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ONLINE RETIREMENT PLANNING TRAINING: THE EFFECTS OF USABILITY
ON COGNITIVE LOAD AND RETIREMENT PLANNING ACTIVITY LEVELS

By

Natasha J. Hardy

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In Applied Cognitive Science and Human Factors

MICHIGAN TECHNOLOGICAL UNIVERSITY

2021

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This dissertation has been approved in partial fulfillment of the requirements for the Degree of DOCTOR OF PHILOSOPHY in Applied Cognitive Science and Human Factors.

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Dedication

To my husband, Alex, you always believed in me.

To my advisor, Kelly, I couldn't have done it without you.

Abstract

The shift from defined benefit to defined contribution retirement plans for the current generation of retiree planners, Generation X, has placed the onus on individuals to gather, comprehend, and utilize complex financial information in order to plan their own retirement. Low savings rates and retirement planning activity indicate that individuals are not up to the challenge. This research investigates the interplay of three facets of cognitive load, usability, tech and retirement anxiety and the effects of a usability intervention on retirement planning activity levels.

Study 1 used semi-structured interviews and cognitive task analysis to explore themes of computer and retirement anxiety among Gen X aged adults. Structural coding and clustering analysis indicated a wide disparity in computer skills, and a general trend to learn computer skills in response to a specific need (e.g., work requirements, desire to learn a new skill). With regards to retirement planning, strong themes emerged regarding difficulty making appropriate goals and finding trusted information to advise decision-making.

Study 2 introduced a usability training intervention to improve financial knowledge and goal setting. The expectation was that high usability would support learning and minimize the effects of any tech and retirement anxiety, thus improving retirement planning outcomes. Results showed that higher levels of financial knowledge are associated with decreased intrinsic cognitive load while financial anxiety has a positive impact on germane cognitive load (e.g., schema

development). Conversely, tech anxiety detracts from schema development and increases likelihood that individuals will be distracted by extraneous or distracting elements in a digital training. Overall, financial knowledge and tech anxiety impacted financial planning outcomes, while the usability manipulation did not have the expected effect. Implications for policy and institutional support are discussed as well as the need for more research utilizing usability manipulations.

Keywords: Gen X, Retirement, Planning, Retirement Anxiety, Tech Anxiety, Cognitive Load, Usability

CHAPTER 1. INTRODUCTION

It may seem dramatic to say that there is a retirement savings crisis but, by nearly any measure of retirement savings success, Americans are falling woefully short. For instance, approximately 50% of working-age households in the United States will be unable to sustain their lifestyle in retirement due to inadequate savings (Munnell, Hou, & Sanzenbacher, 2018). Even for those who have access to employer-sponsored retirement plans, participation rates hover around 50% (Quinby, Munnell, Hou, Belbase, & Sanzenbacher, 2020). More disturbing is the fact that less than half of working age individuals have even attempted to calculate how much money they will need to live comfortably in retirement, according to the long-running Retirement Confidence Survey (2020). This is reflected in poor savings rates, with 17% of individuals aged 45-59 having no retirement savings (Federal Reserve, 2019).

Part of this crisis can be attributed to the decline of defined benefit plans (e.g., pensions) and the rise of defined contribution plans (e.g., 401(k), 403(b)). Between 1975 and 2018, the number of defined benefit plans provided by employers declined by 55% while the number of defined contribution plans increased by 224% (Employee Benefits Security Administration, 2021). This shift translates into an increased need for individuals to gather, comprehend, and utilize complex financial information in order to make their own retirement decisions (Medill, 2000). As Nobel Laureate professor of finance Robert C. Merton stated, “Finding and executing a dynamic portfolio strategy to [provide the required standard of living at the age of 65] is an extremely complex problem to solve, even for the best financial minds.

Yet...the financial services industry is asking employees of all sorts – from brain surgeons, to teachers, to assembly line workers – to solve just such a problem.” (Merton, 2017).

At this time, the generation that is bearing the brunt of the transition to defined contribution plans is the age cohort referred to as Gen X. Gen Xers were born between 1965 and 1980 and are currently 40 to 55 years old. Throughout their youth, Gen X has been at the epicenter of a shift in their economic well-being. In their seminal work, Strauss & Howe (1991) summarize these circumstances, “13ers [Gen X] see no welcome mat on their economic future: Since the mid-1970s, while the costs of setting out in life (college tuitions and housing) have raced ahead of inflation, the rewards (salaries and fringe benefits for young workers) have steadily fallen behind.” In addition, Gen X has been impacted by a shift in federal U.S. Treasury debt, which resulted in young Gen X couples paying five times as much in taxes as the generation before them (Strauss & Howe, 1991). All of these institutional factors, combined with the decline of guaranteed retirement income via pension plans and annuities (Collinson, 2015) and the rise of self-managed defined contribution plans, have created a perfect storm. The result? Little planning, early withdrawals, and low contribution rates for Gen X (Collinson, 2015).

There is no lack of intrapersonal culprits for these dismaying findings, either. Retirement research has found blame across a multitude of psychological and demographic variables including future time perspective, retirement goal clarity, financial knowledge (Hershey, Jacobs-Lawson, McArdle, Hamagami, 2007), risk tolerance (Jacobs-Lawson & Hershey, 2005), financial literacy (Lusardi, Michaud, &

Mitchell, 2011), income, age (Stawski, Hershey, & Jacobs-Lawson, 2007), and gender (Jacobs-Lawson, Hershey, Neukam, 2004).

What has received less attention in the literature is the role that developing technology plays in retirement planning. For example, financial planners now rely on specialized software to aid in developing and presenting retirement plans to their clients (Bi, Finke, & Huston, 2017). More and more digital tools, such as calculators and simulators, educational content, and money management apps, are available for individual use (Bi, Finke, & Huston, 2017; Casas, 2010). This is a particularly interesting challenge as it pertains to Gen X. They grew up during a pivotal shift in how we take in and share information. In 1983, for example, learning new information on a specific topic might involve a dip into Encyclopedia Britannica and a trip to the library, where research involved a card catalogue, print books, and microfiche. Some thirty years later, that same person can sit down at a computer, open Google, type in a few key words, and see literally millions of results. The exponential acceleration of technology and information availability is truly astounding (see Figure 1).

Figure 1. Exponential growth of information availability

The ease of accessing information does not alter the fact that we have a limited information-processing capability (Kahneman, Slovic, Slovic, & Tversky,

1982). And while software and other tools have the potential to mediate the gap in retirement knowledge for individuals, that potential is affected by adoption, access, and use (Bi, Finke, & Huston, 2017) as well as computer experience and anxiety (Mahar, Henderson, & Deane, 1997).

While more experience with computers leads to less computer anxiety and promotes willingness toward using computers (Dyck & Al Awar-Smith, 1994), research has also shown that perceived usefulness and perceived ease of use both play an important role in determining whether people are willing to use technology in general (Lee & Coughlin, 2015) as well as for retirement planning (Casas, 2010). These factors are both components of usability – how well someone can use a tool to accomplish their goals (Nielsen, 1994). With the explosion of online information and tools now available to aid pre-retirees, the question remains whether improving retirement planning tool usability can help overcome computer anxieties and improve retirement planning outcomes.

Lastly, in the field of financial planning, Kiso & Hershey (2016) found that over 40% of individuals rate themselves as having moderate to severe difficulty when thinking about financial planning for retirement. In addition, research has shown that pre-retirees are more likely to have financial worry (Skarborn & Nicki, 2000) than retirees and that financial worry has been found to affect level of retirement savings contributions (Neukam & Hershey, 2003).

The current research seeks to add to this body of literature by investigating the interplay of retirement planning anxiety, computer anxiety, usability, and cognitive load on retirement planning activity levels. In the following literature

review (Chapter 2), I present related work on cognitive load and, within that context, retirement anxiety and technology anxiety as well as learning and design interventions to mitigate cognitive load. These concepts are then presented in a unified theoretical model. In Chapter 3, I present Experiment 1, an exploratory interview study designed to understand how Gen Xers think about and plan for retirement, and how they understand and utilize computers. Experiment 2 (Chapter 4) builds on the concepts of Experiment 1 with an experimental manipulation on how retirement anxiety and technology anxiety contribute to cognitive load when planning for retirement and how a usability intervention can decrease that cognitive load and affect retirement planning and goal setting. This involves testing the proposed theoretical model. Chapter 5 will conclude with overall discussion, study limitations, and recommendations for future research.

This research is centered on individuals between the ages of 40 – 55 (i.e., Gen X) as they a) are unique in how digital technology has accelerated during their lives and b) stand to gain the most from retirement planning interventions in the next decade. Individuals in this age bracket can benefit from compounding interest and are at a point where they are still able to invest more aggressively.

CHAPTER 2. LITERATURE REVIEW

Cognitive load theory

Cognitive load theory (CLT) is the central framework that ties this research together; it is key to understanding how people learn and solve problems, such as planning for retirement. There are three key constructs that comprise CLT and contribute to cumulative mental requirements for learning: intrinsic load, extraneous load, and germane load (Sweller, 2011). Understanding and managing the elements of cognitive load aids instructors in designing materials in order to help individuals learn new information, which involves the process of moving information from short-term (i.e., working) memory to long-term memory.

Intrinsic load is the inherent complexity of the task and occurs when there is a high level of interactivity between elements (Paas, Renkl & Sweller, 2003). Because of this interactivity, it's impossible to simplify the task without compromising the complete understanding and integrity of the task (Hollender, Hofmann, Deneke, & Schmitz, 2010). For example, when individuals learn about financial planning for retirement. In addition to learning new terms such as IRA, Roth, 401(k), matching, and contribution limits, one must also learn about lifespan planning, social security, types of funds, risk, and more. Each of these elements is highly interactive and, as a result, has a high level of intrinsic cognitive load.

Germane cognitive load is how individuals categorize and make sense of information in order to process it (Sweller, 1994). This process is called schema development and allows individuals to perceive meaningful patterns and quickly

solve problems (Glaser & Chi, 1988; Sweller, 2005). Schema development is essential for moving information from working memory to long-term memory. For example, when we learn about retirement, we might first think of enjoying leisure time. Then, we might start to learn more about the amount of money we might need to retire and open a 401(k) to start saving. As a result of opening a 401(k), we might learn about how risk affects the investments in our portfolio. As time progresses, we might add a health savings account (HSA) or a Roth IRA. We also might learn about when we can get Medicaid and Social Security so we can calculate the best time to actually retire. However, if in the middle of this we had to choose between a Roth IRA and a traditional IRA, we would likely only be able to make the vaguest inferences about what could or should happen: there is not enough previously acquired information to solve the problem. Ergo, when intrinsic cognitive load is high, germane cognitive load is also high. In complex domains, acquiring information in a linear and structured way is an important component of schema development (Glaser, Lesgold, & Lajoie, 1985; Seel, Darabi, Nelson, 2006)

Lastly, extraneous load is cognitive load imposed by the design and presentation of materials. Any learning elements that do not lead to recognition and recall of information is considered extraneous (Davids, Halperin, & Chikte, 2015). For example, in many domains, the use of text-based explanations in conjunction with charts or graphs can help make a concept more readily apparent than just a text-based description of the data. These types of integrated presentation, allow learners to easily scan relevant information (Mayer & Moreno, 2003). Alternatively, poorly designed materials might have extra information, which is interesting but not

necessarily relevant. This diverts the learner's attention and depletes cognitive resources. For example, on the website

American Association of Retired Persons (AARP), an educational article on Roth IRA contribution limits also has ads for high-yield savings accounts, links to other off-topic articles, and AARP enrollment information. This additional information demands additional processing and leaves less mental resources for acquiring a meaningful understanding of IRAs (Mayer & Moreno, 2003; Sweller, 1999). It is believed cognitive load is additive, so in complex domains, such as retirement planning, reducing extraneous cognitive load frees up mental resources which can then be dedicated to schema development and moving information from working memory to long-term memory.

Managing cognitive load by understanding the interplay of intrinsic, extraneous and germane cognitive load is key to learning but one must always be cognizant of individual differences as well. For example, someone with a high level of prior knowledge may experience less intrinsic load than someone with little or no prior knowledge (Leppink, Paas, Van der Vleuten, Van Gog, & Van Merriënboer, 2013). Some individuals who experience anxiety in certain situations, such as using computers or planning their finances, will experience more difficulty building schema as anxiety competes for working memory resources that would otherwise be dedicated to learning (Eysenck & Calvo, 1992).

State anxiety contributes to cognitive load

State anxiety is temporarily experiencing apprehension and tension in the face of a specific event (Spielberger, 1972). When individuals experience state

anxiety, such as anxiety about using a computer to accomplish a task, or anxiety about a stressful topic, such as retirement, their ability to learn is further limited as anxiety monopolizes attentional resources dedicated to working memory (Beckers, Wicherts, Schmidt, 2006). Elliot & McGregor (1999) propose that individuals ruminate on their performance and abilities, which lessens performance in achievement situations (e.g., taking a test, performing a task). As a result, there is a negative effect on task performance. In addition, someone who is experiencing anxiety strives to control or reduce anxiety, which consumes more resources and adds to cognitive load (Eysenck, Derakshan, Santos, & Calvo, 2007).

Retirement Anxiety

There are strong implications for state anxiety in the context of financial planning for retirement. In other domains, the presence of state anxiety leads to procrastination (Kamran & Fatima, 2010; Lay, Edwards, Parker, & Endler, 1989) and impaired task performance (Mahar, Henderson, & Deane, 1997). In the domain of financial planning for retirement, Neukam and Hershey (2003) found that retirement planning worry and retirement planning drive predicted the percent of income individuals devoted to retirement savings. Interestingly, they also found there was a relationship between planning worry and planning drive; as planning worry increased, savings levels decreased for individuals who scored high in planning drive. For individuals with low planning drive, there was little effect from planning worry. This implies that even in the presence of strong planning behaviors, financial planning worries can be detrimental to retirement savings.

Using the financial inhibition scale (FIS), which measures financial worry

and planning worry (e.g., fear) and the financial activation scale (FAS), which measures planning drive and financial freedom (e.g., goals) Gutierrez & Hershey (2013) found that individuals with high levels (e.g., top 30%) of financial worry had longer response times for financially relevant retirement threat words in the Emotional Stroop Task. The authors theorize that there is a negative emotional valence associated with retirement concepts in long-term memory which disrupts cognitive processing. From a practical perspective, this processing disruption may further complicate the process of planning and saving for retirement.

Other research has found that the anticipation of retirement can be linked to retirement anxiety (Hayslip, Bezerlein, & Nichols, 1997) and that high retirement anxiety is negatively related to expected satisfaction with future retirement finances (MacEwen, Barling, Kelloway, & Higgenbottom, 1995). Lastly, anxiety about meeting with a financial advisor can actually deter individuals from seeking financial advice. It is worthy of note that much of the peer-reviewed research on retirement anxiety/worry is focused on social aspects, personal fulfillment, and health and there is a very limited amount of research dedicated to financial planning for retirement. The results of financial anxiety and planning research from Neukam & Hershey (2003) and Gutierrez & Hershey (2013) indicate that this is a relevant and valuable topic for further exploration.

Computer Anxiety

Computer anxiety has been defined as “fear and apprehension felt by an individual when considering the utilization of computer technology or when actually using it” (Maurer, 1994) and “fear of computers when using one or fearing the

possibility of using it when needed” (Chua, Chen, & Wong, 1999). Computer anxiety has been shown to have a detrimental effect on performance including a negative relationship between computer anxiety and test performance (Anderson, 1996), slower performance on simple computer tasks (Mahar, Henderson, & Deane, 1997), and learning (Chou, 2001).

Understanding computer anxiety requires balancing some of the seminal work in this domain with a current and updated understanding of how technology has changed over time. There are over a dozen different computer anxiety scales, most of which were developed in the 1980s and 1990s (Powell, 2013). The most frequently used tools for assessing computer anxiety include the Computer Anxiety Rating Scale (CARS; Heinssen Jr., Glass, & Knight, 1987), Computer Anxiety Scale (CAS; Loyd & Gressard, 1984), Marcoulides Computer Anxiety Scale (CAS; Marcoulides, 1989) and Attitude Toward Computers (ATC; Raub, 1981). Since the development of these scales in the 1980s, there has been a tremendous amount of change to computers. Two of the most common computers in the 1980s were the Commodore 64 and the TRS-8; they were capable of running only the most rudimentary programs via a command line interface and looked nothing like devices we have available to us today (see Figure 2 and Figure 3).

Figure 2. Command line interface. Used with permission from Ryan Sutter.

Figure 3. Commodore VIC computer. Used with permission from Ryan Sutter.

Not only have computers improved exponentially since their inception, the concept of what a computer is and what it does has also radically changed. A computer can now be a tablet, a phone, or even a watch. Technology encompasses us and is used for all types of everyday tasks, such as monitoring our heart rate, making a grocery list, communicating with friends, or checking our bank balance. And while we may not experience the glorious frustration of writing twenty-two lines of code and receiving the baffling response, “SYNTAX ERROR,” we now experience cybersecurity threats, data breaches, and routine frustrations from interacting with technology daily. And as the concept and device of a computer has

changed, so has the need for updated measures of computer anxiety.

In a review, Powell categorized and compared antecedents, correlates, and outcomes of computer anxiety between the 1990s and 2000s (See Figure 4) and found that there were some significant differences in published literature between the decades (Significant differences at $< .01$ indicated by * in Figure 1) across antecedents, correlates, and outcomes.

Source: Powell, 2013

Figure 4. Antecedents, correlates, and outcomes of computer anxiety.

These differences indicate that the content of computer anxiety is likely to have changed over time, thus the content validity of measures of computer anxiety has likely decreased as well.

A meta-analysis conducted by Chua, Chen, & Wong (1999) supports the findings of Powell on three correlates: age, gender, and computer anxiety. They noted that computer anxiety measures are reliable but there is low convergent reliability, indicating that they may be measuring different constructs and/or that the content validity has changed over time.

Fortunately, recent work has been done to develop a modern Tech Anxiety Rating Scale (TARS) which includes updated tasks and devices (Steelman & Tislar, 2019). The primary focus of the new TARS is on the cognitive components of anxiety and not self-efficacy and attitudes toward computers; this is critical as prior measures of computer anxiety do not differentiate between these two constructs (Steelman & Tislar, 2019). Preliminary findings from this research show that TARS is negatively correlated with affective responses such as computer self-efficacy and internet attitudes, as well as self-ratings of one's ability to use computers, indicating that it is not measuring these constructs. Rather, tech anxiety is expected to predict self-efficacy as well as tech acceptance (e.g., if one has high tech anxiety, their self-efficacy would be negatively correlated).

I was unable to find any peer reviewed articles that directly measured the effect of computer anxiety on retirement planning performance; however, a recent study used Davis' (1989) Technology Acceptance Model (TAM) to measure individual acceptance and intention to use technology to plan for retirement (Casas, 2010). It is possible that there is some correlation between TAM and computer anxiety as they both include elements of experience, perceived usefulness, and perceived ease of use. This study found that perceived usefulness and perceived ease of use were important factors in intention to use computer technology to plan for retirement.

In summary, the breadth and depth of research on computer anxiety and its correlates has demonstrated a) that computer anxiety has been operationalized in many ways in the last thirty years, b) many correlates have remained stable over time, but others have continued to change as technology has changed, c) in general,

there is a documented negative relationship between computer anxiety and performance on computerized tasks, and d) it is likely that there is an inverse relationship between computer anxiety and intention to use computer technology to plan for retirement.

Instructional design can improve learning and planning outcomes

Instructional design theory applies the theory of cognitive load in order to improve learning outcomes (Mayer, 2010). Cognitive load theory describes these concepts in a more static way while instructional design theory places them in the context of active learning. The goals of instructional design theory are to manage essential processing, foster generative processing, and reduce extraneous processing so that learning can occur.

Essential processing is the processing required to understand the material. More complex material and material that is unfamiliar to the learner can quickly overload the user (e.g., intrinsic cognitive load). Generative processing is processing required to develop a schema of the material which is influenced by the learner's actual motivation to comprehend the material (e.g., germane cognitive load). Extraneous processing results from unnecessary details or poorly designed instruction, which inhibits learning (e.g., creates extraneous cognitive load).

Table 1 shows the relationship between Mayer's theory of the learner's cognitive system and the concepts of cognitive load theory (Sweller, 2010).

Learner processing	Cognitive load theory
Extraneous processing	Extraneous cognitive load
Essential cognitive processing	Intrinsic cognitive load
Generative cognitive processing	Germane cognitive load

Table 1. Relationship between learner processing theory and cognitive load theory.

Traditionally, cognitive load theory is paired with learner processing theory to create a comprehensive framework for designing effective instruction (Mayer, 2010). However, the context of this paper and the proposed experiments is not learning in a structured environment, but the process of going out “into the wild” to gather information from the Internet. In order to do this, we need to extend the language of learning theory into the language of usability.

The interplay of cognitive load, learning theory, and usability

Usability, in its most simplistic definition, is how easy a user interface (e.g., software, app, website) is to use (Nielsen, 2012). The International Organisation for Standardisation (ISO) provides more detail: “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.” In the context of cognitive load and instructional design, high usability can decrease extraneous processing requirements by reducing the effort individuals must take to parse through the interface and content (Davids, Haperin, Chikte, 2015). This frees up working memory and facilitates learning.

Davids, Halperin, & Chikte (2015) relate the concepts of Mayer’s cognitive theory of multimedia learning with key usability heuristics for interface design from

noted usability author Jacob Nielsen (1995) in the domain of e-learning in medical education (Table 2). These heuristics encompass some of the best practices of usability, including error prevention, following real-world conventions, and appropriate feedback for user actions.

Goals for effective learning from Mayer (2010)	Supporting usability heuristics from Nielsen (1995)
Reduce extraneous processing	Minimize memory load, rely on recognition over recall Consistency and conformity to common standards
Manage essential processing	Match real-world language, minimize jargon Maintain visibility of system status, offer timely feedback
Support generative processing	Utilize aesthetic and minimalistic design Prevent user errors and help recover from errors

Table 2. Relationship between cognitive theory of multimedia learning and usability heuristics.

A simple example for how usability can support learner goals is button design. According to Nielsen, highly usable design is consistent with common standards. Consider the image below (Figure 5). On the left is a symbol that a designer might use to indicate the ability to move forward or click next in a lesson. On the right is a common representation for the same action.

Figure 5. Illustration of the heuristic of common standards.

Since the symbol on the left is not a common design practice: someone might think it is just a decorative element or confuse it with the double chevron (>>) that is commonly used to skip forward. As a result, the user may need to put in additional cognitive effort to this element, which is unrelated and not useful to the actual task environment. Juxtapose this with the button on the right. The beveled edges give a contextual clue that you can “press” the button and the text clearly state the purpose of the button. This aligns with the usability heuristic of *consistency and conformity with common standards* as well as Mayer’s (2010) *coherence principle* which states that, “learning is improved when unneeded words and symbols are eliminated...”. In addition to reducing extraneous load, a button design that looks like an analogue button *creates a match between the system and the real world* that allows novice technology users to identify the intent of the button, which capitalizes on the *pretraining principle* for managing essential processing (e.g., people understand pressing a button does something, by making a digital button look like a real-world button a new user can infer that the button will execute the action written on the button). Not only do these types of affordances reduce cognitive load, but poor usability has also been linked to avoidance (Nickerson, 1981), perceptions of user interface attractiveness (e.g., a highly usable interface is rated as more aesthetically pleasing; Tuch, Roth, Hornbæk, Opwis, Vargas-Avila, 2012), learning outcomes (Meiselwitz & Sadera, 2008), and adherence and continued use of medical devices (Lang, Martin, Sharples, Crowe, 2012).

The field of usability is evolving to include the construct of cognitive load, and models, such as the PACMAD model of usability, have evolved to reflect the

importance of cognitive load as a component of usability (Harrison, Flood, and Duce, 2013). However, even this updated model treats cognitive load as a single, rather than multi-faceted, concept. And given the complex interchange between cognitive load, anxiety, and usability, I propose a new model that integrates anxiety, usability, and a multi-faceted conception of cognitive load (Figure 6).

Figure 6. Proposed model of anxiety, usability, and cognitive load.

This new model connects several crucial antecedents to cognitive load that, ultimately, affect an individual's ability to conduct financial planning for retirement in an online environment. Financial and tech anxiety increase cognitive load by monopolizing resources required for developing schema in long-term memory. Anxiety is thought to disrupt learning by monopolizing resources required for developing schema in long-term memory. Higher financial knowledge decreases cognitive load, as pre-existing knowledge helps defray the difficulty of comprehending the material. Lastly, both tech anxiety and system usability to affect extraneous cognitive load. Tech anxiety may increase cognitive load as individuals who have higher levels of tech anxiety may have more difficulty identifying key (e.g.,

non-extraneous) information than individuals with lower levels of tech anxiety.

Usability, on the other hand, should lower extraneous cognitive load as usability seeks to eliminate unneeded, irrelevant, or poorly presented information.

By modeling these constructs separately, we can also manipulate and measure them separately, thus exerting more control over the task and environment. For example, a website with high usability may reduce extraneous cognitive load but still deter learning or engagement due to high intrinsic cognitive load of a complex topic. In the domain of financial planning for retirement, we also want to understand the existing mental schema, as measured by financial knowledge, which should decrease cognitive load.

Conclusion of Literature Review

Retirement planning is a complex problem for the average American to handle. The task demands are high due to high information load, information diversity, and uncertainty (Campbell, 1988). As such, retirement planning is likely to have inherently high intrinsic cognitive load. In addition, retirement anxiety and computer anxiety are likely to have a negative effect on cognition because resources that should be available to serve working memory are subverted by worrisome thoughts. Usability improvements, which are intended to help users successfully complete technology-based tasks, help control the level of cognitive load by ensuring that the learning materials or interface are not unnecessarily overloading the user and have been shown to aid in successful task completion.

CHAPTER 3. EXPERIMENT 1

Introduction

As mentioned previously, Gen X are unique as they were introduced to personal computing in their lifetime, and they are the first generation to have increased responsibility for their personal retirement outcomes. I expect that the changing nature of personal computing plays a role in how this generation thinks about and approaches retirement planning, such that they experience some difficulty using computers for retirement planning tasks (e.g., information search, account management). In addition, I expect that individuals from Gen X will demonstrate some anxiety associated with planning and preparing their own retirement and this will manifest as behaviors such as avoidance, putting off decisions, and making sub-optimal decisions. In summary, the aim of this study is to a) gain insight into Gen X computer experience and use and b) explore concepts of retirement worry.

Method

A qualitative research design was used including semi-structured interviews and cognitive task analysis to identify and explore themes of computer use and retirement worry by Gen Xers ($n = 12$). Semi-structured interviews provide a framework for exploring individual thoughts, behaviors, and actions while allowing the flexibility to probe particular areas of interest. Cognitive task analysis (CTA) is a methodology that enhances the semi-structured interview by delving more into the

cognitive processes involved in complex decision-making in order to understand the development of mental models. The complete protocol, which outlines the semi-structured interview process and cognitive probes to be used, can be found in Appendix A.

Participants

There were 12 participants, seven females and five males, between the ages of 40 and 55. All participants had access to employer-sponsored retirement plans such as a 401(k) or 403(b) and seven of them were participating in their employer's plan, while five were not. Participants were recruited via Craigslist and snowball method and were compensated \$20 in the form of an Amazon gift card for a 60-minute interview.

Procedure

Participant interviews were conducted and recorded via Zoom video and audio-conferencing platform. Participants were required to read and sign the consent form to participate prior to participation. Interviews lasted approximately 60 minutes. The author began by explaining the purpose of the research, clarifying that the participant matched the recruitment criteria (e.g., fell within age range, employed full-time, have access to an employer-sponsored retirement plan), and then requesting verbal permission to record the session. Each interview followed the same pattern of questions set out by the interview and CTA probes. At the close of each interview, the researcher reviewed the payment procedure before thanking the participant and closing the interview.

Data Coding

Participant interviews were recorded and then transcribed by a professional transcription service, which yielded 193 pages of single-spaced text. An analytic memo was generated for each interview; the purpose of these memos was to summarize any prominent points to help understand the themes and patterns in the data and to help establish code choices. Following this, a set of 53 preliminary codes was generated that attempted to capture the essence of research themes. These codes were generated through discussion between the author (NH) and advisor (KSS). Data was first coded using the structural coding method prescribed by Guest, MacQueen, Namey, (2012). This method “acts as a labeling and indexing device, allowing researchers to quickly access data likely to be relevant to a particular analysis from a larger data set” (*p. 141*). Structural coding is particularly appropriate for interview transcripts where the researcher is looking for commonalities among different participants.

The coding procedure consisted of color-coded highlighting of the text to reflect four key themes: retirement, generational concepts, money management in general, and computer abilities. Following the first round of coding, the preliminary and emergent codes (e.g., codes that seemed relevant and necessary upon closer perusal of the data) were discussed and agreed upon by NH and KSS. 10 codes were added, and 13 codes were renamed to better capture the essential meaning of the participants’ language. 21 codes were eliminated. These codes were either redundant to other codes or were unused in the first round of coding, indicating they were not essential. The result was 43 codes which were used in round 2 coding.

In round 2, chunks of relevant text were cut and pasted into Excel and

assigned a primary code. Some overlapping themes required a secondary code. For example, in the same sentence a participant might mention difficulty finding information as well as uncertainty. A separate sheet was created for descriptive information (e.g., gender, age, self-rated skills). A combination of attribute, process, emotional, and pattern coding were applied to the data (Saldaña, 2009). Frequency of each code was then calculated; the most frequently occurring codes are shown in Table 1. Given the overall number of codes, a cutoff point of five mentions was set, resulting in 17 frequently mentioned concepts (see Table 3).

Primary Code	Description
Keeping up	Technology developing fast, harder to learn new skills
Hardship	Divorce, job loss, or other significant personal event affects saving
Learn for work	Learned computer skills primarily because of work
Reason for starting	Motivation to start saving/investing for retirement
Retirement knowledge	Overall level of retirement knowledge, whether incorrect, low, or high
Research	Look for and try to learn about retirement information
Advice	Mentions getting professional or personal advice (friends/family)
Contribution decision	Determines how much to put into retirement plan/investment plan
Withdrawal	Takes a withdrawal from retirement savings, pre-retirement
Worry	Anxious about retirement, having enough money, things going wrong
Plan selection	Reason for choosing a specific type of plan or going with default
Social Security	Ideas about or knowledge about social security
Uncertainty	Unsure if they are doing the right thing, have the right strategy, or don't understand what to do
Reason for not investing	Reasons for not starting to save or not investing
Goals	Financial goals for retirement and strategies for attaining goals
Health insurance	Cost of health insurance, health insurance coverage (or lack thereof), Medicare
Parental influence	Knowledge or lack of knowledge on retirement saving passed down from parents

Table 3. Most frequently occurring codes from Round 2 coding.

Next, a card sorting activity was conducted to provide additional perspective on related themes with the data. Card sorting is a clustering methodology that is commonly used in information architecture to help understand user's mental models in how they sort and group topics (Rosenfeld & Morville, 2002). However, card-sorting can also be used to identify themes in qualitative interview data (Alam & Mueller, 2021). In card sorting, participants use overarching categories and cards to

group ideas thematically. In a hybrid card sort, some categories are pre-determined, and participants can add their own categories as they see fit. For this study, there were four pre-determined categories: investing, retirement, money management, and computer skills.

The card sort was conducted using Optimal Workshop, an online tool that streamlines the process of creating, distributing, and analyzing card-sort research. Participants were students from an advanced statistics course at Michigan Technological University ($n = 10$). Participants spent an average of 7.52 minutes sorting the 43 cards.

There are several methodologies that can be used for analyzing card sorts including agglomerative hierarchical, divisive hierarchical, fuzzy clustering, and mixture modeling (Alam & Mueller, 2021). These methods tend to work best with a larger sample size (e.g., >30) so for this study, the results were analyzed using a best merge method dendrogram. This method is appropriate when a study has fewer participants as it makes clustering assumptions based on individual pair relationships. Other methods, such as principal component analysis and k-means clustering can be used with this type of data, but require a larger sample size (e.g., 30 or more).

A dendrogram shows clusters by listing, on the left, every topic in the card sort and then brackets are drawn between items based on the level of agreement among participants. From left to right, clusters become denser, but the level of agreement drops (see Figure 7).

Figure 7. Example of dendrogram function.

Results

The final analysis used both the most frequently occurring codes and the results of clustering analysis to discuss themes from the interview data. The reason for this is statistical, unmoderated card-sort can lose some of the depth and understanding that comes from listening to participants speak through these concepts (Spencer, 2004). By combining these two methods, we can see the overarching categories more clearly, and support the evidence with the frequency of concept mentions as well as interview verbatims.

Overall, participants grouped the 43 concepts into 5 distinct categories with 63% agreement: computer knowledge, generational and emotional pressures, retirement, money management, and decision-making. There was a higher level of agreement at 73% with 5 smaller categories and a larger number of uncategorized concepts, but the lower level of agreement provided larger clusters that provided excellent insight into the data (see Figure 8).

Figure 8. Clustered concepts at 64% agreement.

Expected Theme: The changing nature of personal computing plays a role in how this generation thinks about and approaches retirement planning, such that they experience some difficulty using computers for retirement planning tasks (e.g.,

information search, account management).

Overall, participants grouped the computer concepts together with a high level of agreement but there was not an overt relationship between increased computer prevalence and retirement planning task success. Rather, the frequent use of the codes KEEPING UP and LEARN FOR WORK indicated that older workers are willing and able to keep up with technological change (Friedberg, 2003) but they find it increasingly difficult to learn new technologies (Weinberg, 2004). Participants mentioned that it was more difficult to learn and keep up with new technology, especially compared to their younger colleagues, but also that they felt that they had the skills to learn what they needed to; it just took them longer.

“...but a lot of it is just keeping up period. Trying to stay on top of things, so you have the ability to, you know, go to students or faculty and say wait there’s a better way to get to this information and here it is.” - F, 53 years old

“Even there’s... so much technology. It comes out that I don’t grip it right when it comes out, I’m always one of those, how do you work it, you know.” – F, 53 years old

“I feel like I’m always a little behind. I think I catch up eventually. I play catch up very well...” – M, 43 years old

“I became all of a sudden, you know...I played catch up with my computer knowledge. You know, like building websites for like the companies as well. Like I became like, I was catching up for lost time.” – M, 42 years old

“...as far as my goals, I mean, in the early days it was just, you know, to know it well enough to, you know, to be good at my job.” – F, 55 years old.

In summary, technology use follows a traditional pattern that has little to do with Gen X and more to do with aging in general.

Expected Theme: Individuals from Gen X will demonstrate some anxiety

associated with planning and preparing their own retirement and this will manifest as behaviors such as avoidance, putting off decisions, and making sub-optimal decisions.

This hypothesis received support from the data. The clustering analysis grouped uncertainty and worry into the same category of emotions and individual differences, but at a lower level of agreement – 60% – while worry and lack of awareness were paired more frequently (73% agreement).

The high occurrence of codes for WORRY and UNCERTAINTY also support this theme. For example, uncertainty was tied to feelings of isolation (e.g., not having any institutional support for saving, long-term well-being) and self-efficacy (e.g., why am I making these important decisions when I have hardly any knowledge) while worry was associated with hopelessness (e.g., I'm not sure it's possible to save enough) and fear (e.g., if any major setback occurs, my retirement savings are not going to be adequate to deal with it).

“I’m not going to starve to death, but I definitely need to pay off my house before I retire, because I won’t be able to do a house payment on what I’m gonna make. I will have to live very frugally, but I won’t be homeless.” – F, 55 years old.

“... I was really anxious about, you know, how long it was taking to add up to anything that looked, you know, that looks like retirement funds. You know, I had a lot of anxiety about that, you know.” – F, 53 years old.

“I find that the difficulty I’m feeling goes beyond dollars and cents but includes a lot of emotional baggage that isn’t positive.” – M, 43 years old.

“...but I never really knew what I was doing, I just kind of went by what I heard. I still don’t... I’m still not really an expert by any

stretch of the imagination, but you know, I like to think I know a little bit more now than I did 20 years ago.” – M, 40 years old.

Many of the verbatims related to uncertainty and worry relate to not having confidence or certainty about what actions to take. The fragmented clustering on these topics supports the lack of any clear mental model about how, exactly, planning for retirement should proceed. By this I mean items such as retirement plan selection, health insurance, advice, goals, and account management all failed to fall into any unified cluster but they are all concepts related to thoughtful planning for retirement (see Figure 9).

Figure 9. Clusters for plan selection, advice, goals, and decisions.

In addition, many of the participant verbatims related to RETIREMENT KNOWLEDGE, RESEARCH, and ADVICE have to do with how difficult it is to understand what best for them personally and how that can relate to not putting in effort.

“You don’t really meet with a guy who talks to you about your stock portfolio anymore. You can meet with a representative from like TIAA-CREF, and talk about the big picture, but I guess at some point, I just sort of went onto autopilot with the retirement thing.”
– F, 53 years old.

“...you can’t merge the two because they’re different types of IRAs. I’ve talked to a guy about it, but they won’t let you do that.” – F, 55 years old.

“Like I’ve got some books and magazines. But I don’t generally spend a lot of time, going and like researching.” – M, 45 years old.

“...the first time I ever invested in a Roth was like last month, you know. It took me a long time to even understand why they were different or why I would choose to do that versus the other thing.” – M, 45 years old.

“Eventually after searching specifically for such information, I was able find some articles on the topic [starting retirement savings in one’s 40s] but they all seemed too generalized and not necessarily speaking exactly to how I felt or what I needed.” – M, 42 years old.”

There also appeared to be an interstitial role played by the transition from defined benefit to defined contribution plans. Namely, participants realized that they were at a critical changing point between pensions and 401(k)s as the preferred retirement vehicle or employers and that shift affected them.

“Pensions are a word that doesn’t exist in any company I’ve worked for, right. So, I think it may be more indicative of the times and how they’ve changed, right.” – M, 43 years old.

“I don’t even remember if there were other options, ‘cause I was so happy there was a teacher pension option... [The benefit of the pension was] Stability. Again, the low-risk. That was a guaranteed pension.” – F, 55 years old

“I’m from a generation that, you know, we used to have a traditional retirement. You worked; you got your retirement. I have never been happy with having to place my money in the hands of people in Wall Street. It’s like that’s the only option.” – F, 55 years old.

“And I would like some day to have money there and be able to stop working, because I know there’s no way I’m getting a pension.” – M, 45 years old.

An analysis of participants’ retirement plan decisions, which include

REASON FOR STARTING, CONTRIBUTION DECISION, PLAN SELECTION, and REASON FOR NOT INVESTING also indicated the struggle many of them had with the responsibility for retirement planning. There are many distinct statements that were made by participants that fell within these codes but the common theme of all of them is delaying or avoiding choices.

“That was about the whole extent of my thought process. Someday I’m going to retire, so I’ll put some money away. So, I didn’t like strategically map it out or plan it.” – F, 55 years old.

“So, yeah, so at that time it really was just kind of a check the box, hold this much out of my paycheck and I’ll you know, I’ll think about it later when I’m less worried about other things.” – F, 55 years old

“I’m not sure I’ve ever intentionally said, okay I’m going to start shoving x number of dollars extra into retirement savings.” – F, 53 years old.

“Well, I’ve just kind of gone with the formula the past and it’s basically just put in as much as they’re matching at least.” – M, 43 years old.

Research by Anderson (2003) demonstrates that people frequently make the non-choice of postponing or avoiding difficult decisions, even when doing so results in missing out on opportunities. As we look at the verbatims from participants, we can see that the codes are not about their contribution or plan decision, but rather the nature of those decisions and the lack of thought that goes into them. Looking at the personal retirement influences, which includes RETIREMENT KNOWLEDGE, RESEARCH, ADVICE, GOALS, HARDSHIP, WITHDRAWAL, and PARENTAL INFLUENCE, we see more of the factors that motivate retirement decisions.

For example, HARDSHIP and WITHDRAWAL demonstrate the difficult

trade-off between current and future consumption. Participants discuss challenges such as divorce, job loss, and health issues, which can either lead to not investing in retirement or taking withdrawals from retirement savings.

“I was you know...I was, you know, a divorced working mom. You know, with the daycare bill bigger than the mortgage. So, was really more concerned about just staying afloat at that time... So, retirement was, I don’t know, either an afterthought or a luxury planning for that.” – F, 55 years old.

“I had even, you know, after leaving those employers, you know even ended up taking, you know, early withdrawal from it, just for you know, kind of financially up the creek reasons.” – F, 53 years old.

“I was vested. So, I don’t know if that’s retirement or not. But when I left, I got like \$3,000. I kind of went through it, you know... And I pulled it out. Yeah. I don’t know. I needed it to buy our first trailer.” – F, 53 years old.

“I’ve cashed in all of them. I’ve had like four of them. I’ve cashed in all of them, because I’ve been pretty low income and so, it’s been hard to get going... I had a lot of health crises.” – F, 48 years old.

“I had a decent size retirement, savings. And I had, you know, I own a house and in that year was really tough and I lost everything. So, you know, once I got back on my feet in 2015, 2016, it really took a year to even work and to get you know, to get my head above water to get back to where I was.” – M, 43 years old.

“I actually had a little bit of a 401(k) going once in my late 20s, early 30s. And I had a few thousand dollars in it, and I drained it. Took the hit, because I just needed the money.” – M, 45 years old.

In summary, participants have anxiety and worry related to retirement planning and demonstrate many behaviors that are expected in association with anxiety and worry including avoiding making plans and myopic decision-making. However, the blame for these shortcomings does not fall completely on the individual; there is evidence that there is difficulty finding and parsing through

retirement planning information and confusion about the overall steps needed to retire.

Experiment 1 Discussion

The key assumption under investigation in this pilot study was that later exposure to computers, such as that experienced by Gen X, may play a role in how this generation thinks about and approaches retirement planning tasks, which are often online. The analysis of interview data indicate that these assumptions were somewhat accurate; later exposure to computers did not seem to have an effect on whether participants were more or less likely to struggle with online retirement planning tasks. While there was a range of beginning exposure times – from middle school to college – every participant mentioned learning computers for work. Most of the motivation for learning computers and developing specific computer skills was driven by the necessity of a job.

These examples show a pattern of learning specific computer skills as needed and only learning the required amount of information to be successful at a task. In terms of other computer usage, participants mentioned being motivated to learn certain programs or software based on their personal interests such as writing, art and design, and music. If we look at this pattern through the lens of retirement planning, we can see a similar pattern: when a retirement planning task overtly needs to be dealt with (e.g., starting a new job, company revises retirement plan) there was evidence that participants would expend the least amount of effort to deal with it. They would expend additional effort if there was something specific that they were interested in or, more likely, concerned about (e.g., starting retirement

savings in your 40s, portfolio risks, fractional ownership).

This finding aligns with research that shows goals are an important factor in retirement savings (Hershey, Mowen, & Jacobs-Lawson, 2003; Stawski, Hershey, & Jacobs-Lawson, 2007). Overall, it seemed that one of the challenges that participants faced with retirement planning is that it doesn't have a definitive success measure or goal. None of the participants had a specific number they felt they needed to reach and, with one exception, they didn't have a set of well-defined goals. As a result, their thoughts about what they should be doing to prepare for retirement were very nebulous. The low number of times goals were mentioned by interviewees as well as the low level of agreement in the clustering analysis regarding goals and retirement planning indicate that not only are individuals not setting goals, they also are not aware of how beneficial it is to set goals.

Overall, this data suggest that Gen X needs more support to not only make their own plans and strategies for retirement saving but they must also determine appropriate goals for themselves based on their lifestyle and personality. In addition, common deterrents such as difficulty finding trusted information related to retirement planning should be minimized as much as possible

CHAPTER 4. EXPERIMENT 2

Introduction

Experiment 1 laid the foundation to better understand how Gen Xers think about and approach retirement planning, particularly as it relates to using computers for retirement planning tasks such as information search and account management. This research also explored themes of anxiety associated with planning and preparing for retirement. The findings suggest that participants – regardless of skill level - spend very little time using computers to learn about or plan for retirement and that decision seems to be partly motivated by the seeming stress and anxiety of trying to plan and execute something so complex. Experiment 2 was designed to measure retirement anxiety and computer anxiety while optimizing usability of a retirement planning and goal setting training in an attempt to decrease the germane cognitive load of retirement planning.

For Experiment 2, an existing validated retirement planning and goal setting module from Hershey, et al., (2003) was adapted into an online training format which was offered in two variations: typical usability and optimized usability. Optimizing for usability reduces working memory requirements and cognitive load (Cooper, 1998) and has the potential to mitigate the effects of computer anxiety and retirement anxiety on retirement planning behaviors. As a result, I expect the following outcomes:

Hypothesis 1. Performance on the knowledge retention task (e.g., financial knowledge test) will be higher for individuals in the high usability intervention than

individuals in the typical usability intervention.

Hypothesis 2. Individuals in the high usability intervention will have more retirement planning activity in the one-month follow-up than individuals in the typical usability intervention.

The next hypotheses are associated with the proposed measurement model and revolve around expected path relationships within the model.

Hypothesis 3. Individual with higher levels of financial knowledge will experience less intrinsic cognitive load as they have some pre-existing knowledge to defray the difficulty of comprehending the material.

Hypothesis 4. As anxiety is thought to disrupt learning by monopolizing resources required for developing schema in long-term memory, I also expect that financial anxiety and tech anxiety will increase germane cognitive load.

Hypothesis 5. Lastly, I expect both tech anxiety and system usability to affect extraneous cognitive load. Tech anxiety may increase cognitive load as individuals who have higher levels of tech anxiety may have more difficulty identifying key (e.g., non-extraneous) information than individuals with lower levels of tech anxiety. Usability, on the other hand, should lower extraneous cognitive load as usability seeks to eliminate unneeded, irrelevant, or poorly presented information.

Methods

Participants

All participants were between 40 and 55 years of age (e.g., Gen X, born between 1965 and 1980), employed full-time (30+ hours per week), and were eligible

to participate in their employer's retirement plan (they were not required to actually invest in order to participate). Multi-method recruiting procedures were used in an attempt to ensure a diverse pool of participants. This included posting on a variety of online forums (Reddit, Facebook, Craigslist) as well as snowball sampling. In order to avoid sampling individuals who were more interested in retirement planning, the study was described as a "study of life planning" following the procedure used by Hershey, et. al., (2003).

A total of 256 complete responses were collected in the first round of data collection; 65 cases were removed for the following reason: 15 cases of ballot box stuffing (e.g., attempts by the same person to take the survey twice), 50 cases of failed recaptcha (e.g., participant was actually a bot; these unexpected elements of data collection will be discussed in the final chapter. Of the remaining 191 complete responses, 124 completed both the initial and follow-up study and were included in the analyses. Each participant received \$15 for completing the first questionnaire and training materials portion of the study and \$10 for completing a one-month follow-up questionnaire. Participant responses were matched using a self-created unique code that consisted of the first letter of Mother's first name, the number of older, living brothers as a two-digit number, the number of their birth month as a two-digit number, and the first letter of their middle name.

Of the 124 completed cases, 77 were male and 47 were female. The median level of education was 16 years (e.g., Bachelor's degree), and the median income was \$50,000. The ethnic background of participants was African American, 22%;

Caucasian, 65%; American Indian or Alaskan Native, .8%; Asian, 1.6%; Native Hawaiian or Pacific Islander, 1.6%, Hispanic or Latino, 9%. These data are different from United States averages. First, the reported median individual income is almost \$20,000 higher than the median individual income reported by the 2019 Census, which was \$31,133. Second, the overall education level was higher with the majority (73%) of participants having a Bachelor or Master's degree. Participants were required to be employed full-time with an employer who provides a retirement plan benefit. Individuals with Bachelor and Master's degrees are more likely to be employed full-time (Congressional Research Service Brief, 2020) and, as a result, also more likely to have access to retirement plans (77% of full-time workers have access to retirement plans v. 39% for part-time workers; U.S. Bureau of Labor Statistics, 2020).

Experimental Design

After being screened for inclusion criteria, all participants completed the university-required informed consent and questions about prior financial knowledge, financial anxiety, tech anxiety, financial planning for retirement. Participants were then randomly assigned to one of three training conditions:

- (1) Control condition - advanced Google search techniques
- (2) Regular usability - financial information and goal setting with typical usability, and
- (3) Optimized usability - financial information and goal setting with optimized usability.

The content of the training modules was presented using Qualtrics survey software. Several other options were considered for delivering the training, but there were too many variables that could not be controlled. Qualtrics allows for anonymous responses and randomization to treatment groups while still having enough flexibility with information display and graphics to create training materials. Participants then rated each training for usability and cognitive load and then completed the financial knowledge test again. Participants then answered demographic questions and created their unique identification code. In one month, participants received an invitation to the follow-up study where they filled in their unique identification code and completed the financial planning for retirement scale a second time. The scales and procedure are summarized in Table 4.

Table 4. Detail of Experiment 2 procedure.

Materials

The financial information and goal setting modules were based on materials developed by Hershey, et al. (2003) which showed that a combination of financial information and goal-setting exercises influences retirement planning behaviors more than financial information or goal setting alone. Hershey's financial information seminar include seven topics that were recommended by a group of professional financial and retirement planning specialists. The topics include

- reasons people do not save for retirement,
- longevity and retirement duration,
- sources of retirement income,
- how inflation affects purchasing power,
- principles of compound interest,
- how incremental savings strategy works, and
- tips for creating an effective personal savings strategy.

The goal setting portion of Hershey's seminar included lecture materials, group discussion, a writing exercise, and guided visualization. The purpose of these exercises was to help formulate and solidify participants' understanding of retirement and emphasize the importance of developing a retirement savings plan.

While the overall topics and content are still relevant today, Hershey's (2003) materials were developed for an in-person, paper and pencil seminar and are now nearly 20 years old. As many of the resources individuals use for retirement

planning are now self-directed in online formats, I used the topics and materials developed by Hershey as a guide and adapted them to an online instruction format.

In order to create content that is readily available on these topics in a typical format someone would see, I selected 7 popular websites that consistently return results when Googling retirement and goal setting topics. These sites included: thebalance.com, AARP, Motley Fool, ssa.gov, Dave Ramsey, Investopedia, and Nerdwallet. I used these sites as guidelines for presentation format, phrasing, jargon, and overall information. See Figure 10 for an example of original and revised content.

Retirement Planning Guide

- DEFINING YOUR RETIREMENT GOALS
- TYPES OF RETIREMENT ACCOUNTS
- INVESTMENT OPTIONS
- TAX CONSIDERATIONS
- COVID-19 AND YOUR RETIREMENT

Planning for retirement starts with thinking about your retirement goals and how long you have to meet them. Then you need to look at the types of retirement accounts that can help you raise the money to fund your future. As you save that money, you have to invest it to enable it to grow. The surprise last part is taxes: If you've received tax deductions over the years for the money you've contributed to your retirement accounts, a significant tax bill awaits when you start withdrawing those savings. There are ways to minimize the retirement tax hit while you save for the future – and to continue the process when that day arrives and you actually do retire.

We'll get into all of these issues here. But first, start by learning the five steps everyone should take, no matter what their age, to build a solid retirement plan.

KEY TAKEAWAYS

- Retirement planning should include determining time horizons, estimating expenses, calculating required after-tax returns, assessing risk tolerance, and doing estate planning.
- Start planning for retirement as soon as you can to take advantage of the power of compounding.
- Younger investors can take more risk with their investments, while investors closer to retirement should be more conservative.
- Retirement plans evolve through the years, which means portfolios should be rebalanced and estate plans updated as needed.

1. Understand Your Time Horizon

Your current age and expected retirement age create the initial groundwork of an effective retirement strategy. The longer the time between today and retirement, the higher the level of risk your portfolio can withstand. If you're young and have 10-plus years until retirement, you should have the majority of your assets in riskier investments, such as stocks. Though there will be volatility, stocks have historically outperformed other securities, such as bonds, over long time periods. The main word here is "long," meaning at least more than 10 years.

SEE HOW E*TRADE CAN HELP YOU SAVE FOR RETIREMENT.
E*TRADE
Open an account

Letting Go to Move On
A long distance order wanted to connect with someone new, but without the usual cost.

A simpler approach is to plan to save a specific amount every month, even if it is a small amount. This is called incremental savings. Once you get comfortable with saving that amount of money, you can increase the amount. Once you see your money grow through the power of compound interest, you'll get excited about what you can accomplish!

Compound interest will grow your savings more

Key Takeaways

Retirement planning should include saving as early as possible, saving even small amounts, and understanding how risk and earnings interact to shape planning strategy.

Figure 10. Comparison of source material (Investopedia on top) and revised content on bottom.

In the optimized usability condition, I used the same goal setting and financial information components as the typical usability training but sought to optimize them for learning and usability. Chisnell, Redish, & Lee (2006) identified a set of heuristics for evaluating websites for adult users that include detailed operationalizations for 20 heuristics related to four elements of learning and usability: interaction design, information architecture, visual design, and information design. The full set of heuristics can be found in Appendix D.

As an example, consider the retirement planning content from NerdWallet.com, a popular financial advice website (see Figure 11). The content is well-organized and fairly comprehensive. However, it requires a high amount of vertical scrolling (Heuristic 4.1) and doesn't utilize some of the principles of information design that make it easy to scan and comprehend, such as bullet points (Heuristic 18.4-5), and there are technical terms (e.g., ETF, CD) that are not defined (Heuristic 20.2-3).

Figure 11. Example of retirement content from Nerdwallet.com.

I created a matrix for each of the 7 websites mentioned previously and examined each site's comparative content on financial planning for retirement against Chisnell's heuristics. Next, I looked at what heuristics were violated "across the board". Namely, which of the heuristics did the majority of the sites fail to implement? This included 10 heuristics. Of these 10 heuristics, the ones selected needed to be able to be manipulated in the Qualtrics experimental platform. For example, heuristic 7 is, "Provide clear feedback on actions" and one of the most consistent violations of this heuristic was that clicking links would take you away from the main page and, in some cases, not allow clear navigation back (e.g., the back button would either not take the user back to their previous location or there was no "breadcrumb" navigation at the top of the page to assist the user with backward navigation). This type of manipulation was difficult to implement in the Qualtrics environment which is designed to have user proceed in a linear fashion.

Therefore, the four heuristics listed in Table 5 were selected for the experimental manipulation as they were consistently violated, and could be manipulated in Qualtrics.

Heuristic	Description
Heuristic 4	Minimize vertical scrolling, eliminate horizontal scrolling
Heuristic 13	Images are relevant and supportive of text content Pages are clean and well-organized
Heuristic 14	Make elements on the page easy to read
Heuristic 20	Use the user's language, minimize jargon and technical terms

Table 5. Heuristics selected for manipulation in optimized condition.

For the optimized usability condition, every effort was made to maximize learning and usability by correcting these shortcomings using the guidance of Chisnell, et al. (2006) heuristics. It is important to note that the regular usability condition was not *deliberately* created to have poor usability; these elements are representative of what an average user might find when searching for information on financial planning for retirement. For example, Investopedia discusses the concept of how inflation affects your spending power in retirement (Figure 12). The same concept was used in Study 2 but included an image immediately near the content to visualize the increase in cost due to inflation (Figure 13).

Inflation will nibble away at your spending power

Inflation is the general rise of the cost of goods and services over time. For example, the amount you would pay for a cup of coffee 50 years ago is much less than what you would pay today. In 1970 a cup of coffee was 25 cents while today that same cup of coffee costs \$1.60.

The goal of investing is to earn more on your investments than inflation increases. If we think of the example from the last lesson, if an investment earns 5% a year and inflation is 2.46% then the real interest rate you earn on that investment is 2.54%.

The other thing to consider with inflation is how much your retirement income can

Figure 12. Source material on inflation from investopedia.com.

Inflation will nibble away at your spending power

Inflation is the general rise of the cost of goods and services over time. For example, the amount you would pay for a cup of coffee 50 years ago is much less than what you would pay today.

Figure 13. Edited content for increased usability and learnability.

As a control, a third group of participants completed a training module on advanced Google search techniques which was matched for length with the usability interventions. This topic was chosen because it is likely to require some of the same technology skills while not interacting with the central topic of retirement planning. The overall structure of this training module followed a syllabus from Google Search

Education entitled “Power Searching with Google” taught by Daniel Russell, a Senior Research Scientist at Google which included: finding and interpreting Google results, finding information faster, checking facts, and advanced operators (Google, (n.d.)).

Measurement Scales

Overall, four key factors were expected to affect cognitive load: financial anxiety, tech anxiety, financial knowledge, and perceptions of system usability.

Prior financial knowledge was measured using five items from Clark, Maki, & Morrill (2014). Financial anxiety related to retirement was measured using nine items from Neukam & Hershey (2003). Anxiety about using computers was measured using 26 items from Steelman & Tislar (2019). Perceptions of the usability of the training module was measured using the system usability scale from Bangor, Kortum, & Miller (2008). Details of each of these measurement scales can be found in Appendix D. As a control for pre-existing (e.g., trait) anxiety, general anxiety was measured using the GAD-7 (Spitzer, Kroenke, Williams & Lowe, 2006).

Cognitive load was measured using ten-item tool that differentiates between intrinsic, extraneous, and germane load (Leppink, Paas, Van der Vleuten, Van Gog, & Van Merriënboer, 2013). Full scales can be found in Appendix D.

The training and goal-setting activity were expected to influence two outcomes – increasing financial knowledge and motivating participants to undertake more financial planning activities related to retirement. Therefore, financial knowledge was measured following the training using the same 5-item measure as before the training. Financial planning activities were measured using the

Retirement Planning Activity Scale (FAS) (Hershey et al., 2007) - a 10-item measure of specific planning activities measured using a seven-point Likert-type scale from (1) strongly disagree to (7) strongly agree. Participants completed the FAS prior to completing the intervention and then completed the FAS again one month after their initial participation date. Following the precedent of Hershey et al., 2007, progress will be measured 1-year post-intervention, but this will not be included in the dissertation due to time limitations.

Results

Pre-intervention descriptives

Pre-intervention measures included financial knowledge, financial anxiety, tech anxiety, general anxiety, and financial activity level (See Table 7). Participants overall displayed a poor level prior financial knowledge. This inference is made based on Clark, Maki, & Morrill (2014) reporting that 75 percent, 61 percent, and 48 percent of participants from a nationally representative sample got the first three questions of the financial knowledge test correct and participants from the current study got 61%, 54%, and 56% correct on the first three questions, respectively. The final two questions are more difficult and only 15% of participants got question four correct and 37% got question five correct. Despite this low level of financial knowledge, the overall level of reported financial planning activity for retirement was quite high, $M = 40.9$, $SD = 8.34$.

Table 6. Descriptive statistics for pre-intervention measures (N = 124).

The overall level of financial anxiety was moderate with a median score of 42.57, which is at the 50th percentile. Financial anxiety had a significant negative correlation with financial knowledge, $r(124) = -.37$, $p < .001$, signifying that as financial anxiety increases, financial knowledge decreases.

Financial anxiety also was significantly and positively correlated with tech anxiety $r(124) = .31$, $p < .001$ and general anxiety $r(124) = .24$, $p < .001$. The mean tech anxiety score was 61, slightly less than the 50th percentile. Overall, there were slight differences between scores for males and females that indicated females had lower financial knowledge and higher levels of anxiety, but none of these differences were statistically significant.

Post-intervention descriptives

Immediate post-intervention measures included cognitive load, system

usability, and financial knowledge (Table 8). One month post intervention, financial activity level was again measured.

Overall, ratings of germane cognitive load were very high, indicating a high level of agreement with statements about the material enhancing participants' level of knowledge. Intrinsic cognitive load also had high ratings, indicating the inherent complexity of the material was very complex. Extraneous cognitive load ratings were moderate to low, indicating disagreement with statements regarding the clarity and effectiveness of the training (e.g., "The instructions and/or explanations were full of unclear language). Lastly, system usability ratings were low $M=51.5$, $SD=9.07$. A SUS score above 68 is considered above average, so the mean score of 51 indicates that overall usability was not exceptional.

	Intrinsic CL		Extraneous CL		Germane CL		Total CL		System Usability	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
All data (N= 124)	7.40	3.46	4.07	3.16	9.12	1.79	7.09	1.69	51.51	9.07
Control (n = 37)	7.13	3.33	4.09	2.91	9.00	1.84	6.97	1.35	51.69	7.15
Regular Condition (n=44)	7.48	3.42	4.14	3.25	8.89	1.79	7.04	1.72	50.34	12.10
Optimized Condition (n= 43)	7.57	3.66	3.98	3.34	9.45	1.74	7.24	1.92	52.56	6.69

Table 7. Descriptive statistics for post-intervention measures.

Manipulation check

The primary manipulation of this study was focused on the effect of usability on cognitive load. By manipulating four components of usability within a training and goal setting module, I expected to see a higher rating of usability in the optimized condition versus the regular condition. Prior to analyses, all variables were first normalized to z-scores. An independent samples t-test was used to examine the difference in SUS between groups and indicated a significant difference between the regular, $M = 50.34$, $SD = 12.10$, and optimized usability conditions, $M = 52.55$, $SD = 6.70$, $t(85) = 7.64$, $p = .007$. A Cohen's d of $.24$ indicated that the manipulation was successful, albeit modest.

The second goal of this study was to create an effective training in an online environment. If the training had the intended effect, I would expect an improvement in financial knowledge (all questions on the financial knowledge test were touched on in the training) as well as an increase in financial planning activity levels following the training as measured by the one-month post-training survey.

The first hypothesis was tested using a mixed factorial ANOVA with optimized and regular usability (i.e., condition) as the between subject factor and time (i.e., FKPre and FK Post) as the within subject factor. Descriptive statistics indicated that on average prior financial knowledge was slightly higher following the intervention in all conditions. However, there was no significant main effect of time, $F(1, 121) = .573$, $p = .451$ and there was no significant interaction between usability condition and time, $F(1, 121) = .015$, $p = .985$.

	Prior Financial Knowledge	Post Financial Knowledge
Control	2.00(1.37); $N = 37$	2.08(1.30); $N = 37$
Regular Usability	2.41(1.21); $N = 44$	2.45(1.30); $N = 44$
Optimized Usability	2.28(1.33); $N = 43$	2.34(1.47); $N = 43$
Total	2.24(1.30); $N = 124$	2.31(1.36); $N = 124$

Table 8. Comparison of pre and post-financial knowledge.

The second hypothesis was tested using a one-way ANOVA. A repeated measures ANOVA was not used because the prior measure of financial activity was meant to serve as a control to ensure that one group did not have more prior financial activity than the others. The post financial activity measure was specifically to determine whether the intervention was effective at motivating individuals to work on the goals they set for themselves as part of the training. Results of the ANOVA showed no significant difference among groups, $F(2,121) = 1.05$, $p = .35$.

Measurement model

Although the results of the intervention did not lead to the expected outcomes, the measurement model is still viable, provided the correlations among predicted pathways are significant. A correlation matrix was calculated with all Experiment 2 variables to examine the strength and direction of these relationships (see Table 9)

Pearson r correlation, N = 124									
	FAS	FIS	FKPre	TARS	GAD-7	Intrinsic CL	Extran. CL	German e CL	Total CL
FAS	1	.190*	.203*	-.202*	-0.142	-.335**	-.278**	.455**	-0.169
FIS	.190*	1	-.371**	.314**	.238*	.255**	0.045	0.115	.231**
FKPre	.203*	.371**	1	-.485**	-.207*	-.536**	-.287**	0.002	.491**
TARS	-.202*	.314**	-.485**	1	.632*	.595**	.438**	-.246**	.508**
GAD-7	-0.142	.238**	-.207*	.632**	1	.484**	.267**	-0.137	.390**
Intrinsic CL	-	.255**	-.536**	.595**	.484*	1	.356**	0.042	.834**
Extran. CL	-	.278**	-.287**	.438**	.267*	.356**	1	-.304**	.654**
Germane CL	.455**	0.115	0.002	-.246**	-0.137	0.042	-.304**	1	.279**
SUS	0.152	-0.109	0.096	-0.053	-0.156	-0.071	-0.045	.202*	0.016
Total CL	-0.169	.231**	-.491**	.508**	.390*	.834**	.654**	.279**	1

* Correlation is significant at the 0.05 level (2-tailed).

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

Table 9. Correlations for Experiment 2 Variables.

In the intervention conditions total cognitive load was significantly positively correlated with financial anxiety $r(87) = .32, p < .001$ and tech anxiety $r(87) = .54, p < .001$ and significantly and negatively correlated with financial knowledge $r(124) = -.60, p < .001$. On specific components of cognitive load, tech anxiety was significantly and positively correlated with intrinsic cognitive load $r(87) = .61, p < .001$ and extraneous cognitive load $r(87) = .47, p < .001$. There was no correlation between tech anxiety and system usability, $r(124) = -.053, p = .558$, indicating that, in these intervention conditions, tech anxiety did not affect ratings of usability. Financial knowledge was significantly and negatively related to intrinsic cognitive load $r(87) = -.61, p < .001$ and extraneous cognitive load $r(87) = -.30, p < .001$. Financial anxiety was significantly and positively related to intrinsic cognitive load $r(87) = .34, p < .001$ and germane cognitive load $r(87) = .21, p = .05$. Lastly, tech anxiety was significantly and negatively related to germane cognitive load $r(87) = -.25, p = .05$ and positively related to extraneous cognitive load $r(87) = .44, p = .05$. Tech anxiety was also significantly and positively related to intrinsic cognitive load $r(87) = .21, p = .05$.

Overall, when the measured relationships are compared to the proposed structural model, one expected relationship is missing: there is no significant correlation between system usability and extraneous cognitive load (Figure 14).

Figure 14. Correlations compared to proposed structural model.

Based on correlations, the proposed theoretical model was unlikely to fit; regardless, there are insights to be gleaned from testing the model with regards to the hypotheses. The measurement model was tested using structural equation modeling in SPSS AMOS 26. Parameter estimation was calculated using the maximum likelihood method (ML). SEM performs a confirmatory factor analysis and path analysis at the same time allowing us to test direct and indirect effects among a set of variables. For a deeper understanding of SEM, refer to Hoyle (1995) and Ullman & Bentler (2012).

Analysis of this model using ML indicated a poor fit with the data $\chi^2(23, N=87) 88.12, p = .000$, as expected. The CFI index was .65 and the RMSEA value was

.18. Hu and Bentler (1999) suggest RMSEA values close to .06 or less and CFI index values close to .95 or above.

Figure 15. Model 1 full path analysis of proposed theoretical model.

The modification fit indices showed that, even with adjustments, the model was unlikely to fit. However, the correlation pathways (Figure 14) and regression weights indicate there is more to learn. The following four models explore these relationships.

For the first of these four models, the outcome variable financial knowledge change was removed; the non-significant regression weights and small R^2 value drove this decision. Recall also that there was no significant difference in pre and post-financial knowledge; as a result, including this variable is likely generating noise in the model.

Figure 16. Model 2, remove financial knowledge change.

Model 2 (Figure 16) showed slightly better fit with the data $\chi^2(18, N=87) 75.00, p=.000$. The CFI index was .68 and the RMSEA value was .19. None of the regression weights or R^2 values changed, indicating that financial knowledge was not contributing to the model.

Next, all non-significant paths in the model were removed. This is an interstitial step prior to adding in new pathways based on significant correlations from the correlation matrix (Table 9). Removing these pathways improved model fit $\chi^2(15, N=87) 70.84, p=.000$. The CFI index was .68 and the RMSEA value was .20. The next model adds in new pathways. Of note are the significant and positive relationships between tech anxiety and intrinsic cognitive load and tech anxiety and extraneous cognitive load as well as the negative relationship between tech anxiety and germane cognitive load and the positive relationship between system usability and germane cognitive load. Model fit once again improved with a notable drop in

the Chi-square value $X^2(19, N=87)$ 40.59, $p = .000$. The CFI index was .84 and the RMSEA value was .13.

Figure 17. Model 4, add pathways based on correlation matrix.

The final model measured model fit with collapsed cognitive load, rather than separate cognitive load. The thought was that if model fit is not dissimilar and the variance explained in the outcome variable is stable, examining the separate factors of cognitive load is unnecessary and a more parsimonious model can be used. However, model fit was poorest of all 5 models tested $X^2(9, N=87)$ 49.59, $p = .000$. The CFI index was .59 and the RMSEA value was .23. In addition, pathways that were significant with the multi-factor cognitive load measure – financial anxiety and usability – are no longer significant.

Figure 18. Model 5, collapse cognitive load to a single factor.

Overall, the best fitting model was Model 4, which included a multi-factor construct for cognitive load and the outcome variable retirement planning activity level. While the AIC was lowest for Model 5, this parsimony came at the expense of better CFI and RMSEA fit indices.

		Chi-square	CFI	RMSEA	AIC
Model 1	DF(54-31) = 23	88.12	0.65	0.18	150.12
Model 2	DF(44-26) = 18	75.00	0.68	0.19	127.00
Model 3	DF(35-20) = 15	70.84	0.68	0.20	110.82
Model 4	DF(44-25) = 19	48.29	0.84	0.13	98.29
Model 5	DF(27-18) = 9	49.59	0.59	0.23	85.59

Table 10. Model fit indices for all 5 models.

To evaluate the a priori hypothesis, the regression weights and squared multiple correlations from Model 4 (Figure 17) were reviewed. In support of

Hypothesis 3, financial knowledge is negatively associated with intrinsic cognitive load, $p < .001$. Thus, cognitive load was lower for individuals who had more pre-existing knowledge to defray the difficulty of comprehending the material. In addition, financial anxiety and financial knowledge were negatively correlated, indicating that when financial anxiety is high, financial knowledge is low. Lastly, although there is a relationship between financial knowledge and intrinsic cognitive load, that relationship does not carry through to action. Namely, there was no effect on financial planning activity levels.

Hypothesis 4 posited that financial anxiety and tech anxiety will increase germane cognitive load as anxiety is thought to disrupt learning by monopolizing resources required for developing schema in long-term memory. While financial anxiety was positively related to germane cognitive load tech anxiety was negatively associated with cognitive load. Regardless of the unexpected direction of the tech anxiety $\rightarrow$ germane cognitive load, both financial anxiety and tech anxiety affected germane cognitive load and ultimately affected the dependent variable, financial planning for retirement. What was unexpected was the relationship between tech anxiety and intrinsic cognitive load; when tech anxiety is high, intrinsic cognitive load is also high. This was unexpected, but in hindsight makes sense – the tech anxiety rating scale used measures the cognitive component of anxiety, rather than self-efficacy and attitudes. It may be that the intrinsic cognitive load of materials is perceived as more difficult when presented in a medium that causes anxiety.

Lastly, Hypothesis 5 investigated the effects of tech anxiety and system usability on extraneous cognitive load. I expected tech anxiety would increase

extraneous cognitive load as individuals who have higher levels of tech anxiety may have more difficulty identifying key (e.g., non-extraneous) information than individuals with lower levels of tech anxiety. There was indeed a positive relationship between tech anxiety and extraneous cognitive load. However, my expectation that usability would lower extraneous cognitive load - as usability seeks to eliminate unneeded, irrelevant, or poorly presented information – was not supported as there was no significant relationship between usability and extraneous cognitive load.

Experiment 2 Discussion

The results of Experiment 2 were somewhat mixed. Results indicated that manipulating structured elements of usability can result in a measurable difference in perceptions of usability. This is an exciting finding. Usability research often focuses on measuring usability and relating that usability to outcomes. For instance, Melnick, Dyrbye, Sinsky, Trockel, West, Nedelec, & Shanafelt (2020) studied the relationship between perceived electronic health record usability and burnout among physicians. There is less empirical work on manipulating these well-defined heuristics and measuring any outcomes related to them. If usability has the power to affect behavioral outcomes then manipulating usability should become a common intervention, particularly as it relates to the ability to improve decision making or reduce errors.

While usability did not have a direct effect on the measured outcomes of improving financial literacy or increasing retirement planning activity levels, there appeared to be an effect on financial anxiety and tech anxiety. Specifically,, financial

anxiety and tech anxiety did not exert influence on germane cognitive load for individuals in the high usability condition but did for the regular usability condition. Future work in usability and outcomes should be done utilizing the detailed heuristics from Chisnell, et al. (2006) as it will benefit both foundational and applied research.

The next interesting findings are among the key independent variables – financial literacy, financial anxiety, and tech anxiety – and cognitive load. First, the significant and large relationship between intrinsic cognitive load and financial knowledge Financial knowledge has been extensively studied and linked to retirement planning outcomes, consumption, and investment performance among other economic behaviors (Mitchell, 2017). In this case the data show that financial knowledge decreases perceptions of the complexity of the material. In so doing, the overall cognitive load of learning the training materials was reduced. While this interplay feels relatively transparent, the relationship between germane cognitive load, tech anxiety, and financial anxiety is cloudier. Intuitively, a positive relationship between financial anxiety and germane cognitive load implies that financial anxiety is detrimental. However, the actual wording and scoring of germane cognitive load shows that a high germane cognitive load score indicates there was an increase in understanding of the materials (Table 10).

The activity really enhanced my understanding of the topic(s) covered.
The activity really enhanced my knowledge and understanding of saving for retirement.
The activity really enhanced my understanding of inflation and interest rates.
The activity really enhanced my understanding of retirement concepts and definitions.

Table 11. Measured elements of germane cognitive load.

The correlations show that financial anxiety is *positively* associated with an *increase* in understanding and tech anxiety is *negatively* associated with an increase in understanding. Vytel, Cornwell, Arkel, and Grillon (2012) found that under low cognitive load, state anxiety decreases performance, but when cognitive load is high resources shift to the complexity of the task at hand and anxiety is reduced. Given the order the variables were measured (e.g., anxiety prior to the training task and cognitive load post-task), this inference can't be made for this study, but it is a potential explanation for the relationship.

The relationships between tech anxiety and germane cognitive load and extraneous cognitive load are also of interest. First, the positive relationship between tech anxiety and extraneous cognitive load indicates that individuals who struggle with aspects of using technology to accomplish a task may have difficulties picking out relevant information presented in a digital format. For instance, if someone with high tech anxiety searches for information on a website, they may be more distracted by competing elements such as links to other resources and ads. As a result, their ability to build any mental schema with the information they find is compromised. This is a unique and exciting finding.

Lastly, the format and effectiveness of the training should be addressed. The online training module presented an opportunity for a new avenue to deliver a less

resource-intensive financial planning and goal-setting training. While Hershey, found that an in-person, 3-hour financial information and goal-setting seminar had a positive influence on financial planning and retirement savings behavior the online training intervention based on those materials had no meaningful effect increasing financial knowledge or on financial planning behaviors. In the online environment, there is a level of interactivity and feedback missing that was likely present in the face-to-face seminar, which may have supported more learning. In addition, the average time-on-task for the online training was 52 minutes, so less time was dedicated overall to learning the material. In an online environment more learning checks, such as brief quizzes or interactive activities such as matching concepts and definitions, could aid learning. While all participants received an e-mail summary of all the goals available and a reminder that they committed to achieve one goal from each of the categories, there were no notifications or reminder of the specific goals they set for themselves. Reminders or notifications of these goals might have increased the level of financial activity among participants.

Lastly, due to technology limitations, only 4 of 20 usability heuristics were manipulated. The sites that were sampled for real-world usability included many more egregious usability violations, in particular the inclusion of distracting details such as ads, links to other articles, and poor backward (e.g., error recovery) navigation. More traditional user testing, such as time-on-task, successful task completion, or cognitive walk-throughs might have been a valuable addition to the pilot work for Experiment 1 and could have illuminated the specific challenges users face.

CHAPTER 5. DISCUSSION

At the outset of this research, Gen X seemed a unique audience for financial planning for retirement. First, because their position seemed unparalleled in history due to the influx of personal computers and subsequent information availability and secondly, because of the institutional changes in the employer/employee retirement schema that are markedly different than the Baby Boomer generation before them.

Study 1 indicated that Gen X age adults are disillusioned by the change from pensions to defined contribution plans – the work it entails for them, as well as the, “you’re on your own” mentality associated with it. And there may be an influx of digital tools, such as calculators and simulators, available for individual use (Bi, Finke, & Huston, 2017; Casas, 2010) to aid in financial planning for retirement but interview data from Study 1 showed that this technology wasn’t necessarily supporting goal clarity or action. Rather, individuals are locating information piecemeal based on their own personal challenges or relying on advice from individuals they perceived to be experts. For example, one participant had historically not had access to a retirement plan through their employer and had put their efforts into locating a retirement plan they could invest in without an employer. Another participant had their savings wiped out by an unexpected job loss and was seeking information about how to start retirement savings in one’s 40s. Building on this, in Study 2 there is a negative relationship between financial anxiety and financial knowledge. It may be low levels of knowledge are a result of difficulty locating helpful and appropriate information, and this leads to financial

anxiety. And although financial knowledge was found to have a strong relationship with intrinsic cognitive load, that relationship did not affect financial planning for retirement outcomes. There is evidence that financial literacy education does not have the desired effect of improving financial behavior (Mandell & Klein, 2009; Willis, 2008, 2011). Research into the efficacy of financial literacy training has suggested that the volatilities of the market and the complexities of new product offerings, as well as the platforms that they are offered are far beyond the scope of what financial literacy education can bridge. So, despite the fact that financial knowledge has consistently been found to be low in the United States and a significant factor affecting retirement planning (Lusardi & Mitchell, 2007; 2011; 2017) it may not be the most fertile path for remediation.

A more fruitful path may be from further examination of tech anxiety. Study 1 did not indicate any unusual anxiety associated with tech use but in Study 2 there was a strong relationship between tech anxiety and all facets of cognitive load which, ultimately, accounted for a large proportion of the variance in retirement planning activity levels. Research on how digital technology can affect retirement planning activity is lacking. A recently published study analyzing an Australian data set found that individuals are more likely to use technology, specifically an app, when they are closer to retirement (Hentzen, Hoffman, Dolan, 2021). However, the benefits of retirement planning come from starting at a younger age, and the authors suggest that timely adoption of technology is a barrier. The authors also found that technical issues with the apps – bugs, technical issues – deter continued use. While usability did not have the expected effect in this study, the data from

Hentzen, et. Al. (2021) suggest that usability does indeed play a role in technology use and adoption for technology. Further work is needed to explore topics of usability and tech anxiety and their effect on retirement planning outcomes.

A potential solution, and a fertile area of development, is providing personalized coaching for behavior change rather than focusing on knowledge remediation. For example, the Noom weight loss app, is designed to teach users about the underlying physiological and psychological that affect hunger, food choices, and eating behavior. Retirement planning is ripe for this type of coaching intervention. The body of research on psychological determinants of retirement is deep and there are many tools scattered throughout dozens of websites that could be curated to coach people through important elements of preparing for retirement. In addition, creating a simple, linear process for receiving this information side-steps many of the challenges of cognitive overload and usability, and can potentially mitigate tech anxiety as well.

Study limitations and future work

Data collection for this study presented many challenges. Originally, I had planned to collect more of the data in person via community colleges, libraries, and other local venues. Due to COVID-19 restrictions, I shifted my strategy to exclusively online data collection. It may have been naïve but I believed that I could tap a variety of venues such as Facebook, Craigslist, and reddit to find the appropriate audience. While this was true – I did collect the majority of my respondents via these avenues I also attracted the attention of survey bots. I learned

that this is an issue that other researchers have encountered, particularly when offering a stipend on an anonymous survey. Sorting through and cleaning out suspected bot responses created a challenge to ensure unreliable data was removed, but allowing the possibility that some people genuinely gave responses that were a little garbled. Ultimately, the data included in the final analyses represented my best effort to include only the most reliable data. Given another opportunity to collect this data, I would proceed with more caution, tighter restrictions via screening participants, and perhaps started with a different, more local, network of participants to start the data collection snowball.

REFERENCES

- Alam, L., & Mueller, S. T. (2021, July). Assessing Clustering Methods to Establish Reliability and Consensus in Card Sorting Tasks. In International Conference on Applied Human Factors and Ergonomics (pp. 961-968). Springer, Cham.
- Albers, M. J. (2011, October). Tapping as a measure of cognitive load and website usability. In *Proceedings of the 29th ACM International Conference on Design of Communication* (pp. 25-32).
- Anderson, A. A. (1996). Predictors of computer anxiety and performance in information systems. *Computers in Human Behavior*, 12(1), 61-77.
- Anderson, C. J. (2003). The psychology of doing nothing: forms of decision avoidance result from reason and emotion. *Psychological Bulletin*, 129(1), 139.
- Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the system usability scale. *Intl. Journal of Human-Computer Interaction*, 24(6), 574-594.
- Bi, Q., Finke, M., & Huston, S. J. (2017). Financial software use and retirement savings. *Journal of Financial Counseling and Planning*, 28(1), 107-128.
- Campbell, D. J. (1988). Task complexity: A review and analysis. *Academy of Management Review*, 13(1), 40-52.
- Casas, C. A. (2010). Factors that determine attitudes toward the use technology to plan for retirement: An empirical analysis. *St Thomas Aquinas College*, Sparkill, NY, 4.

- Chisnell, D. E., Redish, J. C. G., & Lee, A. M. Y. (2006). New heuristics for understanding older adults as web users. *Technical Communication*, 53(1), 39-59.
- Chua, S. L., Chen, D. T., & Wong, A. F. (1999). Computer anxiety and its correlates: a meta-analysis. *Computers in Human Behavior*, 15(5), 609-623.
- Chou, H. W. (2001). Effects of training method and computer anxiety on learning performance and self-efficacy. *Computers in Human Behavior*, 17(1), 51-69.
- Clark, R. L., Maki, J. A., & Morrill, M. S. (2014). Can simple informational nudges increase employee participation in a 401(k) plan?. *Southern Economic Journal*, 80(3), 677-701.
- Collinson, C. (2014). The retirement readiness of three unique generations: Baby boomers, Gen X, and millennials. *Transamerica Center for Retirement Studies*.
- Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience*, 3(3), 201-215.
- Davids, M. R., Halperin, M. L., & Chikte, U. M. E. (2015). Optimising cognitive load and usability to improve the impact of e-learning in medical education. *African Journal of Health Professions Education*, 7(2), 147-152.
- Deck, C., & Jahedi, S. (2015). The effect of cognitive load on economic decision making: A survey and new experiments. *European Economic Review*, 78, 97-119.

- Dong, A., Jong, M. S. Y., & King, R. B. (2020). How Does Prior Knowledge Influence Learning Engagement? The Mediating Roles of Cognitive Load and Help-Seeking. *Frontiers in Psychology, 11*.
- Dyck, J. L., & Smither, J. A. A. (1994). Age differences in computer anxiety: The role of computer experience, gender and education. *Journal of Educational Computing Research, 10*(3), 239-248.
- Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition & Emotion, 6*(6), 409-434.
- Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion, 7*(2), 336.
- Eysenck, M. W., & Van Berkum, J. (1992). Trait anxiety, defensiveness, and the structure of worry. *Personality and Individual Differences, 13*(12), 1285-1290.
- Anon. (2019). Report on the Economic Well-Being of US Households in 2018, May 2019. *Board of Governors of the Federal Reserve System*, Washington, DC, 2.
- Friedberg, L. (2003). The impact of technological change on older workers: Evidence from data on computer use. *ILR Review, 56*(3), 511-529.
- Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: a latent-variable analysis. *Journal of Experimental Psychology: General, 133*(1), 101.
- Glaser, R., Lesgold, A., Lajoie, S., Eastman, R., Greenberg, L., Logan, D., ... & Yengo, L. (1985). Cognitive task analysis to enhance technical skills training and assessment (Contract No. F41689-83-C-0029). Pittsburgh, PA: Learning Research and Development Center.

- Google. (n.d.). *Power Searching with Google - Course*. Google.
- https://coursebuilder.withgoogle.com/sample/course?use_last_location=true.
- Guest, G., MacQueen, K. M., & Namey, E. E. (2012). Themes and codes. *Applied Thematic Analysis*, 49-79.
- Gutierrez, H. C., & Hershey, D. A. (2013). Impact of retirement worry on information processing. *Journal of Neuroscience, Psychology and Economics*, 6, 264-277.
- Harrison, R., Flood, D., & Duce, D. (2013). Usability of mobile applications: literature review and rationale for a new usability model. *Journal of Interaction Science*, 1(1), 1.
- Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In *Advances in Psychology*, 52, 139-183.
- Hayslip, B., Bezerlein, M., & Nichols, S. (1997). Assessing anxiety about retirement: The case of academicians. *International Journal of Aging and Human Development*, 44, 15-36.
- Heinssen Jr, R. K., Glass, C. R., & Knight, L. A. (1987). Assessing computer anxiety: Development and validation of the computer anxiety rating scale. *Computers in Human Behavior*, 3(1), 49-59.
- Hentzen, J. K., Hoffmann, A. O., & Dolan, R. M. (2021). Which consumers are more likely to adopt a retirement app and how does it explain mobile technology-enabled retirement engagement?. *International Journal of Consumer Studies*, 00, 1-23

- Hershey, D. A., Jacobs-Lawson, J. M., McArdle, J. J., & Hamagami, A. (2007). Psychological foundations of financial planning for retirement. *Journal of Adult Development, 14*, 26-36.
- Hershey, D. A., Mowen, J. C., & Jacobs-Lawson, J. M. (2003). An experimental comparison of retirement planning intervention seminars. *Educational Gerontology, 29*, 339-359.
- Hollender, N., Hofmann, C., Deneke, M., & Schmitz, B. (2010). Integrating cognitive load theory and concepts of human-computer interaction. *Computers in Human Behavior, 26*(6), 1278-1288.
- Hoyle, R. H. (1995). Structural equation modeling: Concepts, issues, and applications. Sage.
- Issa, T., & Isaias, P. (2015). Usability and human computer interaction (HCI). In *Sustainable design* (pp. 19-36). Springer, London.
- Jacobs-Lawson, J. M., & Hershey, D. A. (2005). Influence of future time perspective, financial knowledge, and financial risk tolerance on retirement savings behaviors. *Financial Services Review, 14*, 331-344.
- Jacobs-Lawson, J. M., Hershey, D. A., & Neukam, K. A. (2004). Gender differences in factors that influence time spent planning for retirement. *Journal of Women and Aging, 16*, 55-69.
- Kahneman, D., Slovic, S. P., Slovic, P., & Tversky, A. (Eds.). (1982). *Judgment under uncertainty: Heuristics and biases*. Cambridge University Press.

- Kamran, W., & Fatima, I. (2013). Emotional intelligence, anxiety and procrastination in intermediate science students. *Pakistan Journal of Social and Clinical Psychology, 11*(2), 3.
- Kiso, H., & Hershey, D. A. (2017). Working adults' metacognitions regarding financial planning for retirement. *Work, Aging, and Retirement, 3*(1), 77-88.
- Lang, A. R., Martin, J. L., Sharples, S., & Crowe, J. A. (2013). The effect of design on the usability and real-world effectiveness of medical devices: a case study with adolescent users. *Applied Ergonomics, 44*(5), 799-810.
- Lay, C. H., Edwards, J. M., Parker, J. D., & Endler, N. S. (1989). An assessment of appraisal, anxiety, coping, and procrastination during an examination period. *European Journal of Personality, 3*(3), 195-208.
- Lee, C., & Coughlin, J. F. (2015). PERSPECTIVE: Older adults' adoption of technology: an integrated approach to identifying determinants and barriers. *Journal of Product Innovation Management, 32*(5), 747-759.
- Leppink, J., Paas, F., Van der Vleuten, C. P., Van Gog, T., & Van Merriënboer, J. J. (2013). Development of an instrument for measuring different types of cognitive load. *Behavior research methods, 45*(4), 1058-1072.
- Longo, L. (2018). Experienced mental workload, perception of usability, their interaction and impact on task performance. *PloS one, 13*(8).
- Loyd, B. H., & Gressard, C. (1984). Reliability and factorial validity of computer attitude scales. *Educational and Psychological Measurement, 44*(2), 501-505.

- Lusardi, A., & Mitchell, O. S. (2007). Financial literacy and retirement preparedness: Evidence and implications for financial education. *Business economics*, 42(1), 35-44.
- Lusardi, A. and O. S. Mitchell. (2008). Planning and Financial Literacy. How Do Women Fare? *American Economic Review*, 98(2), 413-417.
- Lusardi, A., & Mitchell, O. S. (2011). Financial literacy and retirement planning in the United States. *Journal of pension economics & finance*, 10(4), 509-525.
- Lusardi, A., Michaud, P. C., & Mitchell, O. S. (2011). Optimal financial literacy and saving for retirement. *Wharton Pension Research Council Working Papers*. 184.
- Lusardi, A., & Mitchell, O. S. (2017). How ordinary consumers make complex economic decisions: Financial literacy and retirement readiness. *Quarterly Journal of Finance*, 7(03), 1750008.
- MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, 4(1), 84.
- MacEwen, K. E., Barling, J., Kelloway, E. K., & Higginbottom, S. F. (1995). Predicting retirement anxiety: The roles of parental socialization and personal planning. *The Journal of Social Psychology*, 135(2), 203-213.
- Mahar, D., Henderson, R., & Deane, F. (1997). The effects of computer anxiety, state anxiety, and computer experience on users' performance of computer based tasks. *Personality and Individual Differences*, 22(5), 683-692.

- Mandell, L., & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning, 20*(1).
- Marcoulides, G. A. (1989). Measuring computer anxiety: The computer anxiety scale. *Educational and Psychological Measurement, 49*(3), 733-739.
- Maurer, M. M. (1994). Computer anxiety correlates and what they tell us: A literature review. *Computers in Human Behavior, 10*(3), 369-376.
- Mayer, R. E. (2010). Applying the science of learning to medical education. *Medical education, 44*(6), 543-549.
- Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 43-52.
- McDonald, N., Schoenebeck, S., & Forte, A. (2019). Reliability and inter-rater reliability in qualitative research: Norms and guidelines for CSCW and HCI practice. *Proceedings of the ACM on Human-Computer Interaction, 3*(CSCW), 1-23
- Medill, C. E. (2000). The individual responsibility model of retirement plans today: Conforming ERISA policy to reality, *Emory LJ, 49, 1.*
- Meiselwitz, G., & Sadera, W. (2008). Investigating the connection between usability and learning outcomes in online learning environments. *Journal of Online Learning and Teaching, 4*(2), 234-42.
- Melnick, E. R., Dyrbye, L. N., Sinsky, C. A., Trockel, M., West, C. P., Nedelec, L., & Shanafelt, T. (2020, March). The association between perceived electronic

- health record usability and professional burnout among US physicians.
In *Mayo Clinic Proceedings* (Vol. 95, No. 3, pp. 476-487). Elsevier.
- Merton, R. (2014). The Future of Retirement Planning. *Dimensional Fund Advisors*.
- Mihalca, L., Salden, R. J., Corbalan, G., Paas, F., & Miclea, M. (2011). Effectiveness of cognitive-load based adaptive instruction in genetics education. *Computers in Human Behavior*, 27(1), 82-88.
- Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience*, 24(1), 167-202.
- Mitchell, O. S. (2017). Financial knowledge and key retirement outcomes: an overview of the issue. *Journal of Pension Economics & Finance*, 16(3), 273-276.
- Morin, R., & Fry, R. (2012). More Americans worry about financing retirement. *Pew Research Center. Accessed online*, 10(23), 12.
- Morrin, M., Inman, J. J., Broniarczyk, S. M., Nenkov, G. Y., & Reuter, J. (2012). Investing for retirement: The moderating effect of fund assortment size on the 1/n heuristic. *Journal of Marketing Research*, 49(4), 537-550.
- Munnell, A. H., Hou, W., & Sanzenbacher, G. T. (2018). National retirement risk index shows modest improvement in 2016. *Issue in Brief*, 18-1.
- Nielsen, J. (1994). Usability engineering. Morgan Kaufmann.
- Nielsen, J. (2005). Ten usability heuristics.
- Neilsen, J. (2012) Usability 101: Introduction to usability.
<http://www.nngroup.com/articles/usability-101-introduction-to-usability/>

- Neukam, K. A., & Hershey, D. A. (2003). Financial inhibition, financial activation, and saving for retirement. *Financial Services Review*, 12, 19-37.
- Nickerson, R. S. (1999). Why interactive computer systems are sometimes not used by people who might benefit from them. *International Journal of Human-Computer Studies*, 51(2), 307-321.
- Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist*, 38(1), 1-4.
- Paas, F. G., & Van Merriënboer, J. J. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review*, 6(4), 351-371.
- Powell, A. L. (2013). Computer anxiety: Comparison of research from the 1990s and 2000s. *Computers in Human Behavior*, 29(6), 2337-2381.
- Quinby, L. D., Munnell, A. H., Hou, W., Belbase, A., & Sanzenbacher, G. T. (2020). Participation and Pre-Retirement Withdrawals in Oregon's Auto-IRA. *The Journal of Retirement*, 8(1), 8-21.
- Raub, A. (1981) Correlates of computer anxiety in college students. *Dissertations available from ProQuest*. AAI8208027.
<https://repository.upenn.edu/dissertations/AAI8208027>
- Rhee, N. (2013). The retirement savings crisis. Washington DC: National Institute on Retirement Security.
- Rosenfeld, L., & Morville, P. (2002). Information architecture for the world wide web. " O'Reilly Media, Inc.". Sarason, I. G. (1988). Anxiety, self-preoccupation and attention. *Anxiety Research*, 1(1), 3-7.

- Saldaña, J. (2009). *The coding manual for qualitative researchers*. London: Sage Publications Ltd.
- Schmeck, A., Opfermann, M., Van Gog, T., Paas, F., & Leutner, D. (2015). Measuring cognitive load with subjective rating scales during problem solving: differences between immediate and delayed ratings. *Instructional Science*, *43*(1), 93-114.
- Schram, A., & Sonnemans, J. (2011). How individuals choose health insurance: An experimental analysis. *European Economic Review*, *55*(6), 799-819.
- Seel, N. M., Darabi, A. A., & Nelson, D. W. (2006). A dynamic mental model approach to examine schema development in performing a complex troubleshooting task: Retention of mental models. *Technology, Instruction, Cognition, and Learning*, *4*(4), 273-299.
- Sethi-Iyengar, S., Huberman, G., & Jiang, W. (2004). How much choice is too much? Contributions to 401 (k) retirement plans. *Pension Design and Structure: New Lessons from Behavioral Finance*, *83*, 84-87.
- Shiv, B., & Fedorikhin, A. (1999). Heart and mind in conflict: The interplay of affect and cognition in consumer decision making. *Journal of Consumer Research*, *26*(3), 278-292.
- Skarborn, M., & Nicki, R. (2000). Worry in pre-and post-retirement persons. *The International Journal of Aging and Human Development*, *50*(1), 61-71.
- Spencer, D., & Warfel, T. (2004). *Card sorting: a definitive guide*. Boxes and arrows, 2(2004), 1-23.

- Spielberger, C. D. (1972). Anxiety as an emotional state. *Anxiety, Current Trends and Theory*, 3, 20.
- Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of Internal Medicine*, 166(10), 1092-1097.
- Sprenger, A. M., Dougherty, M., Atkins, S. M., Franco-Watkins, A. M., Thomas, R., Lange, N., & Abbs, B. (2011). Implications of cognitive load for hypothesis generation and probability judgment. *Frontiers in Psychology*, 2, 129.
- Stawski, R. S., Hershey, D. A., & Jacobs-Lawson, J. M. (2007). Goal clarity and financial planning activities as determinants of retirement savings contributions. *International Journal of Aging and Human Development*, 64, 13-32.
- Steelman, K. S., & Tislar, K. L. (2019, July). Measurement of Tech Anxiety in Older and Younger Adults. In *International Conference on Human-Computer Interaction* (pp. 520-527). Springer, Cham.
- Sternberg, S. (1966). High speed scanning in human memory. *Science*, 153, 652-654.
- Strauss, W., & Howe, N. (1991). *Generations: The history of America's future, 1584 to 2069*. William Morrow & Co.
- Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction*, 4(4), 295-312.
- Sweller, J. (2005). Implications of Cognitive Load Theory for Multimedia Learning.
- Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review*, 22(2), 123-138.

- Sweller, J. (2011). Cognitive load theory. In *Psychology of Learning and Motivation* (Vol. 55, pp. 37-76). Academic Press.
- Tuch, A. N., Roth, S. P., Hornbæk, K., Opwis, K., & Vargas-Avila, J. A. (2012). Is beautiful really usable? Toward understanding the relation between usability, aesthetics, and affect in HCI. *Computers in Human Behavior*, 28(5), 1596-1607.
- Ullman, J. B., & Bentler, P. M. (2012). Structural equation modeling. Handbook of Psychology, Second Edition, 2.
- US Department of Labor Employee Benefits Security Administration. (2021). Private Pension Plan Bulletin Historical Tables and Graphs. Retrieved on September 28, 2021 from <https://www.dol.gov/sites/dolgov/files/ebsa/researchers/statistics/retirement-bulletins/private-pension-plan-bulletin-historical-tables-and-graphs.pdf>
- Wang, Q., Yang, S., Liu, M., Cao, Z., & Ma, Q. (2014). An eye-tracking study of website complexity from cognitive load perspective. *Decision Support Systems*, 62, 1-10.
- Weinberg, Bruce A. (2004). Experience and Technology Adoption, *Discussion Papers*, No. 1051, Institute for the Study of Labor (IZA), Bonn.
- Whitney, P., Rinehart, C. A., & Hinson, J. M. (2008). Framing effects under cognitive load: The role of working memory in risky decisions. *Psychonomic Bulletin & Review*, 15(6), 1179-1184.
- Willis, L. E. (2008). Against financial-literacy education. *Iowa Law Review*, 94, 197.

- Willis, L. E. (2011). The financial education fallacy. *American Economic Review*, 101(3), 429-34.
- Vytal, K., Cornwell, B., Arkin, N., & Grillon, C. (2012). Describing the interplay between anxiety and cognition: from impaired performance under low cognitive load to reduced anxiety under high load. *Psychophysiology*, 49(6), 842-852.
- Vytal, K. E., Cornwell, B. R., Arkin, N. E., Letkiewicz, A. M., & Grillon, C. (2013). The complex interaction between anxiety and cognition: insight from spatial and verbal working memory. *Frontiers in Human Neuroscience*, 7, 93.

APPENDICES

APPENDIX A. Probes for pilot study semi-structured interviews

1. Tell me about your experience with computers throughout your life. When were you first exposed to computers?
2. What was your experience with computers at school?
3. When did you first have access to a computer at home?
4. What goals did you have when you were using a computer?
5. Did your goals for using computers change as you got older?
6. Tell me about how you use computers now?
7. Are there any things about computers you feel that you are not good at?
8. How do you figure out things that you don't understand?
9. How would you rate your computer expertise at this point?
10. Have you started saving for retirement? - YES
11. When did you first start saving about retirement?
12. What were your goals at that time?
13. How long did you plan or research before you started saving?
14. Did you do any planning or thinking about retirement prior to starting to save?
15. What options did you have available to you when you started your retirement saving?
16. How did you determine which option to choose?
17. Tell me how you have planned for retirement.
18. What information were you seeking, or what questions were you asking?
19. Why did you need this information?

20. How did you get that information?
21. Were there any difficulties in getting the information you needed from that source?
22. What was the volume of information that you had to deal with?
23. What did you do with this information?
24. Would some other information have been helpful?
25. As you collected and read information, was there anything that triggered questions that you later followed up?
26. What are some of the key things you have had to learn, either by teaching yourself or going to an expert, about retirement or retirement planning.
27. Have you used a computer in any part of the retirement planning process?
28. In what ways?
29. What has the experience been like for you?
30. Were there things you had to do that you were unfamiliar with?
31. How did you feel about your ability to accomplish [retirement planning tasks]?
32. How confident do you feel that you'll be able to retire when you want to?
33. Have you started saving for retirement – NO
34. Tell me more about why you haven't started saving for retirement.
35. What are some of the barriers you have faced?
36. Have you done any planning for retirement?
37. Have you sought any information about planning for retirement? From where?

38. What information were you seeking, or what questions were you asking?
39. Why did you need this information?
40. How did you get that information?
41. Were there any difficulties in getting the information you needed from that source?
42. What was the volume of information that you had to deal with?
43. What did you do with this information?
44. Would some other information have been helpful?
45. As you collected and read information, was there anything that triggered questions that you later followed up?
46. Do you have any plans to start preparing for retirement?

APPENDIX B. Preliminary codes for Experiment 1

Round 1 Codebook	
Code	Summary
<i>Retirement Concepts</i>	
Anxiety	Anxious about retirement, being ready, having enough money, things going wrong
Confidence	Level of confidence regarding retiring, think they will make it by their goal age
Lack of understanding	Demonstrates a lack of understanding by stating something about retirement that is incorrect
Retirement knowledge	Overall level of retirement knowledge
Don't know	Mentions that they aren't sure if they are doing the right thing, don't know if they have the right strategy, don't understand what to do
Procrastination	Reasons for putting off saving for retirement. "I didn't start saving until x because y"
Employer sponsored plans	Uses employer sponsored plan/OR has access but down not use
Non-employer retirement saving	Uses supplementary or substitute retirement savings - why
Plan selection	Chose default retirement plan options or selected an option for a specific reason
Avoidant	Doesn't want to think about or plan for retirement
Strategies	Talks about strategy (or lack thereof) for attaining retirement goals
Retirement plans - lifestyle	Mentions specific retirement plans such as travelling, volunteering, second career, age for retirement
Retirement realities	Misalignment of what they want to do v. what they can do
Planning	Has spent time/done activities with the intent of preparing for or understanding retirement
Saving	Saving for retirement/ y or no
Multiple accts	Rollovers, company changing plans, things that involve paperwork/time to understand
Attention	Not paying attention to retirement documents, planning, resources.

Dissatisfaction	Don't like the options they have for retirement savings
Social Security	Ideas about, knowledge about social security
<i>Money Management Concepts</i>	
Saver	Tends to be conservative, saves money
Spends	Spend as much as they make or more (have discretionary income but don't save)
No discretionary income	No extra income to save; unexpected life event (illness, car repairs, etc) are likely to be huge setbacks
Hardship	Divorce, job loss, or other significant personal event that affects saving
Advice	Mentions getting professional or personal advice (friends family) - why
Values saving	Salient idea of saving instilled at a young age - especially by parents
Budgeting	Has a budget, or doesn't have a budget but mentions it
<i>Generational Life Concepts</i>	
Forgotten generation	Mention the concept or construct of being a middle or "forgotten" generation or identifies with other Gen X concepts
Parents divorced/both work	Mention being a latchkey kid or parents divorced
Key cultural events	Mention effect of events such as cold war/fall of berlin wall, challenger disaster, Jonestown, Watergate, 3 mile, etc.
Boomer/millennial mentality	Mention characteristics they feel are more in line with millennials or boomers (or coder perceives them as such)
Information availability	More information available than ever, don't have to go to the library
Sandwich	Taking care of parents and kids at the same time
2008 recession	Affected by the recession
Caretaking	Boomerang kids, etc. parenting, effect of parenting on financial lifestyle or decisions
DB v. DC	Mentions something related to defined benefit v. defined contribution plans
<i>Computer Skill Concepts</i>	

Problem solver	Trouble shoots computer problems; isn't afraid to get lost or break things
Learning strategy	How individual teaches themselves new computer skills
Casual user	Surfs the internet, online shopping, research, social networking using favored sites
Critical user	Conducts business online such as banking, financial planning, anything that involves sharing personal information or financial information/devines between spam and fake news and real things
Learn for work	Learned computer skills primarily because of work
Learn hardware/software	Learned computer skills because they were interested in computers, code, how things work
Motivation	Motivated to learn for personal reasons
Learned in MS	First introduced to computers in Middle school (had classes, friends had computer, family owned a computer)
Learned in HS	First introduced to computers in High school (had classes, friends had computer, family owned a computer)
Learned in college	First introduced to computers in College (had classes, friends had computer, family owned a computer)
Tool [v. lifestyle]	Use a computer to accomplish tasks (read books, do my job)
Lifestyle	Computer fully integrated into lifestyle
Self-rated skill	Rating of skill level using computers
Foreshadowing	Importance of computers in the future (either are important or are not)
Benefits	Benefits of computers versus other tools/technology
Keeping up	Technology developing fast, harder to learn new skills
Parsing information	Determining what is good v. bad information

APPENDIX C. Scales for Experiment 2

Tech Anxiety Rating Scale

No	Question
1	I worry that something I do will break my device
2	I worry that bad things will happen if I press the wrong button or click the wrong thing
3	I worry that something I do will accidentally delete important information or files
4	I worry about what might happen after I press a button or click something
5	I worry about whether it is safe to connect to the internet (Wi-Fi) in public places)
6	I worry that other people will see information that I don't want them to see
7	I worry that people I don't know (hackers) will steal my information or identity
8	I worry that my device will get infected with a computer virus or malware
9	I worry that people will think I'm stupid if I ask for help
10	I worry that I will look silly or foolish
11	I worry that people will watch and judge me
12	I worry that I will forget how to do something that I've already learned how to do
13	I worry that I won't be able to figure something out on my own
14	I worry that I won't be able to use my programs (or apps) if a new version comes out
15	I worry if I have to do something new
16	I worry when a window or message appears (pops up) on my screen
17	I worry about what will happen if I choose to install or accept an update to my device, program or app
18	I worry that I won't be able to find something that I've saved on my device
19	I worry that I won't be able to get back to where I started after I click a link or open a new page or program

- 20 My worries overwhelm me
- 21 My worries make it difficult to concentrate on my task
- 22 I tell myself that I am too old to do this
- 23 I tell myself I'm not good with computers
- 24 I tell myself that I will never figure out a new task
- 25 I tell myself that I need to do things more quickly
- 26 I rehearse the steps that I need to take in my head

Financial Inhibition Scale

Financial Inhibition Scale (FIS)

I worry about my finances in retirement

I am concerned about being dependent upon friends or family members for financial support after I retire

I often find myself concerned about not having enough money in retirement

I worry about making mistakes in my financial preparations for retirement

I am concerned about being financially stable in retirement

I often feel that something bad will happen in retirement for which I will not have adequately saved

Compared to my friends, I have a lot of fears involving financial planning for retirement

I feel nervous or hesitant when doing financial planning for retirement

I am hesitant about making retirement investment decisions because I am worried about making a mistake

Generalized Anxiety Disorder

Generalized Anxiety Disorder 7-item (GAD-7) scale

Over the last 2 weeks, how often have you been bothered by the following problems?	Not at all sure	Several days	Over half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it's hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3
<i>Add the score for each column</i>	+	+	+	
Total Score (<i>add your column scores</i>) =				

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all _____

Somewhat difficult _____

Very difficult _____

Extremely difficult _____

Source: Spitzer RL, Kroenke K, Williams JBW, Lowe B. A brief measure for assessing generalized anxiety disorder. *Arch Intern Med.* 2006;166:1092-1097.

Financial Knowledge Test

Interest Rate:

Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

More than \$110, Exactly \$110, Less than \$110, DK, RF

Inflation:

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

More than today, Exactly the same, Less than today, DK, RF

Risk:

Is this statement True or False? Buying a single company's stock usually provides a safer return than a stock mutual fund.

True, False, DK, RF

Tax Offset:

Assume you were in the 25 percent tax bracket (you pay \$0.25 in tax for each dollar earned) and you contributed \$100 pretax to an employer's 401(k) plan. Your take-home pay (what's in your paycheck after all taxes and other payments are taken out) will then: Decline by \$100, Decline by \$75, Decline by \$50, Remain the same, DK, RF

Match:

Assume that an employer matched employee contributions dollar for dollar. If the employee contributed \$100 to the 401(k) plan, his account balance in the plan including his contribution would:

Increase by \$50, Increase by \$100, Increase by \$200, Remain the same, DK, RF

Retirement Planning Activity Scale

1. Frequently read articles/brochures on investing or financial planning.
2. Read one or more books on investing or financial planning.
3. Frequently visited financial planning sites on the World Wide Web.
4. Gathered or organized your financial records.
5. Regularly tuned into television/radio shows on investing or financial

planning.

6. Conducted a thorough assessment of your net worth.
7. Identified specific spending plans for the future.
8. Discussed financial planning goals with a professional(s) in the field.
9. Discussed financial retirement plans with an employer's benefits

specialist.

10. Discussed retirement plans with a knowledgeable friend or acquaintance.

Cognitive Load Measure

Cognitive Load Measure of IL, EL, & GL

- The topic/topics covered in the activity was/were very complex.
 - The activity covered formulas that I perceived as very complex.
 - The activity covered concepts and definitions that I perceived as very complex.
 - The instructions and/or explanations during the activity were very unclear.
 - The instructions and/or explanations were, in terms of learning, very ineffective
 - The instructions and/or explanations were full of unclear language.
 - The activity really enhanced my understanding of the topic(s) covered.
 - The activity really enhanced my knowledge and understanding of statistics.
 - The activity really enhanced my understanding of the formulas covered.
 - The activity really enhanced my understanding of concepts and definitions.
-

System Usability Scale

System Usability Scale

- I think that I would like to use this system frequently
- I found the system unnecessarily complex
- I thought the system was easy to use
- I think that I would need the support of a technical person to be able to use this system
- I found the various functions in this system were well integrated
- I thought there was too much inconsistency in this system
- I would imagine that most people would learn to use this system very quickly

I found the system very cumbersome to use

I felt very confident using the system

I needed to learn a lot of things before I could get going with this system

APPENDIX D. Usability Heuristics

Interaction design: Designing the way users work with the site

1. Use conventional interaction elements.
2. Make obvious what is clickable and what is not.
3. Make clickable items easy to target and hit.
4. Minimize vertical scrolling; eliminate horizontal scrolling.
5. Ensure that the Back button behaves predictably.
6. Let the user stay in control
7. Provide clear feedback on actions.
8. Provide feedback in other modes in addition to visual.

Information architecture: Organizing the content

1. Make the structure of the Web site as visible as possible.
2. Clearly label content categories; assist recognition and retrieval rather than recall.
3. Implement the shallowest possible information hierarchy.
4. Include a site map and link to it from every page.

Visual design: Designing the pages

1. Make pages easy to skim or scan.
2. Make elements on the page easy to read.
3. Visually group related topics.

4. Make sure text and background colors contrast.
5. Use adequate white space.

Information design: Writing and formatting the content

1. Make it easy to find things on the page quickly.
2. Focus the writing on audience and purpose
3. Use the users' language; minimize jargon and technical terms.

APPENDIX E. SCALES, MEAN AND SD

Construct	Item wording	Min/ x	Mean	SD
Financial inhibition scale (FIS; Neukam & Hershey, 2003)	I worry about my finances in retirement	7/63	42.57	10.49
	I am concerned about being dependent upon friends or family members for financial support after I retire			
	I often find myself concerned about not having enough money in retirement			
	I worry about making mistakes in my financial preparations for retirement			
	I am concerned about being financially stable in retirement			
	I often feel that something bad will happen in retirement for which I will not have adequately saved			
	Compared to my friends, I have a lot of fears involving financial planning for retirement			
	I feel nervous or hesitant when doing financial planning for retirement			
	I am hesitant about making retirement investment decisions because I am worried about making a mistake			
	I worry that something I do will break my device			
<i>Measured on a seven-point, Likert type scale from (1) strongly disagree to (7) strongly agree.</i> Tech anxiety rating scale (TARS; Steelman & Tislar, 2019)	I worry that bad things will happen if I press the wrong button or click the wrong thing	26/130	60.93	19.58
	I worry that something I do will accidentally delete important information or files			

I worry about what might happen after I press a button or click something
 I worry about whether it is safe to connect to the internet (Wi-Fi) in public places)
 I worry that other people will see information that I don't want them to see
 I worry that people I don't know (hackers) will steal my information or identity
 I worry that my device will get infected with a computer virus or malware
 I worry that people will think I'm stupid if I ask for help
 I worry that I will look silly or foolish
 I worry that people will watch and judge me
 I worry that I will forget how to do something that I've already learned how to do
 I worry that I won't be able to figure something out on my own
 I worry that I won't be able to use my programs (or apps) if a new version comes out
 I worry if I have to do something new
 I worry when a window or message appears (pops up) on my screen
 I worry about what will happen if I choose to install or accept an update to my device, program or app
 I worry that I won't be able to find something that I've saved on my device
 I worry that I won't be able to get back to where I started after I click a link or open a new page or program
 My worries overwhelm me
 My worries make it difficult to concentrate on my task
 I tell myself that I am too old to do this
 I tell myself I'm not good with computers

I tell myself that I will never figure out a new task
 I tell myself that I need to do things more quickly
 I rehearse the steps that I need to take in my head
Measured on a five point, Likert-type scale from (1) never to (5) always.

Financial knowledge
 (FKPre: Clark, Maki, & Morrill, 2014)
 Suppose you had \$100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?
 Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

0/5 2.24 1.30

Is this statement True or False? Buying a single company's stock usually provides a safer return than a stock mutual fund:
 Assume you were in the 25 percent tax bracket (you pay \$0.25 in tax for each dollar earned) and you contributed \$100 pretax to an employer's 401(k) plan. Your take-home pay (what's in your paycheck after all taxes and other payments are taken out) will then:

Assume that an employer matched employee contributions dollar for dollar. If the employee contributed \$100 to the 401(k) plan, his account balance in the plan including his contribution would:

Multiple choice, summative where 0 = incorrect, 1 = correct.

System Usability Scale (SUS; Bangor, Kortum, & Miller, 2008)
 I think that I would like to use this system frequently

0/100 51.51 9.07

I found the system unnecessarily complex
 I thought the system was easy to use

I think that I would need the support of a technical person to be able to use this system
I found the various functions in this system were well integrated
I thought there was too much inconsistency in this system
I would imagine that most people would learn to use this system very quickly
I found the system very cumbersome to use
I felt very confident using the system
I needed to learn a lot of things before I could get going with this system

Measured on a five point, Likert-type scale from (1) strongly disagree to (5) strongly agree.