DATA COLLECTION TECHNOLOGY IN SOCIAL WORK:

EVALUATING BARRIERS TO UTILIZATION

by

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Abstract

This thesis explores Master of Social Work students' Behavioral Intent (BI) to use Excel using the Unified Theory of Acceptance and Technology Usage (UTAUT) as a theoretical framework. Excel was selected as a proxy measure of students' overall readiness for data-intensive professional tasks, including fundraising, outcome tracking and reporting, and assorted administrative and research activities. A survey was adapted from the original UTAUT to measure students' BI to use Excel, as well as four theorized constructs which were hypothesized to explain BI. The survey was then distributed to a sample of students. Fifty-eight complete responses were received and analyzed using scripts written in the R programming language. The five measured constructs were tested for reliability using Cronbach's α and one was discarded after it was found to lack sufficient internal consistency. Significant relationships between the three remaining exogenous constructs and BI were evaluated individually with bivariate regressions and collectively with a multivariable regression. The results of those regressions suggest that the constructs collectively can explain 64% of the variation in the subpopulation's BI, with student expectations about the utility of the software for their careers (Performance Expectancy) being the strongest predictor of BI. Despite methodological limitations, the results of this study highlight potential paths forward for research into strategies for improving student readiness in an increasingly data-driven professional world.

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List of Abbreviations

CSV	Comma Separated Values
EE	Effort Expectancy
FC	Facilitating Conditions
ICT	Information and Communication Technology
IDT	Innovation and Diffusion Theory
MM	Motivational Model
MPCU	Model of PC Utilization
OLS	Ordinary Least Squares
PE	Performance Expectancy
SCT	Social Cognitive Theory
SI	Social Influence
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology

Chapter 1 - Introduction

Background

Early efforts to introduce information and communication technology (ICT) to social work practice were predicated on the idea that it would provide efficiency and improve accuracy in data collection and services delivery. Many such efforts focused on tools for managerial positions, emphasizing that it would assist in developing budgets, processing time sheets, and a variety of other administrative tasks (Nuruis & Cnaan, 1991). With the rapid advancement of software applications, industry-specific tools have become more prevalent in many fields, including social work. New diagnostic tools have enabled social work professionals to quickly identify a disorder and input their conclusion into a computerized system. The development of software tools specifically for the social work profession has improved efficiency and data collection accuracy for professionals, while highlighting the need for a better understanding of how professionals best adopt these tools.

Prior to the inception of such applications, many software tools were cumbersome, and agencies would purchase familiar software to avoid learning new applications (Nuruis & Cnaan, 1991). With the transition to more customized applications, many software developers have emphasized creating increasingly versatile, user-friendly designs capable of appealing to the largest possible user-base. These advancements have optimized several administrative tasks for nonprofits. Agencies are better equipped to manage their finances, conduct extensive research, and track specific outcomes. Increasingly, nonprofits that use innovative technology generate internal efficiencies that correlate with external success (Jaskyte, 2012).

As the world is becoming more reliant on technology, a body of social work research is emerging which attempts to identify advantages of ICT (Deepak, Wisner & Benton, 2016; Goldkind & Wolf, 2016; Shorkey& Uebel, 2014). That research identifies many such advantages, including the ability to serve more clients, provide more targeted services, and deliver services more efficiently (Berzin, Singer & Chan, 2015). The widespread adoption of social media has provided social workers with exponentially more channels for engaging in advocacy. Recently, technology has allowed for social workers to use social media and other online platforms for advocacy and raising awareness about policy changes that affect vulnerable populations (Dunlap & Fawcett, 2008). Applications such as telehealth have allowed for more outreach services and targeting of specialized populations, such as individuals in rural areas (Mishna, Bogo & Sawyer, 2015).

Mobile applications are also becoming increasingly common in the mental health field. There are several apps developed to aid in tracking moods and reducing symptoms of depression, anxiety, and PTSD (Turvey & Roberts, 2015). Research has identified numerous benefits from incorporating technology into practice, but despite the apparent benefits, nonprofits are still underutilizing technology. The John Hopkins Listening Post Project conducted a nationwide survey of 1,100 nonprofits finding that 92% of respondents reported that their organization underutilized their existing technology for programs and service delivery (Geller, Abramson, & de Leon, 2010).

The existing body of literature discusses the numerous challenges associated with the adoption of ICT, which may serve as hypotheses for the slow integration of technology in the field. As agencies have become more dependent on technology, only recently has literature emerged to model barriers to ICT utilization facing the human services sector. The large cost of technology burdens nonprofits that are lacking in resources. Funders are increasingly motivated by the ability of agencies to demonstrate outcomes. In the competitive market for grants, agencies may feel pressured to adopt software to keep funding (Zhang & Gutierrez, 2007). Management often is focused on collecting outcomes and require that direct staff enter information into multiple databases, which is tedious, tiresome, and diverts resources that could otherwise be used for service delivery. Many agencies lack the resources to collate data to identify outcomes and do not have a centralized database system of any sort.

The limited resources can lead to nonprofits minimizing expenditures, such as equipment, adequate training, and IT support for that technology. Advanced applications that are required by funders can involve multiple trainings for staff. The use of technology is also dependent on the type of organization. Larger, well-established organizations that perform a variety of administrative tasks have more sophisticated technology than smaller organizations (Geller, Abrahamson, & Leon, 2010). Many agencies are unable to use the most up-to-date software tools because their computers are outdated and do not meet the minimum requirements to run those tools. In a nationwide study about technology use within nonprofits, one-third of respondents reported that their organizations required more computers to meet their needs (Geller, Abrahamson & Leon, 2010). The limited existing literature confirms that nonprofits are slow to adopt technological tools due to a variety of challenges, but there is limited documentation about how social workers are incorporating ICT in their daily practice (Berzin, Singer, & Chan, 2015).

The lack of empirical evidence challenges researchers investigating why the ICT integration process has been slow. A study by Goldkind, Wolf & Jones (2016) explored the relationship between agency characteristics and the adoption of technology among supervisors, finding that the majority of respondents were well versed in more than one technology. This result suggests that social workers are willing to use technology, but the majority of respondents did not seek out opportunities to learn about technology for professional use. The widespread deficits in technological preparedness among recent social work graduates may indicate shortcomings with how universities are incorporating technology into their curricula.

Statement of the Problem

Understanding and adopting technology is vital for the continued growth of the social work profession. Information and communication technology has contributed to efficiency in allocating resources and improved accuracy in essential data collecting activities, and such technology continues to offer opportunities to enhance services provided by social workers. An increased focus on data and outcomes has bolstered the credibility of human service programs, but the social work profession as a whole still continues to fall short. In 2010, Congress adopted the Affordable Care Act, which included provisions emphasizing cutting costs for health care and costs to public service and explicitly identifying several professions that could contribute to these cost reductions. Social work was not included in that list, with some researchers attributing its omission to a lack of evidence supporting cost reductions (Steketee, Ross & Wachman, 2017).

The lack of data to support the effectiveness of programs within the field represents a challenge for professionals working to attract grants or to justify program development. Using technology and tools can increase the rate at which social workers generate data that support the profession’s overall contribution to public health cost reductions, but first social workers must understand the value of these tools and acquire foundational skills for their use. Evidence suggests that incorporating more technological topics in undergraduate and graduate level curricula can help establish those foundational skills (Colvin & Bullock, 2014; Zeman &

Swanke, 2008; Zorn & Seelmyer, 2017). There is limited research to identify whether students are equipped with the skills necessary to make use of these tools prior to employment in the field. However, a substantial body of research indicates that social work nonprofits have been slow to adopt new technologies, which may be attributable to a dearth of technological education for social work students at the undergraduate and graduate levels. Further assessment of recent graduates' preparedness could help determine if there is a skills gap which may require greater emphasis on technology in the social work curriculum.

Purpose of the Study

Research has shown that social workers can be slow to adapt to technological advancements (Deepak, Wisner & Benton, 2016; Goldkind & Wolfe, 2016; Grady, 2010). In a 2001 study on evidence-based practice, researchers found that social work students had higher levels of anxiety about using computers than MBA and MPA students. Higher levels of computer anxiety were also correlated with high levels of research anxiety, both of which activities are important elements in evidence-based practice (Green & Bertizen, Leininger, & Stauffer, 2001). Social work students felt more comfortable consulting their peers or supervisors and relying on anecdotal information for practice (Aarons & Sawitzsky, 2006; Grady, 2010). The highly interactive nature of social work confounds ICT use and ICT tools are typically employed in non-interactive courses such as research, administration, and policy courses (Mishna, Fantus & McInro, 2017; Siegel, Jennings, Conklin, & Napoletano-Flynn, 1998). This limited interaction with ICT may explain the technological deficits of social work students. Much of the emerging literature focuses on the implications of ICT in practice, highlighting the potential ethical concerns. Few studies have explored technology acceptance and adoption among social work students, instead focusing on pedagogical frameworks for incorporating technology into practice (Bertram, King, Pederson, & Nutt, 2014; Hardcastle & Bisman, 2003).

The purpose of this study is to use the Unified Theory of Acceptance and Use of Technology (UTAUT) as a theoretical framework to gain a better understanding of technology adoption and usage among social work students in order to incorporate technology into learning. To do so, the study will apply the UTAUT's model and will examine the relationship between several independent variables and students' self-reported intentions to use a key software tool. Microsoft Excel has been selected as the software tool because of its ubiquity and its value as a proxy measure for quantitative data skills.

Conceptual Framework

The Unified Theory of Acceptance and Use of Technology forms the theoretical basis for this study. The UTAUT evolved from a synthesis of eight prior models of technology adoption, which in turn grew from the body of research based on the Theory of Reasoned Action (TRA). The TRA posits that individuals' behaviors are influenced by perceptions and attitudes as well as environmental and social pressures. The UTAUT and its extensions identify a number of theoretical constructs which describe individual, social, and environmental determinants of technology adoption.

The UTAUT posits that the exogenous variables of Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions contribute to the endogenous variables of an individual's formation of a behavioral intention to use a particular software tool. That behavioral intention then affects the outcome mechanism of actual adoption of the software tool. Researchers have further identified several moderating mechanisms which modulate the explanatory power of these variables for specific subgroups. Age, gender, experience, and voluntariness of adoption in particular affect measured variations in the relationships between the independent variables and the dependent intention and usage variables significantly.

Additional research has elaborated on the original UTAUT by identifying alternative exogenous, endogenous, moderation, and outcome mechanisms. This stream of research has evaluated numerous exogenous variables such as computer self-efficacy, organizational culture, and perceived risk. Additional endogenous variables include trust, task value, task code, and Hedonic Performance Expectancy. Researchers have also considered a wide variety of moderating mechanisms, such as national culture, ethnicity, religion, income, and technology readiness. Finally, a handful of studies have evaluated alternative outcome measurements, including individual performance and economic development, as well as improved methods for measuring adoption such as frequency and duration of use.

Chapter 2 - Literature Review

Introduction

Over the past two decades, the widespread adoption of a variety of software tools by nonprofits and other social work-related organizations has generated a massive influx of data, but the utility of much of that data remains confined to individual agencies. Proponents of technology in the human service sector have called for the creation of specialized knowledge management systems to improve collaboration and enhance the social service sector's use of data, but technological difficulties have inhibited their adoption (Gillingham & Graham, 2017; Parker-Oliver & Demiris, 2006). Understanding and modeling how professionals in the human services sector adopt data collection technologies remains a challenging unsolved problem, although an extensive body of work drawn from other fields can provide theoretical insight into technology adoption generally.

Technology in Social Work

Human service officials are recognizing the importance of informative data to better serve populations (Clark & Brien, 2016; Deepak, Wisner & Benton, 2016; Goldkind &Wolfe, 2016; Mandayam & Joosten, 2016;). In response to the rapid evolution of information technology, the National Association of Social Work recently revised its code of ethics to incorporate new provisions addressing the appropriate use and role of information and communication technology in social work practice. These provisions eliminate any doubt about whether social workers should adopt technological tools more proactively, but which technologies would generate the most value to the profession and precisely what obstacles prevent their adoption remain open questions. Toward that end, Lauri Goldkind identifies a number of major technologies that are likely to disrupt social work in the near future, including big data and mobile technologies (Goldkind & Wolfe, 2016).

Importance of Data Collection Technologies

The promotion of evidence-based practices to address the widespread research gap emphasized the importance of data collection for the future of social work (Aarons & Sawitzky, 2006; Grady, 2010). A key component of evidence-based practices is the collection of data and an understanding of how to analyze data to better inform practice. Critics frequently question the profession's contributions because of the lack of data to support program efficacy (Dunlop & Fawcett, 2008; Grady, 2010; Steketee et. al., 2017) As resources become scarcer, funders are requiring evidence to support their programs, which represents a challenge for professionals working to justify existing programs and attract grants for new program development (Gillingham & Graham, 2017, Goldkind, 2015; Hackler & Saxton, 2007; Lee & Clerkin, 2017).

Social workers must therefore understand how they can use data for those purposes before they can begin to implement effective collection practices. Prior to program implementation, managers need to know what information to collect and how to gather that information (Rocheleau, 1998). The examination and collection of detailed information about work carried out by social workers can inform and enhance program design (Howard, McMillen, & Pollio, 2003). This is especially important with limited financial resources, when it is most vital for human service organizations to create efficient and effective service delivery programs (Falasca, Zobel, & Ragsdale, 2011).

An effective data collection strategy is vital for monitoring the success of programs, yet the skills for producing such a strategy are often overlooked during program evaluation education and training. Several studies have examined the skills gap in MSW students' abilities to inform their practices with data, noting a large percentage of students were unable to generate and apply useful data or identify relevant data (D'Aprix, Dunlap, Abel, & Edwards, 2004; Hardcastle & Bisman, 2003). Graduate research courses often overlook the importance data collection and use single subject case studies, limiting students' exposure to larger data sets and the challenges involved with collecting and managing them (Bertram, King, Pederson, & Nutt, 2014; Hardcastle & Bisman, 2003).

It is also important for managers to understand how to store data in accessible, portable formats which can be shared with other professionals for use in developing other programs. Big data sets can be used to find unexpected relationships, which can provide insight for the future of social work. Numerous recently developed big data technologies, such as machine learning algorithms, provide the most value when applied to exceptionally large datasets integrated from several sources. Predictive modeling based on such data can enhance the quality and impact of future programs. Managers must understand how data can be integrated within programs and learn ways to maximize its shareability (Rocheleau, 1998). The value of big data is exponential for social service agencies, and it can be used to identify patterns that are impossible to predict with smaller datasets (Goldkind & Wolfe, 2016).

Excel as a Proxy Measure for Data Management Skills

A prevailing challenge for human service organizations is finding a useful general-purpose tool for collecting and analyzing data. Nonprofit agencies commonly adopt individual data collection tools for the sole purpose of reporting to an individual funder, which can result in numerous overlapping tools being used in parallel and in a corresponding fragmentation in data storage. Challenges arise when attempting to collate the data at the end of the program which can lead to duplication in datasets and in processing efforts, as well as inaccurate representation of program outcomes (Hull & Lo, 2006; Orlikowski, 2000). Furthermore, agencies typically do not use this data to inform their practice nor do they recognize the value of data for program planning (Gillingham & Graham, 2016; Goldkind & Wolf, 2014)

Spreadsheets are a valuable, low-cost tool available for nonprofit agencies to carry out many tasks related to managing this data. They can provide a wide range of core administrative functions, such as data collection, statistical analysis, and graphical representation (Patterson & Basham, 2003). Smaller nonprofit agencies that are interested in collecting data can create spreadsheets with macros as an alternative to more costly, custom-designed database tools for collecting outcomes. Spreadsheets can be used for cost-benefit analysis, data collection, and budgeting. Understanding how to use these applications is important for managers and social work students.

Microsoft Excel is one of the most widely adopted spreadsheet applications available, and is often underutilized in social services organizations. Excel was introduced in 1985, and quickly gained recognition for its powerful but flexible design (Hesse & Hesse-Scerno, 2009). The software remains the most ubiquitous data processing tool in the world by a large margin. Over the last twenty years, Excel has essentially maintained a monopoly over the spreadsheet software market, with more than 120 million monthly users in 2017 (Kaissar, 2017). The skills required to use Excel effectively translate to other data processing tools well (Hesse & Hesse-

Scerno, 2009). Thus, an individual's capabilities with Excel can serve as a good proxy measure for their general data processing abilities.

Excel is a widely known application that is low cost and can perform a variety of tasks. Many software applications implement features to enable exporting data directly to Excel or to an intermediary CSV file which can then be opened in Excel, enabling users to consolidate data from disparate sources into a single, familiar tool for conducting analyses.

The Unified Theory of Acceptance and Use of Technology

A large body of research exists which seeks to investigate the motivating factors in technology adoption. A multitude of models have been developed within sociological, psychological, and technological frameworks. The large array of proposed models presented in the literature has presented difficulties for researchers seeking to understand the variables involved in adopting technology. To consolidate prior theoretical work and progress toward a more unified understanding of user technology acceptance, Venkatesh and colleagues developed the Unified Theory of Acceptance and Technology Usage (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). The UTAUT synthesizes eight prior theoretical models: Theory of Reasoned Action, the Technology Acceptance Models 1 and 2, Motivational Model, Theory of Planned Behavior, Model of Personal Computer Utilization, Innovation Diffusion Theory, and Social Cognitive Theory. Generally, these models attempt to explain the factors determining a user's behavioral intent to use a technology, their actual use of a technology, or a combination of both outcome variables. Venkatesh et al. developed the UTAUT by empirically investigating the variables of each of these models, and then consolidating those variables that are fully covariant while eliminating those with no explanatory power. An examination of these eight underlying models can provide useful context for applying the UTAUT and understanding its relatively strong empirical performance in subsequent replication, validation, and extension studies.

The Theory of Reasoned Action (TRA)

Martin Fishbein and Icek Ajzen's Theory of Reasoned Action is one of the most fundamental and influential theories of human behavior (Venkatesh et. al, 2003). The Theory of Reasoned Action uses subjective norms and attitudes to predict behavioral intent to take some specified action, such as adopting a new technology tool. The TRA has been widely used in multiple contexts to describe a large variety of behaviors (Lee, 2012; Sheldon, 2017; Weber, Martin, & Corrigan, 2007; Wong & Chow, 2016;). The theory proposes three variables to describe an individual's behavior: behavioral intent, attitude, and subjective norms.

The TRA postulates that an individual's behavior is dependent on their intention to perform a behavior, which is dependent on attitudes and subjective norm. Attitude is defined as "an individual's positive or negative feeling (evaluative affect) about performing the target behavior" (Venkatesh et. al, 2003). The more positive an individual's attitude is, the stronger their behavioral intent is and the probability that they will take the action is correspondingly increased. Subjective norm is defined as "the person's perception that most people who are important to him think he should not perform the behavior in question" (Venkatesh et. al, 2003). Individuals are strongly motivated by perceptions of others. This pressure can come from a variety of sources, including family, peers, colleagues, and supervisors. More recently, studies have found a significant influence from social media, such as Facebook (Kim, 2012).

When applied to individual acceptance of technology, Davis and colleagues found the variance in behavioral intent was consistent with other TRA studies (Davis & Warshaw, 2000). The UTAUT draws upon the TRA's Social Norms to inform its Social Influence determinant.

The Technology Acceptance Model (TAM)

The Technology Acceptance Model was developed in the 1980's by Davis and colleagues to predict information technology acceptance and usage in the workplace (Davis, 1989). The TAM has been one of the most widely employed theoretical frameworks in the technology acceptance literature and relies on the TRA for much of its paradigm, though it does not include an attitude construct in order to increase the model's parsimony.

The model consists of three core constructs designed to predict behavioral intention. Perceived Usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). The correlation between behavioral intention and extrinsic rewards are strong determinants of usage. Individuals are not likely to use a system unless it provides positive rewards. The model defines Perceived Ease of Use as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). TAM's perceived ease of use is rooted in Bandora's self-efficacy theory and the cost benefit paradigm. Technology that is cumbersome and difficult to use decreases the motivation to use the system. The TAM2 extended the two-factor TAM model to incorporate the TRA Subjective Norm construct as a predictor for behavioral intention under mandatory use contexts (Davis & Warshaw, 2000; Venkatesh et. al, 2003). This model has been widely used and adapted for multiple studies, including a study in social work technology adoption (Edmunds, Thrope & Conole, 2012; Venkatesh et. al, 2003).

Motivation Model (MM)

Drawing on an extensive body of work on the theory of motivation, Vallerand's intrinsic and extrinsic motivation has been used to predict behavioral intention in the context of technology acceptance (Davis et al. 1992). The theory posits that an individual's behavior can be predicted from their intrinsic and extrinsic motivators. Davis et al. define extrinsic motivation as motivation attached to an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis et al. 1992, p. 1112). The model defines intrinsic motivators as those which motivate individuals "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al. 1992, p. 1112). These constructs encompass many of the more specific constructs proposed by the other models.

Model of PC Utilization (MPCU)

Model of PC utilization was developed in 1991 by Thompson, to predict PC usage. The theoretical framework of MPCU was adapted from Triandis's Theory of Behavior. Thompson and colleagues theorized that behavior is contingent on three factors: Attitudes, Subjective Norm, and Habits. To predict usage behavior, Thomson and colleagues identified six determinants: Job Fit, Complexity, Long-Term Consequences, Affect Towards Use, Social Factors, and Facilitating Conditions. The model defines these factors as follows:

> <u>Job Fit</u> "the extent to which an individual believes that using a technology can enhance his or her job" (Thompson et al. 1991, Venkatesh et al., 2003).
>
> <u>Complexity:</u> "The degree to which an innovation is perceived as relatively difficult to understand and use" (Thompson et al. 1991, Venkatesh et al., 2003).

Long-Term Consequences: “Outcomes that have a pay-off in the future” (Thompson et al. 1991, Venkatesh et al. 2003).

Affect Towards Use: “Feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act” (Thompson et al. 1991, Venkatesh et al., 2003).

Social factors: “The individuals internalization of the reference group’s subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations” (Thompson et al. 1991, Venkatesh et al., 2003).

Facilitating Conditions: “Objective factors in the environment which observers agree can make an act easy to accomplish.” (Thompson et al., 1991; Venkatesh et al., 2003)

Although this model was originally designed to predict usage behavior as an outcome, Venkatesh et al. (2003) adapted the model to focus on predicting behavioral intention as a mediating predictor of actual usage.

Innovation and Diffusion Theory (IDT)

Innovation diffusion theory was developed in 1962 by E.M Rogers, to understand the rate at which technologies are developing and spreading through a social system (Rogers, 1995). Rogers identified four main elements in the adoption process: innovation, communication channels, time, and social system that make up the innovation decision process. The innovation decision process consists of five main elements: knowledge, persuasion, decision, implementation, and confirmation. The theory posits that over time, a product gradually becomes diffused, or spread, into a specific population. Moore and Benbassat adopted and refined Roger’s model to predict individual technology acceptance, focusing on the perceived characteristics of adopting and innovation. Their model consisted of seven core constructs:

Relative Advantage: “The degree to which an innovation is perceived as being better than its precursor.” (Rogers, 1995)

Ease of Use: “The degree to which an innovation is perceived as being difficult to use.” (Rogers, 1995)

Image: “The degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system.” (Rogers, 1995)

Visibility: “The degree to which one can see others using the system in the organization.” (Rogers, 1995)

Compatibility: “The degree to which an innovation is perceived as being consistent with the existing values, needs and past experiences of potential adopters.” (Rogers, 1995)

Results Demonstrability: “The tangibility of the results of using the innovation including their observability in the community” (Rogers, 1995)

Voluntariness of Use: "The degree to which use of the innovation is perceived as being voluntary, or of free will." (Rogers, 1995)

Social Cognitive Theory (SCT)

The social cognitive theory developed by Albert Bandora to describe behavior by observation. The theory was adapted and applied in the context of computer usage by Compeau and Higgens’ Computer Self-Efficacy model (Compeau & Higgens, 1995). The Computer Self-Efficacy Scale was comprised of ten questions relating to computer usage to measure their perception in accomplishing a single task. The scale evaluates the following constructs:

Outcome Expectations - Performance: "The performance-related consequences of the behavior. Specifically, performance expectations deal with job-related outcomes" (Compeau and Higgins 1995).

Outcome Expectations - Personal: "The personal consequences of the behavior. Specifically, personal expectations deal with the Individual esteem and sense of accomplishment" (Compeau and Higgins 1995).

Self-Efficacy: "Judgment of one’s ability to use a technology (e.g., computer) to accomplish a particular job or task.” (Compeau and Higgins 1995)

Affect: "An individual’s liking for a particular behavior (e.g. computer use)." (Compeau and Higgins 1995)

Anxiety: Evoking anxious or emotional reactions when it comes to performing a behavior (e.g., using a computer)." (Compeau and Higgins 1995)

Theory of Planned Behavior (TPB)

Proposed by Icek Ajzen in 1985**,** theory of planned behavior developed as extension of TRA to incorporate behavioral control (Ajzen 1991). TPB uses the core concepts of TRA, specifically Subjective Norm and Attitude Towards Behavior and includes Perceived Behavioral Control to predict behavioral outcomes. Perceived Behavioral Control is defined as "the perceived ease or difficulty of performing the behavior (Ajzen 1991, p. 188). In the context of information systems research, the construct has been defined as "perceptions of internal and external constraints on behavior" (Taylor and Todd 1995 p. 149). TPB posits that completing a task is dependent on a person's attitude about that task and their perceived control over the level of difficultly of the task. TPB has been adapted to describe behavioral intention and consequent usage in a variety of technological studies (Davis, 2003; Hong & Chow, 2016; Sheldon, 2010).

Table 2-1

UTAUT Predecessor Theories

Theory	*References*
Theory of Reasoned Action (TRA)	Sheppard et al. (1988), Davis et al. (1989)
Technology Acceptance Model (TAM)	Venkatesh and Davis (2000), Davis (1989)
Motivational Model (MM)	Vallerand (1997), Davis et al. (1992), Venkatesh and Speier (1999)
Theory of Planned Behavior (TPB)	Ajzen (1991), Harrison et al. (1997), Mathieson (1991), Taylor and Todd (1995b)
Combined TAM and TPB (C-TAM-TPB)	Taylor and Todd (1995a)
Model of PC Utilization (MPCU)	Triandis (1977), Thompson et al. (1991)
Innovation Diffusion Theory (IDT)	Rogers (1995), Tornatzky and Klein (1982), Moore and Benbasat (1991), Moore and Benbasat (1996), Agarwal and Prasad (1997), Agarwal and Prasad (1998), Karahanna et at. (1999), Plouffe et al. (2001)

Social Cognitive Theory (SCT)	Bandura (1986), Compeau and Higgins (1995a), Compeau and Higgins (1995b), Compeau et al. (1999)

A Unified Model: The UTAUT

The UTAUT synthesizes and simplifies many of the constructs from these prior models. It incorporates four key exogenous determinants of technology usage: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC). Three of the four determinants (PE, EE & SI) influence the formation of an endogenous construct, Behavioral Intention (BI) to use technology. Facilitating Conditions and Behavioral Intention control the outcome variable, actual technology usage. These constructs are mediated by four moderating conditions: age, gender, experience, and voluntariness (Venkatesh et al., 2003).

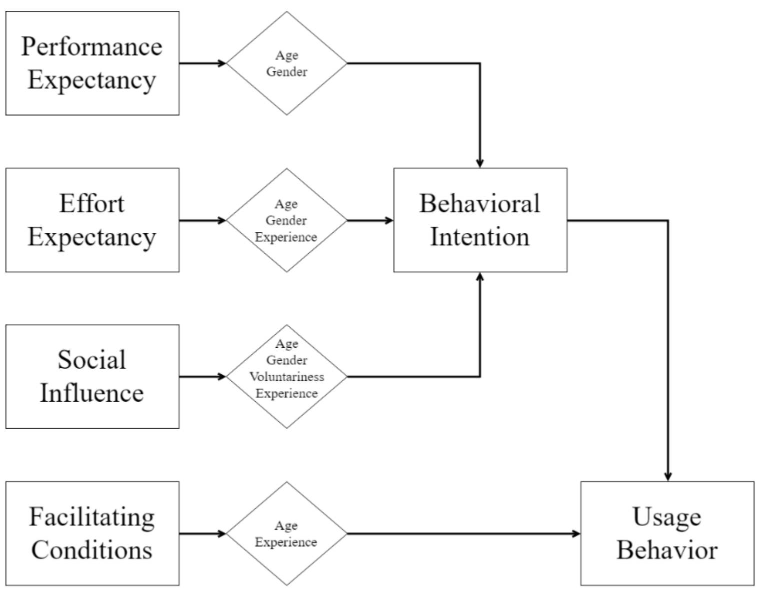

Figure 2-1
UTAUT Research Model

Performance Expectancy

Performance Expectancy is defined as the "degree to which an individual believes that using the system will help him or her attain gains in job performance" (Venkatesh et al., 2003). Performance Expectancy draws upon five of the prior theoretical models: TAM, MM, MPCU, IDT, and SCT, and is one of the strongest predictors of intention (Venkatesh et al., 2003). The combination of the five prior constructs are measured using the following four statements used in the UTAUT:

1. I would find the system useful in my job.
2. Using the system enable me to accomplish task more quickly.
3. Using the system increased my productivity.
4. If I use the system, I will increase my chances of getting a raise.

Effort Expectancy

Effort Expectancy is defined by the "degree of ease associated with the use of the system" (Venkatesh). Effort Expectancy combines the core constructs of three existing models: the TAM, MPCU and IDT, to measure an individual's perception of the difficulty of technology. Technology that is cumbersome and difficult to use decreases the motivation to use the system. Ease of use has been shown to be an important indicator of adopting technology (Davis, 2001; Moore & Benbasat, 1991). Potentially, the impact of this factor has been mitigated with the recent development of more user-friendly applications and near universal dissemination of basic computer skills (Sheldon, 2017). The following statements are included in a typical UTAUT survey to measure EE:

1. My interaction with the system would be clear and understandable.

2. It would be easy for me to become skillful at using the system.
3. I would find the system easy to use.
4. Learning to operate the system is easy for me.

Social Influence

Social Influence is defined as "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et. al., 2003). The conceptual framework of Social Influence is based on social norms, and the notion that an individual's behavior is guided by their perception of how others view them as a result of having used technology (Venkatesh et al., 2003). The three core constructs that make up SI evolved from Subjective Norm (TRA, TAM2, and TPB), Image (IDT) and Social Factors (MPCU). These core constructs are measured with the following statements included in a typical UTAUT survey:

1. People who influence my behavior think that I should use the system.
2. People who are important to me think that I should use the system.
3. The senior management of this business has been helpful in the use of the system.
4. In general, the organization has supported the use of the system.

Notably, this construct is relatively sensitive to moderating factors. For example, women tend to be more sensitive to others' opinions (Venkatesh et al., 2003) and therefore more of the variance in their behavioral intention can be attributed to this factor. Similarly, older workers are more likely to put an increased salience on Social Influences, with that effect declining with experience (Venkatesh et al., 2003).

Facilitating Conditions

Facilitating Conditions are defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” (Venkatesh et al., 2003). This determinant was adapted from three prior constructs: Perceived Behavioral Control (TPB, C-TAM-TPB), Facilitating Conditions (MPCU), and Compatibility (IDT). FC primarily pertain to the perceived organizational support for the technological system. Continuing technological support in an environment is vital for continued use. FC are measured using the following statements included in a typical UTAUT survey:

1. I have the resources necessary to use the system.
2. I have the knowledge necessary to use the system.
3. The system is not compatible with other systems I use.
4. A specific person (or group) is available for assistance with system difficulties.

Table 2-2

Component Constructs of the UTAUT

Construct	*Variable Type*	*Definition*	*Roots*	*Root Constructs*	*Sources*
Performance Expectancy (PE)	Exogenous	The degree to which an individual believes that using the system will help him or her attain gains in job performance (Venkatesh et al. 2003)	TAM, C-TAM-TPB	Perceived Usefulness	Davis (1989), Davis et al. (1989)
			MM	Extrinsic Motivation	Davis et al. (1992)
			MPCU	Job-fit	Thompson et al. (1991)
			IDT	Relative Advantage	Moore and Benbasat (1991)
			SCT	Outcome Expectations	Compeau and Higgins

					(1995b), Compeau et al. (1999)
Effort Expectancy (EE)	Exogenous	The degree of ease associated with the use of the system (Venkatesh et al. 2003)	TAM	Perceived Ease of Use	Davis (1989), Davis et al. (1989)
			MPCU	Complexity	Thompson et at. (1991)
			IDT	Ease of Use	Moore and Benbasat (1991)
Social Influence (SI)	Exogenous	The degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al. 2003)	TRA, TPB	Subjective Norm	Ajzen (1991), Davis et al. (1989), Fishbein and Azjen (1975), Mathieson (1991), Taylor and Todd (1995a, 1995b)
			MPCU	Social Factors	Thompson et al. (1991)
			IDT	Image	Moore and Benbasat (1991)
Facilitating Conditions (FC)	Exogenous	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Venkatesh et al. 2003)	TPB	Perceived Behavioral Control	Ajzen (1991), Taylor and Todd (1995a, 1995b)
			MPCU	Facilitating Conditions	Thompson et al. (1991)
			IDT	Compatibility	Moore and Benbasat (1991)
Behavioral Intention (BI)	Endogenous	An individual's specific intention to	N/A	N/A	Ajzen (1991), Sheppard et

		make use of a technology			al. (1988), Taylor and Todd (1995b)
Use Behavior (UB)	Endogenous	An individual's measured, actual use of a technology	N/A	N/A	N/A
Moderating Factors	Exogenous	Contextual factors or features of individuals which modulate the effects of the primary model factors on BI and/or of BI on UB	TRA, TAM, TPB, C-TAM-TPB, MPCU, IDT	Experience	Davis et al. 1989)
			TRA, TAM, TPB, IDT	Voluntariness	Hartwick and Barki (1994)
			TAM, TPB	Gender	Venkatesh and Morris (2000)
			TPB	Age	Venkatesh and Morris (2000)

Moderating Factors

There are four primary moderators that modify the predicted behavioral intention and usage rates under the UTAUT: gender, age, experience, and voluntariness. The correlation between these four moderators has been highlight in the TAM as well as several of the other models. Gender has been shown to be a moderating factor in Performance Expectancy, Effort Expectancy, and Social Influence (Venkatesh et al., 2003). For example, gender moderates Performance Expectancy because men tend to be more responsive to task-oriented factors (Venkatesh et al., 2003). Age can act as a moderating factor for each of the primary model constructs. In the case of Effort Expectancy, for example, several studies have suggested that age can decrease the user's ability to adapt to new stimuli, increasing the effort associated with adopting a new system (Venkatesh et al., 2003). The user's experience level can also modulate the effects of Effort Expectancy, Social Influence, and Facilitating Conditions. Experience has been shown to reduce the amount of effort users anticipate when learning a new system (Venkatesh et al., 2003). Last, the voluntariness of the user's adoption can impact the extent to which Social Influence predicts their behavioral intention. When the other persons who are the source of the Social Influence have control over the rewards or outcomes associated with usage for the user, the predictive power of Social Influence over behavioral intention is stronger (Venkatesh et al., 2003).

Validations, Integrations, and Extensions of the UTAUT

Numerous studies have built on the foundation of the original UTAUT to validate the model in varying organizational, cultural, and technological contexts, to integrate the theory within alternative theoretical frameworks, and to develop novel mechanisms and factors to extend the original UTAUT constructs (Venkatesh et al., 2016).

Among those studies which have applied and validated the UTAUT, a number evaluated the model when applied to alternative types of users, including physicians (e.g. Alapetite Andersen, Hertzum, 2009; Chang, Hwang, Hung, & Li, 2007), citizens accessing a government service (e.g. Al-Shafi, Weerakkody, & Janssen, 2009; Bühler & Bick, 2013), and students (e.g. Liao, Shim, & Luo, 2004; El-Gayar & Moran, 2007). Researchers have also applied the UTAUT to widely varying technologies, such as social media (e.g. Gruzd, Staves, & Wilk, 2012; Bühler & Bick, 2013; Workman, 2014), web-based learning environments (e.g. Liao et al., 2004; Pynoo et al., 2011), and clinical decision support systems (e.g. Chang et al., 2007). Most of these studies have validated the main effects of the UTAUT's primary constructs on the dependent variables of Behavioral Intention and Usage Behavior (e.g. Liao et al., 2004; Chang et al., 2007; Pynoo et al., 2011; Gruzd et al., 2012; Seid & Lessa, 2012), while others have also considered the effects of some or all of the included Moderating Factors (e.g. Gupta et al., 2008; Al-Shafi et al. 2009; Bühler & Bick, 2013; Workman, 2014). These studies have generally discovered results consistent with the model and have provided empirical support for the validity of the hypothesized primary factors (i.e. PE, EE, SI, and FC). However, relatively few studies have attempted to validate or evaluate the impacts of the moderation variables on the model, which limits the evidence available to verify the model's generalizability to other populations (Venkatesh et al., 2016).

Other studies have integrated elements of the UTAUT into different theoretical frameworks. This stream of research combines elements of the UTAUT with such varying theories as Motivation Theory (e.g. Guo & Barnes, 2011, 2012; Yoo, Han, & Huang, 2012), Transaction Cost Theory (e.g. Guo & Barnes, 2011, 2012), the Equity-Implementation Model (e.g. Hess, Joshi, & McNab, 2010), Innovation Resistance Theory (e.g. Lian & Yen, 2014), and Task-Technology Fit Theory (e.g. Oliveira, Faria, Thomas, & Popovic, 2014; Zhoe, Lu, & Wang, 2010). Most of these studies investigated the relationships between the mechanisms native to the UTAUT and constructs proposed by the integrated framework. While, however, many of these studies have improved upon the original UTAUT's explanatory power, few if any have incorporated the Moderating Factors from the UTAUT.

The largest body of work premised on the UTAUT consists of extensions to the original UTAUT model. Such studies propose one or more new exogenous variables, endogenous mechanisms, moderating factors, or outcome measurements. Proposed exogenous extensions include collaboration-related constructs (e.g. Brown et al., 2010), trust and innovativeness (e.g. Casey & Wilson-Evered, 2012), computer self-efficacy (e.g. Chiu & Wang, 2008; Wang, Jung, Kang, & Chung, 2014), organizational culture (e.g. Dasgupta & Gupta, 2011), team climate for innovation (e.g. Liang, Xue, Ke, & Wei, 2010), and perceived risk (e.g. Martins, Oliveira, & Popovic, 2014). This investigative thread evaluates the effects of new exogenous variables on the four primary exogenous variables of the original model. For example, Casey & Wilson-Evered (2012) studied whether trust and innovativeness have any impacts on performance expectancy, effort expectancy, and social influence.

Researchers have also suggested a wide array of mechanisms endogenous to the model which elaborate on the relationships between the four primary exogenous factors and the two endogenous factors specified in the original UTAUT. For instance, Eckhard, Laumer, and Weitzel (2009) developed a multidimensional construct for characterizing the sources of SI to better explain its effects on the BI and UB. Such new suggested mechanisms include trust (e.g. Carter & Schaupp, 2008; Wang et al., 2012; Alaid & Zhou, 2013; Weerakkody, El-Haddadeh, Al-Sobhi, Shareef, & Dwivedi, 2013; Oh & Yoon, 2014), self-efficacy (e.g. Carter & Schaupp, 2008; Chiu & Wang, 2008; McKenna, Tuunanen, & Gardner, 2013; Xiong, Qureshi, & Najjar, 2013), hedonic performance expectancy (e.g. Lallmahomed, Ab Rahim, Ibrahim, & Rahman, 2013), and perceived threats (e.g. Loose, Weeger, & Gewald, 2014).

Additional suggestions for moderating factors include national culture (e.g. Al-Gahtani, Hubona, & Wang, 2007; Im, Hong, & Kang 2011), income (e.g. Lu, Yu, & Liue, 2009; Liew, Vaithilingam, & Nair, 2014), and education (e.g. Niehaves & Plattfaut, 2010). These studies evaluate the impact of the suggested moderation variables on the relationships between the primary exogenous model factors and the two endogenous variables.

Last, only two new outcome measurements have been proposed and evaluated: individual performance (Sun et al., 2009) and economic development (Xiong, Qureshi, & Najjar, 2013). However, alternative measures of actual usage such as frequency and duration of use have been investigated as mechanisms endogenous to the model (e.g. Venkatesh et al., 2012).

Throughout this extensive body of work, the explanatory power of the original components of the UTAUT has remained remarkably resilient, with extensions providing valuable but marginal improvements to the model's efficacy.

Conclusion

The UTAUT was selected for this study to analyze data technology adoption because of its empirically tested and validated efficacy in previous studies. The lack of research on technology adoption in social work presented challenges for identifying a theoretical framework native to the field which is useful for evaluating technology adoption. One article from 2012 measured students' attitudes toward ICT in course study, work, and social activity using the Technology Acceptance Model as a theoretical framework (Edmunds, Thorpe & Conole, 2012). Results from the study indicated that Perceived Usefulness and Ease of Use are two important drivers in student technology. However, the study was unable to identify how Social Influence may have played a role in adoption and usage. The integration of eight other models and moderating factors via the UTAUT can provide a more accurate picture of the complexities underlying individual technology acceptance and usage. While other models do have some predictive utility, none has achieved the same explanatory power of the UTAUT, which been able to explain over 70% of variance in Behavioral Intention and 50% of variance in actual Usage Behavior. The UTAUT's parsimonious model provides a strong basis and framework for predicting behavioral intention and usage among social work students and identifying factors that may be restricting adoption.

Chapter 3 - Methodology

Introduction

This study was designed to predict master's level social-work students' Behavioral Intention to use Excel. The study used a cross-sectional design and was determined IRB-exempt by the UTA Office of Research. The survey adapted a pre-validated questionnaire developed within the Universal Theory of the Acceptance and Usage of Technology (UTAUT) to measure the students' Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, and Behavioral Intention as they relate to Microsoft Excel. It also collected basic demographic data to characterize the population being tested and to control for demographics. Finally, each variable was analyzed for reliability and validity and the relationships between the independent variables and the dependent variable (BI) was characterized using regression analysis in order to test the study hypotheses.

Hypotheses

This thesis evaluated five hypotheses describing the expected relationships between the primary independent variables (PE, EE, SI, and FC) and the dependent variable (BI).

H1: Performance Expectancy has a significant and positive effect on Behavioral Intention to use Excel.

H2: Effort Expectancy has a significant and positive effect on Behavioral Intention to use Excel.

H3: Social Influence has a significant and positive effect Behavioral Intention to use Excel.

H4: Facilitating Conditions have a significant and positive effect Behavioral Intention to use Excel.

H5: The independent factors will collectively have a significant and positive effect on Behavioral Intention to use Excel.

Measures

The questionnaire consisted of 24 questions – five demographic questions and 19 construct questions designed to measure the five primary model factors under consideration here. All the construct questions were scaled in the same direction, and answers were scored on a five-point Likert scale, where ‘1’ represents ‘strongly agree’ and ‘5’ represents ‘strongly disagree’. Each of the factors (PE, EE, SI, FC) was tested by four such questions and was assigned a composite score consisting of the sum of the responses to each question and thus ranging between 4 to 20. Three of the construct questions related to Behavioral Intention, which was therefore scored on a range of 3 to 15.

Performance Expectancy

Performance Expectancy can be described as the “degree to which an individual believes that using the system will help him or her attain gains in job performance” (Venkatesh et al., 2003). Researchers have found that PE is the strongest predictor of intent to use a technology (Venkatesh et al., 2003 Davis, 1998). However, in this study, technology users were current students who generally had not yet begun their professional career. Additionally, social work is a diversified field where graduates can expect to work in a wide variety of roles and students enter graduate school with widely varying levels and types of prior experience, so it is possible and perhaps even likely that some students did not have significant experience using Excel and would not expect to use it frequently in their career. Therefore, in this setting, PE may vary based on career intentions. Students that are in direct practice focus may not have the same level of experience using Excel as administrative students and may not value it as much as administrative students. For the purpose of this thesis, PE was measured in terms of usefulness to student's future careers instead of relative to their current employment as in the unmodified, original UTAUT questionnaire. However, this determinant still measured the same aspect of BI, the expected gains to be attained by using Excel, but simply reframed it against longer-term future expectations than the unmodified UTAUT does.

Effort Expectancy

Effort Expectancy is defined as the "degree of ease associated with the use of the system". For the purposes of the UTAUT, a low EE value (using the Likert-scaling employed here) indicates that the surveyed individual expects that the system will require *less* effort to use. Individuals tend to be more motivated to use technology that is user-friendly and research indicates a high degree of correlation between Usage Behavior and the user-friendliness of applications (Venkatesh et al, 2016). This factor can be extremely important for individuals that are not as experienced with technology, because they are less experienced in self-teaching and feature discovery and so more likely to be dissuaded by challenging learning curves. The highly interpersonal nature of social work may limit students' experience with technology and may even attract individuals who are personally disinterested in technology and therefore less likely to accumulate relevant experience. Therefore, it was theorized that EE may have an outsized role in determining BI for this particular subpopulation, although the results ultimately did not support that conclusion. Nevertheless, increased EE should predict increased BI.

Social Influence

Social Influence is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et. al., 2003). This survey attempted to measure lower values (meaning stronger agreement on the Likert scaled questions) where the respondent perceives a greater amount of SI in favor of using Excel. Social work students experience SI from a number of relevant sources. The opinions expressed by professors, potential employers, practicum advisers, professional organizations, and academic peers can shape their BI to use Excel. Although the NASW recently called for increased integration of technology in the social work curriculum, the effects of that decision have arguably not percolated down to the students yet. Excel and other similar tools remain a small part of the curriculum at most schools. The profession’s emphasis on interpersonal treatment skills and relative lack of emphasis on managerial or administrative skills may result in a non-significant SI effect on BI if the respondents universally identify low levels of SI. However, assuming variance in the measured SI, increased SI should predict increased BI.

Facilitating Conditions

Facilitating Conditions are defined as “Objective factors in the environment which observers agree can make an act easy to accomplish” (Venkatesh et al., 2003). This construct tests whether an individual’s circumstances permit easy adoption of the technology in question. However, under the original formulation of the UTAUT, FC does not predict BI, but rather influences actual usage separately and distinctly from BI. Given the low utilization rates of Excel among social work students, this study only evaluates BI and therefore evaluates FC as a predictor of BI.

Behavioral Intention

Behavioral Intention (BI) is defined as the user's internal intention to make use of Excel. BI is a strong predictor of Usage Behavior (Venkatesh et al. 2003). Other factors which contribute to Usage Behavior beyond the formation of BI are largely specific to the use context and are likely to change for students once they complete their academic studies and enter the professional world. Thus, this study will focus on BI as the dependent variable and will analyze its relationships with the four exogenous factors of PE, EE, SI, and FC.

Survey Design

A survey was adapted from the original UTAUT questionnaires as described above and was sent out via email to a selection of social work graduate students at the University of Texas Arlington. The full survey questions can be found in Appendix A.

Question Design

The 19 construct questions were derived directly from the UTAUT's validated survey design. Each question serves as an observable variable designed to measure one of the latent variable constructs of the model, except those questions which gather basic demographic data. The researcher has modified the survey in several ways to better fit the research context and hypotheses. First, the general phrasing relating to "the system" has been modified to refer explicitly to the technology being assessed here, specifically *Microsoft Excel*.

Further, given that the survey targeted a population largely consisting of students rather than mid-career professionals, the phrasing of certain items has been altered to more closely match the circumstances of that population. For example, the phrase "my career or future career" has been substituted for references to "my job," in order to encourage students to evaluate the technology within the context of their anticipated career rather than any current employment or academic studies, which may differ drastically from their longer-term employment prospects. Additionally, examples were provided to contextualize the questions to school and career activities.

Similarly, item OE7 under Performance Expectancy prompts the respondent about "getting a raise." Instead, the phrase "getting a job and/or raise" is substituted on the premise that the respondents may be mid-career professionals pursuing a degree part-time or may be completely new entrants to the job market.

For Social Influence questions, educators, classmates, and the university have been substituted for generic references to influential people and for members of the respondent's business's management or organization.

Sample and Data Collection Process

The survey was created and hosted in Qualtrics, and the results were aggregated and exported to Excel for analysis. An email was sent out to a group of professors in separate MSW emphasis fields in order to reduce the chances of eliciting more than one response from any individual student. In addition, the “prevent ballot box stuffing” feature in Qualtrics, which puts a cookie on their browser when they submit a response, was selected to ensure that that students would not take the survey more than once.

The survey was emailed to a non-probability, convenience sample of social work students via a group of volunteer professors. An email was sent out via a committee member requesting that the professors post a link to the survey on their Blackboard course shells for their classes with a non-mandatory request for volunteers to participate. During the first week the survey was open, there was a relatively low response rate, potentially because that period coincided with the end of the semester. In order to increase the response rate, an additional email was sent out to several professors asking them to repost the link to their course shells. In addition, two field instructors were asked to post the survey link on their Blackboard course shell. After the survey was open for three weeks, the IRB application was amended to incorporate an additional distribution channel, the UTA school of social work Facebook page, in an effort to elicit further responses.

All collected responses were voluntary, uncompensated, and submitted via an online form. Responses were submitted anonymously and only select non-identifiable demographic data was collected for each respondent. The results were exported from Qualtrics and imported into excel for analysis.

Sampling Frame

In the spring of 2018, the University of Texas Arlington School of Social Work master's program had 1391 students. 1255 students identified as female and 136 identified as male. The program has two professional concentrations: Community and Administrative Practice (CAP) and Direct Practice. The Direct Practice concentration consists of four specialties: Aging, Children and Family Services, Health Services, and Mental Health Services.

Table 3-1

Target Population Characteristics

Characteristic	**N=1391**

Self-Identified Gender		
Female	1255	
Male	136	
Concentration		
Community and Administrative Practice	89	
Direct Practice	654	
Aging		*19*
Children and Family Services		*239*
Health Services		*114*
Mental Health Services		*282*
Not Specified	737	

Data Processing Techniques

The collected survey data were analyzed using scripts written in the R programming language with the RStudio development environment. R is widely used among statisticians for numerous data analysis applications (Estrada, 2017). An open-source community organized around the language has disseminated thousands of free libraries for carrying out myriad common statistical analysis tasks. This study relies on three widely-used and validated libraries which extend the core functionalities of the R programming language. Readxl was used to load data from the survey responses from Excel into a data model for processing. The Psych library was used to run Cronbach's α analysis on the responses to confirm the internal consistency and validity of the model factors. Last, the built-in R bivariate and multiple regression functions were used to evaluate the hypothesized relationships between the independent and outcome variables. At various stages, Excel was used to compile descriptive statistics and various charts and other illustrations included herein.

Chapter 4 - Results and Analysis

Following the close out of the survey in Qualtrics, the results were downloaded and preliminarily processed in Excel. The complete results are available in Appendix B, but summary results are presented here. The raw survey responses suggest that students were relatively optimistic about the utility and importance of Excel, with overall high agreement expressed for Behavioral Intention (BI) measures coupled with high agreement expressed for Performance Expectancy (PE) and Effort Expectancy (EE).

These results largely conform to the predictions of the Universal Theory of the Acceptance and Usage of Technology (UTAUT), with three of the four model factors serving as significant predictors of the students' Behavioral Intention to use Excel. Each of the exogenous constructs was initially tested for validity using a Cronbach's α analysis. Hypotheses H1, H2, and H4 were then tested using bivariate regression. Hypothesis H3 was excluded from the regression analysis by the Cronbach's α analysis. A multivariate linear regression was run against BI to test its relationship with the other included factors for H5.

Sample Demographics

There were 62 responses in the survey, with 57 completing the entire survey. There were 59 females and three males, with all five of the incomplete responses having been initiated by female respondents.

Table 4-1

Survey Respondent Self-Identified Gender

Gender	***N=60***	***Percent (%)***
Female	57	95
Male	3	5

The mean reported age was 31 with no significant variation along gender lines and only two respondents electing not to report their age.

Table 4-2

Survey Respondent Age Distribution

Age Characteristics N=55	
Mean	31.56
Std. Dev.	8.52
Median	30
Mode	24
Minimum	21
Maximum	56

Table 4-3 lists the reported student concentrations. The survey population was relatively evenly spread across the various concentrations. However, this represents a disproportionate response rate for the CAP and Direct Practice – Aging concentrations. The sampling method resulted in nearly 100% of Aging students receiving an invitation to participate, because one of the sampled classes was Aging-specific and the number of students in that concentration is smaller than a typical class size. The researcher's concentration is in CAP, which likely resulted in the slight overrepresentation of CAP students because of the greater willingness of CAP professors personally known to the researcher to post the survey for their students.

Table 4-3

Survey Respondent Areas of Concentration

Concentration	***Survey N=60***	***Percent (%)***
MSW - Direct Practice with Health	6	10
MSW - Direct Practice with Aging	15	25
MSW - Direct Practice with Children and Families	14	23
MSW - Community and Administrative Practice	15	25
MSW - Direct Practice with Mental Health	9	15

Other	1	1

Survey Responses Summary

Of the 60 total responses to the survey, every respondent indicated that they had at least used Excel once. Nearly half (45%) reported that they used Excel on a weekly basis, the most frequent use-category available in the responses to the question.

Table 4-4

Student Excel-Usage Frequency

Frequency	***Survey N=60***	***Percent (%)***
Never Used	0	0
Used once or twice	14	23
Used a couple times a month	19	32
Used on a weekly basis	27	45

Students reported a mean total BI score of 7 out of a possible 15, with higher values indicating weaker intent to use. The mode for PE was also the minimum possible response score, indicating that many students do in fact perceive Excel as likely to be useful in their professional careers.

Table 4-5

UTAUT Factor Score Response Summary

	PE	***EE***	***FC***	***SI***	***BI***
Question Count	4	4	4	4	3
Min. Possible	4	4	4	4	3
Max. Possible	20	20	20	20	15
Mean	7.9	11.7	10.8	12.5	7.1
Std. Dev.	3.35	5.03	3.32	2.80	3.34
Median	8	11	10	12	7
Mode	4	8	9	11	4

Model Validity and Reliability

As an initial step, the internal validity of each model construct was tested using a Cronbach's α analysis. The analysis was intended to establish that the latent variables (PE, EE, SI, FC, and BI) were actually being measured by the observable variables (the specific answers to the survey questions) theoretically related to those constructs. Cronbach's α can be understood as a lower-bound estimate of the reliability of a test. In this case, we are concerned with the internal consistency reliability of the constructs, meaning specifically the degree to which the observable variables for each factor measure results consistent with each other. If excluding a question from the results significantly improved the observed Cronbach's α for that factor, it was not included in the full data analysis in order to ensure that the internal consistency of the latent variables exceed the generally-recognized minimum tolerable threshold of 0.8 (Lance et al., 2006). No items were removed once the threshold was exceeded, in order to maximize the explanatory power of the results.

Table 4-6 summarizes the initially measured and post-adjustment Cronbach's α values for each construct. The full analysis output can be found in Appendix D.

Table 4-6

Construct Cronbach's α Results

Construct	*Initial Item Count*	*Initial α*	*Adjusted Item Count*	*Adjusted α*	*Final Validity*
PE	4	.85	4	.85	Valid
EE	4	.95	4	.95	Valid
SI	4	.58	3	.67	Invalid
FC	4	.71	3	.86	Valid
BI	3	.89	3	.89	Valid

Three of the five measured constructs exceeded the minimum threshold without any adjustments necessary and were included in the regression analysis as-is.

For Facilitating Conditions, one question was unintentionally reverse-scaled and its removal increased the measured α from 0.71 to 0.86. This question (Q18) investigated the compatibility of Excel with other technologies and was eliminated for the regression analysis so that the minimum threshold for internal reliability was met for this construct. It is possible that the reverse scaling of this question, the only one scaled in that manner in the entire survey, reduced its covariance with the other construct measures and thus its validity.

The Social Influence construct proved more challenging. The initially measured α was 0.58, well below the established minimum threshold for internal reliability. No exclusion of one or even two questions resulted in an α level above 0.8, with the highest achievable being 0.67, which does not even reach the more forgiving 0.7 threshold adopted by some researchers. It is possible that the specificity with which the questions identified potential social influencers decoupled the responses to each question sufficiently to undermine the internal consistency of the construct. The SI construct was therefore eliminated from the model for purposes of the regression analysis, both for the bivariate and multivariate forms. Accordingly, the null hypothesis holds and the hypothesis (H3) that SI has a significant positive effect on BI must be rejected.

Regression Analysis

A simple bivariate regression using an Ordinary Least Squares (OLS) estimator was used to evaluate the relationships between each of the three included exogenous constructs individually and the dependent variable Behavioral Intent (BI) in order to test the hypotheses H1, H2, and H4. A multiple regression model was used to regress BI on the three included exogenous factors while controlling for simultaneous effects in order to test H5. The summary results for each model can be found in Table 4-7. In general, the *p* values for each regression model were used as rough indicators of significance, with the confidence intervals provided as a more detailed guide to the possible range of significance levels. Adjusted R^2 values are included to demonstrate the size of effects measured. Although unadjusted multiple R^2 values are provided in summary tables, the adjusted values were used for the analysis in order to avoid overestimating the relative gains from inclusion of more variables in the multivariable regression when compared to the bivariate regressions.

Bivariate Regression of Performance Expectancy on Behavioral Intention

Hypothesis H1 predicted that Performance Expectancy would have a significant and positive effect on Behavioral Intention to use Excel. The fitted bivariate linear regression model could predict BI with an adjusted R^2 of 0.5282 from PE with the following formula:

$$BI = 0.7762 * PE + 0.4587$$

The calculated *p* value on 55 degrees of freedom for BI regressed on PE was 9.3800×10^{-11}. The confidence intervals for each model parameter can be found in Table 4-7 and indicate positive upper and lower bounds on the model parameters at the 95% confidence level, suggesting that it is highly likely that the model's slope is positive. The extremely small *p* value and positive slope of the model indicate that we should reject the null hypothesis for H1 because there is a significant positive correlation between PE and BI which is highly unlikely to have arisen by chance. The adjusted R^2 indicates that the relationship is quite strong, with 53% of the variance in BI explainable by PE alone.

Bivariate Regression of Effort Expectancy on Behavioral Intention

Hypothesis H2 predicted that Effort Expectancy would have a significant and positive effect on Behavioral Intention to use Excel. The fitted regression model could predict BI with an adjusted R^2 of 0.4052 from EE with the following formula:

$$BI = 0.5145 * EE + 0.8871$$

The calculated p value on 55 degrees of freedom for BI regressed on EE was 6.160×10^{-8}. The confidence intervals for each model parameter can be found in Table 4-7 and indicate positive upper and lower bounds on the model parameters at the 95% confidence level, suggesting that it is highly likely that the model's slope is positive. The extremely small p value and positive slope of the model indicate that we should reject the null hypothesis for H2 because there is a significant positive correlation between EE and BI which is highly unlikely to have arisen by chance. The adjusted R^2 indicates that the relationship is moderately strong, with 41% of the variance in BI explainable by EE alone.

Bivariate Regression of Facilitating Conditions on Behavioral Intention

Hypothesis H4 predicted that Facilitating Conditions would have a significant and positive effect on Behavioral Intention to use Excel. The fitted regression model could predict BI with an adjusted R^2 of 0.1652 from FC with the following formula:

$$BI = 0.4445 * FC + 1.4452$$

The calculated p value on 55 degrees of freedom for BI regressed on FC was 1.002×10^{-3}. The confidence intervals for each model parameter can be found in Table 4-7 and indicate positive upper and lower bounds on the model parameters at the 95% confidence level, suggesting that it is highly likely that the model's slope is positive. The extremely small p value and positive slope of the model indicate that we should reject the null hypothesis for H4 because there is a significant positive correlation between FC and BI which is highly unlikely to have arisen by chance. The adjusted R^2 indicates that the effect is relatively weak, with only 17% of the variance in BI explainable by FC alone.

Multivariate Regression on Behavioral Intention

Hypothesis H5 predicted that the independent factors would collectively have a significant and positive effect on Behavioral Intention to use Excel. The fitted regression model could predict BI with an adjusted R^2 of 0.6535 from PE, EE, and FC with the following formula:

$$BI = 0.6066 * PE + 0.1696 * EE + 0.1482 * FC - 0.7101$$

The calculated p value on 53 degrees of freedom for BI regressed on PE, EE, and FC was 6.160×10^{-13}. The confidence intervals for each model parameter can be found in Table 4-7 and indicate positive upper and lower bounds on the model parameters at the 95% confidence level, suggesting that it is highly likely that the model's slope is positive. The extremely small p value and positive slope of the model indicate that we should reject the null hypothesis for H5 because there is a significant positive relationship between the three independent variables and BI which is highly unlikely to have arisen by chance. The adjusted R^2 indicates that the effect is quite robust, with 66% of the variance in BI attributable to the combined effects of the three independent variables. In addition, it is worth noting that the lower bound of the confidence interval for FC is slightly below zero, which would indicate a negative relationship between that factor and BI. However, the small size of this effect and its presence at the very lower bound of the confidence interval, combined with the bivariate regression for FC suggests that this is unlikely.

Table 4-7

Regression Results

Independent Variable	Model Estimation					Conf. Int. at 0.95		Significance				
	Parameter	*Point Estimate*	*Std. Error*	*t Value*	*Pr(>|t|)*	*2.50%*	*97.50%*	*Residual standard error*	*Degrees of Freedom*	*Multiple R^2*	*Adjusted R^2*	*p Value*
PE	Intercept	0.4587	0.2739	1.675	0.0997	-0.0902	1.008	0.4215	55	0.5366	0.5282	9.380E-11
	Slope	0.7762	0.0973	7.981	9.370E-11	0.5813	0.9712					
EE	Intercept	0.8871	0.2806	3.161	0.00256	0.3247	1.450	0.4732	55	0.4159	0.4052	6.160E-08
	Slope	0.5145	0.0822	6.257	6.160E-08	0.3497	0.6792					
FC	Intercept	1.445	0.3401	4.250	8.340E-05	0.7637	2.127	0.5606	55	0.1801	0.1652	0.0010
	Slope	0.4445	0.1279	3.476	0.001	0.1882	0.7008					
Multivariate (FC, PE, EE)	Intercept	-0.7101	0.8352	-0.850	0.399	-2.385	0.9651	1.968	53	0.6721	0.6535	7.170E-13
	PE Coefficient	0.6066	0.0916	6.619	1.850E-08	0.4228	0.7904					
	EE Coefficient	0.1696	0.0763	2.221	0.0306	0.0165	0.3227					
	FC Coefficient	0.1482	0.1041	1.423	0.1606	-0.0607	0.3570					

Investigating Moderating Factors

Although this study was not structured to investigate the role Moderating Factors play in the unmodified UTAUT, a brief analysis of how the results varied with the collected demographic information can provide some insight into potential biases in the data set. As discussed above, CAP students were relatively overrepresented when compared to the overall student population. Rerunning the multivariable regression with and without CAP students can shed some light on how that overrepresentation may be skewing the results. There were 15 CAP students in the sample population, consisting of a slightly older group with a median age of 33, four years more than the median for the non-CAP students. Given their focus on administration and macro-level social work, it is unsurprising that these students report higher rates of agreement with PE and BI variables when compared to students focused on direct practice. The CAP students reported a mean PE score of 5.2 compared to 8.9 for the non-CAP students. Non-CAP students also reported a significantly higher mean EE score of 12.67 compared to 8.8 for CAP, indicating that the non-CAP students expected Excel to require significantly more effort to use. Consistent with the predictions of the model, the CAP students also reported higher Behavioral Intention to use Excel, with a mean score of 4.67 versus 8 for non-CAP students.

The multivariable regressions also reflect this trend and their results can be found below in Table 4-8. The coefficient for PE in the CAP-specific regression was 0.2235, whereas the non-CAP coefficient was 0.5972, suggesting that Performance Expectancy is a stronger predictor of BI among non-CAP than CAP students, where the consistently high PE has less relevance for explaining the variance in BI. Similarly, the EE coefficient was slightly higher for non-CAP students. FC was slightly lower for non-CAP students, which may account for its relative weakness as a predictor of BI for the model trained on the whole population given that BI was higher for the larger population of non-CAP students.

Although the CAP students were on average slightly older than the non-CAP, age does not seem to be a strong predictor of any of the independent variables nor does it correlate strongly with BI. Bivariate regressions indicate a slight negative relationship between age and three of the model variables, which can be seen in Table 4-9. However, the high residual standard error, low adjusted R^2 values, and high p values suggest that there is no significant relationship between age and any of the model factors and therefore that age is not a confounding variable for the CAP student results.

Table 4-8

Concentration-Adjusted Multivariable Regression Results

Population Subset	Model Estimation					Conf. Int. at 0.95		Significance				
	Model Parameter	Estimate	Std. Error	t value	Pr(>|t|)	2.50%	97.50%	Residual standard error	Degrees of Freedom	Multiple R-squared	Adjusted R-squared	p-value
CAP	Intercept	0.7205	1.8706	0.3850	0.7070	-3.3967	4.8376	1.5690	11	0.4029	0.2401	1.16E-01
	PE Coefficient	0.2235	0.3420	0.6540	0.5270	-0.5292	0.9762					
	EE Coefficient	0.0154	0.1550	0.0990	0.9230	-0.3258	0.3565					
	FC Coefficient	0.4675	0.3534	1.3230	0.2130	-0.3104	1.2453					
Non-CAP	Intercept	-0.7982	1.2057	-0.6620	0.5120	-3.2391	1.6427	2.1210	38	0.6268	0.5973	2.97E-08
	PE Coefficient	0.5972	0.1140	5.2380	6.290E-06	0.3664	0.8279					
	EE Coefficient	0.2001	0.0936	2.1380	0.0390	0.0106	0.3896					
	FC Coefficient	0.1250	0.1182	1.0570	0.2970	-0.1143	0.3643					

Table 4-9

Student Age Bivariate Regressions

Dependent Variable	Model Estimation					Conf. Int. at 0.95		Significance				
	Model Parameter	Estimate	Std. Error	t value	Pr(>|t|)	2.50%	97.50%	Residual standard error	Degrees of Freedom	Multiple R-squared	Adjusted R-squared	p-value
PE	Intercept	8.3125	1.7768	4.6790	2.04E-05	4.7488	11.8763	3.4340	53	0.0010	-0.0179	8.23E-01
	Slope	-0.0122	0.0544	-0.2250	8.23E-01	-0.1212	0.0968					
EE	Intercept	13.6601	2.6475	5.1600	3.78E-06	8.3499	18.9702	5.1170	53	0.0107	-0.0080	4.53E-01
	Slope	-0.0612	0.0810	-0.7560	4.53E-01	-0.2237	0.1012					
FC	Intercept	5.3022	1.7148	3.0920	3.17E-03	1.8628	8.7415	3.3150	53	0.0220	0.0035	0.2800
	Slope	0.0573	0.0525	1.0910	0.28	-0.0480	0.1624					
BI	Intercept	8.3835	1.7692	4.7390	1.65E-05	4.8350	11.9320	3.4200	53	0.0101	-0.0086	0.4653
	Slope	-0.0398	0.0541	-0.7360	0.47	-0.1483	0.0687					

Chapter 5 - Conclusion

This thesis was intended to develop a better understanding of technology adoption and usage among social work students to support strategies for incorporating emerging technologies into student learning. A non-probability, convenience sample survey of 57 UTA MSW students provided data for probing factors underlying social work students' willingness to adopt data processing technologies. Building on the existing literature describing the Universal Theory of the Usage and Acceptance of Technology (UTAUT) and its application in a variety of contexts, the study evaluated students' behavioral intent to use Microsoft Excel and tested whether four theorized factors from the UTAUT contributed significantly to that intent. Thus, this study can be understood as testing the validity of the UTAUT against this specific subpopulation and quantifying the relationships between the various UTAUT factors for that subpopulation. Despite some methodological limitations, the results confirmed the UTAUT model for three of the factors, failed to confirm it for one factor, and provide some quantitative insight into the relative size of the factors' effects on behavioral intention for this specific subpopulation.

Limitations

There were also several limitations on the utility and generalizability of these results. The acceptance of the null hypothesis for H3 represents a risk for Type II error, or the incorrect acceptance of the null hypothesis. The small sample size increased this risk, because β (the probability of a Type II error) is in part a function of sample size. Moreover, the unexpected lack of internal consistency is most likely due to an instrumentation error with the survey design. The modifications made to the original UTAUT survey were especially extensive for the SI questions, which increases the chances that the construct's lack of internal consistency was specific to this version of the questionnaire and not reflective of a generalizable result. Instead of referring to a single generic institution and its leadership, members, and norms, the question presented respondents with a heterogenous collection of institutions and actors. This fragmentation of concerns may have contributed to the failure of the factor to measure a single hidden variable. Thus, although the null hypothesis was accepted in deviation from other lines of UTAUT research, this should not be read as even a partial falsification of the UTAUT itself. Unfortunately, resource constraints prevented the use of a pre-survey to validate the questions and to address these issues prior to the full survey. Future researchers would benefit greatly from carrying out this indispensable step prior to a full survey.

Furthermore, although the probability of a Type I error is low because α was set to 5% for all of the regression analyses, the precise scale of the effects identified could vary significantly from the point estimates calculated in this study. While it may be possible to use these values to estimate the relative importance of Performance Expectations compared to Effort Expectations or Facilitating Conditions, the confidence intervals for the correlation coefficients of both the multivariable and bivariate regressions overlap significantly, indicating the possibility that the relative impact of each factor on the surveyed populations' behavioral intention may not fall precisely in the same order set by the estimated coefficients here.

In addition, the study's adaptation of the UTAUT measured the effects of Facilitating Conditions on Behavioral Intention, whereas the original, unmodified UTAUT measured the effect of FC on actual usage of the technology in question. It is possible that the relatively weak relationship found between FC and BI here supports the conclusions of the unmodified UTAUT. Had the study measured actual usage, the model could have been structured to control for the interactions between FC and BI, allowing for a more thorough investigation of the effects on actual adoption of Excel.

The channels and methods used to distribute the survey represent another potential bias in the results. Students were able to view the description of the survey on Blackboard before beginning it, including a brief mention of its focus on Excel. As a result, students who had not used Excel may have opted out of the survey because of its apparent lack of relevance to them. Even the online delivery of the survey may have unintentionally selected for more tech savvy students, since it is possible that such students are more likely to participate in a novel technological activity such as a survey. Future work could improve on this methodology by employing an in-class survey to supplement any online component to ensure a more representative sample of the student population.

Last, the characteristics of the survey sample population may limit the utility of the results somewhat. The study was not designed to test whether students' concentrations affect their BI to use Excel, so no hypotheses were tested to evaluate such a hypothesis. However, regression analysis suggests that student concentration does have a significant effect on their technology usage patterns. The significant bias toward Aging and CAP students in the survey population indicates a possible threat to the validity of these results as well as a possible area of interest for future researchers to investigate.

Implications and Future Work

As far as the researcher is aware, this study is the first attempt to apply the UTAUT to the field of social work. Despite the previously discussed limitations on the utility and generalizability of these results, the analysis carried out here supports the conclusion that the

UTAUT does largely model social work students' behavior accurately. This highlights a possible path forward for developing improved models for understanding social work students' behavior and for adjusting social work pedagogy to improve student preparedness for a rapidly changing technological world.

The survey results suggest that Performance Expectancy, Effort Expectancy, and Facilitating Conditions are three direct determinants of Behavioral Intention. Performance Expectancy, which is defined as the degree to which an individual believes that using the system will help him or her attain gains in job performance, was the most significant predictor of BI, both when modeled individually with a bivariate regression and as part of a multivariable regression with the other factors.

The correlation between PE and BI indicates that students value applications that will be beneficial to their future career, and that this motivation has a stronger effect on their expressed intention to use the software than the other factors. This is important when thinking about how to incorporate Excel or similar software into the curriculum. Highlighting how specific applications can be advantageous to future careers can potentially increase usage behavior more easily than developing easier to use software or providing infrastructural support to facilitate usage.

The same strategy may also prove important for professional practitioners. The existing literature suggests that nonprofits struggle with processing data. Future research could investigate the scale and impact of each of the factors on how practitioners deal with these deficits. In some instances, nonprofits may lack appropriate resources, which in turn may prevent them from properly tracking outcomes, driving them into a negative spiral where poorly-tracked outcomes limit funding opportunities and further undermine their capacity to track outcomes.

The correlation between Effort Expectancy and BI demonstrates that students value applications that are easy to use, or relatively free of effort. Applications that are cumbersome and difficult to use deter individuals from adopting the technology. While PE had a larger effect on the variance in BI, EE still evinced a statistically significant and substantial effect on BI. These results emphasize the importance of choosing user friendly applications, both for deployment in professional post-graduate contexts and in the classroom.

Much of the current literature surrounding technology use in social work focuses on pedagogical frameworks for incorporating technology into learning, but research on how to model social work students' actual usage behavior is more limited. Such research has focused on identifying cultural and social influences on student behavior, using models such as the TAM. These studies suggest that social workers tend to rely on verbal advice and suggestions from peers and colleagues when deciding what technologies or techniques to adopt in their professional practices (Edmunds et al, 2012). Unfortunately, the Social Influence factor in this study proved too unreliable to test the prior literature on this point, which highlights an opportunity for future researchers to improve upon these results significantly.

Such future researchers can adopt the methodology of this study and apply it to a larger sample size in order to evaluate the relationships between the model factors and student behaviors in greater detail. Use of a pre-validation survey will greatly improve the utility of such research, ensuring that all of the data collected is sufficiently reliable to be included in the full analysis and permitting a test of the actual role of SI in student usage behaviors.

Further enhancements could be achieved by including a more thorough investigation of the role Moderating Factors play in student adoption. Modeling student concentration as a Moderating Factor could yield interesting new insights into how student behavior can be predicted from their chosen specialty, which in turn can guide pedagogical decision-making about how to target the curriculum for those specialties.

Future research would also benefit greatly from the development of a useful measurement for actual technology usage, in order to support the full application of the UTAUT instead of the more limited variation used here. While the extensive body of work conducted to validate the UTAUT elsewhere suggests that BI is a strong predictor of actual technology usage, it is not a full substitute for measuring whether students actually use the technology in question. The many variations and extensions of the UTAUT that have been developed include a number of alternative measures of usage which may represent opportunities to develop a more robust version of the model for social work applications.

Future research could also investigate variation in these results across other majors or degrees facing similar challenges. For example, a study could evaluate the UTAUT as applied to MBA students that specialize in nonprofit management compared to MSW students in an attempt to measure if it is an underlying issue with the social work field or if barriers to technology acceptance are universal. Similar comparisons against MPA, MPH, PsyD, or multidisciplinary students could prove revealing.

Last, more work should be done to identify what technologies will generate the most value for social workers. While Excel is an indispensable technology in almost any modern professional context, the UTAUT's value for guiding social work curricula extends only to predictions about technology adoption, not about which technologies should be adopted. For example, some students' low performance expectations for Excel may actually be an accurate assessment of its utility in their future careers. Without more detailed quantitative analysis of what technologies are most useful, it is difficult to suggest that measures be taken to adjust student performance expectations in an effort to modify their usage behaviors.

Conclusion

To the extent that Excel can be used as a proxy measure for data skills, the results of this study suggest that many social work students are surprisingly well-prepared for data-intensive careers, with 45% of students participating in the survey reporting that they used Excel weekly. The results further suggest that many students place a high value on the importance of those tools for practice, but that others do not. Low expressed intent to use Excel was strongly correlated with low expectations for its utility on the job. Assuming technologies such as Excel are an important part of a social worker's toolkit, adjustments to the curriculum may be necessary to convey that to students.

Nevertheless, this study highlights several possible paths for future research to enhance existing understandings of how to model student behavior and provides analytical and practical tools to support such work. It is the researcher's hope that the included R scripts and detailed explanation of their use will enable future researchers to replicate and build on this work with relatively little effort. Although this study was not intended to design new statistical analysis tools, the dissemination of tools developed incidentally can be of great value in other contexts. The study's test of the UTAUT itself provides useful insight into student behavior and demonstrates how the UTAUT can serve as a powerful framework for developing more detailed models of student technology adoption patterns. Whatever professional landscape results from the rapid evolution of Information and Communications Technologies, it is imperative that researchers equip educators with the correct tools to evaluate how students interact with those technologies.

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Appendix A – Survey Specification

This is the full list of questions submitted to survey respondents. All UTAUT factor questions called for a standard Likert-scale response ranging from strongly disagree (scored as 1) to strongly agree (scored as 5). The available response selections for major and specialty and usage frequency are as documented in the results listed in Chapter 4. Gender provided male/female selectable answers with an option to enter gender as text for respondents who did not identify as male or female. No respondent made use of this option. Age was reported using a text entry field only allowing numeric input. Two responses listed their age as 0, and they were excluded from any analysis that depended on reported age.

Table A-1

Survey Questions

Field Name	***Question Prompt/Field Content***	***UTAUT Factor***
Q1	My name is Cynthia Jewett , and I am requesting your participation in a UT Arlington research study titled, "Data collection social work, evaluating barriers to adoption." The purpose of this study is to use the Unified Theory of Acceptance and Use of Technology (UTAUT) as a theoretical framework to gain a better understanding of technology adoption and usage among social work students in order to incorporate technology into learning. The procedures that you will follow as a research subject is to take the survey which should take about 3 minutes. There are no perceived risks or direct benefits for participating in this study. There are no alternatives to this research project but you may quit at any time. You must be at least 18 years old to participate Do you consent to participating in this survey?	
Q2	Major and Specialty	
Q11	Enter your Age	
Q23	What is your gender - Selected Choice	
Q23_3_TEXT	What is your gender - Prefer to self describe - Text	
Q29	Please choose your usage frequency for Excel	
Q3	I would find Excel useful in my career	PE
Q4	Using Excel enables me to accomplish tasks more quickly	PE
Q5	Using Excel increases my productivity	PE
Q6	If I use Excel, I will increase my chances of getting a job	PE
Q7	My interaction with Excel is clear and understandable	EE
Q8	It would be easy for me to become skillful at using Excel	EE
Q9	I would find Excel easy to use	EE
Q10	Learning to operate Excel is easy for me	EE

Q12	My classmates and professors think that I should use Excel	SI
Q13	Educators have been helpful in the use of Excel	SI
Q14	People whose opinions that I value prefer that I use Excel	SI
Q26	In general the university has been supportive in the use of Excel	SI
Q16	I have the resources necessary to use Excel	FC
Q17	I have the knowledge necessary to use Excel	FC
Q18	Excel is not compatible with other technology I use	FC
Q19	I can get help from others when I have difficulties using Excel	FC
Q20	I intend to use Excel in the next 6 months	BI
Q21	I plan to continue to use Excel frequently	BI
Q22	I will try to use Excel in my daily life	BI

Appendix B – Full Survey Results

Table B-1

Full Survey Responses

Q1	Q2	Q11	Q23	Q29	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q12	Q13	Q14	Q26	Q16	Q17	Q18	Q19	Q20	Q21	Q22
1	5	49	2	4	1	1	1	1	1	1	1	1	3	2	3	3	1	2	5	1	1	1	1
1	2	24	2	2	3	3	2	2	2	2	2	2	5	3	5	3	1	2	5	1	4	4	5
1	1	24	2	2	2	2	2	3	4	4	4	4	3	2	3	3	2	2	4	2	2	4	4
1	5	24	2	3	1	1	1	2	2	3	3	3	2	5	3	3	2	3	2	2	1	3	5
1	1	28	2	4	4	4	4	4	4	4	4	4	5	3	5	3	3	2	3	2	4	4	4
1	1	33	2	3	2	1	2	2	1	2	1	1	3	3	3	4	1	1	5	1	1	2	3
1	1	24	2	3	2	2	3	3	4	4	4	4	2	3	3	4	2	3	5	3	1	2	4
1	6	48	2	3	2	3	2	2	2	2	2	2	2	5	3	5	5	2	3	4	2	2	3
1	1	37	2	2	1	1	1	1	5	3	5	5	3	3	1	5	5	5	3	5	2	4	3
1	2	48	2	4	2	3	3	2	4	3	3	3	3	3	3	3	2	2	5	2	2	2	3
1	1	0	2	3	2	2	2	3	2	2	2	2	2	2	3	2	2	2	2	1	2	2	3
1	5	34	2	3	2	3	1	2	3	3	2	3	2	4	2	4	3	2	4	2	1	2	3
1	1	40	1	4	1	1	1	1	1	2	2	4	3	4	1	3	1	1	5	1	1	1	2
1	4	30	2	2	3	2	4	3	4	4	4	4	3	4	5	3	2	4	3	4	3	4	5
1	5	38	2	4	1	1	1	2	1	1	1	1	3	2	3	3	1	1	5	1	1	1	2
1	5	33	2	4	1	1	1	1	2	1	2	2	1	3	3	3	2	1	4	4	1	2	2
1	1	31	2	2	3	2	3	2	4	4	3	4	3	3	5	3	3	2	2	2	4	5	5
1	2	30	2	3	3	2	2	4	3	2	2	2	5	5	3	4	3	2	3	4	2	3	3
1	5	21	2	4	1	1	1	1	1	1	1	1	2	1	1	2	1	1	3	2	1	1	2
1	4	26	2	3	2	2	2	3	2	2	2	2	2	3	2	2	2	2	2	3	2	2	4
1	2	29	2	4	1	1	1	1	1	1	1	1	3	3	3	3	1	1	1	2	1	1	1
1	2	31	2	4	2	3	1	3	2	2	2	3	3	4	2	3	2	2	2	1	1	1	1
1	5	42	2	4	1	2	2	2	2	2	2	2	2	2	2	3	1	1	4	2	1	1	2
1	1	29	2	3	3	5	3	2	2	4	4	4	3	2	2	3	2	2	3	2	2	3	4
1	1	35	2	4	1	2	2	2	4	3	4	4	3	2	3	3	2	2	5	2	1	2	2
1	5	27	1	2	2	2	2	1	4	3	4	4	4	4	2	3	2	2	4	4	2	3	3
1	4	25	2	4	2	2	1	3	2	2	2	2	3	3	3	2	2	2	5	2	2	2	3
1	5	56	2	2	1	2	1	1	4	2	2	2	1	4	2	3	2	4	3	2	1	2	2
1	1	24	2	2	2	1	2	3	4	4	4	4	3	2	5	3	1	2	5	4	2	2	5
1	2	34	2	3	2	2	2	2	2	2	2	2	3	3	2	3	2	2	3	2	1	2	3

1	3	22	2	4	1	1	1	3	2	2	2	2	3	3	3	1	2	1	1	1	1	1	2
1	5	33	2	3	1	1	1	1	3	5	5	5	2	3	3	3	2	3	4	3	1	2	2
1	1	23	2	2	2	2	2	1	5	5	5	5	2	2	2	4	4	4	2	4	2	3	4
1	5	27	2	4	1	2	2	1	4	4	4	4	1	4	3	3	2	4	5	2	1	1	2
1	1	43	2	2	2	2	1	1	4	5	5	5	3	5	3	5	5	5	5	4	1	3	4
1	2	0	2	2	2	2	2	1	2	3	3	3	3	1	3	3	2	2	3	3	1	2	4
1	1	25	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	2	24	1	3	1	1	1	1	1	1	1	1	4	5	4	5	5	2	4	5	1	1	2
1	2	24	2	4	2	2	2	3	4	2	2	4	5	5	5	3	1	1	5	3	1	1	1
1	4	51	2	4	3	3	2	4	2	2	2	1	3	5	3	2	1	1	4	3	2	1	4
1	4	26	2	4	2	3	2	1	4	4	4	4	3	3	3	3	2	1	3	2	1	2	4
1	4	31	2	2	4	5	3	5	5	5	5	5	4	5	5	4	1	2	5	1	5	4	5
1	3	32	2	4	2	2	2	4	4	4	4	4	5	5	5	3	2	5	5	5	2	2	4
1	2	27	2	4	2	2	2	3	2	3	3	3	4	4	2	3	2	2	2	2	2	2	3
1	4	23	2	4	1	1	1	2	5	4	4	4	3	4	2	5	4	4	4	2	1	1	2
1	5	36	2	4	1	1	1	2	1	2	1	1	3	4	2	3	1	1	5	3	1	2	1
1	5	28	2	4	1	1	1	1	2	2	2	2	1	1	1	5	1	1	5	1	1	1	1
1	5	31	2	4	1	1	1	3	2	2	1	2	3	2	2	3	2	2	4	2	1	1	1
1	5	23	2	4	1	1	1	1	1	1	1	1	1	3	1	5	1	1	3	1	1	1	1
1	4	24	2	2	4	4	4	2	5	4	4	2	5	5	5	5	1	2	5	2	4	5	5
1	3	24	2	3	2	1	2	3	2	4	2	2	3	3	3	1	1	1	5	3	1	2	3
1	1	38	2	3	3	4	4	4	5	5	5	5	2	4	4	4	5	5	4	5	3	3	5
1	2	42	2	4	1	1	1	2	2	2	2	2	3	3	2	3	2	2	5	2	1	1	2
1	2	23	2	3	3	2	2	2	4	3	4	4	3	5	3	3	2	2	3	2	1	4	4
1	3	35	2	3	1	1	1	2	3	5	5	5	2	4	3	5	5	5	3	5	3	3	3
1	4	24	2	3	1	2	1	1	2	2	2	2	3	4	3	3	1	1	5	3	1	1	4
1	3	22	2	3	5	3	4	1	5	5	5	5	3	5	3	2	2	5	3	4	4	5	5
1	2	30	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	2	37	2	4	1	1	1	1	4	4	2	3	5	5	5	5	0	0	0	0	0	0	0
1	5	24	2	4	1	1	1	2	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0
1	3	22	2	3	2	3	2	1	2	2	2	2	3	3	3	3	0	0	0	0	0	0	0
1	2	46	2	2	3	4	3	3	4	5	4	5	2	3	5	3	4	5	3	4	5	5	5

Appendix C – R Scripts

The following is the actual R code used to process the survey results. All of the software used was free, open-source, and available online from the R Foundation's repositories and R Studio's website.

As an initial step, the researcher downloaded and installed R studio from https://www.rstudio.com/. A project folder was then created and R Studio was used to installed the necessary software packages before running the scripts from the project folder. The survey results, having already been cleaned in Excel, were placed in organized subdirectories of the project folder before being used in any calculations.

All folder paths are specified as starting from "./" which corresponds to the project folder. For example, "./SurveyData" would translate to "C:\UserName\Documents\UTAUTResearch\SurveyData" where the project folder can be found at "C:\UserName\Documents\UTAUTResearch."

Lines beginning with "#" are comments which the R environment ignores when executing code. These comments serve to document and explain the code.

```
# standard library for getting data from Excel
library(readxl)
# standard data processing library
library(dplyr)
# tools for displaying linear model results
library(jtools)
# tools for Cronbach's alpha analysis
library(psych)

# function to loop through all the model factors running Cronbach's alpha
process.chronbachs <- function(factors, source_folder, output_folder) {
  for(factor in factors) {
    file_name <- paste(factor, ".xlsx", sep = "")
    source_file <- file.path(source_folder, file_name)
```

```
    survey_results <- read_excel(source_file)
    output_filename <- paste(factor, "_alpha_output.txt", sep = "")
    output_path <- file.path(output_folder, output_filename)

    file_connection <- file(output_path)
      sink(file_connection)
        print(output_filename)
        print(alpha(as.matrix(survey_results), check.keys=TRUE))
      sink()
    close(file_connection)
  }
}

# creates list of factors and then calls function to process them
factors <- c("PE","EE","FC","SI","BI")
survey_results_folder <- "./Data/Cleaned/Detail"
output_folder <- "./Results/Cronbach's Alpha"
process.chronbachs(factors, survey_results_folder, output_folder)

# function for generating all the linear models at once with varying input data
generate.linear.models <-function(source_data) {
  pe_bivariate_model <- lm(BI ~ PE, data = source_data)
  ee_bivariate_model <- lm(BI ~ EE, data = source_data)
  fc_bivariate_model <- lm(BI ~ FC, data = source_data)
  multivariate_model <- lm(BI ~ PE + EE + FC, data = source_data)
  list(pe_bivariate_model, ee_bivariate_model, fc_bivariate_model,
multivariate_model)
}

# function for generating all the linear models at once including Age as a factor
generate.age.models <-function(source_data) {
  pe_bivariate_model <- lm(PE ~ Age, data = source_data)
  ee_bivariate_model <- lm(EE ~ Age, data = source_data)
  fc_bivariate_model <- lm(FC ~ Age, data = source_data)
  bi_bivariate_model <- lm(BI ~ Age, data = source_data)
  multivariate_model <- lm(BI ~ PE + EE + FC + Age, data = source_data)
  list(pe_bivariate_model, ee_bivariate_model, fc_bivariate_model,
bi_bivariate_model, multivariate_model)
}

# function for printing the results of models to file
process.linear.model <- function(lmodel, textoutput_filename) {
  textoutput_file <- file(textoutput_filename)
```

```
    sink(textoutput_file)
      print(summary(lmodel))
      print(coefficients(lmodel))
      print(confint(lmodel, level=0.95))
      print(confint(lmodel, level=0.05))
      print(fitted(lmodel))
      print(residuals(lmodel))
      print(anova(lmodel))
      print(vcov(lmodel))
      print(influence(lmodel))
    sink()
  close(textoutput_file)
}

# generates models for post-alpha adjustment survey results
source_data_folder <- "./Data/Cleaned/AlphaAdjusted"
output_folder <- "./Results/Main"
all_results_file <- file.path(source_data_folder, "AllSurveyResults.xlsx")
all_results_data <- read_excel(all_results_file)
result_models <- generate.linear.models(all_results_data)
for(result_model in result_models) {
  model_name <- deparse(substitute(result_model)
  textoutput_name <- paste(model_name, " Linear Model Results.txt")
  textoutput_filename <- file.path(output_folder, textoutput_name)
  process.linear.model(result_model, textoutput_filename)
}

# generates models for post-alpha adjustment survey results with ages
source_data_folder <- "./Data/Cleaned/AlphaAdjusted"
output_folder <- "./Results/Limitations"
all_results_file <- file.path(source_data_folder,
"AllSurveyResultsWithAges.xlsx")
all_results_data <- read_excel(all_results_file)
result_models <- generate.age.models(all_results_data)
for(result_model in result_models) {
  model_name <- deparse(substitute(result_model)
  textoutput_name <- paste(model_name, " Age Linear Model Results.txt")
  textoutput_filename <- file.path(output_folder, textoutput_name)
  process.linear.model(result_model, textoutput_filename)
}

# generates models for post-alpha adjustment survey results broken out by
concentration
```

```r
source_data_folder <- "./Data/Cleaned/Concentrations"
output_folder <- "./Results/Concentrations"
all_results_file <- file.path(source_data_folder, "CAP.xlsx")
all_results_data <- read_excel(all_results_file)
result_models <- generate.linear.models(all_results_data)
for(result_model in result_models) {
  model_name <- deparse(substitute(result_model))
  textoutput_name <- paste(model_name, " CAP Linear Model Results.txt")
  textoutput_filename <- file.path(output_folder, textoutput_name)
  process.linear.model(result_model, textoutput_filename)
}

# generates models for post-alpha adjustment survey results broken out by
concentration
all_results_file <- file.path(source_data_folder, "NonCAP.xlsx")
all_results_data <- read_excel(all_results_file)
result_models <- generate.linear.models(all_results_data)
for(result_model in result_models) {
  model_name <- deparse(substitute(result_model))
  textoutput_name <- paste(model_name, " NonCAP Linear Model Results.txt")
  textoutput_filename <- file.path(output_folder, textoutput_name)
  process.linear.model(result_model, textoutput_filename)
}
```

Appendix D – Full Analysis Output

Below are the raw, unformatted outputs from the R scripts. Each individual output is separated by line consisting of "*" symbols, followed by a title for the output and then the raw output.

```
****************************************************************

[1] "PE Cronbach's Output"

Reliability analysis
Call: alpha(x = as.matrix(survey_results), check.keys = TRUE)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd
      0.85      0.86    0.85       0.6 6.1 0.033    2 0.84

 lower alpha upper     95% confidence boundaries
  0.79 0.85 0.92

 Reliability if an item is dropped:
   raw_alpha std.alpha G6(smc) average_r  S/N alpha se
Q3      0.76      0.76    0.71      0.52  3.2    0.057
Q4      0.80      0.80    0.79      0.58  4.1    0.049
Q5      0.78      0.79    0.75      0.55  3.7    0.051
Q6      0.91      0.91    0.88      0.77 10.0    0.022

 Item statistics
    n raw.r std.r r.cor r.drop mean   sd
Q3 57  0.91  0.92  0.92   0.83  1.9 0.97
Q4 57  0.87  0.86  0.81   0.74  2.0 1.06
Q5 57  0.88  0.88  0.86   0.78  1.9 0.93
Q6 57  0.70  0.69  0.50   0.48  2.1 1.04

Non missing response frequency for each item
      1    2    3    4    5 miss
Q3 0.40 0.37 0.16 0.05 0.02    0
Q4 0.37 0.39 0.14 0.07 0.04    0
Q5 0.42 0.39 0.11 0.09 0.00    0
Q6 0.33 0.32 0.25 0.09 0.02    0

****************************************************************

[1] "EE Cronbach's Output"
```

```
Reliability analysis
Call: alpha(x = as.matrix(survey_results), check.keys = TRUE)

  raw_alpha std.alpha G6(smc) average_r S/N    ase mean  sd
      0.96      0.96    0.95      0.85  22 0.0095  2.9 1.3

 lower alpha upper     95% confidence boundaries
0.94 0.96 0.98

 Reliability if an item is dropped:
    raw_alpha std.alpha G6(smc) average_r S/N alpha se
Q7       0.96      0.96    0.95      0.90  26   0.0087
Q8       0.94      0.94    0.93      0.85  17   0.0133
Q9       0.93      0.93    0.90      0.81  13   0.0171
Q10      0.94      0.94    0.93      0.84  16   0.0140

 Item statistics
     n raw.r std.r r.cor r.drop mean  sd
Q7  57  0.90  0.90  0.85   0.83  2.9 1.3
Q8  57  0.94  0.94  0.92   0.89  2.9 1.3
Q9  57  0.97  0.97  0.97   0.95  2.9 1.4
Q10 57  0.95  0.95  0.93   0.90  3.0 1.4

Non missing response frequency for each item
       1    2    3    4    5 miss
Q7  0.16 0.35 0.07 0.30 0.12    0
Q8  0.12 0.35 0.16 0.23 0.14    0
Q9  0.16 0.35 0.09 0.26 0.14    0
Q10 0.16 0.30 0.11 0.28 0.16    0

****************************************************************

[1] "SI Cronbach’s Output"

Reliability analysis
Call: alpha(x = as.matrix(survey_results), check.keys = TRUE)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean  sd
      0.53      0.52    0.52      0.21 1.1 0.099  3.1 0.7

 lower alpha upper     95% confidence boundaries
  0.34 0.53 0.73
```

```
 Reliability if an item is dropped:
    raw_alpha std.alpha G6(smc) average_r  S/N alpha se
Q12      0.37      0.36    0.32      0.16 0.56    0.141
Q13      0.34      0.32    0.35      0.14 0.47    0.147
Q14      0.41      0.39    0.35      0.18 0.64    0.133
Q26      0.64      0.65    0.56      0.38 1.83    0.083

 Item statistics
     n raw.r std.r r.cor r.drop mean   sd
Q12 57  0.70  0.70  0.59  0.424  2.9 1.04
Q13 57  0.74  0.73  0.58  0.440  3.4 1.16
Q14 57  0.71  0.68  0.55  0.379  3.0 1.16
Q26 57  0.41  0.44  0.11  0.063  3.3 0.97

Non missing response frequency for each item
       1    2    3    4    5 miss
Q12 0.09 0.23 0.51 0.07 0.11    0
Q13 0.05 0.18 0.33 0.23 0.21    0
Q14 0.09 0.25 0.46 0.04 0.18    0
Q26 0.04 0.11 0.58 0.12 0.16    0

****************************************************************

[1] "FC Cronbach's Output"

Reliability analysis
Call: alpha(x = as.matrix(survey_results), check.keys = TRUE)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean   sd
      0.71       0.7    0.71      0.37 2.3 0.063  2.3 0.91

 lower alpha upper     95% confidence boundaries
  0.58 0.71 0.83

 Reliability if an item is dropped:
     raw_alpha std.alpha G6(smc) average_r  S/N alpha se
Q16       0.48      0.47    0.47      0.23 0.87    0.119
Q17       0.56      0.56    0.57      0.30 1.27    0.101
Q18-      0.83      0.83    0.77      0.62 4.85    0.039
Q19       0.61      0.60    0.60      0.33 1.50    0.092

 Item statistics
```

```
      n raw.r std.r r.cor r.drop mean  sd
Q16  57  0.87  0.87  0.85   0.74  2.2 1.2
Q17  57  0.81  0.80  0.73   0.61  2.3 1.3
Q18- 57  0.45  0.47  0.19   0.14  2.3 1.2
Q19  57  0.77  0.76  0.68   0.55  2.6 1.2

Non missing response frequency for each item
       1    2    3    4    5 miss
Q16 0.32 0.46 0.07 0.05 0.11    0
Q17 0.28 0.46 0.05 0.09 0.12    0
Q18 0.04 0.12 0.28 0.19 0.37    0
Q19 0.19 0.39 0.16 0.18 0.09    0

****************************************************************

[1] "BI Cronbach’s Output"

Reliability analysis
Call: alpha(x = as.matrix(survey_results), check.keys = TRUE)

  raw_alpha std.alpha G6(smc) average_r S/N   ase mean  sd
      0.89       0.9    0.86      0.74 8.6 0.024  2.4 1.1

 lower alpha upper     95% confidence boundaries
  0.85 0.89 0.94

 Reliability if an item is dropped:
    raw_alpha std.alpha G6(smc) average_r S/N alpha se
Q20      0.86      0.86    0.75      0.75 6.1    0.037
Q21      0.80      0.81    0.68      0.68 4.2    0.052
Q22      0.88      0.89    0.80      0.80 7.8    0.030

 Item statistics
     n raw.r std.r r.cor r.drop mean  sd
Q20 57  0.90  0.91  0.84   0.78  1.8 1.1
Q21 57  0.93  0.93  0.90   0.84  2.3 1.2
Q22 57  0.90  0.89  0.80   0.76  3.1 1.3

Non missing response frequency for each item
       1    2    3    4    5 miss
Q20 0.56 0.26 0.05 0.09 0.04    0
Q21 0.32 0.35 0.14 0.12 0.07    0
Q22 0.14 0.23 0.23 0.23 0.18    0
```

```
*****************************************************************

[1] "BI ~ PE Bivariate Regression Output"

Call:
lm(formula = BI ~ PE, data = all_results_data)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.05530 -0.25740 -0.08489  0.25512  0.98888 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  0.45867    0.27389   1.675   0.0997 .  
      PE     0.77623    0.09726   7.981 9.37e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4215 on 55 degrees of freedom
Multiple R-squared:  0.5366,    Adjusted R-squared:  0.5282 
F-statistic: 63.69 on 1 and 55 DF,  p-value: 9.375e-11

(Intercept)    PE
  0.4586693   0.7762275 

                2.5 %    97.5 %
(Intercept) -0.09022039 1.0075591
      PE     0.58130890 0.9711461

2.913316 2.194367 3.147600 2.913316 2.654172 3.659137 3.363047 3.464986 3.257397
3.257397 2.787352 3.563579 2.913316 2.787352
3.257397 2.512374 2.360031 2.512374 3.147600 2.654172 2.913316 2.787352 2.194367
2.512374 2.787352 2.011124 2.913316 2.787352
2.654172 3.033125 2.512374 2.654172 2.654172 2.787352 2.654172 2.194367 2.011124
2.194367 2.011124 2.011124 2.512374 2.512374
2.194367 2.360031 2.011124 2.360031 2.011124 2.194367 2.194367 2.011124 2.011124
2.787352 2.787352 2.194367 2.011124 2.360031
2.011124

 0.69223501  0.80563318  0.31650129  0.82834112  0.34582771  0.08252002
0.37861064 -0.14836078  0.48425995  0.61558591  0.37492578
```

```
-0.09947778 -0.26756495  0.04107525 -0.25739744  0.48762570  0.46839646 
0.13337701 -0.50184901 -0.00842098 -0.08488914  0.21264812 
 0.25512292 -0.06288456 -0.14160057  0.98887564 -0.26756495 -0.14160057 -
0.20468255 -0.20469763  0.31605283 -0.00842098 -0.20468255 
-0.14160057 -0.20468255  0.80563318 -0.01112436 -0.19436682  0.22494362 -
0.01112436 -0.51237430 -0.27630632  0.04170116 -0.36003067 
 0.22494362 -0.36003067 -0.01112436 -0.19436682 -0.19436682 -0.27907355 -
0.27907355 -1.05530107 -1.05530107 -0.19436682 -0.27907355 
-0.62797986 -0.27907355 

Analysis of Variance Table
Response: BI
          Df  Sum Sq Mean Sq F value    Pr(>F)    
      PE   1 11.3141 11.3141  63.692 9.375e-11 ***
Residuals 55  9.7701  0.1776                      
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

            (Intercept)     PE
(Intercept)  0.07501625 -0.026080128
      PE    -0.02608013  0.009460014

$hat
0.02629607 0.03198891 0.04417972 0.02629607 0.01781646 0.11694716 0.06918930 
0.08388221 0.05589999 0.05589999 0.02069158 0.09984048 
0.02629607 0.02069158 0.05589999 0.01820154 0.02257583 0.01820154 0.04417972 
0.01781646 0.02629607 0.02069158 0.03198891 0.01820154 
0.02069158 0.04805166 0.02629607 0.02069158 0.01781646 0.03422922 0.01820154 
0.01781646 0.01781646 0.02069158 0.01781646 0.03198891 
0.04805166 0.03198891 0.04805166 0.04805166 0.01820154 0.01820154 0.03198891 
0.02257583 0.04805166 0.02257583 0.04805166 0.03198891 
0.03198891 0.04805166 0.04805166 0.02069158 0.02069158 0.03198891 0.04805166 
0.02257583 0.04805166 

$coefficients
     (Intercept)      PE
1  -2.984130e-02  1.534842e-02
2   7.823842e-02 -2.308313e-02
3  -2.857250e-02  1.247127e-02
4  -3.570865e-02  1.836620e-02
5   2.478668e-03  1.341567e-03
6  -1.710485e-02  6.799096e-03
7  -5.167293e-02  2.133170e-02
```

```
8   2.369552e-02 -9.625611e-03
9  -5.491194e-02  2.318228e-02
10 -6.980346e-02  2.946905e-02
11 -6.948697e-03  4.956805e-03
12  1.823064e-02 -7.316035e-03
13  1.153436e-02 -5.932521e-03
14 -7.612692e-04  5.430461e-04
15  2.918720e-02 -1.232202e-02
16  1.681682e-02 -2.939333e-03
17  3.003425e-02 -7.844724e-03
18  4.599794e-03 -8.039761e-04
19  4.530496e-02 -1.977463e-02
20 -6.035612e-05 -3.266745e-05
21  3.659454e-03 -1.882184e-03
22 -3.941120e-03  2.811371e-03
23  2.477606e-02 -7.309823e-03
24 -2.168710e-03  3.790584e-04
25  2.624358e-03 -1.872068e-03
26  1.336574e-01 -4.187086e-02
27  1.153436e-02 -5.932521e-03
28  2.624358e-03 -1.872068e-03
29 -1.467032e-03 -7.940237e-04
30  1.369971e-02 -6.318074e-03
31  1.089976e-02 -1.905118e-03
32 -6.035612e-05 -3.266745e-05
33 -1.467032e-03 -7.940237e-04
34  2.624358e-03 -1.872068e-03
35 -1.467032e-03 -7.940237e-04
36  7.823842e-02 -2.308313e-02
37 -1.503579e-03  4.710265e-04
38 -1.887578e-02  5.569030e-03
39  3.040359e-02 -9.524538e-03
40 -1.503579e-03  4.710265e-04
41 -1.767033e-02  3.088514e-03
42 -9.529020e-03  1.665532e-03
43  4.049774e-03 -1.194828e-03
44 -2.308568e-02  6.029809e-03
45  3.040359e-02 -9.524538e-03
46 -2.308568e-02  6.029809e-03
47 -1.503579e-03  4.710265e-04
48 -1.887578e-02  5.569030e-03
49 -1.887578e-02  5.569030e-03
50 -3.771985e-02  1.181650e-02
```

```
51 -3.771985e-02  1.181650e-02
52  1.955845e-02 -1.395189e-02
53  1.955845e-02 -1.395189e-02
54 -1.887578e-02  5.569030e-03
55 -3.771985e-02  1.181650e-02
56 -4.026696e-02  1.051743e-02
57 -3.771985e-02  1.181650e-02

$sigma
0.4145044 0.4105008 0.4230681 0.4097290 0.4226967 0.4251878 0.4219900 0.4248323
0.4199138 0.4165266 0.4222195 0.4251163 0.4237521
0.4253182 0.4238253 0.4200506 0.4204411 0.4249610 0.4195807 0.4253541 0.4251945
0.4243493 0.4238895 0.4252680 0.4249097 0.4023737
0.4237521 0.4249097 0.4244261 0.4244102 0.4231351 0.4253541 0.4244261 0.4249097
0.4244261 0.4105008 0.4253528 0.4245053 0.4241970
0.4253528 0.4194946 0.4236596 0.4253165 0.4224590 0.4241970 0.4224590 0.4253528
0.4245053 0.4245053 0.4235710 0.4235710 0.3998354
0.3998354 0.4245053 0.4235710 0.4164803 0.4235710

$wt.res
 0.69223501  0.80563318  0.31650129  0.82834112  0.34582771  0.08252002
0.37861064 -0.14836078  0.48425995  0.61558591  0.37492578
-0.09947778 -0.26756495  0.04107525 -0.25739744  0.48762570  0.46839646
0.13337701 -0.50184901 -0.00842098 -0.08488914  0.21264812
 0.25512292 -0.06288456 -0.14160057  0.98887564 -0.26756495 -0.14160057 -
0.20468255 -0.20469763  0.31605283 -0.00842098 -0.20468255
-0.14160057 -0.20468255  0.80563318 -0.01112436 -0.19436682  0.22494362 -
0.01112436 -0.51237430 -0.27630632  0.04170116 -0.36003067
 0.22494362 -0.36003067 -0.01112436 -0.19436682 -0.19436682 -0.27907355 -
0.27907355 -1.05530107 -1.05530107 -0.19436682 -0.27907355
-0.62797986 -0.27907355

****************************************************************

[1] "BI ~ EE Bivariate Regression Output"

Call:
lm(formula = BI ~ EE, data = all_results_data)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.00828 -0.29920 -0.01217  0.30354  1.26334 
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.88709    0.28061   3.161  0.00256 **
      EE     0.51446    0.08222   6.257 6.16e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4732 on 55 degrees of freedom
Multiple R-squared:  0.4159,    Adjusted R-squared:  0.4052
F-statistic: 39.15 on 1 and 55 DF,  p-value: 6.158e-08

(Intercept)    EE
  0.8870924   0.5144636

                2.5 %    97.5 %
(Intercept) 0.3247309 1.4494538
      EE    0.3496971 0.6792301

2.342215 2.593375 2.944947 2.879601 2.944947 3.187843 2.879601 3.187843 3.187843
3.069777 2.944947 2.944947 2.944947 2.342215
2.812039 3.187843 3.129587 2.593375 2.248235 2.944947 2.944947 2.879601 2.342215
2.037468 2.342215 3.069777 2.742017 2.342215
2.593375 2.430483 2.879601 2.342215 2.342215 2.593375 2.513969 3.069777 2.430483
1.916020 2.248235 1.916020 2.342215 2.879601
2.513969 2.342215 3.069777 2.944947 1.916020 3.008280 2.342215 1.916020 1.916020
2.430483 2.669247 2.037468 2.342215 2.248235
1.916020

 1.26333613  0.40662493  0.51915488  0.86205609  0.05505326  0.55381389
0.86205609  0.12878129  0.55381389  0.80320681  0.21733092
 0.51915488 -0.29919543  0.48621197  0.18796113 -0.18784350 -0.30116006
0.05237624  0.39751622 -0.29919543 -0.11651962  0.12039870
 0.10727459  0.41202181  0.30353616 -0.06977654 -0.09626592  0.30353616 -
0.14388533  0.39794398 -0.05117417  0.30353616  0.10727459
 0.05237624 -0.06447935 -0.06977654 -0.43048315  0.08398044 -0.01216712
0.08398044 -0.34221515 -0.64353332 -0.27790112 -0.34221515
-0.83370856 -0.94494674  0.08398044 -1.00828010 -0.34221515 -0.18396875 -
0.18396875 -0.69843234 -0.93719572 -0.03746794 -0.61016434
-0.51618429 -0.18396875

Analysis of Variance Table
Response: BI
          Df Sum Sq Mean Sq F value    Pr(>F)
```

```
      EE   1  8.768  8.7680  39.155 6.158e-08 ***
Residuals 55 12.316  0.2239
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
            (Intercept)     EE
(Intercept)  0.07874377 -0.022488282
      EE    -0.02248828  0.006759631

$hat
0.02504289 0.01754702 0.03122213 0.02654722 0.03122213 0.05713844 0.02654722
0.05713844 0.05713844 0.04286016 0.03122213 0.03122213
0.03122213 0.02504289 0.02273784 0.05713844 0.04969589 0.01754702 0.03154712
0.03122213 0.03122213 0.02654722 0.02504289 0.05345959
0.02504289 0.04286016 0.01988854 0.02504289 0.01754702 0.02076869 0.02654722
0.02504289 0.02504289 0.01754702 0.01836143 0.04286016
0.02076869 0.07068762 0.03154712 0.07068762 0.02504289 0.02654722 0.01836143
0.02504289 0.04286016 0.03122213 0.07068762 0.03668257
0.02504289 0.07068762 0.07068762 0.02076869 0.01811250 0.05345959 0.02504289
0.03154712 0.07068762

$coefficients
     (Intercept)      EE
1   0.0875925694 -1.949576e-02
2   0.0076862122 -1.277573e-04
3  -0.0268249377  1.088911e-02
4  -0.0330329134  1.459914e-02
5  -0.0028446237  1.154725e-03
6  -0.0572523006  2.030663e-02
7  -0.0330329134  1.459914e-02
8  -0.0133131822  4.722010e-03
9  -0.0572523006  2.030663e-02
10 -0.0624549430  2.319830e-02
11 -0.0112295746  4.558449e-03
12 -0.0268249377  1.088911e-02
13  0.0154595461 -6.275532e-03
14  0.0337111836 -7.503206e-03
15 -0.0046377773  2.408303e-03
16  0.0194189289 -6.887637e-03
17  0.0272857312 -9.872863e-03
18  0.0009900398 -1.645607e-05
19  0.0352766978 -8.439079e-03
20  0.0154595461 -6.275532e-03
21  0.0060206146 -2.443963e-03
```

```
22 -0.0046135281  2.038982e-03
23  0.0074378125 -1.655458e-03
24  0.0553194056 -1.433268e-02
25  0.0210454777 -4.684159e-03
26  0.0054256136 -2.015293e-03
27  0.0010258664 -8.263110e-04
28  0.0210454777 -4.684159e-03
29 -0.0027197870  4.520727e-05
30  0.0204686726 -4.009536e-03
31  0.0019609304 -8.666475e-04
32  0.0210454777 -4.684159e-03
33  0.0074378125 -1.655458e-03
34  0.0009900398 -1.645607e-05
35 -0.0022379737  3.263139e-04
36  0.0054256136 -2.015293e-03
37 -0.0221423596  4.337389e-03
38  0.0136268948 -3.619485e-03
39 -0.0010797439  2.583021e-04
40  0.0136268948 -3.619485e-03
41 -0.0237272597  5.281052e-03
42  0.0246593935 -1.089840e-02
43 -0.0096454968  1.406388e-03
44 -0.0237272597  5.281052e-03
45  0.0648266676 -2.407926e-02
46  0.0488257717 -1.981997e-02
47  0.0136268948 -3.619485e-03
48  0.0653334539 -2.515778e-02
49 -0.0237272597  5.281052e-03
50 -0.0298512682  7.928894e-03
51 -0.0298512682  7.928894e-03
52 -0.0359246119  7.037146e-03
53 -0.0035892683 -3.954509e-03
54 -0.0050305685  1.303368e-03
55 -0.0423053386  9.416035e-03
56 -0.0458076334  1.095835e-02
57 -0.0298512682  7.928894e-03

$sigma
0.4447056 0.4743011 0.4721505 0.4625375 0.4775146 0.4712262 0.4625375 0.4772341
0.4712262 0.4643232 0.4766290 0.4721505 0.4757804
0.4728508 0.4768738 0.4768491 0.4757212 0.4775211 0.4744012 0.4757804 0.4773035
0.4772864 0.4773463 0.4740852 0.4757395 0.4774766
```

```
0.4773919 0.4757395 0.4771665 0.4744295 0.4775231 0.4757395 0.4773463 0.4775211
0.4774931 0.4774766 0.4738919 0.4774281 0.4775723
0.4774281 0.4752407 0.4692545 0.4760475 0.4752407 0.4632818 0.4593578 0.4774281
0.4566561 0.4752407 0.4768686 0.4768686 0.4678173
0.4599050 0.4775465 0.4701134 0.4722110 0.4768686

$wt.res
 1.26333613  0.40662493  0.51915488  0.86205609  0.05505326  0.55381389
0.86205609  0.12878129  0.55381389  0.80320681  0.21733092
 0.51915488 -0.29919543  0.48621197  0.18796113 -0.18784350 -0.30116006
0.05237624  0.39751622 -0.29919543 -0.11651962  0.12039870
 0.10727459  0.41202181  0.30353616 -0.06977654 -0.09626592  0.30353616 -
0.14388533  0.39794398 -0.05117417  0.30353616  0.10727459
 0.05237624 -0.06447935 -0.06977654 -0.43048315  0.08398044 -0.01216712
0.08398044 -0.34221515 -0.64353332 -0.27790112 -0.34221515
-0.83370856 -0.94494674  0.08398044 -1.00828010 -0.34221515 -0.18396875 -
0.18396875 -0.69843234 -0.93719572 -0.03746794 -0.61016434
-0.51618429 -0.18396875

****************************************************************

[1] "BI ~ FC Bivariate Regression Output"

Call:
lm(formula = BI ~ FC, data = all_results_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.98505 -0.38521 -0.05673  0.20715  1.40742

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   1.4452     0.3401   4.250 8.34e-05 ***
      FC      0.4445     0.1279   3.476    0.001 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5606 on 55 degrees of freedom
Multiple R-squared:  0.1801,    Adjusted R-squared:  0.1652
F-statistic: 12.08 on 1 and 55 DF,  p-value: 0.001002

(Intercept)    FC
   1.445212    0.444512
```

```
                2.5 %    97.5 %
(Intercept) 0.7637156 2.1267076
FC    0.1882122 0.7008118

               47.5 %    52.5 %
(Intercept) 1.4237900 1.4666332
FC    0.4364557 0.4525683

2.334236 2.621280 2.850882 2.621280 2.621280 2.334236 2.439171 3.166799 2.919491
3.047922 2.534039 2.621280 2.702481 2.621280
2.534039 2.985046 3.108423 2.621280 2.439171 2.439171 2.985046 2.534039 2.439171
2.215129 2.919491 3.166799 2.534039 2.439171
2.621280 2.778748 2.702481 2.534039 2.534039 2.534039 2.439171 3.166799 2.215129
2.215129 2.621280 2.334236 2.334236 2.534039
2.702481 2.334236 2.702481 2.702481 2.985046 2.850882 2.534039 2.334236 2.334236
2.439171 2.439171 2.439171 2.215129 2.534039
2.215129

 1.27131567  0.37872018  0.61321963  1.12037757  0.37872018  1.40742178
1.30248673  0.14982560  0.82216625  0.82506092  0.62823847
 0.84282180 -0.05673010  0.20714731  0.46596081  0.01495365 -0.27999610
0.02447150  0.20658066  0.20658066 -0.15661923  0.46596081
 0.01031909  0.23436077 -0.27373982 -0.16679919  0.11171212  0.20658066 -
0.17179007  0.04967951  0.12594572  0.11171212 -0.08454945
 0.11171212  0.01031909 -0.16679919 -0.21512897 -0.21512897 -0.38521184 -
0.33423560 -0.33423560 -0.29797121 -0.46641343 -0.33423560
-0.46641343 -0.70248141 -0.98504635 -0.85088198 -0.53403919 -0.60218479 -
0.60218479 -0.70711985 -0.70711985 -0.43917065 -0.48307816
-0.80198838 -0.48307816

Analysis of Variance Table
Response: BI
          Df  Sum Sq Mean Sq F value   Pr(>F)
FC   1  3.7971  3.7971  12.081 0.001002 **
Residuals 55 17.2872  0.3143
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

            (Intercept)    FC
(Intercept)  0.11564099 -0.04244115
      FC    -0.04244115  0.01635617
$hat
```

```
0.03595484 0.01767890 0.03430109 0.01767890 0.01767890 0.03595484 0.02424093
0.10255967 0.04465649 0.07070572 0.01864280 0.01767890
0.02038393 0.01767890 0.01864280 0.05686727 0.08598724 0.01767890 0.02424093
0.02424093 0.05686727 0.01864280 0.02424093 0.05627851
0.04465649 0.10255967 0.01864280 0.02424093 0.01767890 0.02608739 0.02038393
0.01864280 0.01864280 0.01864280 0.02424093 0.10255967
0.05627851 0.05627851 0.01767890 0.03595484 0.03595484 0.01864280 0.02038393
0.03595484 0.02038393 0.02038393 0.05686727 0.03430109
0.01864280 0.03595484 0.03595484 0.02424093 0.02424093 0.02424093 0.05627851
0.01864280 0.05627851

$coefficients
     (Intercept)      FC
1   0.1290513009 -4.081828e-02
2   0.0041118739  1.022008e-03
3  -0.0375161708  1.875148e-02
4   0.0121642614  3.023432e-03
5   0.0041118739  1.022008e-03
6   0.1428674372 -4.518825e-02
7   0.0880788182 -2.491916e-02
8  -0.0258845929  1.110428e-02
9  -0.0687804908  3.232556e-02
10 -0.1055948944  4.669743e-02
11  0.0237928483 -4.841102e-03
12  0.0091507586  2.274424e-03
13  0.0008108126 -7.040157e-04
14  0.0022490579  5.590042e-04
15  0.0176470168 -3.590617e-03
16 -0.0015829192  7.172325e-04
17  0.0420641881 -1.828208e-02
18  0.0002656941  6.603836e-05
19  0.0139697240 -3.952299e-03
20  0.0139697240 -3.952299e-03
21  0.0165789392 -7.512041e-03
22  0.0176470168 -3.590617e-03
23  0.0006978138 -1.974247e-04
24  0.0332873309 -1.114939e-02
25  0.0229004284 -1.076278e-02
26  0.0288170336 -1.236227e-02
27  0.0042307971 -8.608352e-04
28  0.0139697240 -3.952299e-03
29 -0.0018651742 -4.635897e-04
30 -0.0018959675  1.075564e-03
```

```
31 -0.0018000740  1.562976e-03
32  0.0042307971 -8.608352e-04
33 -0.0032020838  6.515241e-04
34  0.0042307971 -8.608352e-04
35  0.0006978138 -1.974247e-04
36  0.0288170336 -1.236227e-02
37 -0.0305557496  1.023446e-02
38 -0.0305557496  1.023446e-02
39 -0.0041823557 -1.039526e-03
40 -0.0339282683  1.073134e-02
41 -0.0339282683  1.073134e-02
42 -0.0112848611  2.296117e-03
43  0.0066661950 -5.788151e-03
44 -0.0339282683  1.073134e-02
45  0.0066661950 -5.788151e-03
46  0.0100401869 -8.717734e-03
47  0.1042721493 -4.724649e-02
48  0.0520561182 -2.601890e-02
49 -0.0202253031  4.115218e-03
50 -0.0611278007  1.933442e-02
51 -0.0611278007  1.933442e-02
52 -0.0478179767  1.352861e-02
53 -0.0478179767  1.352861e-02
54 -0.0296982926  8.402208e-03
55 -0.0686137968  2.298177e-02
56 -0.0303731606  6.179991e-03
57 -0.0686137968  2.298177e-02

$sigma
0.5376673 0.5634083 0.5593942 0.5444899 0.5634083 0.5311145 0.5365969 0.5653934
0.5541029 0.5536856 0.5591825 0.5538425 0.5657491
0.5650875 0.5621706 0.5657990 0.5643974 0.5657929 0.5650867 0.5650867 0.5653771
0.5621706 0.5658011 0.5648496 0.5645178 0.5652953
0.5655947 0.5650867 0.5653110 0.5657614 0.5655378 0.5655947 0.5656836 0.5655947
0.5658011 0.5652953 0.5649997 0.5649997 0.5633254
0.5639033 0.5639033 0.5643203 0.5621570 0.5639033 0.5621570 0.5574981 0.5487081
0.5533979 0.5610268 0.5596133 0.5596133 0.5573538
0.5573538 0.5625588 0.5617416 0.5549736 0.5617416

$wt.res
 1.27131567  0.37872018  0.61321963  1.12037757  0.37872018  1.40742178
1.30248673  0.14982560  0.82216625  0.82506092  0.62823847
```

```
 0.84282180 -0.05673010  0.20714731  0.46596081  0.01495365 -0.27999610
0.02447150  0.20658066  0.20658066 -0.15661923  0.46596081
 0.01031909  0.23436077 -0.27373982 -0.16679919  0.11171212  0.20658066 -
0.17179007  0.04967951  0.12594572  0.11171212 -0.08454945
 0.11171212  0.01031909 -0.16679919 -0.21512897 -0.21512897 -0.38521184 -
0.33423560 -0.33423560 -0.29797121 -0.46641343 -0.33423560
-0.46641343 -0.70248141 -0.98504635 -0.85088198 -0.53403919 -0.60218479 -
0.60218479 -0.70711985 -0.70711985 -0.43917065 -0.48307816
-0.80198838 -0.48307816

****************************************************************

[1] "BI ~ Multivariable Regression Output"

Call:
lm(formula = BI ~ PE + EE + FC, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.5247 -0.9536  0.0128  1.0128  5.6950 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -0.71011    0.83520  -0.850   0.3990    
PE           0.60660    0.09164   6.619 1.85e-08 ***
EE           0.16956    0.07633   2.221   0.0306 *  
FC           0.14816    0.10413   1.423   0.1606    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.968 on 53 degrees of freedom
Multiple R-squared:  0.6721,	Adjusted R-squared:  0.6535 
F-statistic: 36.21 on 3 and 53 DF,  p-value: 7.169e-13

(Intercept)          PE          EE          FC 
 -0.7101085   0.6065969   0.1695551   0.1481634 

                  2.5 %    97.5 %
(Intercept) -2.38531559 0.9650985
PE           0.42278993 0.7904038
EE           0.01645473 0.3226554
FC          -0.06068855 0.3570153
```

```
                 47.5 %     52.5 %
(Intercept) -0.7627301 -0.6574870
PE           0.6008231  0.6123706
EE           0.1647459  0.1743642
FC           0.1416029  0.1547238

 7.304954  5.225125 10.763569  8.936330  7.892691 13.585793 11.066390 14.002396
12.196549 12.153766  8.351124 12.745466  9.254048
 7.142847 10.438402  8.705131  8.225306  6.438319  8.496756  7.596364  9.846702
8.181569  4.420133  4.828335  7.735501  6.990721
 8.449056  6.846521  7.044916  8.821923  7.264703  6.388087  6.388087  7.503349
6.579034  7.597318  3.686765  3.445586  3.940308
 2.987153  5.485164  6.968376  5.203733  4.878567  5.953577  6.827661  4.172460
6.686946  4.568297  2.987153  2.987153  7.016076
 7.524741  3.911468  3.517210  5.005338  2.838989

 5.69504592  3.77487484  1.23643136  5.06367032  1.10730897  0.41420721
2.93360968 -3.00239643  1.80345087  2.84623420  1.64887551
-0.74546588 -2.25404814  0.85715259 -1.43840180  0.29486861 -0.22530626
0.56168113 -1.49675613 -0.59636424 -1.84670172  0.81843057
 1.57986681  1.17166507 -0.73550099  2.00927911 -1.44905617  0.15347938 -
1.04491573 -0.82192297  0.73529749  0.61191284 -0.38808716
-0.50334919 -0.57903388  1.40268226  0.31323540  0.55441384  1.05969194
1.01284730 -1.48516351 -1.96837572 -0.20373350 -0.87856665
-0.95357712 -2.82766071 -0.17245986 -2.68694571 -0.56829659  0.01284730
0.01284730 -4.01607568 -4.52474086  0.08853199 -0.51720954
-2.00533838  0.16101070

Analysis of Variance Table
Response: BI
          Df Sum Sq Mean Sq F value    Pr(>F)
PE         1 351.15  351.15 90.6419 4.556e-13 ***
EE         1  61.83   61.83 15.9594 0.0002009 ***
FC         1   7.84    7.84  2.0247 0.1606211
Residuals 53 205.32    3.87
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

             (Intercept)           PE           EE           FC
(Intercept)  0.697565687 -0.040703586 -0.004866619 -0.035379103
PE          -0.040703586  0.008397923 -0.003504302  0.002111910
EE          -0.004866619 -0.003504302  0.005826401 -0.004981113
FC          -0.035379103  0.002111910 -0.004981113  0.010842394
```

```
$hat
0.05116888 0.03346552 0.05413383 0.03163153 0.04626612 0.22568376 0.09364001
0.19080035 0.08210769 0.11002458 0.05400356 0.12385407
0.03312452 0.04639199 0.06377700 0.09550251 0.12137536 0.01892761 0.09825450
0.08047075 0.06299770 0.04160442 0.03601766 0.05562200
0.13180371 0.16934227 0.02902676 0.03727116 0.01816193 0.09327569 0.03540680
0.03112587 0.03112587 0.02208727 0.02491091 0.15162847
0.07881912 0.06290970 0.04995124 0.06378057 0.03398981 0.05545391 0.03489348
0.03693449 0.14008462 0.05933768 0.22850184 0.08192579
0.03341814 0.06378057 0.06378057 0.03118626 0.03097920 0.05061043 0.07071525
0.03455553 0.06837918

$coefficients
     (Intercept)            PE            EE            FC
1   0.1705524086  3.670218e-02 -2.048678e-02 -1.663892e-02
2   0.1944327528 -2.266108e-02  6.890182e-03 -3.745312e-03
3  -0.0750890381  8.476755e-03 -1.183341e-03  6.306489e-03
4  -0.0406597704  7.416364e-03  1.703236e-02 -1.765509e-02
5   0.0139110991 -4.437197e-03  7.628339e-03 -6.678688e-03
6  -0.0322069200  5.581668e-03  4.441260e-03 -7.695244e-03
7  -0.1020795168  2.912713e-02  7.154803e-03 -2.198765e-02
8   0.5181488761 -4.487807e-02  1.495987e-02 -5.680714e-02
9  -0.1613217600  1.096212e-02  5.737711e-03  5.943905e-03
10 -0.3129646933  2.711597e-02 -8.504422e-03  3.580053e-02
11  0.0184886129 -3.833182e-03  1.211659e-02 -1.395451e-02
12  0.0613230347 -1.150369e-02  5.668245e-04  1.183715e-03
13  0.0423460325 -2.468524e-03 -8.102182e-03  4.343990e-03
14  0.0103589873  5.017845e-03 -5.722086e-03  4.565234e-03
15  0.0444132486 -1.272282e-02 -4.998581e-04  4.999196e-03
16 -0.0091927677 -2.243576e-03  2.302204e-03  8.323172e-04
17  0.0088982022  1.809112e-03 -9.977605e-04 -2.279984e-03
18  0.0164711508 -8.397213e-04 -2.573105e-05  7.518951e-05
19  0.0007880136 -1.975222e-02  1.329885e-02 -3.988066e-03
20 -0.0196165418  3.185755e-03 -5.929016e-03  7.361029e-03
21  0.1077944144 -6.384543e-03  3.286751e-03 -1.839140e-02
22  0.0101309857 -1.105547e-03  4.652016e-03 -5.738804e-03
23  0.1177003992 -6.848672e-03 -2.887249e-04 -4.423608e-03
24  0.0903666196  2.208514e-03 -4.870470e-03 -4.155036e-03
25  0.0211832438 -6.576584e-03  9.750048e-03 -1.378665e-02
26 -0.0521581939 -2.404577e-02  7.039830e-03  2.874977e-02
27 -0.0057742363 -4.002967e-03 -2.290909e-03  5.377819e-03
28  0.0047490833  7.161530e-04 -6.049140e-04 -8.266715e-05
```

```
29 -0.0194361398 -7.460807e-04  1.010512e-03 -7.199397e-04
30  0.0262968969 -9.158800e-03  8.378286e-03 -9.500751e-03
31  0.0111388314 -3.460662e-03  3.571444e-03 -1.686962e-03
32  0.0196822460  1.812353e-03 -2.637219e-03  1.095813e-03
33 -0.0124828673 -1.149430e-03  1.672576e-03 -6.949861e-04
34 -0.0086927831 -1.196026e-03  2.925145e-04  8.117743e-04
35 -0.0224371016 -3.060067e-04 -7.011425e-05  2.158707e-03
36 -0.0530232980 -1.285177e-02  3.316312e-03  2.055256e-02
37  0.0337766523 -2.836402e-03  1.633511e-03 -3.443746e-03
38  0.0562682461 -9.767041e-04 -2.142010e-03 -1.865736e-03
39  0.0728529697 -4.853953e-03 -3.733415e-03  4.058964e-03
40  0.1043778318 -3.541400e-03 -4.329246e-03 -9.735883e-04
41 -0.0921462479  5.972276e-04  1.075467e-03  6.776325e-03
42 -0.0685141023  1.173285e-02 -1.512256e-02  1.627666e-02
43 -0.0088465801  9.188151e-04  2.164949e-04 -6.598051e-04
44 -0.0642618842  2.331939e-03 -1.870497e-04  4.518192e-03
45 -0.0469785115  1.525521e-02 -1.320810e-02  8.545115e-03
46 -0.0717328922  2.288241e-02 -2.132390e-02  1.215624e-02
47 -0.0052356464 -2.431464e-04  3.193909e-03 -4.803871e-03
48 -0.0434581259  2.807952e-02 -2.028418e-02  8.117867e-04
49 -0.0368549870  2.136405e-03  8.595442e-04 -5.856746e-05
50  0.0013239641 -4.492033e-05 -5.491364e-05 -1.234933e-05
51  0.0013239641 -4.492033e-05 -5.491364e-05 -1.234933e-05
52 -0.1182806713 -1.487204e-02  9.494796e-03  7.479556e-03
53 -0.1156359020 -4.080766e-03 -1.037282e-02  2.643650e-02
54  0.0070484649 -1.366257e-04 -4.371710e-04  1.080032e-04
55 -0.0559843111  4.139129e-03 -1.836645e-03  4.921053e-03
56 -0.1109881897  1.166003e-03  8.039442e-03 -4.009951e-03
57  0.0182530234 -6.599667e-04 -4.693913e-04 -6.392381e-04

$sigma
1.814153 1.914416 1.979249 1.854538 1.980855 1.986013 1.940595 1.932429 1.969865
1.942540 1.973130 1.984014 1.961493 1.983354
1.976363 1.986621 1.986806 1.985529 1.975027 1.985213 1.969395 1.983701 1.974517
1.980039 1.984068 1.963426 1.976594 1.986967
1.981697 1.983477 1.984372 1.985215 1.986333 1.985832 1.985421 1.975832 1.986570
1.985498 1.981358 1.981776 1.976006 1.967136
1.986878 1.983204 1.981962 1.945520 1.986899 1.948661 1.985468 1.987085 1.987085
1.904824 1.882075 1.987046 1.985692 1.966827
1.986951

$wt.res
```

```
 5.69504592  3.77487484  1.23643136  5.06367032  1.10730897  0.41420721
2.93360968 -3.00239643  1.80345087  2.84623420  1.64887551
-0.74546588 -2.25404814  0.85715259 -1.43840180  0.29486861 -0.22530626
0.56168113 -1.49675613 -0.59636424 -1.84670172  0.81843057
 1.57986681  1.17166507 -0.73550099  2.00927911 -1.44905617  0.15347938 -
1.04491573 -0.82192297  0.73529749  0.61191284 -0.38808716
-0.50334919 -0.57903388  1.40268226  0.31323540  0.55441384  1.05969194
1.01284730 -1.48516351 -1.96837572 -0.20373350 -0.87856665
-0.95357712 -2.82766071 -0.17245986 -2.68694571 -0.56829659  0.01284730
0.01284730 -4.01607568 -4.52474086  0.08853199 -0.51720954
-2.00533838  0.16101070

****************************************************************

[1] "BI ~ Multivariable Regression Output - CAP Students Only"

Call:
lm(formula = BI ~ PE + EE + FC, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max
-2.0467 -0.5880 -0.1396  0.2524  3.7210

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.72047    1.87058   0.385    0.707
PE           0.22350    0.34199   0.654    0.527
EE           0.01535    0.15501   0.099    0.923
FC           0.46746    0.35341   1.323    0.213

Residual standard error: 1.569 on 11 degrees of freedom
Multiple R-squared:  0.4029,    Adjusted R-squared:  0.2401
F-statistic: 2.474 on 3 and 11 DF,  p-value: 0.1161

(Intercept)          PE          EE          FC
 0.72046873  0.22350032  0.01534583  0.46746228

                 2.5 %    97.5 %
(Intercept) -3.3966588 4.8375962
PE          -0.5292155 0.9762161
EE          -0.3258232 0.3565149
FC          -0.3103858 1.2453103
```

```
                 47.5 %    52.5 %
(Intercept) 0.600466632 0.8404708
PE          0.201560880 0.2454398
EE          0.005401764 0.0252899
FC          0.444790311 0.4901343

5.279010 5.949511 6.254857 3.301741 4.994127 3.545702 4.277587 5.731127 5.630393
6.046702 3.545702 4.252011 3.139624 4.973665
3.078240

 3.720989522  0.050488558  1.745143265  0.698259482  0.005873175  0.454297521 -
0.277586774 -0.731126928 -0.630393270 -2.046702247
-0.545702479 -0.252010915 -0.139623528 -1.973665185 -0.078240196

Analysis of Variance Table
Response: BI
          Df  Sum Sq Mean Sq F value  Pr(>F)
PE         1  5.9016  5.9016  2.3983 0.14974
EE         1  8.0583  8.0583  3.2748 0.09773 .
FC         1  4.3053  4.3053  1.7496 0.21277
Residuals 11 27.0681  2.4607
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

            (Intercept)           PE           EE          FC
(Intercept)  3.49908427 -0.470231299  0.069076048 -0.26430031
PE          -0.47023130  0.116957435 -0.007353143 -0.01292465
EE           0.06907605 -0.007353143  0.024027301 -0.04275529
FC          -0.26430031 -0.012924654 -0.042755285  0.12489794

$hat
0.1095580 0.3988249 0.2588082 0.1983309 0.3442775 0.1676345 0.3616880 0.2680051
0.5873233 0.2417730 0.1676345 0.1381464 0.3888066
0.1610161 0.2081730

$coefficients
     (Intercept)            PE            EE            FC
1   0.0979216499 -0.0964597366 -4.544980e-03  0.1274562792
2  -0.0461780089  0.0100364346 -8.442147e-04  0.0012382083
3  -0.8332059808  0.1289583358  3.441846e-02  0.0029483739
4   0.2234673376  0.0164129959  5.439652e-05 -0.0443340817
5   0.0009157567 -0.0005254038 -3.328038e-04  0.0009427299
6   0.1857046983 -0.0185231250 -7.818108e-03  0.0027884057
```

```
7   0.0525102460 -0.0420514672 -6.857208e-03  0.0348545403
8   0.1119126255  0.0253171635  2.819344e-02 -0.0985150186
9  -0.4637996081  0.1478417895 -8.077114e-02  0.0536418042
10  0.3636302616 -0.0114805495 -7.388211e-02  0.0293428330
11 -0.2230686047  0.0222499898  9.391117e-03 -0.0033494347
12 -0.0204155245 -0.0015646037  7.287710e-03 -0.0097189590
13 -0.1279152474  0.0092836349 -9.619270e-03  0.0263047607
14  0.4058891941 -0.0979830424  6.059415e-02 -0.1034886590
15 -0.0442327468  0.0028344335 -3.014331e-04  0.0045104100

$sigma
1.073255 1.645109 1.515227 1.626650 1.645236 1.637685 1.641565 1.622893 1.615708
1.467766 1.634329 1.642997 1.644268 1.497503
1.645003

$wt.res
 3.720989522  0.050488558  1.745143265  0.698259482  0.005873175  0.454297521 -
0.277586774 -0.731126928 -0.630393270 -2.046702247
-0.545702479 -0.252010915 -0.139623528 -1.973665185 -0.078240196

*****************************************************************

[1] "BI ~ Multivariable Regression Output - NonCAP Students Only"

Call:
lm(formula = BI ~ PE + EE + FC, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max
-4.6021 -0.8721  0.1094  1.1230  5.7261

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.79819    1.20574  -0.662    0.512
PE           0.59715    0.11400   5.238 6.29e-06 ***
EE           0.20009    0.09359   2.138    0.039 *
FC           0.12498    0.11819   1.057    0.297
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.121 on 38 degrees of freedom
Multiple R-squared:  0.6268,    Adjusted R-squared:  0.5973
F-statistic: 21.27 on 3 and 38 DF,  p-value: 2.968e-08
```

```
(Intercept)          PE          EE          FC 
 -0.7981867   0.5971464   0.2000887   0.1249808 

                  2.5 %    97.5 %
(Intercept) -3.23907898 1.6427055
PE           0.36637221 0.8279206
EE           0.01062083 0.3895566
FC          -0.11428875 0.3642503

                47.5 %     52.5 %
(Intercept) -0.8742958 -0.7220777
PE           0.5899507  0.6043422
EE           0.1941809  0.2059965
FC           0.1175201  0.1324414

 9.049474  8.055269 14.035495  8.527435 12.832441  9.374543 10.515843  8.883382  
8.336108  4.757224  7.066707  6.801745  3.766140 
 7.133054  7.273910 12.191064  6.457679  8.327346  8.524315  8.696049  6.329579  
7.526992  3.890523  4.538140  2.890677  7.001833 
 7.602099 12.341280  9.874466  6.604776  7.663854  4.885325 10.818797 13.855000 
11.188098  7.051706  8.393095  7.805308  4.413159 
 6.329579  6.838861  7.551629 

 4.9505264  0.9447305 -3.0354954  1.4725649 -0.8324408 -2.3745431 -1.5158434  
0.1166183 -0.3361081  1.2427759  1.9332926  0.1982554 
 0.2338603 -2.1330536  5.7260897  2.8089364  0.5423205  0.6726536 -1.5243154 -
0.6960493 -0.3295790 -0.5269915  0.1094769 -0.5381397 
 0.1093231 -4.0018333 -4.6020995  1.6587205 -1.8744662 -0.6047756  1.3361462 -
0.8853246  1.1812025  0.1450002  2.8119023  0.9482938 
-1.3930952 -0.8053079  1.5868411  0.6704210 -2.8388612 -0.5516293 

Analysis of Variance Table
Response: BI
          Df  Sum Sq Mean Sq F value    Pr(>F)    
PE         1 228.159 228.159 50.7217 1.683e-08 ***
EE         1  53.877  53.877 11.9774  0.001346 ** 
FC         1   5.030   5.030  1.1182  0.296992    
Residuals 38 170.934   4.498                      
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

            (Intercept)          PE           EE           FC
```

```
(Intercept)  1.45380803 -0.080960126 -0.014886732 -0.057744821
PE          -0.08096013  0.012995243 -0.005154363  0.004032156
EE          -0.01488673 -0.005154363  0.008759535 -0.006626096
FC          -0.05774482  0.004032156 -0.006626096  0.013969620

$hat
0.03584057 0.06227530 0.22548599 0.06757742 0.13603926 0.03774848 0.06551292
0.12113191 0.14337265 0.09254124 0.19798268 0.05200536
0.13398932 0.07891566 0.06489449 0.12367514 0.03258449 0.05213133 0.03278118
0.10741470 0.04751973 0.02929334 0.27719665 0.06557075
0.12198491 0.04313506 0.03989200 0.09576366 0.06665818 0.03899680 0.17362758
0.06863720 0.05742284 0.24674461 0.09688933 0.06032283
0.11755096 0.10468053 0.07168863 0.04751973 0.11351326 0.15149132

$coefficients
    (Intercept)            PE            EE            FC
1   0.019053195 -1.119202e-04  0.0212082172 -0.0217188551
2   0.036669497 -6.997450e-03  0.0084320548 -0.0075517442
3   0.805496174 -6.217745e-02  0.0142914673 -0.0694929560
4   0.049331640 -7.822202e-03  0.0137346101 -0.0153268823
5   0.103662250 -1.557627e-02  0.0007682507  0.0003128406
6   0.030687818  6.694203e-04 -0.0113631723  0.0064096268
7   0.055374002 -1.442794e-02 -0.0003546498  0.0051474872
8  -0.003055604 -1.318426e-03  0.0013188828  0.0001650081
9   0.010748623  3.879034e-03 -0.0024294826 -0.0031511899
10  0.194673732 -1.116973e-03 -0.0082348380 -0.0063147885
11 -0.002232471 -3.283640e-02  0.0122052746  0.0260751832
12  0.014754075  6.937918e-04 -0.0011311507 -0.0002146094
13  0.049392196 -3.798397e-03  0.0014079719 -0.0035624828
14 -0.163362324  2.219709e-02 -0.0209374467  0.0232151592
15  0.400403705  3.251601e-02 -0.0311171892 -0.0198117272
16 -0.439887082  3.393122e-02 -0.0073830632  0.0406230541
17  0.039769672 -2.301333e-03 -0.0001240065 -0.0005756898
18  0.024515557 -2.701725e-03  0.0047896914 -0.0058417470
19 -0.036510412 -2.164663e-03 -0.0026931737  0.0069176479
20  0.015678116 -8.995191e-03  0.0090811916 -0.0091361195
21 -0.026197415 -4.584527e-04  0.0019847760 -0.0004093394
22 -0.025941595 -4.214500e-04  0.0005645497  0.0012702330
23  0.012710291 -4.076698e-05 -0.0026929940  0.0033507831
24 -0.074697167  4.228233e-03  0.0013236592  0.0008674000
25  0.023235723 -9.263933e-04 -0.0007465409 -0.0003388612
26 -0.281212968 -9.082289e-03  0.0144767530  0.0104523708
27 -0.274712285  6.068043e-03 -0.0114103277  0.0331617860
```

```
28 -0.216786957  1.192590e-02  0.0083232812  0.0064502157
29  0.128100775 -6.656145e-03  0.0025854842 -0.0197316046
30 -0.051559034  1.172527e-03  0.0002317846  0.0030639242
31 -0.030598262 -1.735411e-02  0.0063340398  0.0189394193
32 -0.130589969  5.937010e-03  0.0004735687  0.0064837405
33 -0.092867344  9.147328e-03 -0.0007932741  0.0067751956
34 -0.019309823  2.268094e-03  0.0019760281 -0.0028176214
35 -0.132661204  3.033009e-02  0.0077625501 -0.0213452380
36  0.045286512  5.157118e-03 -0.0084314923  0.0052324781
37 -0.031359368 -2.072825e-02  0.0170396810 -0.0049506886
38 -0.055831446  7.859810e-03 -0.0101779773  0.0123288410
39  0.243658741 -1.408244e-02 -0.0014108807 -0.0078832076
40  0.053290102  9.325727e-04 -0.0040373799  0.0008326677
41 -0.155542439  4.505459e-02 -0.0298951376  0.0074975048
42  0.004208604 -5.653272e-03  0.0092622231 -0.0114467190

$sigma
1.983138 2.143387 2.073233 2.134707 2.144330 2.112217 2.133864 2.149282 2.148550
2.138651 2.119877 2.149118 2.148982 2.118094
1.916290 2.092006 2.147467 2.146376 2.134222 2.145964 2.148662 2.147579 2.149275
2.147430 2.149293 2.041443 2.005899 2.130163
2.125579 2.146985 2.135753 2.144081 2.140052 2.149203 2.093611 2.143354 2.135507
2.144820 2.132257 2.146410 2.091441 2.147123

$wt.res
 4.9505264  0.9447305 -3.0354954  1.4725649 -0.8324408 -2.3745431 -1.5158434
0.1166183 -0.3361081  1.2427759  1.9332926  0.1982554
 0.2338603 -2.1330536  5.7260897  2.8089364  0.5423205  0.6726536 -1.5243154 -
0.6960493 -0.3295790 -0.5269915  0.1094769 -0.5381397
 0.1093231 -4.0018333 -4.6020995  1.6587205 -1.8744662 -0.6047756  1.3361462 -
0.8853246  1.1812025  0.1450002  2.8119023  0.9482938
-1.3930952 -0.8053079  1.5868411  0.6704210 -2.8388612 -0.5516293

****************************************************************

[1] "PE ~ Age Bivariate Regression Output"

Call:
lm(formula = PE ~ Age, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max
-4.0562 -2.8792 -0.0196  1.9804  9.0658
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  8.31254    1.77675   4.679 2.04e-05 ***
Age         -0.01221    0.05435  -0.225    0.823
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.434 on 53 degrees of freedom
Multiple R-squared:  0.0009509, Adjusted R-squared:  -0.0179
F-statistic: 0.05045 on 1 and 53 DF,  p-value: 0.8232

(Intercept)         Age
 8.31254211 -0.01220612

                 2.5 %     97.5 %
(Intercept)  4.7488324 11.8762518
Age         -0.1212093  0.0967971

                 47.5 %      52.5 %
(Intercept)  8.20059899  8.42448524
Age         -0.01563012 -0.00878211

8.056214 8.044008 8.044008 8.031801 8.031801 8.031801 8.031801 8.019595 8.019595
8.019595 8.019595 8.019595 8.019595 8.019595
8.019595 8.019595 8.019595 8.007389 7.995183 7.995183 7.982977 7.982977 7.982977
7.970771 7.970771 7.958565 7.958565 7.946359
7.946359 7.934153 7.934153 7.934153 7.934153 7.921946 7.909740 7.909740 7.909740
7.897534 7.897534 7.885328 7.885328 7.873122
7.860916 7.848710 7.848710 7.824297 7.799885 7.799885 7.787679 7.751061 7.726649
7.726649 7.714442 7.690030 7.629000

-4.056213691  4.955992424 -2.044007576 -1.031801461  0.968198539 -3.031801461 -
4.031801461 -0.019595345  0.980404655  1.980404655
 1.980404655 -4.019595345  0.980404655 -0.019595345  5.980404655 -3.019595345 -
3.019595345 -0.007389230  1.004816886  0.004816886
 1.017023001 -0.982976999 -1.982976999  8.029229116 -3.970770884  5.041435232 -
3.958564768  3.053641347  4.053641347  2.065847462
 1.065847462  9.065847462 -1.934152538  2.078053578 -0.909740307 -3.909740307 -
3.909740307  0.102465808  0.102465808 -0.885328076
-2.885328076 -2.873121961 -3.860915846  7.151290270 -2.848709730 -3.824297500 -
2.799885269 -0.799885269 -1.787679154  5.248939193
 2.273351423  1.273351423 -3.714442461  4.309969769 -2.628999654
```

```
Analysis of Variance Table
Response: PE
          Df Sum Sq Mean Sq F value Pr(>F)
Age        1   0.59   0.595  0.0504 0.8232
Residuals 53 625.11  11.795

            (Intercept)          Age
(Intercept)  3.15684141 -0.093221009
Age         -0.09322101  0.002953431

$hat
0.04612464 0.04108466 0.04108466 0.03654550 0.03654550 0.03654550 0.03654550
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715 0.02896961 0.02593287
0.02593287 0.02339695 0.02339695 0.02339695 0.02136184
0.02136184 0.01982754 0.01982754 0.01879405 0.01879405 0.01826137 0.01826137
0.01826137 0.01826137 0.01822950 0.01869844 0.01869844
0.01869844 0.01966819 0.01966819 0.02113875 0.02113875 0.02311012 0.02558231
0.02855530 0.02855530 0.03600372 0.04545537 0.04545537
0.05093242 0.07036841 0.08582980 0.08582980 0.09431170 0.11277795 0.16770775

$coefficients
     (Intercept)           Age
1  -0.4323519980  1.124828e-02
2   0.4846340327 -1.237704e-02
3  -0.1998783593  5.104681e-03
4  -0.0919575249  2.296500e-03
5   0.0862890243 -2.154938e-03
6  -0.2702040741  6.747938e-03
7  -0.3593273487  8.973658e-03
8  -0.0015790324  3.836005e-05
9   0.0790029802 -1.919250e-03
10  0.1595849928 -3.876860e-03
11  0.1595849928 -3.876860e-03
12 -0.3239070826  7.868801e-03
13  0.0790029802 -1.919250e-03
14 -0.0015790324  3.836005e-05
15  0.4819130431 -1.170730e-02
16 -0.2433250701  5.911191e-03
17 -0.2433250701  5.911191e-03
18 -0.0005331252  1.250703e-05
19  0.0641172627 -1.437143e-03
```

```
20  0.0003073650 -6.889370e-06
21  0.0564968000 -1.190055e-03
22 -0.0546055053  1.150217e-03
23 -0.1101566580  2.320353e-03
24  0.3802595575 -7.321304e-03
25 -0.1880533682  3.620674e-03
26  0.1977336468 -3.301805e-03
27 -0.1552616293  2.592597e-03
28  0.0950455008 -1.218532e-03
29  0.1261708001 -1.617574e-03
30  0.0476336812 -2.969920e-04
31  0.0245759860 -1.532292e-04
32  0.2090375480 -1.303331e-03
33 -0.0445970998  2.780591e-04
34  0.0311842950  2.312803e-04
35 -0.0063312121 -3.334438e-04
36 -0.0272092980 -1.433023e-03
37 -0.0272092980 -1.433023e-03
38 -0.0001123049  6.376632e-05
39 -0.0001123049  6.376632e-05
40  0.0081202737 -7.782615e-04
41  0.0264643744 -2.536393e-03
42  0.0496510954 -3.267224e-03
43  0.0982073396 -5.393827e-03
44 -0.2406419968  1.186452e-02
45  0.0958595123 -4.726221e-03
46  0.1923924933 -8.380597e-03
47  0.1886176645 -7.665430e-03
48  0.0538852406 -2.189899e-03
49  0.1360117021 -5.394159e-03
50 -0.5415825166  2.041088e-02
51 -0.2778399733  1.023502e-02
52 -0.1556239488  5.732846e-03
53  0.4906307784 -1.790664e-02
54 -0.6579309637  2.364287e-02
55  0.5526410152 -1.932834e-02

$sigma
3.419024 3.395415 3.455089 3.464127 3.464493 3.440633 3.420082 3.467192 3.464436
3.455932 3.455932 3.420566 3.464436 3.467192
3.363112 3.440957 3.440957 3.467193 3.464317 3.467193 3.464254 3.464448 3.456008
3.279418 3.422221 3.394520 3.422569 3.440737
```

```
3.420434 3.455116 3.463982 3.226679 3.456609 3.454973 3.464853 3.423720 3.423720
3.467163 3.467163 3.464971 3.443526 3.443679
3.424505 3.317987 3.443948 3.424860 3.444342 3.465333 3.457842 3.384004 3.451479
3.462270 3.424685 3.408634 3.444086

$wt.res
-4.056213691  4.955992424 -2.044007576 -1.031801461  0.968198539 -3.031801461 -
4.031801461 -0.019595345  0.980404655  1.980404655
 1.980404655 -4.019595345  0.980404655 -0.019595345  5.980404655 -3.019595345 -
3.019595345 -0.007389230  1.004816886  0.004816886
 1.017023001 -0.982976999 -1.982976999  8.029229116 -3.970770884  5.041435232 -
3.958564768  3.053641347  4.053641347  2.065847462
 1.065847462  9.065847462 -1.934152538  2.078053578 -0.909740307 -3.909740307 -
3.909740307  0.102465808  0.102465808 -0.885328076
-2.885328076 -2.873121961 -3.860915846  7.151290270 -2.848709730 -3.824297500 -
2.799885269 -0.799885269 -1.787679154  5.248939193
 2.273351423  1.273351423 -3.714442461  4.309969769 -2.628999654

****************************************************************

[1] "EE ~ Age Bivariate Regression Output"

Call:
lm(formula = EE ~ Age, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max
-8.3741 -4.0986 -0.5781  3.9627  8.6669

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 13.66009    2.64747   5.160 3.78e-06 ***
Age         -0.06124    0.08098  -0.756    0.453
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.117 on 53 degrees of freedom
Multiple R-squared:  0.01067,   Adjusted R-squared:  -0.007992
F-statistic: 0.5718 on 1 and 53 DF,  p-value: 0.4529

(Intercept)         Age
13.66008632 -0.06123545
```

```
                 2.5 %     97.5 %
(Intercept)  8.3499323 18.9702403
Age         -0.2236572  0.1011863

                 47.5 %      52.5 %
(Intercept) 13.49328395 13.82688869
Age         -0.06633744 -0.05613347

12.37414 12.31291 12.31291 12.25167 12.25167 12.25167 12.25167 12.19044 12.19044
12.19044 12.19044 12.19044 12.19044 12.19044
12.19044 12.19044 12.19044 12.12920 12.06796 12.06796 12.00673 12.00673 12.00673
11.94549 11.94549 11.88426 11.88426 11.82302
11.82302 11.76179 11.76179 11.76179 11.76179 11.70055 11.63932 11.63932 11.63932
11.57808 11.57808 11.51685 11.51685 11.45561
11.39437 11.33314 11.33314 11.21067 11.08820 11.08820 11.02696 10.84326 10.72078
10.72078 10.65955 10.53708 10.23090

-8.3741418  7.6870937 -4.3129063  7.7483291  2.7483291  4.7483291 -8.2516709
3.8095646  3.8095646  3.8095646 -4.1904354 -8.1904354
-0.1904354 -2.1904354  2.8095646 -4.1904354 -1.1904354 -4.1292000 -4.0679645
3.9320355 -1.0067291  2.9932709  3.9932709  4.0545064
-3.9454936  2.1157418 -7.8842582 -2.8230227  4.1769773  3.2382127 -2.7617873
8.2382127 -4.7617873  4.2994482 -6.6393163 -4.6393163
 6.3606837 -3.5780809 -0.5780809  3.4831546  6.4831546 -6.4556100  6.6056255
8.6668609 -7.3331391 -2.2106682 -3.0881973 -3.0881973
 7.9730382  7.1567446  2.2792155 -2.7207845 -6.6595491 -3.5370782 -0.2309009

Analysis of Variance Table
Response: EE
          Df  Sum Sq Mean Sq F value Pr(>F)
Age        1   14.97  14.975  0.5718 0.4529
Residuals 53 1387.93  26.187

            (Intercept)          Age
(Intercept)   7.0091017 -0.206977624
Age          -0.2069776  0.006557471

$hat
0.04612464 0.04108466 0.04108466 0.03654550 0.03654550 0.03654550 0.03654550
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715 0.02896961 0.02593287
0.02593287 0.02339695 0.02339695 0.02339695 0.02136184
```

```
0.02136184 0.01982754 0.01982754 0.01879405 0.01879405 0.01826137 0.01826137
0.01826137 0.01826137 0.01822950 0.01869844 0.01869844
0.01869844 0.01966819 0.01966819 0.02113875 0.02113875 0.02311012 0.02558231
0.02855530 0.02855530 0.03600372 0.04545537 0.04545537
0.05093242 0.07036841 0.08582980 0.08582980 0.09431170 0.11277795 0.16770775

$coefficients
     (Intercept)           Age
1  -0.8926001466  0.0232223126
2   0.7517015527 -0.0191976606
3  -0.4217482621  0.0107710034
4   0.6905564633 -0.0172456041
5   0.2449400903 -0.0061170086
6   0.4231866395 -0.0105684468
7  -0.7354159302  0.0183659015
8   0.3069823799 -0.0074576425
9   0.3069823799 -0.0074576425
10  0.3069823799 -0.0074576425
11 -0.3376737207  0.0082032392
12 -0.6600017710  0.0160336800
13 -0.0153456704  0.0003727983
14 -0.1765096955  0.0042880188
15  0.2264003674 -0.0055000323
16 -0.3376737207  0.0082032392
17 -0.0959276829  0.0023304086
18 -0.2979174388  0.0069890951
19 -0.2595764003  0.0058182229
20  0.2509027816 -0.0056238098
21 -0.0559249603  0.0011780098
22  0.1662796503 -0.0035025338
23  0.2218308030 -0.0046726696
24  0.1920190321 -0.0036970266
25 -0.1868562517  0.0035976253
26  0.0829829860 -0.0013856704
27 -0.3092339875  0.0051636656
28 -0.0878674267  0.0011265055
29  0.1300096683 -0.0016667906
30  0.0746657226 -0.0004655345
31 -0.0636804489  0.0003970422
32  0.1899541989 -0.0011843484
33 -0.1097958394  0.0006845678
34  0.0645196363  0.0004785140
35 -0.0462054057 -0.0024334847
```

```
36 -0.0322866817 -0.0017004319
37  0.0442662999  0.0023313585
38  0.0039216580 -0.0022267041
39  0.0006335898 -0.0003597501
40 -0.0319476690  0.0030619216
41 -0.0594638201  0.0056991187
42  0.1115609123 -0.0073411172
43 -0.1680225443  0.0092282771
44 -0.2916411779  0.0143789662
45  0.2467612367 -0.0121662225
46  0.1112141411 -0.0048444763
47  0.2080401515 -0.0084547612
48  0.2080401515 -0.0084547612
49 -0.6066113668  0.0240579161
50 -0.7384287724  0.0278295256
51 -0.2785566523  0.0102614187
52  0.3325234704 -0.0122494384
53  0.8796420424 -0.0321044572
54  0.5399465382 -0.0194030809
55  0.0485375928 -0.0016975779

$sigma
5.027649 5.050345 5.130107 5.049030 5.151726 5.122598 5.033086 5.138343 5.138343
5.138343 5.132447 5.035637 5.166268 5.157099
5.151130 5.132447 5.163611 5.133553 5.134621 5.136711 5.164406 5.149234 5.135858
5.134979 5.136647 5.157831 5.046925 5.151199
5.133137 5.146420 5.151857 5.036031 5.123171 5.131175 5.082046 5.125353 5.089025
5.141974 5.165703 5.143218 5.085793 5.086319
5.082312 5.020366 5.062264 5.156894 5.147709 5.147709 5.040134 5.062757 5.155750
5.151244 5.074382 5.140026 5.166218

$wt.res
-8.3741418  7.6870937 -4.3129063  7.7483291  2.7483291  4.7483291 -8.2516709
3.8095646  3.8095646  3.8095646 -4.1904354 -8.1904354
-0.1904354 -2.1904354  2.8095646 -4.1904354 -1.1904354 -4.1292000 -4.0679645
3.9320355 -1.0067291  2.9932709  3.9932709  4.0545064
-3.9454936  2.1157418 -7.8842582 -2.8230227  4.1769773  3.2382127 -2.7617873
8.2382127 -4.7617873  4.2994482 -6.6393163 -4.6393163
 6.3606837 -3.5780809 -0.5780809  3.4831546  6.4831546 -6.4556100  6.6056255
8.6668609 -7.3331391 -2.2106682 -3.0881973 -3.0881973
 7.9730382  7.1567446  2.2792155 -2.7207845 -6.6595491 -3.5370782 -0.2309009

****************************************************************
```

```
[1] "FC ~ Age Bivariate Regression Output"

Call:
lm(formula = FC ~ Age, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.5920 -2.2199 -0.7333  1.2380  7.6942 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)   
(Intercept)  5.30216    1.71476   3.092  0.00317 **
Age          0.05725    0.05245   1.091  0.28000   
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.315 on 53 degrees of freedom
Multiple R-squared:  0.02198,   Adjusted R-squared:  0.00353 
F-statistic: 1.191 on 1 and 53 DF,  p-value: 0.28

(Intercept)         Age 
 5.30216168  0.05724718 

                  2.5 %    97.5 %
(Intercept)  1.86278064 8.7415427
Age         -0.04795319 0.1624476

                47.5 %     52.5 %
(Intercept) 5.19412396 5.41019940
Age         0.05394263 0.06055173

6.504352 6.561600 6.561600 6.618847 6.618847 6.618847 6.618847 6.676094 6.676094
6.676094 6.676094 6.676094 6.676094 6.676094
6.676094 6.676094 6.676094 6.733341 6.790588 6.790588 6.847836 6.847836 6.847836
6.905083 6.905083 6.962330 6.962330 7.019577
7.019577 7.076824 7.076824 7.076824 7.076824 7.134071 7.191319 7.191319 7.191319
7.248566 7.248566 7.305813 7.305813 7.363060
7.420307 7.477555 7.477555 7.592049 7.706543 7.706543 7.763790 7.935532 8.050026
8.050026 8.107274 8.221768 8.508004

-2.50435250  4.43840032 -2.56159968  5.38115314 -0.61884686  3.38115314 -
3.61884686  0.32390596 -0.67609404  1.32390596 -2.67609404
```

```
 5.32390596 -1.67609404 -1.67609404 -1.67609404 -1.67609404  0.32390596 -
0.73334122  0.20941159 -1.79058841 -0.84783559  1.15216441
 1.15216441  0.09491723 -3.90508277 -0.96232995 -2.96232995  1.98042287
2.98042287 -0.07682432 -2.07682432 -3.07682432 -1.07682432
 4.86592850 -4.19131868 -0.19131868  0.80868132 -1.24856586 -0.24856586 -
1.30581304  7.69418696 -2.36306022  7.57969259  7.52244541
-4.47755459 -4.59204895 -1.70654332 -3.70654332  6.23620950  5.06446796 -
2.05002641  2.94997359 -4.10727359 -3.22176795 -0.50800386

Analysis of Variance Table
Response: FC
          Df Sum Sq Mean Sq F value Pr(>F)
Age        1  13.09  13.088  1.1913   0.28
Residuals 53 582.26  10.986

            (Intercept)         Age
(Intercept)  2.94041560 -0.08682999
Age         -0.08682999  0.00275095

$hat
0.04612464 0.04108466 0.04108466 0.03654550 0.03654550 0.03654550 0.03654550
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715 0.02896961 0.02593287
0.02593287 0.02339695 0.02339695 0.02339695 0.02136184
0.02136184 0.01982754 0.01982754 0.01879405 0.01879405 0.01826137 0.01826137
0.01826137 0.01826137 0.01822950 0.01869844 0.01869844
0.01869844 0.01966819 0.01966819 0.02113875 0.02113875 0.02311012 0.02558231
0.02855530 0.02855530 0.03600372 0.04545537 0.04545537
0.05093242 0.07036841 0.08582980 0.08582980 0.09431170 0.11277795 0.16770775

$coefficients
     (Intercept)           Age
1  -0.2669390443  6.944814e-03
2   0.4340200029 -1.108441e-02
3  -0.2504923891  6.397310e-03
4   0.4795859888 -1.197694e-02
5  -0.0551536588  1.377379e-03
6   0.3013394396 -7.525497e-03
7  -0.3225234825  8.054537e-03
8   0.0261009939 -6.340816e-04
9  -0.0544810187  1.323529e-03
10  0.1066830065 -2.591692e-03
11 -0.2156450438  5.238749e-03
```

```
12  0.4290110568 -1.042213e-02
13 -0.1350630313  3.281139e-03
14 -0.1350630313  3.281139e-03
15 -0.1350630313  3.281139e-03
16 -0.1350630313  3.281139e-03
17  0.0261009939 -6.340816e-04
18 -0.0529097987  1.241255e-03
19  0.0133625324 -2.995118e-04
20 -0.1142572631  2.560996e-03
21 -0.0470982442  9.920829e-04
22  0.0640040611 -1.348189e-03
23  0.0640040611 -1.348189e-03
24  0.0044952240 -8.654852e-05
25 -0.1849424178  3.560777e-03
26 -0.0377442141  6.302622e-04
27 -0.1161876088  1.940129e-03
28  0.0616412544 -7.902725e-04
29  0.0927665537 -1.189315e-03
30 -0.0017713917  1.104448e-05
31 -0.0478867822  2.985700e-04
32 -0.0709444774  4.423328e-04
33 -0.0248290869  1.548073e-04
34  0.0730205186  5.415613e-04
35 -0.0291689038 -1.536229e-03
36 -0.0013314559 -7.012335e-05
37  0.0056279060  2.964031e-04
38  0.0013684566 -7.770050e-04
39  0.0002724338 -1.546870e-04
40  0.0119769830 -1.147895e-03
41 -0.0705714703  6.763696e-03
42  0.0408365987 -2.687198e-03
43 -0.1927991892  1.058908e-02
44 -0.2531314233  1.248030e-02
45  0.1506703876 -7.428596e-03
46  0.2310164801 -1.006305e-02
47  0.1149633587 -4.672116e-03
48  0.2496957826 -1.014765e-02
49 -0.4744685125  1.881719e-02
50 -0.5225488810  1.969355e-02
51  0.2505460776 -9.229570e-03
52 -0.3605340451  1.328129e-02
53  0.5425187921 -1.980041e-02
54  0.4918134017 -1.767341e-02
```

```
55  0.1067872979 -3.734832e-03

$sigma
3.327284 3.286670 3.326510 3.258724 3.345089 3.311959 3.306942 3.345920 3.344873
3.341022 3.324893 3.260962 3.337877 3.337877
3.337877 3.337877 3.345920 3.344639 3.346102 3.336760 3.344116 3.342323 3.342323
3.346205 3.301151 3.343515 3.320405 3.334726
3.320115 3.346214 3.333583 3.318407 3.342836 3.276199 3.294389 3.346124 3.344316
3.341659 3.346050 3.341222 3.167682 3.329765
3.172289 3.174439 3.286394 3.282773 3.337453 3.304615 3.226335 3.265988 3.332995
3.318765 3.292273 3.312443 3.345340

$wt.res
-2.50435250  4.43840032 -2.56159968  5.38115314 -0.61884686  3.38115314 -
3.61884686  0.32390596 -0.67609404  1.32390596 -2.67609404
 5.32390596 -1.67609404 -1.67609404 -1.67609404 -1.67609404  0.32390596 -
0.73334122  0.20941159 -1.79058841 -0.84783559  1.15216441
 1.15216441  0.09491723 -3.90508277 -0.96232995 -2.96232995  1.98042287
2.98042287 -0.07682432 -2.07682432 -3.07682432 -1.07682432
 4.86592850 -4.19131868 -0.19131868  0.80868132 -1.24856586 -0.24856586 -
1.30581304  7.69418696 -2.36306022  7.57969259  7.52244541
-4.47755459 -4.59204895 -1.70654332 -3.70654332  6.23620950  5.06446796 -
2.05002641  2.94997359 -4.10727359 -3.22176795 -0.50800386

*****************************************************************

[1] "BI ~ Age Bivariate Regression Output"

Call:
lm(formula = BI ~ Age, data = all_results_data)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.4681 -2.8313 -0.3885  1.5717  8.4473 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  8.38353    1.76916   4.739 1.65e-05 ***
Age         -0.03980    0.05411  -0.736    0.465    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.42 on 53 degrees of freedom
```

```
Multiple R-squared:  0.0101,    Adjusted R-squared:  -0.008573 
F-statistic: 0.541 on 1 and 53 DF,  p-value: 0.4653

(Intercept)         Age 
 8.38352971 -0.03980077 

                 2.5 %      97.5 %
(Intercept)  4.8350488 11.93201066
Age         -0.1483382  0.06873665

                 47.5 %      52.5 %
(Intercept)  8.27206495  8.49499447
Age         -0.04321014 -0.03639139

7.547714 7.507913 7.507913 7.468112 7.468112 7.468112 7.468112 7.428311 7.428311 
7.428311 7.428311 7.428311 7.428311 7.428311 
7.428311 7.428311 7.428311 7.388510 7.348710 7.348710 7.308909 7.308909 7.308909 
7.269108 7.269108 7.229307 7.229307 7.189507 
7.189507 7.149706 7.149706 7.149706 7.149706 7.109905 7.070104 7.070104 7.070104 
7.030304 7.030304 6.990503 6.990503 6.950702 
6.910901 6.871101 6.871101 6.791499 6.711897 6.711897 6.672097 6.552694 6.473093 
6.473093 6.433292 6.353691 6.154687 

-3.5477136  6.4920872 -3.5079128  1.5318880  1.5318880 -3.4681120 -4.4681120  
1.5716887  2.5716887 -0.4283113  5.5716887 -3.4283113 
-4.4283113 -1.4283113  6.5716887 -1.4283113  1.5716887 -0.3885105  0.6512903 -
0.3487097 -0.3089090  0.6910910 -3.3089090  4.7308918 
-4.2691082  1.7706926 -4.2293074  0.8104933  4.8104933  6.8502941 -4.1497059  
6.8502941 -4.1497059  0.8900949 -1.0701044 -2.0701044 
-2.0701044 -1.0303036 -1.0303036 -1.9905028  2.0094972 -2.9507020  2.0890987  
4.1288995 -2.8711005 -2.7914990 -2.7118974 -2.7118974 
 1.3279033  8.4473056  0.5269072  0.5269072 -3.4332921  0.6463095 -1.1546867 

Analysis of Variance Table
Response: BI
          Df Sum Sq Mean Sq F value Pr(>F)
Age        1   6.33  6.3262   0.541 0.4653
Residuals 53 619.78 11.6940               

            (Intercept)          Age
(Intercept)  3.12991893 -0.092425993
Age         -0.09242599  0.002928243
```

```
$hat
0.04612464 0.04108466 0.04108466 0.03654550 0.03654550 0.03654550 0.03654550
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715
0.03250715 0.03250715 0.03250715 0.03250715 0.03250715 0.02896961 0.02593287
0.02593287 0.02339695 0.02339695 0.02339695 0.02136184
0.02136184 0.01982754 0.01982754 0.01879405 0.01879405 0.01826137 0.01826137
0.01826137 0.01826137 0.01822950 0.01869844 0.01869844
0.01869844 0.01966819 0.01966819 0.02113875 0.02113875 0.02311012 0.02558231
0.02855530 0.02855530 0.03600372 0.04545537 0.04545537
0.05093242 0.07036841 0.08582980 0.08582980 0.09431170 0.11277795 0.16770775

$coefficients
    (Intercept)           Age
1  -0.378150948  9.838156e-03
2   0.634844876 -1.621326e-02
3  -0.343029969  8.760622e-03
4   0.136526872 -3.409552e-03
5   0.136526872 -3.409552e-03
6  -0.309089501  7.719043e-03
7  -0.398212776  9.944762e-03
8   0.126649841 -3.076754e-03
9   0.207231854 -5.034364e-03
10 -0.034514184  8.384665e-04
11  0.448977892 -1.090719e-02
12 -0.276260222  6.711297e-03
13 -0.356842234  8.668907e-03
14 -0.115096197  2.796077e-03
15  0.529559904 -1.286480e-02
16 -0.115096197  2.796077e-03
17  0.126649841 -3.076754e-03
18 -0.028030624  6.575939e-04
19  0.041558766 -9.315106e-04
20 -0.022251132  4.987435e-04
21 -0.017160249  3.614655e-04
22  0.038390904 -8.086704e-04
23 -0.183813707  3.871873e-03
24  0.224052247 -4.313776e-03
25 -0.202182447  3.892707e-03
26  0.069449568 -1.159686e-03
27 -0.165880616  2.769916e-03
28  0.025226848 -3.234211e-04
29  0.149728045 -1.919590e-03
30  0.157951994 -9.848173e-04
```

```
31 -0.095682654  5.965733e-04
32  0.157951994 -9.848173e-04
33 -0.095682654  5.965733e-04
34  0.013357202  9.906454e-05
35 -0.007447244 -3.922215e-04
36 -0.014406605 -7.587479e-04
37 -0.014406605 -7.587479e-04
38  0.001129236 -6.411765e-04
39  0.001129236 -6.411765e-04
40  0.018256992 -1.749783e-03
41 -0.018431209  1.766480e-03
42  0.050991775 -3.355446e-03
43 -0.053138902  2.918540e-03
44 -0.138938091  6.850151e-03
45  0.096612965 -4.763369e-03
46  0.140434537 -6.117314e-03
47  0.182690257 -7.424540e-03
48  0.182690257 -7.424540e-03
49 -0.101030653  4.006827e-03
50 -0.871588121  3.284797e-02
51 -0.064396500  2.372226e-03
52 -0.064396500  2.372226e-03
53  0.453494372 -1.655127e-02
54 -0.098661254  3.545411e-03
55  0.242726246 -8.489229e-03

$sigma
3.415429 3.327710 3.416449 3.445586 3.445586 3.417430 3.394174 3.445258 3.433285
3.451848 3.361822 3.418374 3.395455 3.446499
3.325729 3.446499 3.445258 3.451943 3.451163 3.452029 3.452104 3.451014 3.421009
3.388082 3.400113 3.443456 3.401171 3.450511
3.386054 3.316577 3.403173 3.316577 3.403173 3.450128 3.449125 3.440192 3.440192
3.449359 3.449359 3.441085 3.440868 3.427464
3.439879 3.403149 3.428661 3.429789 3.430851 3.430851 3.447198 3.231529 3.451530
3.451530 3.415935 3.451065 3.447912

$wt.res
-3.5477136  6.4920872 -3.5079128  1.5318880  1.5318880 -3.4681120 -4.4681120
1.5716887  2.5716887 -0.4283113  5.5716887 -3.4283113
-4.4283113 -1.4283113  6.5716887 -1.4283113  1.5716887 -0.3885105  0.6512903 -
0.3487097 -0.3089090  0.6910910 -3.3089090  4.7308918
-4.2691082  1.7706926 -4.2293074  0.8104933  4.8104933  6.8502941 -4.1497059
6.8502941 -4.1497059  0.8900949 -1.0701044 -2.0701044
```

```
-2.0701044 -1.0303036 -1.0303036 -1.9905028  2.0094972 -2.9507020  2.0890987
4.1288995 -2.8711005 -2.7914990 -2.7118974 -2.7118974
 1.3279033  8.4473056  0.5269072  0.5269072 -3.4332921  0.6463095 -1.1546867
```