were added to gather more useful data. The questions concerning Excel experience and knowledge in the CSE survey were also changed to gather more specific information.

During this study, students were given up to 10 tries on each question. As a result, several students spent over 2 hours on the exam.

Second study (Spring 2011)

The second study took place near the beginning of the academic term. One hundred three students participated. On the survey two “trick” or counter-intuitive questions were added to the CSE questions to discover whether such questions could help determine whether the participants can accurately rate their skills on Excel.

Third study (Spring 2011)

The third study took place near the end of the academic term. Forty one students participated. The cognitive and skill-based questions were added to the survey to better identify whether cognitive knowledge has effect on performance. Additionally, participants were requested to answer the CSE questions again after the hands-on skills exam.

In summary, the pilot and data collection events allowed us to accumulate over 250 observations. The analysis results and conclusions will be discussed in chapters 4 and 5 respectively.
3.5 Analysis Plan

Rogers (2008) explained that when analyzing data from assessments, “[i]n most cases, descriptive statistics is all that you need to use. … generally, sophisticated statistical analysis is not required.”

Similarly, Case et al (2004) administered a computer literacy test in which regression, correlation analysis, and stepwise regression was used to determine whether independent variables could be used as predictors of scores on the test and to find the overall best predictive model.

In a study in which students’ perception of their computer proficiency was compared with their knowledge of three levels of proficiency in computer application skills, the researchers used descriptive statistics and simple regression to analyze the data (Grant et al. 2009).

Following their lead, this study will use descriptive statistics, regression, and stepwise regression to analyze the data and find the best predictive model among the variables. Multivariate statistics will also be used to analyze the data.

3.6 Assumptions

In all research there are some assumptions which must be made. In this study, the following are assumed:

- A self-report survey method is good enough to determine an individual’s perceived self-efficacy with a software program. As shown in the literature review, self-report surveys are widely used in research, yet their reliability is questioned by some.
- The vendor’s simulated hands-on skills exam is sufficient and accurately measures the students’ skills. Several vendors use hands-on skills exams in a simulated environment. For the purposes of this study, an off-the-shelf exam is assumed to be appropriate and sufficient.
Summary

This chapter outlined the demographics of the target population, followed by an overview of the computer self-efficacy survey and its accompanying direct assessment measures and hands-on skills exam will be discussed. The processes used to conduct the study, the research question and ensuing hypotheses were discussed, followed by how the data for the study was collected. The next chapter will discuss the data analysis.
Chapter 4: Analysis and Discussion

This chapter provides an analysis of the data. The main analysis will be conducted in a manner consistent with the procedures methods found in the literature for this type of study. The model tested and analyses within the study will be reported in accordance with generally accepted guidelines. Every effort has been made to report the findings and methods used in this study as completely as possible.

4.1 Pilot study results

Of the 128 students who took both the survey and hands-on skill exam in the pilot study, 60% of the students were male and 40% were female. Most participants are majoring in one of the 6 majors in the school of business; however, 14 students were from majors outside the school of business. The majority of students were juniors (72) and seniors (47). The initial results from the pilot study were not unexpected. Computing experience, comfort level with computers, and class standing (sophomore, junior, etc.) had a positive influence on competence as measured by the hands-on exam. Windows users scored better than MAC and Linux users, possibly because users of Excel for MAC have a different interface, and Excel does not run on Linux platforms.

For computer usage history, 2/3 of the students have used a computer for over 10 years; the remaining 1/3 have used a computer for 3-10 years. Not surprisingly, none of the students are neophytes with computer usage of less than 3 years.

4.2 Demographics of study participants

Table 2 provides the demographical data provided by the participants. This data is the summary of the answers the 269 total participants submitted on the self-rating CSE survey. As Table 2 shows, the participants were primarily male (63% versus 36% female), with over half of
the students being up to 22 years old. As the class from which the students volunteered is a 300-level course, as expected the majority (69%) of students were juniors.

Table 2: Participant Demographics

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 22 years old</td>
<td>55%</td>
<td>Accounting 19%</td>
</tr>
<tr>
<td>23-26 years old</td>
<td>30%</td>
<td>Business Administration, Entrepreneurship, or International Management 20%</td>
</tr>
<tr>
<td>37-35 years old</td>
<td>10%</td>
<td>Economics 3%</td>
</tr>
<tr>
<td>Over 35 years old</td>
<td>5%</td>
<td>Finance, Insurance, Risk, or Real Estate 15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Human Resources 3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information Systems 19%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marketing 12%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other 9%</td>
</tr>
</tbody>
</table>

Computing experience, satisfaction, and comfort level

Students were asked to rate themselves in three different areas relating to their experience, comfort, and satisfaction with computers:

1. how long they have been using computers (computer experience),
2. how comfortable they are using computers (comfort level), and
3. how satisfied they are with their computer skills (satisfaction).

As can be seen in Table 3, the majority of the students have used a computer for over 7 years, with over 2/3 of them having more than 10 years’ experience with computers. Less than 1/3 (31%) of the students were either satisfied or very satisfied with their skills using a computer; very few (5%) were unsatisfied with their computer skills. An overwhelming majority of students are comfortable working with computers.
As outlined in Table 4, the length of time a student has used a computer is not significantly related to the student’s comfort level in using a computer ($r = .006, p = .922$), and is negatively related to satisfaction with computer skills ($r = -.203, p = .001$), while there is a positive relationship between comfort level and satisfaction ($r = .349, p < .001$). While this suggests that as the length of time a student has used a computer increases, satisfaction with his or her computer skills decreases, the $r$-squared value is only .041, meaning that computer experience only accounts for 4% of the variability in satisfaction with computer skills.

Likewise, though there is a significant and positive relationship between comfort level and satisfaction with computer skills, the $r$-square value is only .121, indicating that only 12% of the variability in satisfaction is attributed by the comfort level.
Table 4: Correlations of length of computer usage, comfort level, and satisfaction with skills

<table>
<thead>
<tr>
<th></th>
<th>How long have you been using a computer?</th>
<th>How comfortable do you feel using computers, in general?</th>
<th>How satisfied are you with your current skills for using a computer?</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long have you been using a computer?</td>
<td>Pearson Correlation: 1</td>
<td>.006</td>
<td>-.203**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>269</td>
<td>269</td>
<td>269</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.922</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>269</td>
<td>269</td>
<td>269</td>
</tr>
<tr>
<td>How satisfied are you with your current skills for using a computer?</td>
<td>Pearson Correlation: -.203</td>
<td>.349</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.000</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>269</td>
<td>269</td>
<td>269</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

While interesting, these results suggest that a student’s computing experience, the comfort level with computers, and the satisfaction with his or her computer skills are moderately interdependent.

Performing regression analysis of these variables against the dependent variable (score on the hands-on skills exam) resulted in a total R Square value of only .025, which shows that about 2.5% of the variation in the score of the hands-on skills exam can be attributed to these three variables (see Table 5).

Table 5: Model summary for length of computer use, comfort level, and satisfaction

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
<td>F Change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>df1</td>
<td>df2</td>
</tr>
<tr>
<td>1</td>
<td>.133a</td>
<td>.018</td>
<td>.014</td>
<td>23.547</td>
<td>.018</td>
<td>4.424</td>
</tr>
<tr>
<td>2</td>
<td>.143b</td>
<td>.021</td>
<td>.013</td>
<td>23.561</td>
<td>.003</td>
<td>.711</td>
</tr>
<tr>
<td>3</td>
<td>.158c</td>
<td>.025</td>
<td>.013</td>
<td>23.556</td>
<td>.004</td>
<td>1.110</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), How long have you been using a computer?
b. Predictors: (Constant), How long have you been using a computer?, How comfortable do you feel using computers, in general?

c. Predictors: (Constant), How long have you been using a computer?, How comfortable do you feel using computers, in general?, How satisfied are you with your current skills for using a computer?

d. Dependent Variable: Hands-on score

4.3 Data Analysis and Results

This section will outline the data analysis and results. Where detailed analyses were performed, summary results will be discussed, and the detailed analyses will be listed in the appendices.

4.3.1 Hypothesis 1

Hypothesis 1 predicts that participants who rate themselves higher on a CSE survey should also have a higher score on the cognitive and skill-based questions and on the hands-on skills exam.

The descriptive statistics for the CSE items are shown in Table 6. The mean CSE ratings range from 3.50 to 4.40. (In the Likert scale used for this survey, 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree.) The hands-on skills exam score of 73% is fundamentally an average grade. Students who take the Introduction to MS Excel course must receive an 80% to pass the course.

Table 6: Descriptive Statistics for Hypothesis 1 CSE items

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-on score</td>
<td>72.86</td>
<td>23.710</td>
<td>248</td>
</tr>
<tr>
<td>I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets</td>
<td>3.50</td>
<td>1.022</td>
<td>248</td>
</tr>
<tr>
<td>I know enough about using spreadsheet software to take upper-level business courses</td>
<td>3.54</td>
<td>1.017</td>
<td>248</td>
</tr>
<tr>
<td>I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet</td>
<td>4.40</td>
<td>.723</td>
<td>248</td>
</tr>
<tr>
<td>I feel confident that I can work with multiple worksheets in a workbook file</td>
<td>4.03</td>
<td>.904</td>
<td>248</td>
</tr>
</tbody>
</table>
The analysis for hypothesis 1 will have two parts: each CSE question will be considered individually, followed by the overall CSE rating.

Analyses of each CSE item

The analysis of each CSE item is summarized below. The detailed analyses of each CSE item, including SPSS printouts of model summaries, coefficients, and box plots, may be viewed in Appendix 7.

All of the CSE items weakly or moderately support hypothesis 1. The CSE questions had R Square values ranging from 0.034 to 0.121, and Coefficients ranging from 4.892 to 11.140, as can be seen in Table 7. All of the coefficients were positive, and each had a 95% confidence interval (CI) that had both positive lower bounds and upper bounds.

Table 7: CSE Survey Items – R Square values and Coefficients for hands-on skills exam

<table>
<thead>
<tr>
<th>CSE Survey Item</th>
<th>Mean CSE rating</th>
<th>R Square</th>
<th>Coefficient</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets</td>
<td>3.50</td>
<td>0.05</td>
<td>5.196</td>
<td>2.36 - 8.04</td>
</tr>
<tr>
<td>I know enough about using spreadsheet software to take upper-level business courses</td>
<td>3.54</td>
<td>0.065</td>
<td>5.933</td>
<td>3.10 - 8.76</td>
</tr>
<tr>
<td>I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet</td>
<td>4.40</td>
<td>0.087</td>
<td>9.676</td>
<td>5.74 - 13.61</td>
</tr>
<tr>
<td>I feel confident that I can work with multiple worksheets in a workbook file</td>
<td>4.03</td>
<td>0.092</td>
<td>7.951</td>
<td>4.81 - 11.09</td>
</tr>
<tr>
<td>I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet</td>
<td>4.31</td>
<td>0.121</td>
<td>11.14</td>
<td>7.36 - 14.92</td>
</tr>
<tr>
<td>I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet</td>
<td>4.04</td>
<td>0.071</td>
<td>7.417</td>
<td>4.04 - 10.79</td>
</tr>
</tbody>
</table>
Generally, as the CSE rating increased, the score on the hands-on skills exam also increased (see Figure 9). Some of the results may seem skewed. For example, the item statement “I feel confident that I can insert or modify and formula (such as sum, average, etc.) to calculate…” has a “4” mean exam score for the rating “strongly disagree.” However, only one student indicated a rating of “strongly disagree” for this item statement. The majority of students rated themselves as “agree” or “strongly agree” for this item statement.

Figure 9. Summary of CSE Survey ratings versus hands-on skills exam scores

To determine if the variability in the hands-on score is cumulative if all the CSE items are considered in one model, a stepwise regression analysis of each predictor variable was
The model summary shown in Table 8 shows each predictor variable as it was added into the model one by one, with model 8 including all of the predictor variables. For brevity, only the final model (model 8) is shown (the entire SPSS output is in Appendix 8). Model 8 shows us that all of the predictor variables (the CSE ratings) only account for less than 15% of the variability in the hands-on skills exam score. The coefficients for each variable in model 8 also show that these variables, when taken as a whole, have little effect on the score of the hands-on skills exam. Indeed, all but one item (“I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet”) has a 95% CI that is negative on the lower bound and positive on the upper bound. This suggests that when taken together, the CSE items are not good predictors of performance on the hands-on skills exam.

Table 8: Model Summary and Coefficients for all stepwise regression analysis for CSE items

| Model | R     | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | Coefficients
|-------|-------|----------|-------------------|--------------------------|-------------------|--------------
|       |       |          |                   |                          |                   | Unstandardized Coefficients | Standardized Coefficients | 95.0% Confidence Interval for B |
|       |       |          |                   |                          |                   | B | Std. Error | Beta | t | Sig. | Lower Bound | Upper Bound |
| 8     | .382³ | .146     | .117              | 22.280                   | .001              | .213 | 1 | 239 | .645 |

h. Predictors: (Constant), All CSE items
i. Dependent Variable: Hands-on score
Overall CSE Rating

To determine whether the previous results would remain the same for an overall CSE rating, a dummy variable was calculated by summing the self-reported rating for the CSE items in the survey and dividing by the number of items to arrive at an overall (average) CSE rating. This rating was then used as a predictor variable for the hands-on skills exam score.

The mean overall CSE rating was 3.95 out of 5. This suggests that overall, students were confident in their Excel skills. When compared to the average score of nearly 73% on the hands-on skill exam, these results confirm previous research findings that the students over-estimated their skill with Excel.

Regression results (see Table 9) indicate that that less than 12% of the variability of the hands-on score can be attributed to the CSE rating (R square = .118). This result is slightly less
than the 14.6% given by the stepwise results shown in Table 8. The regression results report a coefficient of 12.093, suggesting that for each unit the overall CSE rating increases, the hands-on exam score should increase by about 12 units.

Table 9: Hypothesis 1 Model Summary and Coefficients

<table>
<thead>
<tr>
<th>Hypothesis 1 Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

<sup>a</sup> Predictors: (Constant), OverallCSE

b. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>OverallCSE</td>
</tr>
</tbody>
</table>

<sup>a</sup> Dependent Variable: Hands-on score

These results suggest that an indirect assessment of skill in the form of a computer self-efficacy survey is not a good predictor of competence.
4.3.2 Hypothesis 2

Hypothesis 2 predicts that participants with more computing experience will have a higher score on hands-on skills exam. The survey asked the number of years of computing experience, grouped into the following clusters: 0-1 year (1), 1-3 years (2), 4-6 years (3), 7-9 years (4), and 10+ years (5). As mentioned previously, 91% of the students have used a computer for more than 7 years (7-9 years = 24%, 10+ years = 67%).

Exploring the data, we find that at first glance computer usage length does not affect the score on the hands-on skills exam. Students with 0-1 year experience generally did as well as students with over 10 years’ experience with computers (see boxplot in Figure 10). If the outlier data points are excluded, the result is the same.

![Figure 10. Boxplot for H2 computer usage length](image)

Regression analysis was conducted to determine if longevity of computer use (in years) could be used as a predictor of scores on the hands-on skill exam. A significant regression
model was found that had an R Square value of .018 (see Table 10). These results indicate that longevity of computer use accounts for less than 2% of the variability in the hands-on skills exam score. Further, the coefficient registers as 4.44 (95% CI = .282 – 8.589), indicating that as the rating for this CSE survey question increases by one unit (e.g. from 3-5 years to over 5 years), the hands-on exam score should increase by over 4 units.

Table 10: Hypothesis 2 Model Summary and Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.133a</td>
<td>.018</td>
<td>.014</td>
<td>23.547</td>
<td></td>
<td>.018</td>
<td>4.424</td>
<td>1</td>
<td>246</td>
<td>.036</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), How long have you been using a computer?

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>52.579</td>
<td>9.758</td>
</tr>
<tr>
<td></td>
<td>How long have you been using a computer?</td>
<td>4.435</td>
<td>2.109</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

These results suggest that longevity of computer use is not a very good predictor of competence in Excel.
Hypothesis 2a

Hypothesis 2a predicts that participants with more experience with the software package being used in the study will have a higher score on the hands-on skills exam. Students who have used Excel longer and more frequently are expected to do better on the hands-on skills exam.

The survey asked the length of time for Excel experience (0-1 year, 1-3 years, 3-5 years, 5+ years), and the frequency of Excel usage (daily, greater than once a week, about once a week, less than once a week, less than once a month).

Nearly 29% of the students have used Excel more than 5 years, 20% have used Excel for 3-5 years, 36% have used it for 1-3 years, and 15% have used Excel for one year or less. However, the length of usage does not appear to affect performance on the hands-on skills exam. Excluding outlier data points, the boxplot in Figure 11 shows that regardless of the length of usage of Excel, the scores on the hands-on skills exam appear quite similar.

![Boxplot for H2 Excel usage length](image)

Figure 11. Boxplot for H2 Excel usage length
As can be seen in Table 11, the length of time a student has been using Excel only accounts for about 2% of the variation in exam scores (R Square = .019). Moreover, the coefficient is 3.112 (95% CI = .301 – 5.923), suggesting that for each unit increase in Excel usage (e.g. from “3-5 years” to “more than 5 years”) the score on the hands-on exam should increase by just over 3 units.

Table 11: Model Summary and Coefficient for Excel Usage Length and Hands-on Exam Score

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.138&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.019</td>
<td>.015</td>
<td>23.532</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>64.590</td>
<td>4.076</td>
</tr>
<tr>
<td></td>
<td>How long have you been using Microsoft Excel?</td>
<td>3.112</td>
<td>1.427</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), How long have you been using Microsoft Excel?

a. Dependent Variable: Hands-on score

These results suggest that the length of time a participant has been using Excel is not a good predictor of performance.

For frequency of usage, only 3% of the students reported using Excel daily, 5% use it more than once a week (quite often), 12% use Excel about once a week (frequently), 28% use
Excel less than once a week (infrequently), and 51% use Excel less than once a month (rarely). Thus, it should be noted that 79% of students use Excel less than once a week.

This is reflected in the scores on the hands-on skills exam. As shown in the boxplot (see Figure 12), as frequency increases, the average score on the hands-on skills exam increases, and the range of scores generally narrows.

Regression analysis revealed that the frequency of Excel usage accounts for only 5.5% ($r^2 = .055$) of the variability in the exam score (see Table 12). Furthermore, the coefficient registers as $5.17$ (95% CI = $2.492 – 7.849$), indicating that for each unit increase in Excel usage frequency (e.g. from “more than once a week” to “daily”), the hands-on skills exam score should increase by about 5 units.
Table 12: Model Summary and Coefficient for Excel usage frequency and hands-on score

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.236(^a)</td>
<td>.055</td>
<td>.052</td>
<td>23.090</td>
<td>.055</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.452</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>246</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Which of the following best describes your current usage of MS Excel?

<table>
<thead>
<tr>
<th>Coefficients(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstandardized Coefficients</td>
</tr>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Which of the following best describes your current usage of MS Excel?</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

These results indicate that by itself, frequency of Excel usage is not a good predictor of performance.

When analyzed together, these Excel usage length and Excel usage frequency only account for less than 6% of the variability in the exam score (R Square = .059; see Table 13). Additionally, the coefficients register as:

length of usage = 1.511 (95\% CI = -1.413 – 4.435)

frequency of usage = 4.683

This suggests that as length of usage and frequency of usage increases by one unit, the score on the hands-on skills exam could increase by about 6 units, but due to the negative lower bound for length of usage, it could also increase by about 3 units.
### Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
<td>F Change</td>
</tr>
<tr>
<td>1</td>
<td>.244(^a)</td>
<td>.059</td>
<td>.052</td>
<td>23.088</td>
<td>.059</td>
<td>7.745</td>
</tr>
</tbody>
</table>

*a. Predictors: (Constant), Which of the following best describes your current usage of MS Excel?, How long have you been using Microsoft Excel?*

### Coefficients\(^a\)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>60.252</td>
<td>4.216</td>
<td></td>
</tr>
<tr>
<td>How long have you been using Microsoft Excel?</td>
<td>1.511</td>
<td>1.484</td>
<td>.067</td>
</tr>
<tr>
<td>Which of the following best describes your current usage of MS Excel?</td>
<td>4.683</td>
<td>1.442</td>
<td>.213</td>
</tr>
</tbody>
</table>

*a. Dependent Variable: Hands-on score*

These results suggest that, either separately or together, length of Excel usage and frequency of Excel usage are not good predictors of performance on the hands-on skills exam.
**Hypothesis 2b**

The hands-on skill exam utilizes Excel version 2007 for Windows, which shares a common interface (the task ribbon) with Excel for Windows version 2010 and Excel 2011 for Mac OS. Participants were asked “Which version of Excel are you most familiar with or use most often?” Hypothesis 2b predicts that participants with more experience with the software package being used in the study will have a higher score on the hands-on skills exam. Therefore, those students who reported familiarity with Windows Excel 2007 or 2010, or Excel 2011 for Mac should have a higher score than those who do not have familiarity with those versions.

For this analysis, a dummy variable was created which combined the survey answers to be “1” for students who reported Windows Excel 2007 or 2010 or Mac Excel 2011 as the version with which they are most familiar, and “0” for all other versions. There were 159 students (59%) who reported they were most familiar with the “exam version” of Excel, versus 89 students (34%) who reported they were most familiar with a “non-exam version” of Excel, with 21 cases (7%) missing.

The mean exam score for the users of the “hands-on skills exam version” was 74%, while the mean exam score for the users of the “non-exam version” was 71%. Interestingly, there were several perfect or near-perfect scores on the exam for both groups.

As can be seen in the boxplot for this variable (see Figure 13), when outlier data points are excluded, the range for those students familiar with the “exam version” of Excel is slightly more narrow than for those familiar with non-exam versions.
Figure 13. Boxplot for "exam version" of Excel

Regression analysis revealed that familiarity with the “exam version” of Excel had negligible effect on the variability of the hands-on skills exam score (R Square value = .002; see Table 14). Likewise, the coefficient registers as 2.321 (95% CI = -3.867 – 8.509), suggesting that students who use the “exam version” of Excel only scored on average 2.3 units better on the hands-on skills exam. However, as the lower bound of the 95% CI is a negative number, the effect is uncertain.
Table 14: Model Summary and Coefficients for Exam Version

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
<td>F Change</td>
<td>df1</td>
<td>df2</td>
</tr>
<tr>
<td>1</td>
<td>.047</td>
<td>.002</td>
<td>-.002</td>
<td>23.732</td>
<td>.002</td>
<td>.546</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Windows Excel 2007 or 2010 or Mac 2011

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>71.371</td>
<td>2.516</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

These results suggest that whether a student is more familiar with Excel 2007 or 2010 for Windows or Excel 2011 for MAC is not a good predictor for performance on the hands-on skills exam.
4.3.3 Hypothesis 3

Hypothesis 3 tests whether it is possible to identify a subset of indirect and direct assessments (CSE, cognitive questions, and skill-based questions) that would be a valid alternative to a hands-on skills test. To test this hypothesis, the hands-on test is the dependent variable, with the predictor variables being the overall CSE ratings, the cognitive question scores, and the skill-based question scores.

The overall CSE rating was calculated by adding the self-reported rating for the CSE items in the survey and dividing by the number of items to arrive at the average (overall) CSE rating. The CSE survey questions are designed to allow students to rate their self-efficacy using a 5-point Likert scale where 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. There was also an option to choose “This is not a function or feature of MS Excel” but none of the participants chose that answer for any of the questions.

The cognitive score was calculated by adding the score on each cognitive question (0 = incorrect, 1 = correct), and dividing by the number of questions to arrive at the overall cognitive score. The questions are multiple-choice, and measured the students’ cognitive knowledge of Excel.

The skills-based score was calculated by adding the score on each skill-based question (0 = incorrect, 1 = correct), and dividing by the number of questions to arrive at the overall skill-based score. The questions are multiple-choice, and measured the students’ skills in Excel by asking questions that require hands-on experience with Excel to answer.

On average, students rated themselves 3.9 out of 5 on general computer self-efficacy, scored 72% on cognitive questions, and 67.5% on skill-based questions. For the
CSE questions, a 3.9 rating is nearly equal to the “4 = Agree” rating. These results indicate that students agree or strongly agree that they are confident they can accomplish basic and intermediate tasks within Excel, yet the scores on the cognitive and skill-based questions indicate a lower level of knowledge and skill. When compared with the average score of nearly 73% on the hands-on skills exam, the results suggest that students over-estimated their CSE rating, but they accurately assessed their cognitive knowledge.

Stepwise regression using SPSS was used to find the best overall predictive model among these three independent variables. “The stepwise method in SPSS is the same as the forward method, except that each time a predictor is added to the equation, a removal test is made of the least useful predictor. As such, the regression equation is constantly being reassessed to see whether any redundant predictors can be removed” (Field 2005).

Table 15 shows the model summary for this regression analysis. Model 1 refers to the first stage when only the overall CSE rating is used as a predictor. Model 2 shows the second stage when the overall CSE rating and the score on the cognitive questions are used as predictors. Model 3 shows the final stage when overall CSE rating, cognitive question score, and skill-based question score are used as predictors of competence as measured by the hands-on skills exam.

As can be seen in Table 15, the R Square value for overall CSE rating is .276. This suggests that nearly 28% of the variability of the hands-on score is accounted for by overall CSE rating. When the score on the cognitive questions is added, the R square value increases to .459, suggesting that nearly 46% of the variability on the hands-on score could be attributed to these variables. When the score on the skill-based questions is added, the R square value increases only incrementally to .461, a negligible effect. The
model shows that less than half of the variability in the hands-on skills exam score is due to the combination of the overall CSE rating, the overall cognitive question score, and the overall skill-based question score.

The coefficients in this model indicate that as the overall CSE rating increases by one unit, the hands-on exam score should increase by nearly 16 units, while the overall cognitive score and skill-based scores’ coefficients register as .987 and -.082 respectively. This suggests that the cognitive score has a negligible effect on the hands-on exam score, while the skill-based score has a negative effect.

Table 15: Hypothesis 3 Regression Model Summary and Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
</tr>
<tr>
<td>1</td>
<td>.526a</td>
<td>.276</td>
<td>.256</td>
<td>29.218</td>
<td>.276</td>
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<tr>
<td>2</td>
<td>.678b</td>
<td>.459</td>
<td>.428</td>
<td>25.611</td>
<td>.183</td>
</tr>
<tr>
<td>3</td>
<td>.679c</td>
<td>.461</td>
<td>.413</td>
<td>25.955</td>
<td>.001</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), OverallCSE
b. Predictors: (Constant), OverallCSE, CognitiveScore
c. Predictors: (Constant), OverallCSE, CognitiveScore, SkillbasedScore

<table>
<thead>
<tr>
<th>Coefficientsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
</tr>
<tr>
<td>OverallCSE</td>
</tr>
<tr>
<td>CognitiveScore</td>
</tr>
<tr>
<td>SkillbasedScore</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score
As the SPSS stepwise regression method is virtually the same as the forward method, it was decided to use the backward stepwise regression to confirm the results. During this analysis, the variable for the score on the skill-based questions was removed. After removal, the R Square value returned .459, the value seen previously in the forward method (see Table 16). The overall skill-based score appears to have a negative influence on the skill-based exam score.

Table 16: Backwards Regression Model Summary and Coefficients for Hypothesis 3

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Change</td>
</tr>
<tr>
<td>1</td>
<td>.679&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.461</td>
<td>.413</td>
<td>25.955</td>
<td>.461</td>
</tr>
<tr>
<td>2</td>
<td>.678&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.459</td>
<td>.428</td>
<td>25.611</td>
<td>-.001</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), SkillbasedScore, CognitiveScore, OverallCSE

b. Predictors: (Constant), CognitiveScore, OverallCSE

c. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Model</th>
<th>Model Summary Coefficients</th>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unstandardized Coefficients</td>
<td>Standardized Coefficients</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>-57.423</td>
<td>25.397</td>
</tr>
<tr>
<td>OverallCSE</td>
<td>15.759</td>
<td>6.422</td>
</tr>
<tr>
<td>CognitiveScore</td>
<td>.987</td>
<td>.294</td>
</tr>
<tr>
<td>SkillbasedScore</td>
<td>-0.082</td>
<td>.295</td>
</tr>
<tr>
<td>OverallCSE</td>
<td>15.113</td>
<td>5.913</td>
</tr>
<tr>
<td>CognitiveScore</td>
<td>.966</td>
<td>.281</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score
The coefficients of model 2 for Overall CSE and Cognitive Score are 15.113 and .966 respectively. Together, an increase in one unit of each should result in an increase of about 16 units on the hands-on skills exam. This reflects the previous findings.

To determine whether the model is significantly better at predicting competence than using the means as a “best guess,” an ANOVA test was conducted. As Table 17 shows, the F-ratio for overall CSE rating is only 13.7 (p=.001), when the cognitive question score is added it increases to 14.8 (p<.001), and when the skill-based question score is added the F-ratio decreases 9.6 (p<.001). These results suggest that these models did not significantly improve the ability to predict competence as measured by the hands-on skill exam.

Table 17: ANOVA Results for Hypothesis 3

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>1730.150</td>
<td>1</td>
<td>11730.150</td>
<td>13.741</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>30732.166</td>
<td>36</td>
<td>853.671</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>42462.316</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Regression</td>
<td>19505.205</td>
<td>2</td>
<td>9752.603</td>
<td>14.869</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>22957.110</td>
<td>35</td>
<td>655.917</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>442462.316</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Regression</td>
<td>19557.829</td>
<td>3</td>
<td>6519.276</td>
<td>9.677</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>22904.487</td>
<td>34</td>
<td>673.661</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>442462.316</td>
<td>37</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), OverallCSE
b. Predictors: (Constant), OverallCSE, CognitiveScore
c. Predictors: (Constant), OverallCSE, CognitiveScore, SkillbasedScore
d. Dependent Variable: Hands-on score
Hypothesis 3a predicts that a combination of CSE survey and cognitive questions is a valid alternative to a hands-on skills test. As seen above, the combination of the overall CSE survey rating and overall score on the cognitive questions accounts for nearly 46% of the variability in the hands-on skills exam score.

Reviewing the data from hypothesis 1, we find that 5 of the 8 survey items in which the respondents stated they “strongly agree” with the statement resulted in a mean score of 80% or more on the hands-on skills exam (see Figure 14). A score of 80% was used as this is the score students must attain to pass the Introduction to Excel course. Of those 5 items, 4 of them for which the respondents stated they “agree” with the statement resulted in a mean score of 70% or higher on the hands-on skills exam. This suggests that these items may be good predictors of performance on the hands-on skills exam. These items are:

- I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet (text)
- I feel confident that I can work with multiple worksheets in a workbook file (multi)
- I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet (chart)
- I know enough about using spreadsheet software to take upper-level business courses. (upper)
Exploring the cognitive questions in a similar fashion, we find that the mean exam score was higher for all students with correct answers with the exception of one question (see Figure 15). Two questions had a mean exam score above 80% for correct answers and whose mean exam scores for incorrect answers were more than 20 points lower. Those questions are:

- “A(n) ____ (range) is a name assigned to two or more cells in order to reference them in a formula” and
- “An Excel file is called a ____ (workbook).”

A third question could be added to this list, as the mean for the correct answers is more than 20 points higher than the mean for the incorrect answers. However, it was excluded because the mean exam score for the correct answers is only 75%.
With the exception of the “sorting” question, the remaining correct answers produced a mean score ranging from 71% to 75%.

![Boxplot of cognitive questions and mean exam score](image)

**Figure 15. Cognitive questions and mean exam score**

Reviewing the boxplot of cognitive questions versus the mean exam score reveals an interesting finding. It is clear that, as a group, those that scored better on the cognitive questions also scored better on the hands-on skills exam (see Figure 16). Additionally, the range of scores was narrower for those that scored higher on the cognitive questions.

These results suggest that it may be worthwhile to analyze each cognitive question against the hands-on skills exam score to determine which, if any, would be good predictors of performance on the exam.
Figure 16. Cognitive Score and Hands-on Exam Score

Table 18 shows the R Square value and the coefficient of each of the cognitive questions when subjected individually to regression analysis. The results confirm that 38% and 14.6% variability on the hands-on skills exam can be attributed to two questions:

An Excel file is called a ____. (“workbook”)

A (n) ____ is a name assigned to two or more cells in order to reference them in a formula. (“range”)

These could be joined by a third question (“The ____ command removes data and stores it for future use”) for which nearly 12% of the variability on the hands-on skills exam could be attributed. All three of these questions had positive values in the 95% CI lower bound.
<table>
<thead>
<tr>
<th>Cognitive question</th>
<th>R Square</th>
<th>Coefficient</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>____ is the default number format. (general)</td>
<td>.002</td>
<td>3.08</td>
<td>-18.9 – 25.06</td>
</tr>
<tr>
<td>An Excel file is called a ____ (workbook).</td>
<td>.332</td>
<td>38.18</td>
<td>20.14 - 56.21</td>
</tr>
<tr>
<td>The contents of the active cell are displayed in the ____ (formula bar).</td>
<td>.063</td>
<td>24.78</td>
<td>-7.07 - 56.63</td>
</tr>
<tr>
<td>____ arranges data in sequential order. (sorting)</td>
<td>.036</td>
<td>-28.46</td>
<td>-77.42 - 20.50</td>
</tr>
<tr>
<td>A(n) ____ is a name assigned to two or more cells in order to reference them in a formula. (range)</td>
<td>.146</td>
<td>25.65</td>
<td>4.98 - 46.31</td>
</tr>
<tr>
<td>A(n) ____ page layout is wider than it is long. (landscape)</td>
<td>.058</td>
<td>22.06</td>
<td>-7.53 - 51.65</td>
</tr>
<tr>
<td>Rows or columns are ____ if column letters or row numbers are skipped. (hidden)</td>
<td>.015</td>
<td>8.35</td>
<td>-14.20 - 30.90</td>
</tr>
<tr>
<td>A(n) ____ chart displays data as a collection of points. (scatter)</td>
<td>.013</td>
<td>12.26</td>
<td>-23.77 - 48.28</td>
</tr>
<tr>
<td>The ____ command removes data and stores it for future use. (cut)</td>
<td>.118</td>
<td>29.60</td>
<td>2.68 - 56.51</td>
</tr>
</tbody>
</table>

It is also interesting to note the coefficients of the questions. Several questions registered coefficients over 20, which at first glance appears that for every correct answer, the score on the exam should increase by over 20. But this actually indicates that students who got the question correct scored an average of 20+ points more on the exam than students who got the question incorrect.

To determine which questions would make the best model combined, a stepwise regression analysis was performed. All the cognitive questions were added to the regression model one by one, and SPSS analyzed each and produced a model with only two questions (see Table 19). As shown, the “workbook” question by itself had an R Square value of .347, meaning it could account for nearly 35% of the variability in the hands-on skills exam. When the “range” question is added, the R Square value increased to .429, meaning the regression model can now account for nearly 43% of the variability in the hands-on skills exam.
Table 19: Model Summary for Cognitive Questions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
<td>F Change</td>
<td>df1</td>
<td>df2</td>
<td>Sig. F Change</td>
</tr>
<tr>
<td>1</td>
<td>.589&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.347</td>
<td>.329</td>
<td>27.746</td>
<td>.347</td>
<td>19.157</td>
<td>1</td>
<td>36</td>
<td>.000</td>
</tr>
<tr>
<td>2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.655&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.429</td>
<td>.396</td>
<td>26.327</td>
<td>.081</td>
<td>4.984</td>
<td>1</td>
<td>35</td>
<td>.032</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), An Excel file is called a workbook.

b. Predictors: (Constant), An Excel file is called a workbook., A(n) ____ is a name assigned to two or more cells in order to reference them in a formula.

When considering the coefficients of the model, the “workbook” question’s coefficient registered at 39.46, suggesting that on average, persons who got this question correct scored an average of 39 points higher on the skills exam. When the “range” coefficient of 19.59 is added to the model, the “workbook” question’s coefficient decreased to 36.19.

When analyzed together, these two questions returned an R Square value of .423, meaning that they could account for just over 42% of the variability in the score on the hands-on skills exam (see Table 20).

Table 20: Model Summary for cognitive model

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
<td>F Change</td>
<td>df1</td>
<td>df2</td>
<td>Sig. F Change</td>
</tr>
<tr>
<td>1</td>
<td>.651&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.423</td>
<td>.391</td>
<td>26.104</td>
<td>.423</td>
<td>13.206</td>
<td>2</td>
<td>36</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), A(n) ____ is a name assigned to two or more cells in order to reference them in a formula., An Excel file is called a workbook.

The coefficients for these two questions also changed when analyzed as one model. The “workbook” question registered a coefficient of 35.25, while the “range” question registered a 20.47 coefficient. These results indicate that these two questions could be valid predictors of performance on the hands-on skills exam.
Regression analysis was performed on the 4 CSE items and the 2 cognitive questions that are potentially valid predictors. The 6 variables yielded an R Square value of .521, indicating that 52% of the variability in the hands-on skills exam score could be attributed to these variables (see Table 21).

Table 21: Model summary for CSE and cognitive questions

<table>
<thead>
<tr>
<th>Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), A(n) _____ is a name assigned to two or more cells in order to reference them in a formula., I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet, An Excel file is called a workbook., I know enough about using spreadsheet software to take upper-level business courses, I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, I feel confident that I can work with multiple worksheets in a workbook file.

The coefficients shown in Table 22 show that three of the four CSE items had negative or negligible coefficients of -3.456, -1.593, and 1.271. One CSE item had a coefficient of 13.311. The two cognitive questions had coefficients of 29.82 and 17.30. Yet of them all, only one cognitive question (“An Excel file is called a workbook”) had a 95% CI with a positive value in the lower bound.

Table 22: Coefficients for CSE items and cognitive questions

<table>
<thead>
<tr>
<th>Coefficientsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>(CSE) I know enough about using spreadsheet software to take upper-level business courses</td>
</tr>
<tr>
<td>(CSE) I feel confident that I can work with multiple worksheets in a workbook file</td>
</tr>
</tbody>
</table>
I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet.

An Excel file is called a workbook.

A(n) ____ is a name assigned to two or more cells in order to reference them in a formula.

Subjecting the 6 variables to a stepwise regression analysis confirmed the results – one CSE item and the two cognitive questions with the high coefficients comprised the best model with an R Square value of .517 (see Table 23).

Table 23: Model summary for stepwise CSE and cognitive questions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F Change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>df1</td>
</tr>
<tr>
<td>1</td>
<td>.576&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.332</td>
<td>.314</td>
<td>27.707</td>
<td>.332</td>
</tr>
<tr>
<td>2</td>
<td>.676&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.456</td>
<td>.426</td>
<td>25.343</td>
<td>.124</td>
</tr>
<tr>
<td>3</td>
<td>.719&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.517</td>
<td>.476</td>
<td>24.215</td>
<td>.061</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), An Excel file is called a workbook.

b. Predictors: (Constant), An Excel file is called a workbook., I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet

c. Predictors: (Constant), An Excel file is called a workbook., I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, A(n) ____ is a name assigned to two or more cells in order to reference them in a formula.
The coefficients for these variables also confirmed that these three variables indeed to make a potentially valid predictor set for performance on the hands-on skills exam. Model 3 in Table 24 shows coefficients of 28.333, 10.861, and 17.003 for these variables.

### Table 24: Coefficients for the stepwise CSE items and cognitive questions

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>52.381</td>
<td>6.046</td>
<td>.8664</td>
</tr>
<tr>
<td>An Excel file is called a workbook.</td>
<td>38.175</td>
<td>8.900</td>
<td>.576</td>
</tr>
<tr>
<td>2 (Constant)</td>
<td>10.216</td>
<td>15.710</td>
<td>.650</td>
</tr>
<tr>
<td>An Excel file is called a workbook.</td>
<td>29.781</td>
<td>8.651</td>
<td>.450</td>
</tr>
<tr>
<td>I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td>12.298</td>
<td>4.289</td>
<td>.374</td>
</tr>
<tr>
<td>3 (Constant)</td>
<td>6.238</td>
<td>15.129</td>
<td>.412</td>
</tr>
<tr>
<td>(COG) An Excel file is called a workbook.</td>
<td>28.333</td>
<td>8.294</td>
<td>.428</td>
</tr>
<tr>
<td>(CSE) I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td>10.861</td>
<td>4.154</td>
<td>.331</td>
</tr>
<tr>
<td>(COG) A(n) ____ is a name assigned to two or more cells in order to reference them in a formula.</td>
<td>17.003</td>
<td>8.077</td>
<td>.253</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

Performing stepwise regression analysis on all of the CSE survey items and all of the cognitive questions combined resulted in a model with one CSE item and two cognitive questions:

- An Excel file is called a ____ (workbook).
- I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.
- The ____ command removes data and stores it for future use (cut).

The resulting model yielded an R Square value of .567, indicating that nearly 57% of the variability in the hands-on skills exam score could be attributed to these variables (see Table 25). The coefficients of the model were as follows:

“Workbook”: 27.588 (95% CI = 11.161 – 44.015)
“Charts”: 14.460 (95% CI = 6.199 – 22.720)
“Cut”: 21.822 (95% CI = 1.708 – 41.937)

Table 25: Model Summary hypothesis 3a stepwise regression

| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics |  |
|-------|-----|----------|-------------------|---------------------------|-------------------|
|       | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1     | .589³ | .347     | .329             | 27.746                    | .347              | 19.157 | 1 | 36 | .000  |
| 2     | .710³ | .505     | .476             | 24.515                    | .157              | 11.113 | 1 | 35 | .002  |
| 3     | .753³ | .567     | .528             | 23.266                    | .062              | 4.861  | 1 | 34 | .034  |

a. Predictors: (Constant), An Excel file is called a workbook.
b. Predictors: (Constant), An Excel file is called a workbook., I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.
c. Predictors: (Constant), An Excel file is called a workbook., I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, The ____ command removes data and stores it for future use.

These results indicate that combination of CSE and Cognitive questions could be a good candidate for an alternative to hands-on skills exams.
Hypothesis 3b

Hypothesis 3b predicts that a combination of CSE survey and skill-based questions is a valid alternative to a hands-on skills test. Regression analysis on the overall CSE ratings and the total skill-based score show that a significant regression model was found (F = 6.351, p. < .005) that had a .261 R Square value. This indicates that 26% of the variability in the hands-on skills exam score can be accounted for by these two variables. As previous analyses have shown, Overall CSE ratings has a high coefficient of 18.48, indicating that for each increase in overall CSE rating (e.g. from “agree” to “strongly agree”) the hands-on score should increase by over 18 units. The overall skill-based score registered a coefficient of .286, suggesting that for each skill-based question answered correctly the score on the hands-on skills exam should increase by less than one-third of 1 unit (see Table 26).

Table 26: Model summary and coefficient for CSE and skill-based questions

<table>
<thead>
<tr>
<th>Model Summary(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), SkillbasedScore, OverallCSE
b. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Coefficients(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
As shown previously, four questions from the CSE survey appear to be good predictors of performance on the hands-on skills exam. Exploring the skills-based questions, we find that three questions with correct answers have a mean exam score of above 80% (and mean exam scores for incorrect answers are more than 20 points lower; see Figure 17):

- $A$5 is an example of a(n) ____ cell reference. ($A$5)
- #DIV/0 is an example of a(n) ____. (#DIV/0)
- In the image below, the cell address for the name Mia Fillion is ____. (address)

![Figure 17. Skill-based and mean exam score](image)

To determine which questions would make the best model combined, a stepwise regression analysis was performed. All the skill-based questions were added to the regression model one by one, and SPSS analyzed each and produced a model with only one question (“$A$5 is an example of a(n) ____ cell reference”). Table 27 shows us that this question had an R Square value of .156, suggesting that it can account for over 15% of the variability in the hands-on exam score. The coefficient registered at 26.495 (95% CI = 5.947 – 47.042), indicating
that every person that got this question correct scored an average of over 26 points better on the exam than those students who got this question wrong. These results were confirmed via backwards stepwise regression.

Table 27: Model summary and coefficient for skill-based questions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.395*</td>
<td>.156</td>
<td>.133</td>
<td>31.151</td>
<td>.156</td>
<td>6.826</td>
<td>1</td>
<td>37</td>
<td>.013</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), $A5$ is an example of a(n) ____ cell reference.

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>59.130</td>
<td>6.495</td>
<td></td>
</tr>
<tr>
<td>$A5$ is an example of a(n) ____ cell reference.</td>
<td>26.495</td>
<td>10.141</td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

To understand why the other two questions (“#DIV/0 is an example of a(n) ____” and “In the image below, the cell address for the name Mia Fillon is ____”) were not included in the stepwise model, a forced entry regression analysis was performed using the three best questions. As can be seen in Table 28, the model shows an R Square value of .204, which is .08 higher than the model with only one question (“$A5$ is an example of a(n) ____ cell reference”0. The coefficients register as:

- “address”: -5.652 (95% CI = -71.046 – 59.743)
- “$A5$”: 17.803 (95% CI = -6.157 – 41.764)
- “#DIV/0”: 16.409 (95% CI = -7.014 – 39.833).
As can be seen, the 95% confidence intervals for each of these questions have negative values in the lower bound. Given these results, it was determined that these three questions together would not be valid predictors of performance on the hands-on skills exam.

Table 28: Model Summary and coefficient for skill-based question 2

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>_1</td>
<td>_1</td>
<td>.451</td>
<td>.204</td>
<td>.135</td>
<td>31.109</td>
<td>.204</td>
<td>2.981</td>
<td>3</td>
<td>35</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), #DIV/0 is an example of a(n) ____, In the image below, the cell address for the name Mia Fillion is ____. $A$5 is an example of a(n) ____ cell reference.

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>59.788</td>
<td>33.290</td>
</tr>
<tr>
<td></td>
<td>In the image below, the cell address for the name Mia Fillion is _____.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$A$5 is an example of a(n) ____ cell reference.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>#DIV/0 is an example of a(n) _____.</td>
<td>17.803</td>
<td>11.803</td>
</tr>
<tr>
<td></td>
<td>#DIV/0 is an example of a(n) _____.</td>
<td>16.409</td>
<td>11.538</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

Performing regression analysis on the combined four potentially valid CSE survey items and the two potentially valid skills-based questions revealed interesting results. The combined R Square value was .363, indicating that over 36% of the variability in the hands-on skills exam score could be attributed to by these variables (see Table 29). The coefficients for the items and questions ranged from -.468 to 15.347, with all of the 95% confidence intervals including both negative and positive values.
Table 29: Model Summary and Coefficients for CSE and skill-based questions

### Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.603a</td>
<td>.363</td>
<td>.244</td>
<td>29.089</td>
<td>.363</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.043</td>
</tr>
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<td></td>
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<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.018</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), #DIV/0 is an example of a(n) ____, I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet, $A$5 is an example of a(n) ____ cell reference., I know enough about using spreadsheet software to take upper-level business courses, I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, I feel confident that I can work with multiple worksheets in a workbook file

### Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Std. Error</td>
<td>Beta</td>
<td>t</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>2.213</td>
<td>22.114</td>
</tr>
<tr>
<td></td>
<td>(CSE)</td>
<td>1.180</td>
<td>7.045</td>
</tr>
<tr>
<td></td>
<td>I know enough about using spreadsheet software to take upper-level business courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(CSE)</td>
<td>2.568</td>
<td>10.693</td>
</tr>
<tr>
<td></td>
<td>I feel confident that I can work with multiple worksheets in a workbook file</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(CSE)</td>
<td>-.468</td>
<td>9.500</td>
</tr>
<tr>
<td></td>
<td>I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(CSE)</td>
<td>11.963</td>
<td>8.681</td>
</tr>
<tr>
<td></td>
<td>I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(SK)</td>
<td>6.734</td>
<td>12.625</td>
</tr>
<tr>
<td></td>
<td>$A$5 is an example of a(n) ____ cell reference.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(SK)</td>
<td>15.347</td>
<td>11.405</td>
</tr>
<tr>
<td></td>
<td>#DIV/0 is an example of a(n) ____</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score
To explore further, all of the CSE items and all of the skill-based questions were subjected to a stepwise regression analysis. The results shown in Table 30 included one CSE item (“I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet”) and one skill-based question (“#DIV/0 is an example of a(n) ____”). The R Square value for the best model is .356, suggesting that about 36% of the variability in the hands-on skills exam score could be attributed to this model. This is about one half of one percent lower than the analysis with four CSE items and two skill-based questions. The coefficients for this model were 15.31 for the CSE item (95% CI = 6.197 – 24.420) and 18.97 for the skills-based question (95% CI = .636 – 37.297).

Table 30: Model Summary and Coefficients for CSE and skill-based stepwise regression

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>1</td>
<td>.527a</td>
<td>.277</td>
<td>.258</td>
<td>28.821</td>
<td>.277</td>
<td>14.199</td>
</tr>
<tr>
<td>2</td>
<td>.597b</td>
<td>.356</td>
<td>.320</td>
<td>27.580</td>
<td>.079</td>
<td>4.404</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet

b. Predictors: (Constant), I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, #DIV/0 is an example of a(n) ____.

### Coefficientsa

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B Std. Error Beta t Sig.</td>
<td>Lower Bound Upper Bound</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.259 17.790 .527 .296 .769</td>
<td>-30.787 41.305</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17.294 4.589 .527 3.768 .001</td>
<td>7.995 26.593</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.965 17.059 .174 .863 -31.633 37.563</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(CSE) I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
#DIV/0 is an example of a(n) ____.  

<table>
<thead>
<tr>
<th></th>
<th>18.967</th>
<th>9.038</th>
<th>.287</th>
<th>2.098</th>
<th>.043</th>
<th>.636</th>
<th>37.297</th>
</tr>
</thead>
</table>

a. Dependent Variable: Hands-on score

These results suggest that a combination of CSE and Skill-based questions is a candidate for an alternative to hands-on skills exams.
**Hypothesis 3c**

Hypothesis 3c predicts that a combination of cognitive questions and skill-based questions is a valid alternative to a hands-on skills test. As shown previously, two cognitive questions (“An Excel file is called a ___” and “A(n) ___ is a name assigned to two or more cells in order to reference them in a formula”) and two skills-based questions (“$A$5 is an example of a(n) ___ cell reference” and “#DIV/0 is an example of a(n) ___”) are potentially valid predictors of performance on the hands-on skills exam.

Performing regression analysis on these four questions revealed that this combined model resulted in an R Square value of .474 and the coefficients ranged from 7.21 to 32.04 (see Table 31). This indicates that this model accounts for 47% of the variability in the exam score, and that persons who got these questions correct scored an average of 7 to 32 points better on the exam than persons who got these questions wrong. Unfortunately, the 95% CI for three of the four questions included negative values in the lower bound.

**Table 31: Model summary and coefficients for cognitive and skill-based questions**

<table>
<thead>
<tr>
<th>Model Summary</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>R</td>
</tr>
<tr>
<td>_ 1</td>
<td>.689&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), #DIV/0 is an example of a(n) ___, A(n) ___ is a name assigned to two or more cells in order to reference them in a formula., An Excel file is called a workbook., $A$5 is an example of a(n) ___ cell reference.

<table>
<thead>
<tr>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Unstandardized Coefficients</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td>_ 1 (Constant)</td>
<td>37.954</td>
</tr>
</tbody>
</table>
A stepwise regression was performed to determine which combination of these questions would result in a better predictive model. The model included only two cognitive questions (“An Excel file is called a workbook” and “A(n) ____ is a name assigned to two or more cells in order to reference them in a formula”), with no skills-based questions (see Table 32). This might seem strange, but reviewing the analysis of overall skills-based score in hypothesis 3, we remember that the skills-based questions had little effect on the hands-on skills exam score.

Table 32: Model summary and coefficients for stepwise cognitive and skill-based questions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>R Square</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.576</td>
<td>.332</td>
<td>.314</td>
<td>27.707</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.651</td>
<td>.423</td>
<td>.391</td>
<td>26.104</td>
<td>.091</td>
<td>.563</td>
<td>1</td>
<td>36</td>
<td></td>
<td>.023</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), An Excel file is called a workbook.
b. Predictors: (Constant), An Excel file is called a workbook., A(n) ____ is a name assigned to two or more cells in order to reference them in a formula.
Another stepwise regression which included all of the cognitive and skill-based questions was performed. The resulting model consisted of three questions (two cognitive and one skill-based):

- An Excel file is called a workbook. (workbook)
- A(n) ____ is a name assigned to two or more cells in order to reference them in a formula. (range)
- In the image below, the cell address for the name Mia Fillion is ____. (address)

The R Square value for this model is .500 (see Table 33), suggesting that 50% of the variability of the hands-on score could be attributed to these variables. The coefficients were:

- workbook: 38.518 (95% CI = 21.634 – 55.402)
- range: 22.767 (95% CI = 5.579 – 39.955)
- address: -57.141 (95% CI = -100.044 - -4.237)

Table 33: Stepwise regression model for all cognitive and skill-based questions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.589ₐ</td>
<td>.347</td>
<td>.329</td>
<td>27.746</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.655ₐ</td>
<td>.429</td>
<td>.396</td>
<td>26.327</td>
<td></td>
</tr>
</tbody>
</table>
a. Predictors: (Constant), An Excel file is called a workbook.

b. Predictors: (Constant), An Excel file is called a workbook., A(n) ____ is a name assigned to two or more cells in order to reference them in a formula.

c. Predictors: (Constant), An Excel file is called a workbook., A(n) ____ is a name assigned to two or more cells in order to reference them in a formula., In the image below, the cell address for the name Mia Fillion is ____.
**Hypothesis 3d**

Hypothesis 3d predicts that a combination of CSE survey, cognitive questions, and skill-based questions is a valid alternative to a hands-on skills test. To test this hypothesis, a regression analysis on the potentially valid 4 CSE items, the 2 potentially valid cognitive questions, and the 2 potentially valid skills-based questions was performed. Table 34 shows that the resulting R Square value was .548, indicating that nearly 55% of the variability in the hands-on skills exam score could be attributed to the included variables.

Table 34: Model summary for hypothesis 3d

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>.740*</td>
<td>.548</td>
<td>.428</td>
<td>25.308</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.548</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.550</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.001</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), #DIV/0 is an example of a(n) ____, I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet, A(n) ____ is a name assigned to two or more cells in order to reference them in a formula., An Excel file is called a workbook., $A$5 is an example of a(n) ____ cell reference., I know enough about using spreadsheet software to take upper-level business courses, I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, I feel confident that I can work with multiple worksheets in a workbook file.

The coefficients in Table 35 show a range of -4.312 to 27.943, with the 4 of the lowest 5 coefficients belonging to the CSE items. The two cognitive questions yielded the highest coefficients. Unfortunately, only one cognitive questions (workbook) had a 95% confidence interval that included only positive values; the rest included both negative and positive values.

Table 35: Coefficients for hypothesis 3d

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
</table>

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Subjecting these variables to a stepwise regression resulted in a model with two cognitive questions and one CSE item (see Table 36) that shows that nearly 52% of the variability in the hands-on skills exam score could be attributed to this model.

Table 36: Model summary for hypothesis 3d stepwise

<table>
<thead>
<tr>
<th>Model Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

1. (Constant)
2. (CSE) I know enough about using spreadsheet software to take upper-level business courses
3. (CSE) I feel confident that I can work with multiple worksheets in a workbook file
4. (CSE) I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet
5. (CSE) I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet
6. (COG) An Excel file is called a workbook.
7. (COG) A(n) _____ is a name assigned to two or more cells in order to reference them in a formula.
8. (SK) $A$5 is an example of a(n) _____ cell reference.
9. (SK) #DIV/0 is an example of a(n) _____.
Table 37 lists the “best fit” model (model 3) for the stepwise regression. It shows the CSE item registers a coefficient of 10.861, while the two cognitive questions registered 17.003 and 28.333. The R Square and coefficient values were confirmed by a backwards stepwise regression analysis.

Table 37: Coefficients for hypothesis 3d stepwise

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>52.381</td>
<td>6.046</td>
</tr>
<tr>
<td></td>
<td>An Excel file is called a workbook.</td>
<td>38.175</td>
<td>8.900</td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>10.216</td>
<td>15.710</td>
</tr>
<tr>
<td></td>
<td>An Excel file is called a workbook.</td>
<td>29.781</td>
<td>8.651</td>
</tr>
<tr>
<td></td>
<td>I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td>12.298</td>
<td>4.289</td>
</tr>
<tr>
<td>3</td>
<td>(Constant)</td>
<td>6.238</td>
<td>15.129</td>
</tr>
<tr>
<td></td>
<td>(COG) An Excel file is called a workbook.</td>
<td>28.333</td>
<td>8.294</td>
</tr>
<tr>
<td></td>
<td>(CSE) I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet</td>
<td>10.861</td>
<td>4.154</td>
</tr>
</tbody>
</table>
A name assigned to two or more cells in order to reference them in a formula.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17.003</td>
<td>8.077</td>
<td>.253</td>
<td>2.105</td>
<td>.043</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.606</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33.400</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

To explore further, all the CSE items, cognitive questions, and skill-based questions were subjected to a stepwise regression analysis. The resulting model had one CSE item and two cognitive questions:

- An Excel file is called a workbook. (workbook)
- I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet. (chart)
- The ____ command removes data and stores it for future use. (cut)

The R Square value for the model is .567, suggesting that nearly 57% of the variability in the hands-on score could be attributed to these three variables (see Table 38). The coefficients of the model registered at:

- workbook: 27.588 (95% CI = 11.161 – 44.015)
- chart: 14.450 ((95% CI = 6.199 – 22.720)
- cut: 21.822 (95% CI = 1.708 – 41.937)

### Table 38: Model Summary and Coefficients for CSE, Cognitive, and Skill-based questions

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.589&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.347</td>
<td>.329</td>
<td>27.746</td>
<td>.347</td>
<td>19.157</td>
<td>1</td>
<td>36</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>.710&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.505</td>
<td>.476</td>
<td>24.515</td>
<td>.157</td>
<td>11.113</td>
<td>1</td>
<td>35</td>
<td>.002</td>
</tr>
<tr>
<td>3</td>
<td>.753&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.567</td>
<td>.528</td>
<td>23.266</td>
<td>.062</td>
<td>4.861</td>
<td>1</td>
<td>34</td>
<td>.034</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), An Excel file is called a workbook.
b. Predictors: (Constant), An Excel file is called a workbook., I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet
c. Predictors: (Constant), An Excel file is called a workbook., I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet, The ____ command removes data and stores it for future use.
### Model

<table>
<thead>
<tr>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>(Constant) -15.875</td>
<td>16.997</td>
<td>-.934</td>
</tr>
<tr>
<td>(COG) An Excel file is called a workbook. 27.588</td>
<td>8.083</td>
<td>.412</td>
</tr>
<tr>
<td>(COG) I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet 14.460</td>
<td>4.065</td>
<td>.423</td>
</tr>
<tr>
<td>(COG) The _____ command removes data and stores it for future use. 21.822</td>
<td>9.898</td>
<td>.253</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

The conclusions and implications of the hypotheses testing results will be discussed in Chapter 5.

### 4.4 Observations of Student Responses, Activity, etc.

During the administration of the survey and the hands-on skills exam, the students were observed by faculty members. The faculty members were in attendance to both help the students in case of problems with the survey or exam, and to note any unusual behavior among the students. The following are a few interesting observations:

- Students reported that a multiple-choice or short answer question which asked the steps to accomplish a task was especially difficult because it is hard to remember the exact steps needed to complete a task unless they are using Excel.
- Students tended to try to collaborate or even look up the answers in a browser during the hands-on exam. Unlike Japan, where cheating on an exam can be a “violation of the
Penal Code” (Kyodo_News 2011), cheating on an exam at this university is only a violation of the honor code. Students reported that because they felt this is not a real exam but only for extra credit, and they were not explicitly instructed not to collaborate or look up answers, that it was okay to do so. To mitigate this phenomenon, the survey and hands-on test were conducted in a monitored computer lab.

- Students reported that many tasks were ambiguous, or at least ambiguously worded. For example, the wording for the task on how to employ word wrap on a cell or group of cells was quite confusing.

- Several students were unable to follow the written instructions, both concerning the exam administration (such as which password to use) and within the hands-on exam to accomplish a task (such as “at the insertion point, TYPE the formula to subtract cell H15 from the sum of cells I7 through I12” yet students attempted to click the sum icon and select cells). This was regarded by the students as a weakness or flaw in the testing program.

- Within the hands-on exam students did a noticeable amount of guessing. When asked why, some students mentioned they did not remember exactly how to do a task, and others mentioned that they did not know the answer, but with 10 tries they felt that guessing was a good thing to do.

- The students’ memories are untrustworthy. Several students stated they took the Excel class when in fact they did not or took a different class which contained an introduction to Excel as a module.

- After taking the survey and hands-on skills exam, several students signed up for and took the Introduction to Microsoft Excel course.
Summary

This chapter has provided the analyses of the data and observations of students during the study. The analyses were conducted using data exploration and regression analysis. The next chapter will summarize the results of the hypotheses testing, the conclusion and implications of the results, and potential directions for future research.
Chapter 5: Conclusions

Chapter 5 concludes the discussions generated in the previous chapters, and outlines the implications of the results. A summary of the main contributions of this dissertation are identified, along with the limitations, both known and discovered along the way. Additionally, chapter 5 provides directions for future research.

5.1 Results

The goals of this study were to discover:

- Whether a combination of indirect and direct assessments could be a valid alternative to a hands-on skills exam
- If a subset of items and questions from those indirect and direct assessments could be used as a valid alternative to a hands-on skills exam, and thereby discover
- Potential valid predictors of performance of software skills, as measured by a hands-on skills exam.

Summary of Conclusions

A CSE survey, tested by hypothesis 1, is not a good predictor of performance on the hands-on skills exam, and thus not a valid alternative.

Length of computer experience, length of experience with spreadsheets, and familiarity with the “hands-on skills exam version” of Excel, tested by hypotheses 2, 2a, and 2b, are not good predictors of performance on the hands-on skills exam, and thus not valid alternatives.

A combination of indirect and direct assessments (CSE survey, cognitive questions, and skill-based questions), as a whole, does not appear to be a valid alternative to a hands-on skills exam.
A combination of computer self-efficacy items, cognitive questions, and skill-based questions could be an alternative to a hands-on skills exam.

### 5.2 Implications and Contributions

These findings have important theoretical and practical and implications and contributions. Theoretical implications and contributions include:

- Until now, there has been no study that has compared and tested a CSE survey, cognitive questions, skill-based questions, and a hands-on skills exam. Marcolin, et al (2000) developed a framework in which they researched self-report (CSE) with cognitive and affective questions, followed by a pencil and paper test (see Figure 1). This research fills the gaps in the hands-on and skills-based areas of the framework.

- At the conclusion of a longitudinal study by Smith (2004), in which student self-efficacy and performance were measured before and after instruction, it was recommended that Marcolin’s (2000) study be extended to include measurements of computer self-efficacy, software knowledge, and task performance. This study met their call for research by validating the affective or self-report measures with cognitive and skill-based questions as well as hands-on skills tasks, and determining whether self-report assessments are valid alternatives to hands-on skills exams.

- This study confirms previous studies which reported that CSE surveys are not reliable in the majority of cases. In this study, not only did the students over-estimate their skills, but their memory of whether they had taken a course to develop Excel skills was not accurate.

- This study has confirmed Simon’s (1996) findings that cognitive ability failed to be a good predictor of performance.

- This study shows the types of questions that can be indicative of competence. Students that answered several of the cognitive and skill-based questions correctly also received high scores on the hands-on skills exam. While these questions alone were not enough to be a valid alternative to a hands-on skills exam, they are indicative that students who answered them correctly do have skills with Excel.
This study confirmed previous research which indicated the majority of students over-estimate their computer or software skills (McCourt Larres et al. 2003; Ballantine et al. 2007). Computer self-efficacy (CSE) surveys tend to be unreliable in the majority of cases, and this study proved no different.

Practical implications and contributions include:

- A combination of indirect and direct assessments is not a valid alternative to an actual hands-on skills exam. This will save time and money spent by universities who want to determine the best method to determine the software skills of their incoming and/or graduating students. Colleges and universities are finding that hands-on skills exams, be they simulated or not, are the best way to measure actual competence. For example, Tesch, et al. (2003) implemented skills assessment exams for all incoming freshmen to ensure they possess the requisite software skills with Microsoft Office. In North Carolina, where high school students are taught business productivity software (Microsoft Office), Grant et al. (2009) implemented an online assessment for word processing and presentation software skills, but focused a software skills course on spreadsheet skills.
- Schools interested in determining whether their own student body would benefit from either a CSE survey or a direct assessment such as cognitive or skill-based questions, or an actual hands-on skills exam, could apply a modified version of this study. The results could then be used to justify a course of action that would better prepare their students with the software skills necessary to succeed in school and in the workplace.

5.3 Limitations

In all studies there are limitations, and this study is no different. The following is a list of limitations, both known and discovered:

- Sample size: The primary limitation of this study was the small sample size. The study utilized students from only one school (business) in the university. There were several
students who are not registered as majors within the school of business, but these are a very small minority.

- Self-selection: The students were self-selected into participation. As a result, it is quite likely that two groups of students participated: 1) students who are very skillful with Excel and welcomed the chance to easily earn extra credit points, and 2) students who needed the extra credit points and thus participated though they might have questionable skills with Excel. These two groups are represented by the large range of scores on the hands-on skills exam.

- The vendor’s hands-on skills exam accepted only the answer programmed into the Excel simulation exam program. This is problematic because for each task there is more than one way to accomplish it. For example, rather than click an icon, one could navigate the menus or press a sequence of keys. Unfortunately, if that solution method was not the one programmed into the simulation exam, (e.g. wrong click = wrong answer), the answer was deemed incorrect. To mitigate this, participants were allowed up to 10 tries to accomplish each task. Allowing this may have permitted students to get a task correct through guessing.

- Students could end the CSE survey, cognitive and skill-based question test, and the hands-on skills test at any time.

5.5 Directions for Future Research

There are several directions this research could follow in the future. Not all could be explored, but several have generated enough interest to include here:

- Survey the faculty to discover their observations about student competence with Excel. Several of the faculty gave anecdotal evidence that the Excel competence of students is lacking. A survey which would qualify which courses require Excel competence, including
the level of competence, would allow researchers to target the students in those classes. While this narrows the target audience, it also helps identify which skills the faculty expect.

- Instead of hands-on skill exam in a simulated environment, use a real Excel spreadsheet with a separate list of tasks to accomplish. This will more closely resemble real-life tasks in that a participant isn’t limited to the solution or steps to reach the solution that the vendor accepts, but the task will be graded as correctly done or not. Grading will be more difficult, but could be automated with the use of macros and scripting. The results should more closely reflect actual competence with Excel.

- Survey the customers of the school (the employers who hire the school’s graduates) to discover their needs and expectations of the software skill level of the graduates. In this study, only one customer was interviewed. The indirect and direct assessments could then be constructed to reflect those needs and expectations.

- Perform a longitudinal study in which incoming freshman are testing for skill level, and then again tested as graduating seniors to determine if skills are being used/retained during their education.

- Implement this method with a test-out process, in which students who passed the hands-on skills test with a grade of 80% or better would not have to take the Introduction to Excel course. The CSE survey items and cognitive and skill-based questions could then be continually measured against the hands-on skills exam and be adjusted accordingly.

- Study the results at a deeper granularity. For example, compare the CSE chart statement, cognitive questions on charts, skill-based questions on charts, and the chart tasks on the hands-on skill exam to achieve specific granularity.
References


Hurt, M. (1990). IS-user relationships: Factors which impact their perceived effectiveness and differences between IS and users. Austin, TX, University of Texas at Austin. PhD.


Kyodo_News. (2011). "Test taker seeks answers online during exams at several universities."
Retrieved 28 February 2011, 2011, from


Thong, J. Y. L., W. Y. Hong and K. Y. Tam (2002). "Understanding user acceptance of digital libraries: what are the roles of interface characteristics, organizational context, and


Appendices

Appendix 1: Initial Survey for pilot study

The following is the initial survey for the pilot study, administered on SurveyMonkey.com:

1. Demographic information

First, tell us a bit about yourself

Please enter your VCU email address:

Gender

- Male
- Female

What is your major? (If you are still undecided, indicate your most likely choice)

- Prefer not to answer
- Accounting
- Business Administration/Entrepreneurship/International Management
- Economics
- Finance/Financial Technology/Financial Planning/Risk and Insurance
- Human Resources
- Information Systems
- Marketing
- Real Estate
- Other (please specify)

Which of the following best applies to you?

- Freshman
- Sophomore
- Junior
- Senior
- Post-baccalaureate
- Graduate Student

2. Computing experience

The following questions concern your general computer experience and knowledge.

How long have you been using a computer?

- Less than 6 months
- 6-12 months
- 1-3 years
- 4-6 years
- 7-9 years
- 10 years or more
How comfortable do you feel using computers, in general?
- Very comfortable
- Somewhat comfortable
- Neither comfortable nor uncomfortable
- Somewhat uncomfortable
- Very uncomfortable

How satisfied are you with your current skills for using a computer?
- Very satisfied - I can do everything that I want to do
- Somewhat satisfied - I can do most things I want to do
- Neither satisfied nor unsatisfied
- Somewhat unsatisfied - I can’t do many things I would like to do
- Very unsatisfied - I can’t do most things I would like to do

What is your primary computing platform (operating system)?
- DOS
- Macintosh OS X
- Macintosh (Other than OS X)
- OS2
- Unix or Linux
- Microsoft Windows
- Don’t Know
- Other

3. Spreadsheet knowledge
The following questions concern your skills with spreadsheets (specifically Microsoft Excel, which is used in the School of Business).

I know enough about using spreadsheet software to take upper-level business courses, including INFO360
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets
- Strongly Agree
- Agree
- Neither agree nor disagree
- disagree
- Strongly disagree

I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
I feel confident that I can work with multiple worksheets in a workbook file
   - Strongly Agree
   - Agree
   - Neither Agree nor Disagree
   - Disagree
   - Strongly Disagree

I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet.
   - Strongly Agree
   - Agree
   - Neither Agree nor Disagree
   - Disagree
   - Strongly Disagree

I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet.
   - Strongly Agree
   - Agree
   - Neither Agree nor Disagree
   - Disagree
   - Strongly Disagree

I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.
   - Strongly Agree
   - Agree
   - Neither Agree nor Disagree
   - Disagree
   - Strongly Disagree

I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet.
   - Strongly Agree
   - Agree
   - Neither Agree nor Disagree
   - Disagree
   - Strongly Disagree

This concludes the survey. Thank you for your participation.
Appendix 2: Survey Revision 1 for 1st data collection

Because the demographic and computing experience questions remained the same as in the pilot study, but several of the Excel questions were changed, we will only present the Excel questions in this appendix:

3. Spreadsheet knowledge

The following questions concern your experience and skills with spreadsheets (specifically Microsoft Excel 2007, which is used in the School of Business).

How long have you been using Microsoft Excel?

- 0-1 year
- 1-3 years
- 3-5 years
- more than 5 years

Which of the following best describes your current usage of MS Excel?

- I use Excel rarely (less than once a month)
- I use Excel infrequently (less than once a week)
- I use Excel frequently (about once a week)
- I use Excel quite often (more than once a week)
- I use Excel daily

Which version of Excel are you most familiar with or use most often?

- Excel 2000
- Excel 2002-2003
- Excel 2007
- Excel 2010

What is the most often reason for using Excel?

- Required at work
- Required by instructors / professors
- Managing my personal life or work
- As a tool I CHOOSE to help me at work
- As a tool I CHOOSE to help with classwork
- Other

INFO 162 Introduction to Microcomputer-based Spreadsheet Packages: Introduces students to fundamentals of spreadsheet processing on the microcomputer. Topics include the entering of text, numbers and formulas, formatting, moving, copying, recalculation, graphing, retrieving, saving, and printing. The course will help students prepare financial analyses and products other VCU course work may require.

I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets.

- Strongly Agree
- Agree
- Neither agree nor disagree
I know enough about using spreadsheet software to take upper-level business courses.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

We would like a bit more detail about your skills with spreadsheets. The next questions are about more specific spreadsheet functionality.

I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

I feel confident that I can work with multiple worksheets in a workbook file.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

This concludes the survey. Thank you for your participation.
Appendix 3: Survey Revision 2 for 2nd data collection

For the second data collection, there were several questions added to the survey, both demographical and domain specific. Due to this, we included the entire survey:

1. Demographic information

Please enter your VCU email address: ________________________

Gender

□ Male
□ Female
□ Prefer not to answer

What is your major? (If you are still undecided, indicate your most likely choice)

□ Accounting
□ Business Administration/Entrepreneurship/International Management
□ Economics
□ Finance/Financial Technology/Financial Planning/Risk and Insurance
□ Human Resources
□ Information Systems
□ Marketing
□ Real Estate
□ Other (please specify)

Which of the following best applies to you?

□ Freshman
□ Sophomore
□ Junior
□ Senior
□ Post-baccalaureate
□ Graduate Student

2. Computing experience

The following questions concern your general computer experience and knowledge.

How long have you been using a computer?

□ Less than 6 months
□ 6-12 months
□ 1-3 years
□ 4-6 years
□ 7-9 years
□ 10 years or more

How comfortable do you feel using computers, in general?

□ Very comfortable
□ Somewhat comfortable
□ Neither comfortable nor uncomfortable
□ Somewhat uncomfortable
□ Very uncomfortable

How satisfied are you with your current skills for using a computer?
□ Very satisfied - I can do everything that I want to do
□ Somewhat satisfied - I can do most things I want to do
□ Neither satisfied nor unsatisfied
□ Somewhat unsatisfied - I can't do many things I would like to do
□ Very unsatisfied - I can't do most things I would like to do

What is your current primary computing platform (operating system)?
□ Mainframe / VAX
□ DOS
□ Apple OS X
□ Apple OS (other than OSX)
□ OS2
□ Unix or Linux
□ Windows 3 / 95
□ Windows NT
□ Windows 2000
□ Windows XP
□ Windows Vista
□ Windows 7

Please enter the years’ experience you have with each operating system

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<thead>
<tr>
<th>Operating Systems</th>
<th>Years Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainframe / VAX</td>
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<tr>
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<td></td>
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<tr>
<td>Other</td>
<td></td>
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<tr>
<td>Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

3. Spreadsheet knowledge
How long have you been using Microsoft Excel?
□ 0-1 year
□ 1-3 years
Which of the following best describes your current usage of MS Excel?
- I use Excel rarely (less than once a month)
- I use Excel infrequently (less than once a week)
- I use Excel frequently (about once a week)
- I use Excel quite often (more than once a week)
- I use Excel daily

Which version of Excel are you most familiar with or use most often?
- Windows Excel version prior to Excel 2000
- Windows Excel 2000 (included in Office 2000)
- Windows Excel 2002 (included in Office XP)
- Windows Excel 2003 (included in Office 2003)
- Windows Excel 2007 (included in Office 2007)
- Windows Excel 2010 (included in Office 2010)
- Apple MAC Excel version prior to Excel 9.0
- Apple MAC Excel 9.0 (part of Office 2001)
- Apple MAC 2001 Excel 10.0 (part of Office v. X)
- Apple MAC 2004 Excel 11.0 (part of Office 2004)
- Apple MAC 2008 Excel 12.0 (part of Office 2008)
- Apple MAC 2011 Excel 14.0 (part of Office 2011)

What is the most often reason for using Excel?
- Required at work
- Required by instructors / professors
- Managing my personal life or work
- As a tool I CHOOSE to help me at work
- As a tool I CHOOSE to help with classwork
- Other

4. Spreadsheet Knowledge Continued

INFO 162 Introduction to Microcomputer-based Spreadsheet Packages: Introduces students to fundamentals of spreadsheet processing on the microcomputer. Topics include the entering of text, numbers and formulas, formatting, moving, copying, recalculation, graphing, retrieving, saving, and printing. The course will help students prepare financial analyses and products other VCU course work may require.

Have you taken INFO 162?
- Yes
- No
If yes, please enter the year you took the class, and the Excel version (2003, 2007, 2010)

I have knowledge of spreadsheet software that is equivalent to that taught in INFO162:
Introduction to Spreadsheets
□ Strongly Agree
□ Agree
□ Neither agree nor disagree
□ disagree
□ Strongly disagree

I know enough about using spreadsheet software to take upper-level business courses.
□ Strongly Agree
□ Agree
□ Neither Agree nor Disagree
□ Disagree
□ Strongly Disagree

5. Spreadsheet knowledge

We would like a bit more detail about your skills with spreadsheets. The next questions are about more specific spreadsheet functionality.

I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet
□ Strongly Agree
□ Agree
□ Neither Agree nor Disagree
□ Disagree
□ Strongly Disagree
□ This is not a feature or function of MS Excel

I feel confident that I can work with multiple worksheets in a workbook file
□ Strongly Agree
□ Agree
□ Neither Agree nor Disagree
□ Disagree
□ Strongly Disagree
□ This is not a feature or function of MS Excel

I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet.
□ Strongly Agree
□ Agree
□ Neither Agree nor Disagree
□ Disagree
□ Strongly Disagree
□ This is not a feature or function of MS Excel

I feel confident that I can save an Excel spreadsheet as a picture file (.jpg, .bmp, .gif, etc.)
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
This is not a feature or function of MS Excel

I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet.
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
This is not a feature or function of MS Excel

I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
This is not a feature or function of MS Excel

I feel confident that I can duplicate a slide in MS Excel
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
This is not a feature or function of MS Excel

I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
This is not a feature or function of MS Excel

Thank you.
This concludes the survey. Thank you for your participation.
Appendix 4: Surveys for final data collection

Pre-skills exam survey

Page 1. Demographic information

First, tell us a bit about yourself

Please enter your VCU email address: ____________

Gender
○ Male
○ Female
○ Prefer not to answer

Age
○ Up to 22 years old
○ 23-26 years old
○ 27-35 years old
○ 35 years old and over

What is your major? (If you are still undecided, indicate your most likely choice)
○ Accounting
○ Business Administration/Entrepreneurship/International Management
○ Economics
○ Finance/Financial Technology/Financial Planning/Risk and Insurance
○ Human Resources
○ Information Systems
○ Marketing
○ Real Estate
○ Other (please specify)

Which of the following best applies to you?
○ Freshman
○ Sophomore
○ Junior
○ Senior
○ Post-baccalaureate
○ Graduate Student
Page 2. Computing experience

The following questions concern your general computer experience and knowledge.

How long have you been using a computer?
○ Less than 6 months
○ 6-12 months
○ 1-3 years
○ 4-6 years
○ 7-9 years
○ 10 years or more

How comfortable do you feel using computers, in general?
○ Very comfortable
○ Somewhat comfortable
○ Neither comfortable nor uncomfortable
○ Somewhat uncomfortable
○ Very uncomfortable

How satisfied are you with your current skills for using a computer?
○ Very satisfied - I can do everything that I want to do
○ Somewhat satisfied - I can do most things I want to do
○ Neither satisfied nor unsatisfied
○ Somewhat unsatisfied - I can't do many things I would like to do
○ Very unsatisfied - I can't do most things I would like to do

What is your current primary computing platform (operating system)?
○ Mainframe / VAX
○ DOS
○ Apple OS X
○ Apple OS (Other than OS X)
○ OS2
○ Unix or Linux
○ Microsoft Windows
○ Don't Know
○ Other
Please enter the years experience you have with each operating system

<table>
<thead>
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<th>Years Experience</th>
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<td>Unix or Linux</td>
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<td>Windows 7</td>
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</tr>
<tr>
<td>Other (please specify)</td>
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</tbody>
</table>

Page 3. Spreadsheet knowledge

The following questions concern your experience and skills with spreadsheets (specifically Microsoft Excel 2007, which is used in the School of Business).

How long have you been using Microsoft Excel?
- ○ 0-1 year
- ○ 1-3 years
- ○ 3-5 years
- ○ more than 5 years

Which of the following best describes your current usage of MS Excel?
- ○ I use Excel rarely (less than once a month)
- ○ I use Excel infrequently (less than once a week)
- ○ I use Excel frequently (about once a week)
- ○ I use Excel quite often (more than once a week)
- ○ I use Excel daily

Which version of Excel are you most familiar with or use most often?
- ○ Windows Excel version prior to Excel 2000
- ○ Windows Excel 2000 (included in Office 2000)
- ○ Windows Excel 2002 (included in Office XP)
- ○ Windows Excel 2003 (included in Office 2003)
- ○ Windows Excel 2007 (included in Office 2007)
- ○ Windows Excel 2010 (included in Office 2010)
- ○ Apple MAC Excel version prior to Excel 9.0
- ○ Apple MAC Excel 9.0 (part of Office 2001)
- ○ Apple MAC 2001 Excel 10.0 (part of Office v. X)
- ○ Apple MAC 2004 Excel 11.0 (part of Office 2004)
- ○ Apple MAC 2008 Excel 12.0 (part of Office 2008)
○ Apple MAC 2011 Excel 14.0 (part of Office 2011)

What is the most often reason for using Excel?
○ Required at work
○ Required by instructors / professors
○ Managing my personal life or work
○ As a tool I CHOOSE to help me at work
○ As a tool I CHOOSE to help with classwork
○ Other

Page 4. Spreadsheet Knowledge Continued

INFO 162 Introduction to Microcomputer-based Spreadsheet Packages: Introduces students to fundamentals of spreadsheet processing on the microcomputer. Topics include the entering of text, numbers and formulas, formatting, moving, copying, recalculation, graphing, retrieving, saving, and printing. The course will help students prepare financial analyses and products other VCU course work may require.

Have you taken INFO 162?
○ Yes
○ No
If yes, please enter the year you took the class, and the Excel version (2003, 2007, 2010)

I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets
○ Strongly Agree
○ Agree
○ Neither agree nor disagree
○ disagree
○ Strongly disagree

I know enough about using spreadsheet software to take upper-level business courses.
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree

Page 5. Spreadsheet knowledge

We would like a bit more detail about your skills with spreadsheets. The next questions are about more specific spreadsheet functionality
I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

I feel confident that I can work with multiple worksheets in a workbook file
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

Page 6. Spreadsheet knowledge

I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet.
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

I feel confident that I can save an Excel spreadsheet as a picture file (.jpg, .bmp, .gif, etc.)
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet.
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel
Page 7. Spreadsheet knowledge

I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

I feel confident that I can duplicate a slide in MS Excel
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet.
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

Page 8. Cognitive questions

Please answer the following cognitive questions concerning MS Excel.

_____ is the default number format.
○ A. Number
○ B. Text
○ C. Accounting
○ D. General

An Excel file is called a ____.
○ A. document
○ B. workbook
○ C. worksheet
○ D. range
In the image below, the cell address for the name Mia Fillion is ____.
○ A. 6
○ B. A
○ C. A6
○ D. 6A

In the image above, the selected cell contains a(n) ____.
○ A. formula
○ B. address
○ C. number
○ D. text format

The contents of the active cell are displayed in the ____.
○ A. Formula bar
○ B. Name box
○ C. worksheet window
○ D. status bar

When you copy a range of cells, you can paste it ____.
○ A. anywhere in a worksheet
○ B. at the end of the worksheet
○ C. only into a range of the same size
○ D. only into a new workbook

When your cell contents do not fit in a cell, you can fix it by doing any of the following EXCEPT ____.
○ A. manually adjusting the column width
○ B. inserting a new column
○ C. making the text appear on multiple lines
○ D. using AutoFit
Which of the following numbers could NOT be used in a calculation?
- A. (978) 555-4501
- B. $5609.98
- C. 48%
- D. They all could be used in a calculation.

___ arranges data in sequential order.
- A. Filtering
- B. Sorting
- C. Splitting
- D. Merging

A(n) ___ is a name assigned to two or more cells in order to reference them in a formula.
- A. group
- B. merge
- C. range
- D. address

A(n) ___ page layout is wider than it is long.
- A. scaled
- B. aligned
- C. portrait
- D. landscape

Rows or columns are ___ if column letters or row numbers are skipped.
- A. hidden
- B. merged
- C. split
- D. sorted

You can merge all of the following EXCEPT ___.
- A. nonadjacent cells
- B. horizontally
- C. vertically
- D. both vertically and horizontally

$A$5 is an example of a(n) ___ cell reference.
- A. absolute
- B. relative
- C. mixed
- D. currency
#DIV/0 is an example of a(n) ____.
○ A. absolute cell reference
○ B. AutoSum formula
○ C. division function
○ D. error message

A(n) ____ chart displays data as a collection of points.
○ A. column
○ B. line
○ C. scatter
○ D. area

In the formula 4+B4*(D6-500), ____ is calculated first.
○ A. 4+B4
○ B. B4*D6
○ C. D6-500
○ D. The formula is calculated left to right.

Which of the following is NOT correct about creating formulas?
○ A. You can click a cell to reference it in a formula.
○ B. When both multiplication and division commands are in a formula, Excel calculates from left to right.
○ C. Operations within parentheses are done first.
○ D. You can view the results of a calculation in the Formula bar.

The ____ command removes data and stores it for future use.
○ A. Delete
○ B. Backspace
○ C. Cut
○ D. Remove

Page 9. Thank you

This concludes the survey. Thank you for your participation.
Post-skills exam survey

To determine if the self-perception of computers skills (CSE) changed after having taken the hands-on skills exam, the following CSE survey was given.

Page 1. Demographic information

Now that you have taken the skills-exam, please answer the following questions.
Please enter your VCU email address: ______________

We would like a bit more detail about your skills with spreadsheets. The next questions are about more specific spreadsheet functionality

Page 2. Spreadsheet knowledge

I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

I feel confident that I can work with multiple worksheets in a workbook file
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel

Page 3. Spreadsheet knowledge

I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet.
○ Strongly Agree
○ Agree
○ Neither Agree nor Disagree
○ Disagree
○ Strongly Disagree
○ This is not a feature or function of MS Excel
I feel confident that I can save an Excel spreadsheet as a picture file (.jpg, .bmp, .gif, etc.) from within Excel.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
- This is not a feature or function of MS Excel

I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
- This is not a feature or function of MS Excel

Page 4. Spreadsheet knowledge

I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
- This is not a feature or function of MS Excel

I feel confident that I can duplicate a slide in MS Excel
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
- This is not a feature or function of MS Excel

I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree
- This is not a feature or function of MS Excel
Page 5. Thank you

This concludes the survey. Thank you for your participation.
## Appendix 5: Hands-on Skills Test questions and sample task screenshot

<table>
<thead>
<tr>
<th>Category</th>
<th>Activity</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Absolute Cell Address</td>
<td>Specify that the formula in the edit line will always ml A4 even if</td>
</tr>
<tr>
<td></td>
<td>dialled into another cell.</td>
<td>pressed ENTER when done.</td>
</tr>
<tr>
<td>General</td>
<td>Align Cell Contents</td>
<td>Center the text in the selected cells.</td>
</tr>
<tr>
<td>Basic</td>
<td>AutoFit Column</td>
<td>Change the width of the selected column to automatically fit the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>widest entry in the column.</td>
</tr>
<tr>
<td>General</td>
<td>Border Lines</td>
<td>Create a border on the bottom of the selected cell B2.</td>
</tr>
<tr>
<td>General</td>
<td>Cell Formatting - Remove</td>
<td>Remove the formatting from the selected cells without removing the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cell contents.</td>
</tr>
<tr>
<td>General</td>
<td>Center Across Cells</td>
<td>Center the selected text across the selected cells.</td>
</tr>
<tr>
<td>General</td>
<td>Center on page horizontally</td>
<td>Specify that the current worksheet will be horizontally centered on</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the page.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Chart - Change Type</td>
<td>Change the chart type to a 3-D non-exploded pie chart.</td>
</tr>
<tr>
<td>Basic</td>
<td>Chart - Create</td>
<td>Insert a 2-D Column chart based on the selected data.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Chart - Format</td>
<td>Specify that the selected legend will automatically appear at the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bottom of the chart. Do NOT click and drag.</td>
</tr>
<tr>
<td>General</td>
<td>Color Text</td>
<td>Change the color of the text in the selected cell to yellow.</td>
</tr>
<tr>
<td>Basic</td>
<td>Copy a worksheet</td>
<td>Put a copy of the selected worksheet at the end of the workbook.</td>
</tr>
<tr>
<td>Basic</td>
<td>Create charts using the pie chart types</td>
<td>Create a pie chart based on the selected data.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Create formulas using the AVERAGE function</td>
<td>Select and insert the worksheet function that displays the sum of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>specified values divided by the number of values.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Create formulas using the IF function</td>
<td>Select and insert the worksheet function that displays different</td>
</tr>
<tr>
<td></td>
<td></td>
<td>values based on whether a condition is true or false.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Create formulas using the PMT function</td>
<td>Select and insert the worksheet function that will use constant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>payments and a constant interest rate to calculate payments for a</td>
</tr>
<tr>
<td></td>
<td>Delete Rows</td>
<td>Permanently remove the selected rows from the workbook. (Do NOT use CONTROL+-)</td>
</tr>
<tr>
<td>Basic</td>
<td>Delete Sheet</td>
<td>Remove the worksheet &quot;OFFICES&quot; from the workbook.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Display formula contents</td>
<td>Specify that cells containing formulas will display the formula (not</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the result of the formula) in the cell.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Edit a chart</td>
<td>Add a Horizontal Axis Title to the bottom of the selected chart.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Specify that the name of the axis will be &quot;Q1SALES&quot;. Press ENTER when done.</td>
</tr>
<tr>
<td>Basic</td>
<td>Fill Series - Drag and Drop</td>
<td>Use the fill handle to fill cells F23 through I23 with the series</td>
</tr>
<tr>
<td></td>
<td></td>
<td>represented in the selected cells.</td>
</tr>
<tr>
<td>General</td>
<td>Find Text</td>
<td>Search for the words &quot;TURKISH&quot; in the worksheet.</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Format chart data labels</td>
<td>Specify that the selected data labels will display the values of the data.</td>
</tr>
<tr>
<td>Basic</td>
<td>Formula - Add</td>
<td>At the insertion point, type the formula that will add the contents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of cells H7 through H11 and divide the total by 5. Press Enter when done. (Do NOT use spaces in the formula.)</td>
</tr>
<tr>
<td>Basic</td>
<td>Formula - Subtract</td>
<td>At the insertion point, type the formula that will subtract the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>contents of cell H15 from the sum of cells I7 through I12. Press ENTER when done.</td>
</tr>
<tr>
<td>Basic</td>
<td>Function - Autosum</td>
<td>With a single action, insert sum functions into each of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>selected cells. (Do NOT use ALT+=.)</td>
</tr>
<tr>
<td>Basic</td>
<td>Hide Column</td>
<td>Hide the selected column. (Do NOT click and drag on the column</td>
</tr>
<tr>
<td></td>
<td></td>
<td>header to change column width.)</td>
</tr>
<tr>
<td>Basic</td>
<td>Insert Cells</td>
<td>Insert cells at the selected location. Shift the remaining cells to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the right. (Do NOT use CONTROL-=.) (Do NOT use CONTROL+=.)</td>
</tr>
<tr>
<td>Basic</td>
<td>Insert Worksheet</td>
<td>Add a new worksheet to the current workbook.</td>
</tr>
<tr>
<td>General</td>
<td>Margins</td>
<td>Set the top and bottom margins of the printed worksheet to 1.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>inches.</td>
</tr>
<tr>
<td>Basic</td>
<td>Merge Cells</td>
<td>Merge the selected cells into a single cell.</td>
</tr>
<tr>
<td>Basic</td>
<td>Move Sheet</td>
<td>Move the current sheet named &quot;PRINT TRANSLATIONS&quot; so that it</td>
</tr>
<tr>
<td></td>
<td></td>
<td>appears between the sheets named &quot;OFFICES&quot; and &quot;EMPLOYEE PIVOT&quot;.</td>
</tr>
<tr>
<td>General</td>
<td>Number Format - Currency</td>
<td>Format the selected cells so that the number 20 appears as $20.00 (as currency with two decimal places).</td>
</tr>
<tr>
<td>General</td>
<td>Number Format - Date</td>
<td>Format the selected serial date numbers as dates in the format Day-Month (14-Mar).</td>
</tr>
</tbody>
</table>
**General** | **Orientation** | Change the current page orientation to landscape.
---|---|---
**Basic** | **Position a chart** | Move the selected chart to the upper left corner of the worksheet.
**Basic** | **Print a chart** | Print only the chart on this worksheet.
**General** | **Print Preview** | Display a preview of what the worksheet will look like when printed.
**General** | **Print Workbook** | Print 2 copies of pages 2 to 3 of this worksheet.
**Basic** | **Rename Worksheet** | Rename the current worksheet "PRINT TRANSLATIONS".
**Basic** | **Resize a chart** | Resize the chart so that it covers cells A1 to H15.
**General** | **Save in Different Location** | Save the current workbook as "SHIPPING RECORD.xlsx" onto Removable Disk (G:).
**Basic** | **Select Column** | With a single action, select all the cells in column A. (Do NOT click and drag across worksheet cells to select the column.)
**Basic** | **Select non-adjacent cells** | Select cell range G8 to G10 without deselecting the currently selected cells.
**Basic** | **Select Worksheet** | With a single action, select the entire worksheet. (Do NOT click and drag across worksheet cells to select the worksheet.)
**Intermediate** | **Set Print Area** | Set the selected cells as the print area.
**General** | **Shading** | Remove the blue shading from the selected cells.
**Basic** | **Sort** | Automatically arrange the selected rows so that each item in the first column will appear in alphabetical order.
**Basic** | **Unhide columns** | Display the columns currently hidden in this worksheet.
**General** | **Wrap Text** | Specify that text in the current cell will appear on multiple lines within the cell.

**Sample task screenshot**

![Sample task screenshot](image-url)
# Appendix 6: Frequency Analysis of Hands-on Skills Exam tasks

## Hands-on Skills Exam Frequency Analysis

| Average Score: 68% | Total Students: 254 |

### Performance Tasks

<table>
<thead>
<tr>
<th>Category</th>
<th>Activity</th>
<th>Task [task_id]</th>
<th>Avg. Time (mm:ss)</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Skipped</th>
<th>Not Present</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Absolute Cell Address</td>
<td>Specify that the formula in the edit line will always multiply by cell A4 even if pasted into another cell. Press ENTER when done. [1]</td>
<td>01:39</td>
<td>41</td>
<td>195</td>
<td>17</td>
<td>20</td>
<td>15%</td>
</tr>
<tr>
<td>General</td>
<td>Align Cell Contents</td>
<td>Center the text in the selected cells. [9]</td>
<td>00:20</td>
<td>234</td>
<td>16</td>
<td>2</td>
<td>21</td>
<td>85%</td>
</tr>
<tr>
<td>Basic</td>
<td>AutoFit Column</td>
<td>Change the width of the selected column to automatically fit the widest entry in the column. [36]</td>
<td>00:38</td>
<td>188</td>
<td>51</td>
<td>12</td>
<td>22</td>
<td>68%</td>
</tr>
<tr>
<td>General</td>
<td>Border Lines</td>
<td>Create a border on the bottom of the selected cell B2. [56]</td>
<td>00:41</td>
<td>208</td>
<td>42</td>
<td>4</td>
<td>19</td>
<td>76%</td>
</tr>
<tr>
<td>General</td>
<td>Cell Formatting - Remove</td>
<td>Remove the formatting from the selected cells without removing the cell contents. [72]</td>
<td>01:05</td>
<td>87</td>
<td>157</td>
<td>6</td>
<td>23</td>
<td>31%</td>
</tr>
<tr>
<td>General</td>
<td>Center Across Cells</td>
<td>Center the selected text across the selected cells. [75]</td>
<td>01:23</td>
<td>151</td>
<td>98</td>
<td>4</td>
<td>20</td>
<td>55%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Chart - Change Type</td>
<td>Change the chart type to a 3-D non-exploded pie chart. [83]</td>
<td>00:38</td>
<td>233</td>
<td>15</td>
<td>2</td>
<td>23</td>
<td>85%</td>
</tr>
<tr>
<td>Basic</td>
<td>Chart - Create</td>
<td>Insert a 2-D Column chart based on the selected data. [86]</td>
<td>00:26</td>
<td>226</td>
<td>17</td>
<td>8</td>
<td>22</td>
<td>82%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Chart - Format</td>
<td>Specify that the selected legend will automatically appear at the bottom of the chart. Do NOT click and drag. [88]</td>
<td>00:35</td>
<td>213</td>
<td>31</td>
<td>7</td>
<td>22</td>
<td>78%</td>
</tr>
<tr>
<td>General</td>
<td>Color Text</td>
<td>Change the color of the text in the selected cell to yellow. [121]</td>
<td>00:20</td>
<td>227</td>
<td>19</td>
<td>1</td>
<td>26</td>
<td>83%</td>
</tr>
<tr>
<td>Basic</td>
<td>Delete Rows</td>
<td>Permanently remove the selected rows from the workbook. (Do NOT use CONTROL--.) [257]</td>
<td>00:21</td>
<td>225</td>
<td>20</td>
<td>3</td>
<td>25</td>
<td>82%</td>
</tr>
<tr>
<td>Basic</td>
<td>Delete Sheet</td>
<td>Remove the worksheet &quot;OFFICES&quot; from the workbook. [259]</td>
<td>00:19</td>
<td>232</td>
<td>17</td>
<td>2</td>
<td>22</td>
<td>84%</td>
</tr>
<tr>
<td>Basic</td>
<td>Fill Series - Drag and Drop</td>
<td>Use the fill handle to fill cells F23 through I23 with the series represented in the selected cells. [328]</td>
<td>00:58</td>
<td>133</td>
<td>105</td>
<td>15</td>
<td>20</td>
<td>48%</td>
</tr>
<tr>
<td>General</td>
<td>Find Text</td>
<td>Search for the words &quot;TURKISH&quot; in the worksheet. [340]</td>
<td>00:27</td>
<td>226</td>
<td>25</td>
<td>2</td>
<td>20</td>
<td>82%</td>
</tr>
<tr>
<td>Basic</td>
<td>Formula - Add</td>
<td>At the insertion point, type the formula that will add the contents of cells H7 through H11 and divide the total by 5. Press Enter when done. (Do NOT use spaces in the formula.) [388]</td>
<td>01:34</td>
<td>121</td>
<td>113</td>
<td>20</td>
<td>19</td>
<td>44%</td>
</tr>
<tr>
<td>Basic</td>
<td>Formula - Subtract</td>
<td>At the insertion point, type the formula that will subtract the contents of cell H15 from the sum of cells I7 through I12. Press ENTER when done. [391]</td>
<td>01:57</td>
<td>99</td>
<td>134</td>
<td>19</td>
<td>21</td>
<td>36%</td>
</tr>
<tr>
<td>Basic</td>
<td>Function - Autosum</td>
<td>With a single action, insert sum functions into each of the selected cells. (Do NOT use ALT--.) [394]</td>
<td>00:35</td>
<td>195</td>
<td>45</td>
<td>10</td>
<td>23</td>
<td>71%</td>
</tr>
<tr>
<td>Basic</td>
<td>Hide Column</td>
<td>Hide the selected column. (Do NOT click and drag on the column header to change column width.) [452]</td>
<td>00:20</td>
<td>226</td>
<td>22</td>
<td>5</td>
<td>20</td>
<td>82%</td>
</tr>
<tr>
<td>Basic</td>
<td>Insert Cells</td>
<td>Insert cells at the selected location. Shift the remaining cells to the right. (Do NOT use CONTROL-=.) (Do NOT use CONTROL+-.) [482]</td>
<td>00:40</td>
<td>200</td>
<td>46</td>
<td>7</td>
<td>20</td>
<td>73%</td>
</tr>
<tr>
<td>Basic</td>
<td>Insert Worksheet</td>
<td>Add a new worksheet to the current workbook. [491]</td>
<td>00:18</td>
<td>226</td>
<td>24</td>
<td>1</td>
<td>22</td>
<td>82%</td>
</tr>
<tr>
<td>General</td>
<td>Margins</td>
<td>Set the top and bottom margins of the printed worksheet to 1.25 inches. [535]</td>
<td>00:34</td>
<td>229</td>
<td>21</td>
<td>4</td>
<td>19</td>
<td>83%</td>
</tr>
<tr>
<td>Basic</td>
<td>Merge Cells</td>
<td>Merge the selected cells into a single cell. [553]</td>
<td>00:41</td>
<td>197</td>
<td>44</td>
<td>8</td>
<td>24</td>
<td>72%</td>
</tr>
<tr>
<td>Basic</td>
<td>Move Sheet</td>
<td>Move the current sheet named &quot;PRINT TRANSLATIONS&quot; so that it appears between the sheets named &quot;OFFICES&quot; and &quot;EMPLOYEE PIVOT&quot;. [576]</td>
<td>00:33</td>
<td>218</td>
<td>33</td>
<td>3</td>
<td>19</td>
<td>79%</td>
</tr>
<tr>
<td>General</td>
<td>Number Format - Currency</td>
<td>Format the selected cells so that the number 20 appears as $20.00 (as currency with two decimal places). [599]</td>
<td>00:31</td>
<td>220</td>
<td>32</td>
<td>4</td>
<td>17</td>
<td>80%</td>
</tr>
<tr>
<td>General</td>
<td>Number Format - Date</td>
<td>Format the selected serial date numbers as dates in the format Day-Month-Year. [601]</td>
<td>00:47</td>
<td>210</td>
<td>37</td>
<td>6</td>
<td>20</td>
<td>76%</td>
</tr>
<tr>
<td>General</td>
<td>Orientation</td>
<td>Change the current page orientation to landscape. [626]</td>
<td>00:22</td>
<td>234</td>
<td>16</td>
<td>3</td>
<td>20</td>
<td>85%</td>
</tr>
<tr>
<td>General</td>
<td>Print Preview</td>
<td>Display a preview of what the worksheet will look like when printed. [692]</td>
<td>00:20</td>
<td>239</td>
<td>10</td>
<td>3</td>
<td>21</td>
<td>87%</td>
</tr>
<tr>
<td>General</td>
<td>Print Workbook</td>
<td>Print 2 copies of pages 2 to 3 of this worksheet. [705]</td>
<td>00:31</td>
<td>241</td>
<td>9</td>
<td>4</td>
<td>19</td>
<td>88%</td>
</tr>
<tr>
<td>Basic</td>
<td>Rename Worksheet</td>
<td>Rename the current worksheet &quot;PRINT TRANSLATIONS&quot;. [746]</td>
<td>00:35</td>
<td>220</td>
<td>33</td>
<td>3</td>
<td>17</td>
<td>80%</td>
</tr>
<tr>
<td>General</td>
<td>Save in Different Location</td>
<td>Save the current workbook as &quot;SHIPPING RECORD.xlsx&quot; onto Removable Disk (G:). [783]</td>
<td>00:47</td>
<td>221</td>
<td>29</td>
<td>2</td>
<td>21</td>
<td>80%</td>
</tr>
<tr>
<td>Basic</td>
<td>Select Column</td>
<td>With a single action, select all the cells in column A. (Do NOT click and drag across worksheet cells to select the column.) [815]</td>
<td>00:20</td>
<td>220</td>
<td>24</td>
<td>7</td>
<td>22</td>
<td>80%</td>
</tr>
<tr>
<td>Basic</td>
<td>Select Worksheet</td>
<td>With a single action, select the entire worksheet. (Do NOT click and drag across worksheet cells to select the worksheet.) [821]</td>
<td>00:25</td>
<td>208</td>
<td>40</td>
<td>3</td>
<td>22</td>
<td>76%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Set Print Area</td>
<td>Set the selected cells as the print area. [830]</td>
<td>00:30</td>
<td>196</td>
<td>54</td>
<td>4</td>
<td>19</td>
<td>71%</td>
</tr>
<tr>
<td>General</td>
<td>Shading</td>
<td>Remove the blue shading from the selected cells. [833]</td>
<td>01:01</td>
<td>156</td>
<td>93</td>
<td>2</td>
<td>22</td>
<td>57%</td>
</tr>
<tr>
<td>Basic</td>
<td>Sort</td>
<td>Automatically arrange the selected rows so that each item in the first column will appear in alphabetical order. [860]</td>
<td>00:35</td>
<td>217</td>
<td>32</td>
<td>5</td>
<td>19</td>
<td>79%</td>
</tr>
<tr>
<td>General</td>
<td>Wrap Text</td>
<td>Specify that text in the current cell will appear on multiple lines within the cell. [1044]</td>
<td>01:40</td>
<td>111</td>
<td>131</td>
<td>16</td>
<td>15</td>
<td>40%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Create formulas using the IF function</td>
<td>Select and insert the worksheet function that displays different values based on whether a condition is true or false. [1068]</td>
<td>01:39</td>
<td>103</td>
<td>124</td>
<td>25</td>
<td>21</td>
<td>37%</td>
</tr>
<tr>
<td>Basic</td>
<td>Create charts using the pie chart types</td>
<td>Create a pie chart based on the selected data. [1069]</td>
<td>00:19</td>
<td>227</td>
<td>23</td>
<td>3</td>
<td>20</td>
<td>83%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Display formula contents</td>
<td>Specify that cells containing formulas will display the formula (not the result of the formula) in the cell. [1072]</td>
<td>01:25</td>
<td>111</td>
<td>119</td>
<td>18</td>
<td>25</td>
<td>40%</td>
</tr>
<tr>
<td>Level</td>
<td>Task Description</td>
<td>Time</td>
<td>Accuracy</td>
<td>173</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------</td>
<td>--------</td>
<td>----------</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Intermediates Select and insert the worksheet function that displays the sum of specified values divided by the number of values.</td>
<td>01:21</td>
<td>92</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Basic Unhide columns Display the columns currently hidden in this worksheet.</td>
<td>00:36</td>
<td>47</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Basic Position a chart Move the selected chart to the upper left corner of the worksheet.</td>
<td>00:40</td>
<td>71</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Basic Print a chart Print only the chart on this worksheet.</td>
<td>00:34</td>
<td>32</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediates</td>
<td>Intermediate Format chart data labels Specify that the selected data labels will display the values of the data.</td>
<td>01:11</td>
<td>90</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Basic Resize a chart Resize the chart so that it covers cells A1 to H15.</td>
<td>00:43</td>
<td>89</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Basic Select non-adjacent cells Select cell range G8 to G10 without deselecting the currently selected cells.</td>
<td>00:44</td>
<td>75</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>Basic Copy a worksheet Put a copy of the selected worksheet at the end of the workbook.</td>
<td>00:51</td>
<td>73</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediates</td>
<td>Intermediates Create formulas using the PMT function Select and insert the worksheet function that will use constant payments and a constant interest rate to calculate payments for a loan.</td>
<td>01:59</td>
<td>145</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>General Center on page horizontally Specify that the current worksheet will be horizontally centered on the page.</td>
<td>01:34</td>
<td>137</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediates</td>
<td>Intermediates Edit a chart Add a Horizontal Axis Title to the bottom of the selected chart. Specify that the name of the axis will be &quot;Q1SALES&quot;. Press ENTER when done.</td>
<td>01:11</td>
<td>97</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7: Hypothesis 1 Detailed Analyses

The first item on the survey is “I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets.” This question was preceded by a paragraph explaining the content of the course. Exploring the data for this item we find that the trend generally supports the hypothesis – the stronger the agreement with the statement, the higher the mean score on the hands-on skills exam (see Figure 18).

![Figure 18. Mean hands-on skill exam scores for CSE item 1](image)

However, checking the boxplot for this item against the hands-on score reveals that all the CSE ratings included extreme values, suggesting that this item only weakly supports the hypothesis (see Figure 19).
Figure 19. Boxplot for CSE item 1

This item had a mean of 3.5 out of 5 on a Likert scale, where 3 = “neither agree nor disagree,” and 5 = “strongly agree.” A 3.5 suggests that the average student felt they had knowledge of the Introduction to Spreadsheets course, though they did not have confidence in their knowledge. Regression resulted in an R Square value of .05, indicating that 5% of the hands-on skills exam score could be accounted for by this variable (see Table 39). Further, the coefficient registers as 5.196 with a 95% confidence interval (95% CI) of 2.357 to 8.036, suggesting that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by just over 5 units.

Table 39: Model Summary and Coefficient for CSE item 1

<table>
<thead>
<tr>
<th>Model Summary</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>R</td>
</tr>
<tr>
<td>Model</td>
<td>R</td>
</tr>
</tbody>
</table>
a. Predictors: (Constant), I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets

b. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>54.651</td>
<td>5.261</td>
</tr>
<tr>
<td></td>
<td>I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets</td>
<td>5.196</td>
<td>1.442</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

The second item on the survey is “I know enough about using spreadsheet software to take upper-level business courses.” Most of the students are juniors or seniors, and as such they are taking the upper-level business courses. Exploring the data for this item reveals that the trend generally supports the hypothesis – a higher self-rating resulted in a higher average score on the hands-on skills exam (see Figure 20).

Figure 20. Mean hands-on skill exam scores for CSE item 2
Like the first item, the boxplot for this item shows that nearly all the CSE ratings had extreme values affecting the mean hands-on score (see Figure 21). This suggests that the support for hypothesis 1 may not be strong.

![Boxplot for CSE item 2](image)

**Figure 21. Boxplot for CSE item 2**

This second CSE item had a mean of 3.54, indicating that the students did not have strong confidence in their knowledge of spreadsheet software. The R Square value is .065 (see Table 40), suggesting that 6.5% of the variability in the hands-on score could be attributed to this variable. Additionally, the coefficient registers as 5.933, suggesting that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by just under 6 units. These results suggest that this CSE item moderately supports hypothesis 1.

**Table 40: Model Summary and Coefficient for CSE item 2**

<table>
<thead>
<tr>
<th>Model Summary</th>
<th>b</th>
</tr>
</thead>
</table>

177
The third item, “I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet,” had a mean CSE rating of 4.40. This indicates that the majority of students are agree (126) or strongly agree (127) with the statement. Exploring the data for this item shows that the trend generally support hypothesis 1 – a higher CSE rating results in a higher score on the hands-on skills exam (see Figure 22).
The low mean score of 22 for the “strongly disagree” response may appear worrisome. However, there were only 3 students who responded with “strongly disagree” to this statement. Additionally, only 3 students responded with “disagree” and 8 students responded with “neither agree nor disagree.” The majority of students responded with “agree” (113) and “strongly agree” (121).

Regression analysis reveals that the R Square value is .087, suggesting that nearly 9% of the variability in the hands-on score could be attributed to this variable (see Table 41). Moreover, the coefficient registers as 9.676, indicating that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by nearly 10 units. These results indicate that this CSE item generally supports hypothesis 1.

Table 41: Model Summary and Coefficient for CSE item 3

| Model Summaryb |    |    | Adjusted R | Std. Error | Change Statistics | Change Statistics | Durbin-Watson |
|----------------|----|----|            |            | R Square | R Square | Change | F Change | df1 | df2 | Sig. F | Change |
| Model          |    |    | Square     | Estimate   |          |          |        |          |     |     |        |         |
| 1              | .295<sup>a</sup> | .087 | .083       | 22.699     | .087     | 23.489   | 1      | 246      | .000 | 1.780 |

<sup>a</sup> Predictors: (Constant), I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet

<sup>b</sup> Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>30.332</td>
<td>8.892</td>
<td>3.411</td>
</tr>
</tbody>
</table>

179
The fourth item, “I feel confident that I can work with multiple worksheets in a workbook file,” had a mean CSE rating of 4.03, suggesting that the average student agrees that he or she has confidence in their ability to work with multiple worksheets. Exploring the data reveals that as a CSE rating increased, the mean score on the hands-on skills exam increase also (see Figure 23). This trend suggests that this CSE item supports hypothesis 1.

Figure 23. Mean hands-on skill exam scores for CSE item 4

The boxplot for this CSE item reveals that only the “disagree” rating resulted in a tightly-clustered hands-on exam score. However, there were only 11 students who responded with “disagree” to this statement. The “strongly agree” rating also had several outlying scores (see Figure 24). Like the previous item, the low mean score of 22 for the “strongly disagree” item may seem worrisome, but only 3 students responded with this rating.
The R Square value for this item is .092, indicating that 9% of the variability in the hands-on skills exam score could be attributed to this variable (see Table 42). Further, the coefficient registers as 7.951, indicating that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by nearly 8 units. These results suggest that this CSE item supports hypothesis 1.

Table 42: Model Summary and Coefficient for CSE item 4

<table>
<thead>
<tr>
<th>Model Summary^b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), I feel confident that I can work with multiple worksheets in a workbook file

b. Dependent Variable: Hands-on score

Coefficients^a
The fifth item, “I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet,” had a mean CSE rating of 4.31, indicating that the majority of students agreed or strongly agreed that they are confident in formatting text. This was to be expected, as formatting, copying, moving, inserting, and deleting text is much the same across all the Microsoft Office Suite programs. Exploring the data shows that as the CSE rating increases, the average score on the hands-on skills exam increases (see Figure 25). It is interesting to note that only two students strongly disagreed with this statement, 6 disagreed, and 11 responded “neither agree nor disagree.” The majority of students agreed or strongly agreed with this statement.

![Figure 25: Mean hands-on skill exam scores for CSE item 5](image)

The R Square value is higher than the other variables at .121, suggesting that 12% of the variability in the hands-on skills exam score could be attributed to this variable (see Table 43).
Additionally, the coefficient registers as 11.140, indicating that as the rating for this CSE survey item increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by just over 11 units. These results suggest that CSE item supports hypothesis 1.

Table 43: Model Summary and Coefficient for CSE Item 5

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.347</td>
<td>.121</td>
<td>.117</td>
<td>22.278</td>
<td>.121</td>
<td>33.777</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet

b. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24.842</td>
<td>8.382</td>
<td>2.964</td>
</tr>
<tr>
<td></td>
<td>11.140</td>
<td>1.917</td>
<td>.347</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

The sixth item, “I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet,” deals with functionality that could be considered slightly more difficult than the others. As such, a mean CSE rating of 4.04 was unexpected; one would presume a lower rating. Exploring the data produced unanticipated results. Only one student reported that s/he strongly disagreed with this statement, and received a score of 4 on the exam. The average score on the hands-on skills exam for the “disagree,”
“neither disagree nor agree,” and “agree” categories were quite similar at 70, 67, and 69 respectively. Those that reported they strongly agreed with the statement received an average of 84 on the exam (see Figure 26).

Figure 26. Mean hands-on skill exam scores for CSE item 6

The descriptive statistics for this item reveal that only 1 student responded with “strongly disagree” for this statement; 14 students disagreed with the statement, and 37 students neither agreed nor disagreed. Again, the majority of the students (about 80%) agreed or strongly agreed with the statement. The boxplot for this item shows that while the “strongly agree” rating had an average score of 84% on the hands-on exam, there were several outlier scores that were much lower (see Figure 27). Furthermore, the range of hands-on scores for the “agree” and “neither agree nor disagree” ratings was quite large.
Figure 27. Boxplot for CSE item 7

This variable produced an R Square value of .071, indicating that 7% of the variability in the hands-on skills exam score could be attributed to this variable (see Table 44). Further, the coefficient registers as 7.417, indicating that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by over 7 units.

Table 44: Model Summary and Coefficient for CSE item 6

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.266</td>
<td>.071</td>
<td>.067</td>
<td>22.902</td>
<td>.071</td>
<td>18.742</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1246</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.746</td>
<td></td>
</tr>
</tbody>
</table>
a. Predictors: (Constant), I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet

b. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>42.921</td>
<td>7.067</td>
<td>6.074</td>
</tr>
<tr>
<td>I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet</td>
<td>7.417</td>
<td>1.713</td>
<td>.266</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Hands-on score

The seventh item, “I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet,” could also be considered slightly more difficult. Its mean CSE rating of 3.88 is not unexpected (a rating of 4 = agree with the statement). Exploring the data shows that as the rating increases, the average score on the hands-on skills exam also slightly increases (see Figure 28).

![Figure 28. Mean hands-on skill exam scores for CSE item 7](image)

Unfortunately, however, there are some anomalies to consider, such as the range of scores for this item (see the boxplot in Figure 29). The range for the “strongly agree” rating is 74
points (min. 24 to max. 98). The “strongly disagree” rating had only 4 respondents, with a minimum score of 4 and a maximum score of 96 on the hands-on skills exam (a range of 92). This range of is eclipsed by the range of 94 for both the “disagree rating (min. 2 to max. 96) and the “neither agree nor disagree” rating (min. 4 to max. 98). Further eclipsing these ranges, the “agree” rating had a range of 100 point (min. 0 to max. 100). These results weaken the strength of support for hypothesis 1.

![Boxplot for CSE item 7](image)

**Figure 29. Boxplot for CSE item 7**

The R Square value of .057 suggests that 6% of the variability in the hands-on skills exam score could be attributed to this variable (see Table 45). Moreover, the coefficient registers as 6.166, indicating that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by just over 6 units.
These results indicate that this CSE item is not a good predictor of performance, and only weakly supports hypothesis 1.

Table 45: Model Summary and Coefficient for CSE item 7

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>.239$^a$</td>
<td>.057</td>
<td>.053</td>
<td>23.070</td>
<td>.057</td>
<td>14.883</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet

b. Dependent Variable: Hands-on score

a. Dependent Variable: Hands-on score

The final CSE item, “I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet,” had a mean CSE rating of 3.95, indicating that most of the students agree or strongly agree with this statement. Exploring the data reveals that as the CSE rating increases the mean score on the hands-on skills exam also increases (see Figure 30).
However, exploring the data deeper shows that for this item the ranges in the hands-on exam score were all quite large (see Figure 31). The “strongly agree” and “agree” ratings both had a range of 98 (min. 2 to max 100). The “disagree” rating had a range of 96 (min. 0 to max. 96), followed by the “neither agree nor disagree” rating, which had a range of 92 (min. 4 to max. 96). The “strongly disagree” rating had a range of 92 (min. 4 to max 96), but only 2 respondents gave themselves this rating.

Figure 31. Boxplot for CSE item 8
The R Square value for this variable is 0.034 (see Table 46), suggesting that the variability in the hands-on score that could be attributed to the variable is about 3%. Additionally, the coefficient registers as 4.892 (95% CI = 1.626 – 8.158), indicating that as the rating for this CSE survey question increases by one unit (e.g. from agree to strongly agree), the hands-on exam score should increase by nearly 5 units. These results suggest that this CSE item weakly supports hypothesis 1.

Table 46: Model Summary and Coefficient for CSE item 8

<table>
<thead>
<tr>
<th>Model Summary</th>
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<th></th>
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</thead>
<tbody>
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<td>Model</td>
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<td>R Square</td>
<td>Adjusted R Square</td>
<td>Std. Error of the Estimate</td>
<td>Change Statistics</td>
<td>Durbin-Watson</td>
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<tr>
<td>1</td>
<td>.185&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.034</td>
<td>.030</td>
<td>23.349</td>
<td>.034</td>
<td>8.706</td>
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a. Predictors: (Constant), I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet

b. Dependent Variable: Hands-on score

<table>
<thead>
<tr>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Model</td>
<td>Unstandardized Coefficients</td>
<td>Standardized Coefficients</td>
<td>95.0% Confidence Interval for B</td>
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<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td>t</td>
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<td>1</td>
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<td>53.547</td>
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<td>4.892</td>
<td>1.658</td>
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a. Dependent Variable: Hands-on score
Table 47: Model Summary and Coefficients for stepwise regression analysis of all CSE items

### Model Summary

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<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>Durbin-Watson</th>
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<td>R Square Change</td>
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<td>.050</td>
<td>.046</td>
<td>23.154</td>
<td>.050</td>
<td>.000</td>
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<tr>
<td>2</td>
<td>.266&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.071</td>
<td>.063</td>
<td>22.951</td>
<td>.020</td>
<td>.021</td>
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<tr>
<td>3</td>
<td>.328&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>.096</td>
<td>22.537</td>
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<tr>
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<td>.339&lt;sup&gt;d&lt;/sup&gt;</td>
<td>.115</td>
<td>.100</td>
<td>22.490</td>
<td>.007</td>
<td>.155</td>
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<td>.380&lt;sup&gt;e&lt;/sup&gt;</td>
<td>.144</td>
<td>.126</td>
<td>22.160</td>
<td>.029</td>
<td>.004</td>
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<td>.146</td>
<td>.117</td>
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<td>1.789</td>
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</table>

a. Predictors: (Constant), I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets
b. Predictors: (Constant), a, I know enough about using spreadsheet software to take upper-level business courses
c. Predictors: (Constant), a, b, I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet
d. Predictors: (Constant), a, b, c, I feel confident that I can work with multiple worksheets in a workbook file
e. Predictors: (Constant), a, b, c, d, I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet
f. Predictors: (Constant), a, b, c, d, e, I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet
g. Predictors: (Constant), a, b, c, d, e, f, I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet
h. Predictors: (Constant), a, b, c, d, e, f, g, I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet
i. Dependent Variable: Hands-on score

### Coefficients<sup>a</sup>

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<th>Model</th>
<th>B</th>
<th>Std. Error</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
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<td>.000</td>
<td>2.318</td>
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<td>3.029</td>
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<tr>
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<td>5.114</td>
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<td>.006</td>
<td>.058</td>
<td>.954</td>
<td>-6.080</td>
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<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

192
| 6 (Constant) | 17.824 | 9.471 | 1.882 | .061 | -.833 | 36.482 |
| I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets | .190 | 1.943 | .088 | .098 | .922 | -3.637 | 4.016 |
| I know enough about using spreadsheet software to take upper-level business courses | 1.932 | 1.958 | .083 | .987 | .325 | -1.925 | 5.788 |
| I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet | .229 | 3.188 | .007 | .072 | .943 | -6.050 | 6.509 |
| I feel confident that I can work with multiple worksheets in a workbook file | 2.443 | 2.550 | .093 | .958 | .339 | -2.580 | 7.465 |
| I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet | 7.581 | 2.825 | .236 | 2.683 | .008 | 2.016 | 13.146 |
| I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet | .988 | 2.259 | .035 | .438 | .662 | -3.461 | 5.437 |
| 7 (Constant) | 17.860 | 9.499 | 1.880 | .061 | -.852 | 36.572 |
| I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets | .198 | 1.949 | .009 | .102 | .919 | -3.641 | 4.036 |
| I know enough about using spreadsheet software to take upper-level business courses | 1.961 | 1.988 | .084 | .986 | .325 | -1.955 | 5.877 |
| I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet | .258 | 3.209 | .008 | .080 | .936 | -6.065 | 6.580 |
| I feel confident that I can work with multiple worksheets in a workbook file | 2.472 | 2.575 | .094 | .960 | .338 | -2.601 | 7.544 |
| I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet | 7.617 | 2.858 | .238 | 2.665 | .008 | 1.987 | 13.247 |
| I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet | 1.030 | 2.309 | .037 | .446 | .656 | -3.518 | 5.578 |
The ANOVA results shown in Table 48 likewise show that the model is not significantly better at predicting the outcome than using the means as a best guess. Rather, the results show that as each predictor is added to the model, the value of the F-ratio decreases, suggesting that the initial model was better at predicting the outcome variable than each subsequent model.
Table 48: ANOVA for Hypothesis 1

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<td>1</td>
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<td>1</td>
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<td></td>
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<td>131887.600</td>
<td>246</td>
<td>536.128</td>
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<td>2</td>
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<td>3986.484</td>
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<td>4002.321</td>
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<td>247</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6</td>
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a. Predictors: (Constant), I have knowledge of spreadsheet software that is equivalent to that taught in INFO162: Introduction to Spreadsheets
b. Predictors: (Constant), a, I know enough about using spreadsheet software to take upper-level business courses
c. Predictors: (Constant), a, b, I feel confident that I can copy, move and delete rows and columns in order to organize data in a spreadsheet
d. Predictors: (Constant), a, b, c, I feel confident that I can work with multiple worksheets in a workbook file
e. Predictors: (Constant), a, b, c, d, I feel confident that I can format the text in cells, and copy, move, insert, or delete cell data in a spreadsheet
f. Predictors: (Constant), a, b, c, d, e, I feel confident that I can insert or modify a formula (such as sum, average, etc.) to calculate numbers in a spreadsheet
g. Predictors: (Constant), a, b, c, d, e, f, I feel confident that I can create, format, and modify charts based on selected cells in a spreadsheet
h. Predictors: (Constant), a, b, c, d, e, f, g, I feel confident that I can change the print settings in order to print exactly what I want from a spreadsheet
i. Dependent Variable: Hands-on score
Vita

Stephen P. Larson

Education
Ph.D., School of Business, Virginia Commonwealth University, Richmond, VA; 2011.
MS, Technology Management, Mercer University, Atlanta, GA, 2000.
MPA, Brigham Young University, Provo, UT 1990.

Honors and Awards
Southern Association for Information Systems Conference 2009 Best Student Paper award

Association Memberships
Association for Information Systems (AIS)
InfraGard
KPMG PhD Project IS Doctoral Student Association
Association for Digital Forensics, Security and Law (ADFSL)

Research Interests
My research interests include computer forensics, project management, system analysis and design, international/global IT and global IT project management, digital privacy, and computer self-efficacy.

Peer-reviewed Publications and Papers

Peer-Reviewed Conference Articles and Presentations


Invited, Non-Peer Reviewed Presentations

Non-Peer-reviewed Publications and Papers

Teaching Experience
Fall 2010 – Fundamentals of Data Communications (INFO 370), VCU, Instructor
Fall 2010 – Forensic Accounting (ACCT 610, masters level) VCU, Guest Lecturer
Fall 2010 – Introduction to e-Business Technologies (INFO 202 - online) VCU, Teaching Assistant
Summer 2010 – Accounting Information Systems (ACCT 307), VCU, Guest Lecturer
Spring 2010 - Fundamentals of Data Communications (INFO 370), VCU, Teaching Assistant
Spring 2010 – Business Information Systems (INFO 360), VCU, co-Instructor
Fall 2009 – Systems Development (INFO 630, masters level), VCU, Teaching Assistant
Fall 2009 – Information Systems Management (INFO 640, masters level), VCU. Teaching Assistant
Fall 2009 – Fundamentals of Data Communications (INFO 370), VCU, Teaching Assistant
Fall 2009 – Systems Analysis and Design (INFO 361), VCU, Teaching Assistant
Spring 2009 – IT Project Management (INFO 643, masters level), VCU, Instructor
Fall 2008 – Systems Development (INFO 630, masters level), VCU, Teaching Assistant
Spring 2008/Fall 2007 – Adult Sunday school class, LDS Church, Nagoya, Japan, volunteer teacher (in Japanese)
Spring 2002 – PMP Preparation Course, Bellsouth, Atlanta, GA, Contracted Co-Instructor
Spring 2001 – Project Management, Mercer University (Continuing Education Dept.), Instructor
Fall 2000 – Project Management, Mercer University (Continuing Education Dept.), Instructor
Fall 1992 – Introduction to Business, Edmonds Community College, Kobe Campus, Instructor
Fall 1992 – Business Communications (in Japanese), Edmonds Community College, Kobe
Campus, Instructor

**Professional Training Delivered**

Fall 2007/ Spring 2008 - Project management concepts, processes, and methods. SAIC/Pfizer.
  Instructor (English and Japanese)
Fall 2003 – Spring 2007 – taught video-on-demand topics and concepts to company customers,
distributors and resellers (in Japanese)
Spring 1999 – Spring 2000 – taught employees networking concepts and network idiosyncrasies
  specific to the company
Spring 1998 – Spring 1998 – delivered training on business applications (in English and
  Japanese)
Fall 1996 – Windows NT Administrator course, Hitachi K.K., Japan. Instructor (one week
Fall 1996 – Windows 95 Installation and Configuration course, Hitachi K.K., Japan (one week
Fall 1995 – Fall 1997 – customer training on networks and server and desktop operating systems
  (in English and Japanese)
Spring, Summer, and Fall 1994 – Introduction to Networks, Networked Software, Tax
  Applications, and Business Productivity Software (weekly seminar, in Japanese), KPMG
  K.K., Tokyo, Japan.

**Institutional and Scholarly Service**

Department Service:
Fall 2010: Assist faculty with ABET accreditation

School of Business Service:
Summer/Fall 2010: Assist curriculum committee member with program assessment

Scholarly Service:

Member of editorial review board for International Journal of Social and Organizational
  Dynamics in Information Technology
2011 ADFSL Conference on Digital Forensics, Science and Law conference committee
2011 American Conference on Information Systems mini-track chair

Reviewer for:
- American Medical Informatics Association 2011 Annual Symposium
- Journal of Information Technology for Development
- Conference of the Southern Association for Information Systems (SAIS) 2010
- American Conference on Information Systems (AMCIS) 2009, 2010
- Journal of Digital Forensic Science and Law
- International Research Workshop on IT Project Management (IRWITPM)
- Hawaii International Conference on System Sciences (HICSS) 2009

Co-Editor for AIS SIGSAND 2009 Proceedings

**Professional Certifications**
Microsoft Certified System Engineer - NT (1996)
Novell Certified Netware Engineer 3.x (1996)
Compaq ASE (1996)
Cisco Certified Network Associate (2001)

**Previous Work Experience**
Deputy Site Lead / Sr. Project Manager – SAIC (contract) 06/2007 to 07/2008
Co-Managed 1-year IT-Transformation project worth $6.5M
Project team consisted of 7 project managers and 31 team members representing 10 nationalities/cultures
Performed business process engineering/re-engineering
Developed team members’ skills and effectiveness

Country Manager  C-COR Japan 10/2005 to 07/2007
Restarted business operations in Japan
Designed and developed $12M video archiving and streaming solution
Successfully transferred operations to reputable distributors and resellers

Technical Project Manager  C-COR – Beaverton, OR  10/2003 to 10/2005
Provided technical support and project management for design, development, installation and maintenance of video-on-demand systems in the US and Japan
Successfully repaired relationships with distributors, resellers, and customers after Japan office closure
Authored over 160 technical articles for the company’s Knowledge Base system used by employees and customers (see Appendix for partial list)

Provided training, project management and IT services to client companies, including Bellsouth and Symantec. Projects included:
Team-taught PMP prep courses at client site (Bellsouth)
Localized training materials into Japanese and delivered training
Managed and supported LANs/WANs/wLANs installation and configuration projects
Performed computer forensics analyses
Facilitated the monitoring and support of mission-critical systems (Symantec)

Adjunct Faculty  Mercer University – Atlanta, GA  8/2000 – 4/2001
Taught project management courses

IS Manager  VerticalOne Corp. – Atlanta, GA  3/2000 – 7/2001
Responsible for IT budgeting and forecasting, vendor relationships and SLAs, technical training, and all IT assets
Saved $120K per year and enhanced productivity by deploying wireless e-mail for staff
Facilitated WAN and email system integration after acquisition by Yodlee

IS/IT Consulting – UT, WA, Japan, and GA:

Contract project manager for $260K capacity planning and disaster recovery system
Performed system design and installation

Contract IT Manager
Managed and supported network infrastructure throughout Asia Pacific offices
Managed $400K email system upgrade and migration in Asia Pacific

Designed and installed over $900K in systems for several Fortune 500 financial clients
Developed and delivered technical training in English and Japanese

Contract IT Manager
Expanded LAN to WAN with multiple email systems
Managed budget, IT resources/personnel, vendor SLAs and contracts

Microsoft K.K. Tokyo, Japan (1/1993 – 10/1993)
Developed and localized context-sensitive help system for Japanese version of MS Access.

Edmonds Community College, Japan Campus Kobe, Japan (6/1992 – 1/1993)
Designed and installed peer-to-peer computer network
Managed 3 computer labs
Taught computer and business courses

Developed context-sensitive help system for MS Access