WOMEN’S SELF-IDENTIFIED SOURCES OF STUDENT SUPPORT IN A MASTER’S-LEVEL HEALTH INFORMATICS DATABASE COURSE

A thesis presented
by
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to
The School of Education

In partial fulfillment of the requirements for the degree of
Doctor of Education in the field of Education

College of Professional Studies
Northeastern University
Boston, Massachusetts
March 2017
Abstract

This study examined the supports that female students sought out and found of value in an online database design course in a health informatics master’s program. A target outcome was to help inform the practice of faculty and administrators in similar programs. Health informatics is a growing field that has faced shortages of qualified workers who understand the business, health care, and technical issues involved. Educating new workers has in part meant teaching clinicians (including many nurses) a cluster of new skills surrounding the “collection, storage, retrieval, communication and optimal use of health related data, information and knowledge… for the purposes of problem solving, decision making and assuring highest quality health care” (Hovenga, Kidd, Garde, & Hullin Lucay Cossio, 2010, p. 9). The online database design course examined in this research was the first induction into this cluster of skills. Seven alumni were interviewed in depth about their challenges and sources of support. These were analyzed with Interpretive Phenomenological Analysis (Smith, 2004) using a lens of the Social Cognitive Career Theory of Lent, Brown, and Hackett (1994, 2002). Four themes emerged: comparing herself to others, not showing weakness, internal motivation, and peer support. Participants were challenged by feeling that they were less prepared or skilled than others, which led them to believe that their brains weren’t “wired this way.” Peer support was a particularly strong contribution to success, as well as the self-motivation of the participants. Recommendations include structuring the course (and possibly a sequence of courses) to encourage the formation of peer groups that will provide support.

Keywords: Health informatics, STEM, women, online education, STEM education
Acknowledgements

I want to thank the participants who took the time to recall and examine their experiences in the database design course, opening themselves up to an analysis of their experiences. If nothing else, what I have learned here will change my practice in the future.

I want to thank Dr. Chris Unger, my tireless advisor, who kept pushing me forward and kept finding ways for me to improve my work.

I want to personally thank Dr. Natasha Axelson, whose encouragement and text review supported me to actually finish.

I want to thank Dr. Kelly Conn for her insightful comments, which improved this paper.

I want to thank Dr. Kristin Greenwood, who provided insights that improved this paper.
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Chapter I: Introduction

Technology has been central to the evolving changes of twenty-first century healthcare. This has left a significant shortage of workers with knowledge of health care and technology. Educators have struggled to fill this shortage with students. Taking people with technical knowledge and educating them in health care would burden already-constrained clinical education programs, and technology-savvy workers are already in short supply in industry (Xue & Larson, 2015). Thus, a computer science major might not be interested in additional education about the clinical work in health care because that computer science major already has strong job prospects. This has left a focus on teaching technical skills to people who have non-technical backgrounds, some of whom have clinical backgrounds, such as nurses and pharmacists, and some of whom have backgrounds that are neither clinical nor technical. A definition for “technical background” will be offered in the next paragraph, followed by details about the technology involved in health informatics in the following paragraphs.

“Technical background” is used in this paper to refer to a cluster of technical skills and aptitudes that prepare students for advanced technical courses in the health informatics program at the center of this study. These advanced technical courses cover how health data is represented and stored, as well as how it can be retrieved and analyzed. The technical skills and aptitudes needed include: computer programming, data structures, statistics, algebra, algorithms, and symbolic logic. Students in the program who need to improve in these areas take introductory technical courses. The introductory database design that was at the center of this study is one example of such a course.

Why is there such a shortage of workers who understand both technology and health care? There has been a sudden demand for these workers that began with an explosive
discovery. Preventable medical errors in hospitals killed up to 98,000 people per year, which was more people than the number killed by motor-vehicle accidents, breast cancer, and AIDS combined (Kohn, Corrigan, & Donaldson, 1999). The 98,000 figure was from a groundbreaking report from the Institute of Medicine in 1999 that sparked a revolution in health care technology.

Besides the large size of the problem, the report focused on fixes at the level of the health care system, not the individual clinician. In other words, the report showed that the problem was not a few bad clinicians but a bad system that relied on humans to have super-human memory for detail, and the solution was at the system level. Computers are very good at details without getting tired or forgetting a step, but the health care system relied on paper and humans rather than computers.

Fixing the health care system was a challenge because the economic incentives were misaligned between the groups that provided medical services and the groups who paid for the services. A massive investment in technology was needed. A massive investment by the federal government in health technology caused the health informatics field to boom and a new field of practice evolved. The general name of this new field of technology was known as health informatics. In brief, this technology focused on electronic medical record systems and the exchange of health data between systems and the analysis of the health data. There are many other aspects to the technology, such as bar-code medication administration, which involves scanning a bar code on the patient and a bar code on the medication packet to make sure the right medication is going to the right patient at the right time; other technologies include clinical decision support systems which flag medication orders that may be inappropriate for a patient due to an allergy or other known issue. This massive technology implementation became health care’s moonshot in 2009 with the American Recovery and Reinvestment Act (ARRA). The
ARRA included the Health Information Technology for Economic and Clinical Health (HITECH) Act, which committed $25.9 billion to promote the adoption of health information technology, mostly toward electronic medical records (Pipersburgh, 2011).

Health informatics promised to bring both savings within the health care system and increase quality of care. Health care had much room for improvement. In 1999, if a hospital conducted lab tests that had recently been done at another hospital because those other results were not available, the hospital was paid for doing the lab tests again. Bates et al. (1998) estimated that 8.6% of diagnostic tests were duplicates, adding to healthcare costs. Buying a computer system to track lab results was expensive, and getting that computer system to “talk” to a computer system at another hospital raised all kinds of compatibility and interoperability issues. Before 1999, the hospital would have had to pay for that system, a system that would have resulted in the hospital getting paid for fewer lab tests. Similarly, a hospital would pay to install a system to reduce medical errors by using bar codes to make sure the right medications went to the right patients or a clinical decision support system that would flag medication orders that were likely inappropriate. Without those systems, when a patient was made sick by a preventable error, the hospital would be paid to treat the patient’s problem. These economic disincentives were significant barriers to technology adoption. Given this problem, the American Recovery and Reinvestment Act (ARRA) of 2009 provided direct money and indirect financial incentives for technology adoption in health care. It also established standards for the electronic systems to communicate with each other. Health informatics involved more than tracking lab results, but similar barriers and economic disincentives existed for many of the systems used in health care. This left many opportunities to reduce costs and increase quality through health informatics.
With federal money, hospitals made massive efforts to adopt electronic systems. To do this, they needed workers with specialized training and skills. The HITECH Act included funding for education and job training, and it was estimated that 50,000 new workers would be needed (Hersh, 2013). These workers would be in a field called health informatics, which was “an evolving scientific discipline that deals with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge... for the purposes of problem solving, decision making and assuring highest quality health care” (Hovenga, Kidd, Garde, & Hullin Lucay Cossio, 2010, p. 9).

Ultimately, the adoption of electronic systems reduced mortality from preventable medical errors (Poon et al., 2010; Neily et al., 2010; Starmer et al, 2014), but estimates of such deaths remained high (James, 2013). James found estimates as high as 200,000 to 400,000 deaths per year due to preventable medical errors. The review by James used newer estimation methods, and the increase from earlier estimates was likely due to better estimation, not a true increase. Either way, the importance of reducing preventable medical errors did not fade, and the efforts in health informatics continued.

The work of health informatics required people, each of whom had knowledge in all three areas: technology, the clinical context, and business processes. Using the lab example from above, it demonstrates the need for health informatics workers were needed who understood the technology involved in the electronic systems (computers, software, networks, data analytics etc.) as well as the clinical context (how lab tests are ordered, how the results are used, who uses the results, etc.), and understood the business processes (billing, process improvement, etc.). It was (and is) important to have health informatics workers who understood all three areas.
Due to the nature of the field, people who enter the field of health informatics often come from one of three areas: technology, business, or clinical practice. This makes sense, as these are the key areas of knowledge involved in health informatics, and someone who already has strong knowledge in at least one area has an advantage over someone with no related background. This may explain why there are few entering the field who have no related background. The first group of entrants listed above – those who have backgrounds in technology – are often computer science or information technology (IT) workers, who can learn enough about the clinical context and business issues to be effective health informatics workers. The second group of entrants - those who have business backgrounds - are often business analysts who can learn the technical and business issues involved in health informatics. The third group of entrants – those from clinical practice— are often nurses or pharmacists who can learn the technical and business issues involved in health informatics. These clinicians are the largest group of entrants into the field of health informatics. The majority of the clinicians entering the field are nurses, which contributes to a heavily female ratio in health informatics because about 91 percent of nurses are women (Landivar, 2013). In the health informatics master’s program at Northeastern University in which this study was conducted, 62 percent of the enrolled students in 2017 were women.

For students who do not have a business background, learning the business issues in health informatics is manageable. For students who do not have a clinical background, learning the clinical issues is manageable. For students who do not have a technology background --or a background that is related to technology-- learning the technology issues involved in health informatics can be quite challenging. This asymmetry is due to an asymmetry in the amount of knowledge from each of the three key areas involved in health informatics. For example, a health informaticist implementing a laboratory record system would need to know enough about
the health care context to know that a hemoglobin A1c is a blood test used by clinicians to
monitor patients with diabetes, but she would not need to know the large volume of information
that clinicians know about how the test is used. She would need to know some of the business
workflow options for improving the care of patients with diabetes, but she would not need to
match the full business knowledge of someone with an MBA. However, she would be expected
to have enough technical knowledge to use the technology to analyze the data that included the
hemoglobin A1c results, looking for patterns and trends in the data, and she would need to
understand the computer systems and networks involved. Learning to do this technical work is
not trivial, and it poses a larger challenge than learning the other two areas, clinical context and
business practices.

This study sought to examine a master’s degree program in health informatics at
Northeastern University. This master’s program has a core curriculum divided up to match the
three key areas of health informatics: clinical context, business, and technology. As described
above, the technical core can be challenging for students who do not have a background in
technology. The type of thinking and approaches involved in science, technology, engineering,
and math are often related, causing them to be collectively referred to by the acronym STEM.
Jeffers, Safferman, and Safferman (2004), emphasized the connections between the different
parts of STEM, and that what was learned in each of the different parts of STEM were mutually
supportive. Technology can include many things, but for this paper, the focus of what is referred
to as “technology” is: writing computer code, computer scripting, and computer programming,
but not just the use of technology. Whether or not Jeffers, Safferman, and Safferman are correct
about the connections between different parts of STEM, it is clear that many STEM programs
include courses in coding, scripting, or programming, while other programs that are classified as
STEM include math and science but not coding or other related technology studies. (Even as this paper is being written, technology is already an increasing part of many STEM and non-STEM subjects, but for a master’s program such as the one at the center of this study, students enter having had previous studies that may not have included much focus on technology.)

In the health informatics program at the center of this study, students who do not have technology backgrounds generally have found the technical core courses more challenging. In recognition of this, the program offers different technical core classes (selectives) for students who do or do not have a technical background. Students who do not have a technical background begin the technology core with a course in database design that was specially designed for students who do not have a technical background. This course teaches students about databases, but it also teaches students about the thinking and approaches used in other technology courses. Students who do have a technical background begin with a different technology course in the technology core. This makes the course in database design a key turning point for students who do not have a technical background, bringing them into the world of technology and the technology core in the program.

The data analytics mentioned previously is not the only part of technology involved in health informatics. The health related data is mostly stored in databases. The master’s program at the center of this research has a course in database design to teach students how to design a database in which one can collect, store, and retrieve health data. (This course is offered on campus and online.) Data cannot just be crammed into a database like unmatched socks stuffed into an over-filled drawer. A database model provides structure to the data and assigns relationships within parts of the data. Designing a proper model is critical for gathering the correct information and storing it in ways that it can be properly retrieved later. One must match
the “socks” and store them in an organized fashion, which is especially important when the “socks” are health records for millions of patients. Learning database design also teaches a type of representational thinking that carries over to other technology-focused classes in the program and to other aspects of handling data in health informatics. As a key transition into the thinking and skills needed to deal with health data, the course in database design is the place where students with non-technology backgrounds struggle. It is also the course—once completed—that seems to leave students feeling that they have entered the technology world of health data. This makes the database design course the ideal focus for the problem of inducting non-technology students into the technology portions of health informatics. While other STEM fields and STEM degree programs may not be centered around database design, the concept of bringing students without a technology background into a technology track could apply to any STEM field, especially since technology is an increasing part of all STEM fields (and many non-STEM fields).

**Research Problem**

Against a backdrop of science, technology, engineering, and math (STEM) fields where women are under-represented, health informatics draws a substantial number of women. In a variety of STEM fields, the educational pipeline has been actively researched, from early schooling to undergraduate studies to PhD education to hiring. Much has been written about the barriers that dissuade women from entering the fields, as well as the sources of support that have encouraged women to enter the fields and successfully stay in them. Many women enter the field of health informatics, but the sources of support that would encourage them to successfully stay in the field have not been fully explored. Unfortunately, there is a lack of knowledge about sources of support for women in technology courses specifically at the master’s level. This
leaves little guidance for health informatics educators who want to have proper supports for women at the master’s level.

**Justification for the Research Problem**

Being a woman “affected absolutely everything” (MacLachlan, 2006, p. 239). This was the major theme identified by MacLachlan in surveys of women in graduate-level STEM programs. This theme was reflected in persistence to graduation. In a general undergraduate population, being male predicted a lower chance of graduating (Webber & Ehrenberg, 2010). But in STEM fields, being female predicted a lower chance of graduating (Ehrenberg, 2010).

Explanations for this gendered difference in graduation rates in STEM were varied, and they will be covered in the literature review. Although there was much research done on gender differences in persistence to graduation in STEM fields (including some literature that questioned whether there truly was a difference), the research focused on traditional campus programs, without considering the effect of online education. Online education is increasingly popular, but it adds another variable to women’s persistence in STEM. Yu-Hui, C., & Yu-Chang (2015) found that women had different preferences for online discussion modality than men. Women preferred audio/video discussion over text-based discussion more than men did. These different preferences for online tools and the many different explanations for disparities in graduation rates between men and women strongly suggest that something complicated is happening, and direct research is needed to examine the sources of support that women and men find most effective in online technology courses.

**Deficiencies in the Evidence**

Much has been studied about women in STEM programs, yet there was little found that focused on master’s-level STEM programs, and even less on women’s experiences in online
STEM programs. The literature on women in undergraduate STEM and in PhD STEM programs is not enough for comparison for anyone focused on women’s participation in a master’s-level STEM program. Kanny, Sax, and Riggers-Piehl (2014) divided explanations for women’s under-representation in STEM education into five categories: “individual background characteristics; structural barriers in K-12 education; psychological factors, values, and preferences; family influences and expectations; and perceptions of STEM fields” (Kanny, Sax, and Riggers-Piehl, 2014, p. 142). The literature focused on undergraduate STEM education in terms of selection of STEM majors and persistence in STEM majors, and the literature also focused on doctoral STEM programs (Ampaw & Jaeger, 2011; Gardner, 2009; Bekki, et al., 2013). As stated above, little research has focused on master’s-level STEM programs or online master’s-level STEM programs.

**Relating the Discussion to Audiences**

The most direct audiences for this research are instructors and administrators in online master’s-level health informatics programs who have an interest in designing programs with proper supports to increase retention and ultimate success. By small extension, this research can also apply to instructors and administrators in other master’s-level online STEM programs. I anticipate using the results of this research to directly guide updates made to the structure of the master’s-level health informatics program and the online courses in it.

**Significance**

Health Informatics combines technical skills and clinical understanding. It has elements of biological and life sciences as well as elements of computer and information science. In biological and life sciences, women earned 3,291 master’s degrees in 2001-02 compared to 2,423 master’s degrees by men, whereas in computer and information science, women earned 2,749
master’s degrees in 2001-02 compared to 5,605 master’s degrees by men (Goan & Cunningham, 2006). Health informatics draws heavily on the female population.

Even for STEM degree programs that do not have trouble attracting women, it is still important to know what supports work best for students at the master’s level. Kanny, Sax, and Riggers-Pieh (2014) found five meta-narratives in 324 research articles in a review of 40 years of research into the gender gap in college-level STEM, and there has been a concerted effort to close the gender gap in STEM, yet very little of the literature focuses on master’s-level STEM programs. Master’s-level programs feed the workforce needs, and online programs are more popular with working students (Cameron, 2013). With so little known about supports for women in online master’s-level STEM courses, combined with the likelihood that online courses will be chosen to educate existing workers, there is a need for knowledge about the supports for women in an online, master’s-level health informatics program.

Positionality Statement

This positionality statement examines the potential sources of the researcher’s bias in regards to the study of an online database design course in a health informatics master’s program, as well as ways to minimize such bias. I will start by addressing the fact that I am not a woman. I do have a background in software development and database design, and I am the instructor of the course that was examined. I am also the director of the program at the center of this research. Next, I will examine how reduced these potential sources of bias. I will review a potential source of cognitive bias and how I overcame it, as well as a subtle source of potential bias suggested by Jupp and Slattery (2006).

Author background. Any examination of what supports work best for women may have been biased by my gender. Through this research, I hoped to offer insight into the supports
women feel helped them succeed in an online database design course. I relayed what I heard them say. I have a strong background in technology, and I have been programming computers from a very young age. Due to this, I may have approached online courses differently than people who do not have the same background, and since the technology used in online courses matched my background, I may not have clearly seen how people with a non-technology background perceive online courses. My technical background also meant that I may not have understood the experience of people with a non-technical background when faced with a course in database design. Even my categorization of the nursing profession as focusing more on science than technology may have been influenced by my positionality. As the instructor of the database design course that was examined and the director of the health informatics program in which the course was situated, I could easily have had a personal bias against seeing any flaws in the course or the program. For all of these potential sources of bias, awareness of my positionality and awareness of my potential bias were the best ways to control the bias.

*Author’s experience.* At the time of the research, I had directed the Northeastern University health informatics master’s program at the center of this research for seven years, and I had taught the database design course for almost as long, so I had some preconceived ideas about the topic of research. Since the database design course was usually the first deeply technical course in the program for students with a non-technical background, I worked hard to help students make the transition into the technical mindset needed. I had worked with other instructors in the program who are brilliant people and masterful with technology, yet they have struggled to teach the students with non-technical backgrounds, and I had worked with instructors who could more easily teach students with non-technical backgrounds. The instructor made a difference. I chose to teach the database design course because I saw its importance as a
transition for students with a non-technology background, and I told students this. I offered myself as a guide to them, and over time I developed a good sense of what helps non-technical students “get it.” As a teacher, I was proud of helping them in their journeys. As a researcher, I may not have wanted to hear that I created a challenge that they faced, and it may have been difficult to hear if students turned to sources of support outside my classroom or my program. Again, awareness of these potential sources of bias was the best way to control the bias.

Having taught the database design course for many years, I had developed beliefs about the challenges and sources of support for students in the course. I believed that students often benefited from support in self-concept (the belief that they could learn database design) as much as direct explanation of the material. Given this observation, I took care to interweave different kinds of “self-perception” support into my lectures as well as direct communications with individual students and formal course structure (e.g. discussion boards). In lectures, in emails, and in discussion boards, I reminded students that this was hard, but they could do it. I also saw students forming study groups and social groups, both of which were mostly composed of female students. I was left to suspect that there were other sources of support that I was unaware of, which could be more formalized. I was not sure to what degree students found those self-identified sources of support to be helpful or not helpful. It was for these reasons that I wished to pursue this study. My preconceived ideas were the genesis of this research, but they were also a source of researcher bias. Awareness was my best defense.

I had pre-existing ideas of the barriers that women had faced in STEM fields and STEM education, and this could have caused me to inadvertently distort research by listening for gender-based explanations. This was complicated by the mix of student backgrounds in the database course. The core curriculum of the health informatics master’s program at Northeastern
University was very flexible in order to accommodate students with various backgrounds, roughly categorized as clinical or technical or “other.” Students who do not have a technical background (clinical or “other”) were steered toward database design, and students who had a technical background were usually steered away from the course, toward other technical courses. As mentioned earlier, a majority of the students in the health informatics graduate program at Northeastern University were nurses, and a vast majority of nurses were women. The result of this was that there were a large number of women in the database design course who were nurses. As I developed ideas about supporting students in the database design course, anything that I saw as driven by the student being a clinician may actually have been driven by the student being a nurse or have been driven by the student having a non-technical background. I chose to undertake this research in large part to focus on my presumed influence of gender, but I needed to be very aware of this bias so as to not hear gender-based explanations over other explanations. It was important to note that I do not claim that gender had an inherent influence on challenges faced by students in my course or an influence on what sources of support they found effective, only that I had preconceived notions that social and institutional biases based on gender may have influenced each student’s beliefs about the course, resulting in different sources of support tending to be more effective for women. Awareness and care during the research were my best defenses against this bias.

There was a subtle form of bias that must be given explicit attention. Jupp and Slattery (2006) cautioned against “deficit understandings of student differences” (p. 199). There may have been differences between the supports that work best for women and for men, but this would not mean that the women are missing something or are deficient. I was conscious of the fact that as a male in a male-dominated field, it was easy to think of a male-friendly approach as
the default approach and a female-friendly approach as “different” or “deficit” approach. Remaining conscious of this was the best way to avoid this bias. Even in a field not numerically dominated by men, the very question of what supports women’s needs could have led to a mentality that women need more or different supports because they need help. I did not intend this as a direction of thinking, and I was very open to the possible finding that women’s supports would not be different from the supports I would want as a man. If there was any difference between what the women sought and what I might seek, I was careful not to think of one way as “more” or “less.”

**Research Questions and Goals of the Study**

This research attempted to answer the central question of what supports do female students enrolled in an online database design course in a health informatics master’s program perceive as being most beneficial? To pursue this topic, the following three research questions were used to guide the study:

1. What challenges did women with in an introductory online graduate database design course perceive as challenges to their learning?
2. What self-identified sources of support did women pursue and find helpful in support of their participation in an introductory online graduate database design course, and how did they find them helpful?
3. What sources of support did women wish they would have been provided within their participation in an introductory online graduate database design course, and how did they perceive those sources of support being of personal value?

The goal of this research was to inform the practice of administrators of online master’s health informatics programs, as well as administrators of similar programs.
Theoretical Framework

The theoretical framework for this research was the Social Cognitive Career Theory of Lent, Brown, and Hackett (1994, 2002) who built their Social Cognitive Career Theory to organize career-related interest, choice, and performance. Their work was based on Bandura’s (1986) Social Cognitive Theory.

Social Cognitive Theory. Bandura’s (1986) Social Cognitive Theory sought to explain a connection between thoughts and actions. He proposed a triadic reciprocal causation between environment, person, and behavior called triadic reciprocality. In triadic reciprocality, the environment, person, and behavior all contribute in a recursive process of self-determination in a self-regulating and self-reflective person. In other words, the three affect each other in an ongoing feedback loop. A person observes the outcomes of his or her own behavior as well as the outcomes of the behavior of others (social learning). This in turn drives a person’s behavior. As Bandura (1986) wrote, “What people think, believe, and feel affects how they behave” (p. 5).

According to Bandura’s (1986) theory, a person’s judgment of observed outcomes is based on self-evaluation, particularly a person’s perceived self-efficacy. Bandura (1986) defined self-efficacy as the set of beliefs about one’s control over one’s actions, which is based on one’s perceived ability to accomplish the action, and an important point is that these beliefs elicit action. If one believes that one has a personal attribute such as strength and one has been able to lift a heavy weight, then this feeds back to beliefs that one is able to lift things and thus one is more likely to try to lift a heavy weight. Bandura emphasized the observational learning aspect of the theory. If one believes that one has a personal attribute of strength, and one observes another person in the environment with similar strength attempt to lift a heavy object successfully, then this feeds back one’s beliefs that one would be able to successfully lift the
weight. We learn and are shaped by our experiences, and these include our observations of the experiences of others. Our self-efficacy is shaped by behavior and environmental factors, and in return, self-efficacy shapes our behavior. Pajares (2005) wrote, “of all self-beliefs, it is the beliefs that individuals hold about their competence, or self-efficacy beliefs, that powerfully influence the choices people make, the effort they expend, how long they persevere in the face of challenge, and the degree of apprehension they bring to the task at hand” (p. 295).

**Social Cognitive Career Theory.** Lent, Brown, and Hackett (1994, 2002) built their Social Cognitive Career Theory to organize career-related interest, choice, and performance. Their work was based on Bandura’s (1986) Social Cognitive Theory. Starting with Bandura’s interlocking model of three sociocognitive processes (self-efficacy, outcomes expectations, and goals), Lent, Brown, and Hackett added person variables and context variables. These all interact bidirectionally, just as in Bandura’s theory.

**Self-efficacy.** The first sociocognitive process in Social Cognitive Career Theory was self-efficacy. Bandura described self-efficacy as “people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances” (as cited in Lent, Brown, & Hackett, 1994, p. 83). Self-efficacy was also defined as a “dynamic set of self-beliefs that are specific to particular performance domains and that interact complexly with other person, behavior, and contextual factors” (Lent, Brown, & Hackett, 1994). The performance domain considered in this research was the field of health informatics, and the context was an online master’s program. In simple terms, self-efficacy was a student’s beliefs about the question: *Can I do it?* The allowance for complex, dynamic interaction in the theory brought together the various aspects of this health informatics program and the self-beliefs of women in the program. For example, health informatics involves technical subjects such as
database design. Students have self-beliefs about their abilities in database design, and these self-beliefs can interact with person factors (encouragement or discouragement from family or peers) and behavior factors (studying in a group or alone or not at all) and contextual factors (grades on assignments in the database design course). The complex interaction between these factors is an important part of understanding the theory. For example, a student might receive a poor grade on the same day that someone tells her that nurses aren’t good at database design and a study partner echoes this thought. This would have a different effect on the student’s sense of self-efficacy had the same factors occurred on a different day. To represent this example as a combination of three factors belies the complexity of the interaction within each factor and between the factors. People receive complicated combinations of messages about their self-efficacy, and a low mark on a seemingly easier homework problem might have a different effect than a low mark on a homework problem that appears more difficult. (A personal note: my experience has been that after three hours of struggling with a database design assignment, almost anyone will lose confidence, but in the evening, confidence can be lost much faster.)

**Outcomes expectations.** The second sociocognitive process in Social Cognitive Career Theory, outcomes expectations, involved “imagined consequences of performing particular behaviors” (Lent, Brown, & Hackett, 1994, p. 83). In simple terms, this was a student’s beliefs about the question: *Will I get a good result?* For example, a student might imagine that working hard on an assignment in a database design course will lead to a good grade, which will lead to a good job, or a student might instead imagine that further studying will not crack the impossible nut, leading to a low grade and to poor career prospects.

**Goals.** Lent, Brown, and Hackett (2002) defined goals, the third sociocognitive process in Social Cognitive Career Theory, as “the determination to engage in a particular activity or to
effect a particular future outcome” (p. 263). In simple terms: Am I ready to do this? For example, a student’s determination to conquer a challenging assignment in database design could be high or could be low.

**Person variables.** Person variables were not specifically enumerated by Lent, Brown, and Hackett (1994, 2000, 2002). These are qualities of an individual. Some examples were gender, ethnicity, and socioeconomic status. An important distinction between Social Cognitive Career Theory and other theories that built upon Bandura’s (1986) Social Cognitive Theory was that Social Cognitive Career Theory did not envision personal attributes and abilities (e.g. intelligence) to be static (Betz and Hackett, 1981). The dynamic interaction of all the elements caused each element to affect another.

**Context.** Lent, Brown, and Hackett (2002) modeled context elements (e.g. a supportive environment) as a part of Social Cognitive Career Theory. This was part of the complex interaction between the elements of the model. Sources of support mostly fell into this category, but the complex interactions between the elements blurred the boundaries.

**Applying the theory.** Social Cognitive Career Theory can be used to explain the performance of a student in a database course. A student might start with a low sense of self-efficacy with database design and might expect that the outcome of attempting assignments would be a low grade. These variables would influence the student’s goals, reducing the student’s drive to complete the assignment. Gender is a person variable, and a woman might believe that being a woman makes her not as good at database design, which lowers self-efficacy and makes the outcome expectation even more negative and further reduces her goal drive. On the positive side, a context of a supportive environment might positively influence self-efficacy and goal drive. It is important to note the bidirectional feedback. All of what is described above
would likely lead to a low grade, which would lower the student’s sense of self-efficacy and goal drive, which would lead to a low grade, etc. It is also important to note that Social Cognitive Career Theory posited a complex interaction between the different variables. It was more than outcomes affecting one’s sense of self-efficacy, which affects goal drive, which affects outcomes.

The combination of the three sociocognitive processes (self-efficacy, outcomes expectations, and goals) with person variables and context provided a framework to explain persistence in an online database design course in a health informatics master’s program. The complex interactions and bidirectional feedback accurately captured the real-life influences of supports on a student’s sense of self-efficacy, outcomes expectations, and goal drive, which included interactions between the variables that might not be directly caused by sources of support. For example, encouragement one day might work whereas another day it will not because of complex interactions between the variables.

**Summary**

The following three research questions were used to guide the study:

1. What challenges did women in an introductory online graduate database design course perceive as challenges to their learning?

2. What self-identified sources of support did women pursue and find helpful in support of their participation in an introductory online graduate database design course, and how did they find them helpful?

3. What sources of support did women wish they would have been provided within their participation in an introductory online graduate database design course, and how did they perceive those sources of support being of personal value?
Social Cognitive Career Theory informed the researcher’s consideration of three areas related to this study: students’ beliefs about their own technical capabilities (self-efficacy), whether they will be successful in problem sets in a technical class (outcomes expectations), and their determination to complete the technical coursework successfully (goals). These beliefs can be summarized with the questions: *Can I do it?, Will I get a good result, and Am I ready to do this?* A variety of previous experiences shaped students’ beliefs before they enrolled in the program, and a graduate program can only change how it serves students once they are in the program. When faced with a challenge in a technical subject it was possibly harder to overcome that challenge when the student had negative self-beliefs about the student’s own self-efficacy with technology, outcomes expectations regarding a technical problem set, or goals, which formed a complex feedback loop. When this happened, the students could have turned to different sources of support.

This research explored the challenges and sources of support for women in a database design course in a master’s level program in health informatics.
Chapter II: Literature Review

Health informatics is a 21st century STEM field. An understanding of how to build supports for women in a master’s-level health informatics program with online courses requires combining several areas of knowledge and research. This literature review analyzes research on STEM education as a facet of 21st century learning, persistence and the status of women in STEM fields/education, and the development of online education. The review of STEM education in the United States shows the importance of STEM education for building a modern workforce. The review of 21st century learning situates this literature review in the new skills and new ways of learning for the 21st century that ultimately results in the development of online education.

The State of STEM Education in the United States

According to the White House (“Educate to Innovate,” 2013), President Barack Obama stated:

One of the things that I’ve been focused on as President is how we create an all-hands-on-deck approach to science, technology, engineering, and math… We need to make this a priority to train an army of new teachers in these subject areas, and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve. (p. 1)

President Obama was not just paying lip service to the importance of STEM. The prominent place to which STEM had risen in the United States was demonstrated by the adoption of the Next Generation Science Standards (NGSS) in 2013. These standards were “developed by the states to improve science education for all students” (Next Generation Science Standards, n.d.). This was a shift in focus that had educators moving the emphasis from “simply teaching science ideas to helping students figure out phenomena and design solutions to problems” (Krajcik,
The focus on STEM continued, and in 2015, President Obama announced $240 million to support STEM programs for students (Glum, 2015). The reason for the focus on STEM was clear: according to the President’s Council of Advisors in Science and Technology, “Economic projections point to a need for approximately 1 million more STEM professionals than the U.S. will produce at the current rate over the next decade if the country is to retain its historical preeminence in science and technology” (as cited in Xue and Larson, 2015). A million trained STEM professionals might have seemed like a large gap, but the Monthly Labor Review (Xue & Larson, May 2015) presented a more nuanced picture, finding that academia was oversupplied with STEM professionals while government and private sectors had shortages of STEM professionals in specific areas. This fact was supported by a survey of Fortune 1000 firms (Bayer Facts of Science Education, 2014), which found that half of the talent recruiters in those companies reported difficulty filling jobs that require STEM degrees, with 94% of the talent recruiters responding that this was due a shortage of qualified candidates, and 68% of the talent recruiters expecting an increase in shortages of STEM candidates in the next 10 years.

Looking beyond the general need for STEM workers in the workforce, health informatics has a history of shortages of workers. Estimates in 2009 of the new number of health informatics workers needed were about 50,000 new full-time professionals (Hersh, 2013). The need for more workers did not fade over time. A report from Burning Glass Technologies (December 2014) projected that the demand for health informatics would grow at twice the overall employment rate, while there was already a shortage of workers in the field.

Is Nursing a Technical Field? This paper treats clinical backgrounds as non-technology backgrounds, with nursing being the most common background of health informatics students who have a clinical background. This raises the question of whether nursing is a technical field.
Nursing programs do include science courses and often include a math course (usually statistics). Nurses are active users of technology, but most nursing programs have not included technical courses in coding or scripting. (This is changing.) For example, the Florida College System considers nursing a STEM field because many of the topics in a nursing curriculum are clearly science. This led the president of University of South Florida to state, “I would like to add another ‘M’ to the STEM because it’s science, technology, engineering, mathematics and medical degrees. The job markets are there. We have many new companies looking for the workforce in STEM degrees” (Jordan, 2013). As of 2017, the University of South Florida bachelor of science in nursing program required one statistics course but did not require any computer programming or computer scripting courses (UF College of Nursing, 2017). This was representative of most nursing programs at the bachelor’s level.

**Shortages of Students in STEM**

This literature review examines shortages in the health informatics workforce and the need to attract non-STEM students to the field. This raises the question of whether there truly are so few students who have STEM undergraduate backgrounds and why there are so few. To answer the first part of that question, the shortage is clear. The National Center for Education Statistics found that only 250,000 out of about 1.6 million undergraduate degrees were in STEM (as cited in Jensen, Neely, Hatch, & Piorczynski, 2015). The second part of the question, why there are so few STEM majors, has two parts: students choosing to pursue STEM and students in persisting to graduation in STEM programs. This review will address those two parts in order.

**Choosing to Pursue STEM**

**Choosing STEM at the undergraduate level.** There is research on attracting students to STEM majors (Qidwai, Riley, & El-Sayed, 2013; Gayles, 2011, Heidel et al., 2011). This
research focuses on students who have already chosen a master’s-level health informatics program, and a deep examination of why undergraduates choose STEM is beyond the scope of this review.

**Students without technology backgrounds pursuing STEM master’s degrees.** There is very little data on the number of non-STEM undergraduate background students who are pursuing master’s level STEM education and STEM careers, and even less is known about students with STEM backgrounds that are less technical pursuing master’s level technology programs. There are many documented efforts to get elementary school students into STEM. As described above, there is research on attracting undergraduate students to STEM majors. There is research on keeping students in STEM undergraduate majors, which will be covered in the next section. We do have the data that international students earn 44% of the master’s degrees granted in the United States in computer and information science (National Center for Education Statistics, November 1997). No information is available on the backgrounds of these students or about the backgrounds of domestic students who pursue master’s level STEM degree programs. For the academic year 2011-12, a total of 91,584 master’s degrees were conferred in STEM fields in the United States. This was a large increase from the 70,018 STEM master’s degrees granted in 2005-06 or the 59,458 STEM master’s degrees granted in 2000-01 (National Center for Education Statistics, 2013).

**Persistence in Higher Education**

Persistence to graduation has long been a concern in higher education, with a long history of research. Understanding why people drop out and why people persist has been a key foundation in the formation of interventions to reduce dropouts and increase persistence to graduation. Spady (1970, 1971) distinguished between integration in the social domain of
college and integration in the academic domain of college. Both areas contribute to a student’s persistence to graduation. Tinto (1975) described these domains as reciprocal in creating a model that explained attrition. In simple terms, one could spend too much time socializing and not enough time studying, or one could spend too much time studying and not enough time socializing. The first combination is more clearly a recipe for being kicked out for poor academic performance, but the second combination could also lead to withdrawal for emotional reasons or even suicide, which Tinto pointed out was lumped together with other forms of non-persistence in previous research. In order to persist in college, a student needed a balance of the two domains. Another domain for understanding attrition came from Pascarella and Terenzini (1980): a student’s external environment (external to the college, e.g. work). Bean and Metzner (1985) worked this into a new model of social integration, academic integration, and external environment (again, external to the college, not just external to the student).

After Spady (1970, 1971) and Tinto (1975), research moved toward more elaborate models of persistence and deeper analysis, but the fundamental sense of social and academic integration remained. Tinto (1987) still found the basis for effective retention to be a commitment to quality education in an inclusive educational community as well as a strong, inclusive social community. Within this, details were added over time. For example, Terenzini and Pascarella (1977) tested Tinto’s model and confirmed that integration into social and academic systems were equally important for student persistence to graduation, but they also found that informal interactions with faculty were associated with increased integration in both social and academic systems, which were associated with increased persistence to graduation.

Beyond the persistence models of social integration, academic integration, and external environment, the research uncovered other explanations for persistence. Winham (1994) and
Moore (1995) found that full-time enrollment most predicted persistence, while Feldman (1993) and Price (1993) found that part-time enrollment most predicted non-persistence. Race, class, and gender were found to be explanatory variables for college persistence. Walpole, Chambers, and Goss (2014) found that gender mattered more than race as a predictor of persistence in community colleges but not in four-year colleges. Blustein (1986) found that cognitive ability and student expectations were most predictive of success in community colleges. Kuh (2007) wrote that, “Socioeconomic background, financial means, college readiness, and support from home substantially influence whether a person will earn a credential or degree” (para. 2). First-generation college students also got attention in the literature. Terenzini, Springer, Yaeger, Pascarella, and Nora (1996) found that first-generation students differed in background from traditional students and had different experiences while in college. Solmon (1981) found that having student loans correlated with reduced persistence among men at all income levels, but effects on women depended greatly on loan amount and parental earnings. At the college level, there were many explanations and predictors of persistence, along with a resulting array of recommendations for improving persistence.

**Persistence in STEM at the undergraduate level.** While there is research on persistence and lack of persistence in undergraduate majors, much of it is very specific to undergraduate studies. For example, while improving the K-12 STEM pipeline to college is a worthy endeavor, it is not a useful recommendation for someone working with a master’s program in STEM. Part of the research on persistence in STEM at the undergraduate level does have seeming application to the master’s level. Griffith (2010) found that academic preparation prior to college explained much of the persistence of students in STEM undergraduate majors. This may inform the admissions criteria for a master’s program in STEM, and it might inform
the development of master’s courses that account for different levels of preparation. Courses in STEM are well known for having more challenging grading standards than other majors. Ost (2011) and Rask (2010) examined the relationship between grades in STEM courses and persistence in STEM. There was a clear relationship between grades in early STEM classes and persistence in STEM majors. (Author’s note: teaching a graduate database design course to non-STEM background students is a struggle between properly evaluating students and encouraging students to not give up over a few low grades.)

**Persistence in STEM at the PhD level.** At the PhD level, persistence was also researched. Some of the research articles on persistence levels in PhD programs were particular to PhD program design, but there were also general predictors of PhD program persistence that covered a variety of explanations. Litalien and Guay (2015) found that perceived competence was the major predictor of persistence in a PhD program, while faculty and advisor support had only indirect effects through improving perceived competence. Frasier (2013) found that being a primary caretaker for children increased time to completion for PhD students. Stock, Aldrich-Finegan, and Siegfried (2009) found that coming from a top-60 undergraduate school slightly increased persistence to timely completion of an economics PhD, but mentoring by faculty was more influential. They also found a predictor of timely completion that is particularly applicable to a PhD program and may not general to other levels of programs: a pre-thesis paper was inversely correlated with timely completion of the thesis, which was the opposite of the expected effect, that completing a pre-thesis would ease the production of the thesis.

**Persistence in STEM at the master’s level.** Despite a variety of research on persistence in STEM at undergraduate and doctoral levels, both of which are outlined above, there is no available research on persistence in STEM that is specific to the master’s level.
Gender and STEM

**Educating women.** Long before online education existed, there was a focus on women in education. The groundbreaking Equality of Educational Opportunity study (Coleman, et al., 1966) looked at education opportunities in four areas: segregation in public schools, equality of educational opportunity, how much students were learning, and relationships between student learning and types of schools they attended. Before that, women were divided into those who were career-motivated and those who were homemaking-motivated (Hoyt & Kennedy, 1958). Astin and Myint (1971) looked at the career development of women after high school, and their survey offered possible selections for career choices that were grouped into ten categories. Despite the presence of a category called *miscellaneous*, which included “all other choices” (Astin and Myint, p. 373), an entire category was created for *housewife*, separate from all the other categories. Astin and Myint’s study conceived of women in typically male-dominated fields as being more career-oriented, and career-orientation was seen as zero sum with homemaker-orientation. Women chose a family or chose a serious career, and serious careers were those dominated by men. At the time of Astin and Myint’s study, STEM fields were heavily dominated by men.

**The effect of gender on ability in science.** Up until this section, the literature review has focused the general population of students following education in STEM fields, but there have been many scholarly articles about the shortage of women in STEM.

**Early explanations for women’s low participation in STEM: Intrinsic characteristics.** Political correctness is not new. It goes back at least to Bambara (1970). While it might seem common knowledge now that it is not politically correct to attribute women’s underrepresentation in STEM to lesser innate ability, there has been a slow progression of the
focus on women in STEM through a variety of explanations that focus on intrinsic characteristics. In the 1970’s, women who went into male-dominated fields (the “serious fields”) were measured in terms of their attributes that resembled male attributes. Maccoby and Jacklin (1974) examined some of these attributes, including higher-level cognitive processing, achievement motivation and dispelled beliefs about gender differences in those attributes, but the work makes clear that such beliefs were widespread.

Lubinski and Benbow (1992) noted that education research on women in STEM had been going in a negative direction, and they found a new direction for education research by borrowing from psychiatry. In the field of psychiatry, Meehl (1972) described in detail the genetic foundations of schizophrenia, rehashing with noticeable frustration what he believed was well known at the time, and he explained the reason that many clinicians rejected the genetic foundations of schizophrenia: a genetic foundation for schizophrenia would be incompatible with a psychological intervention. Besides describing what he believed was a clear genetic foundation for schizophrenia, Meehl emphasized the point that people can accept a genetic explanation for schizophrenia without giving up on psychological interventions. Many psychiatric researchers and clinicians hesitated to accept clear evidence of a genetic foundation for schizophrenia because they incorrectly believed that this meant giving up on psychological interventions. In simple terms, the argument about whether schizophrenia was caused by nature or nurture caused people to see it as one or the other, but not both. Those who provided treatments based on nurture did not want to believe explanations of causality based on nature. Meehl argued that a causality based in nature (genetics) could be accepted without denying the effectiveness of a treatment based on nurture (counseling). Lubinski and Benbow (1992) transferred this idea to education. They found that gifted women did as well in math as their
male counterparts but chose to take fewer courses than their male counterparts, and they applied Meehl’s idea to reject the attribution of gender differences to socialization:

Some theorists may be drawn to explanations stemming from socialization because of the erroneous conclusion that if gender differences are environmentally determined, they are somehow more readily modifiable. Whether individual differences in a behavioral trait are primarily determined by biological or environmental factors is not what determines how responsive the differences will be to environmental intervention. Environmentally determined individual differences may be highly resistant to change, and biologically determined individual differences often are quite modifiable. (p. 66)

A correct model of the cause may not be the best basis for a fix, and we must not let ourselves become biased towards believing a cause that seems most directly related to a fix. In other words, the effectiveness of social interventions in women’s participation in STEM may cause people to accept the explanation that women’s differing participation in STEM is due to socialization, but we must remember that just because social interventions influence the situation does not mean that social causes are the reason for the situation. Also, we can believe certain explanations for the cause of the situation without limiting solutions to those solutions that are based on the beliefs of the cause.

**Modern explanations for women’s low participation in STEM.** As research moved beyond a focus on the supposed intrinsic characteristics of women that explained their participation in STEM, there was a portion of research that claimed that women were underrepresented in STEM and examined other possible contributing factors. However, other portions of research claimed that the gaps between women and men in STEM had closed. Answers to this debate were contradictory and often looking at different measures. For example,
In explaining the nuanced picture of women’s representation in STEM, Heilbronner (2013) pointed back to Lubinsky and Benbow (1992) as having identified a gender gap in STEM and pointed to Hyde and Mertz (2009) as suggesting that a gender gap no longer existed. Heilbronner went on to cite a National Science Foundation (2011) report showing that women had earned more doctoral degrees in science than in the past, but Heilbronner cited the same report showing that women were still underrepresented in many STEM fields, including engineering and computer science. Lubinsky and Benbow (1992) examined 20 years of data on gifted children for differences between the genders in abilities (such as mathematical reasoning) and attributes (interests and values). For abilities, they found that there was a gender gap 20 years ago (which is what Hilbronner seemed to refer to), but they found that more recently “males and females are converging toward a common mean on a variety of abilities, including mathematical reasoning” (Lubinsky & Benbow, 1992, p. 62). Even if one were to set aside the shift over time that could cause results and reports to change, the measurements in Lubinsky and Benbow did not paint a clear picture. Among gifted children who took the SAT-Mathematics test, males in the upper score ranges vastly outnumbered females (for example, among gifted children who scored above 700 on SAT-M, males outnumbered females 13 to 1). Yet, they reported no gender-based difference in scores on Advanced Raven Progressive Matrices. The authors reported that enrollment in math and science classes differed between males and females who had similar grades or where females had superior grades, driven by presumed differences in attributes (interests and values). The work identified by Heilbronner as suggesting that the gender gap no longer existed was Hyde and Mertz, which actually was quite similar to Lubinsky and Benbow in finding that a gap had existed but was closing or had closed. They found that in the general population, girls and boys had reached parity in mathematics, but among the gifted,
more males than females were in the top percentiles, but the gap was closing. Finding the same pattern of higher variability in math scores among males that Lubinsky and Benbow found, Hyde and Mertz examined scores across countries to find that this pattern was not universal, and the pattern of higher variability in math scores among males correlated with higher levels of gender inequality. They concluded that the increased variability in math scores for males was “largely an artifact of changeable sociocultural factors, not immutable, innate biological differences between the sexes” (Hyde & Mertz, 2009, p. 8801).

**Women’s representation in STEM.** Moving past a sampling of the conflicting measures of science ability from the previous section, the statistics on gendered participation and representation in STEM are also not unitary. They start with clear disparities that closed over time but still leave substantial differences. Kelly (1987) reported that in 1982, advanced secondary school classes in Physics and Chemistry had 80 and 65 percent (respectively) of students who were male, with 41 percent of the students in advanced Biology classes who were male. In 1999-2000, 40% of undergraduate degrees in physical sciences were earned by women, and 20% of undergraduate degrees in engineering were earned by women (National Center for Education Statistics, 2001). These statistics led Blickenstaff (2005) to state, “There is no dispute that women are underrepresented in science, technology, engineering and mathematics (STEM) majors and careers” (p. 369). These statistics are stark, but a clearer look at this comes from a single data set.

The Integrated Postsecondary Education Data System (IPEDS) Completion Survey (IPEDS, n.d.) reviewed detailed statistics of the completion rates of 2 and 4-year post-secondary degrees from 1966 to 2013. In 2000, 37% of all STEM degrees were earned by women. If biological sciences degrees were excluded from the STEM degree totals (calculations made by
author), 27% of degrees went to women. In 2013, the numbers had hardly changed. 36% of all STEM degrees were earned by women, which became 24% if biological sciences were excluded. Despite this leveling and slight worsening in the 21st century, these numbers were an improvement over the more distant past. In 1990, 29% of STEM degrees went to women (23% excluding biological sciences), and in 1980, 25% of STEM degrees went to women (22% excluding biological sciences). See Figure 1 for a graph of the IPEDS data showing the percentage of STEM degrees and STEM degrees without biological sciences that were awarded to women. While women have made large gains in biological sciences, they remained substantially under-represented in STEM, especially in the non-biological STEM degrees.

![Figure 1](image-url)  

*Figure 1.* Percentage of post-secondary STEM degrees earned by women & STEM not including biological sciences & biological science, 1966-2013. Based on data from IPEDS (n.d.).
Explanations for women’s underrepresentation in STEM. The previous section of this literature review presented evidence of women’s representation in completing STEM degrees. The literature provides explanations for women’s under-representation in STEM. Kanny, Sax, and Riggers-Piehl (2014) methodically surveyed 40 years of literature on women in STEM, and they divided explanations for women’s under-representation in STEM education into five categories: “individual background characteristics; structural barriers in K-12 education; psychological factors, values, and preferences; family influences and expectations; and perceptions of STEM fields” (Kanny, Sax, and Riggers-Piehl, 2014, p. 142). Using their analysis and the other research available, I have isolated these themes that repeatedly surfaced as influential over women’s representation in STEM education and will briefly discuss each.

Individual background characteristics. One group of explanations for women’s underrepresentation in STEM focuses on the individual background characteristics of women. This is not necessarily a repeat of the intrinsic characteristics argument. MacLachlan (2006) found that women in the doctoral program being examined had different family backgrounds and ethnic identities, and they also had different educational experiences. Many of them had supportive teachers who encouraged them to attend elite colleges, but not all women came from such backgrounds. Peer groups had an influence in persistence in STEM, but college roommates did not (Ost 2010).

Structural barriers in K-12 education. Some of the structural barriers in K-12 would not have lessons for a master’s-level STEM program, but some would. Peterson (2014) examined structural barriers for females pursuing STEM in K-12 education and found many factors. Teacher passion and classroom characteristics were the most significant influences, and self-concept was the most common and most powerful barrier.
Psychological factors, values, and preferences. Sabot and Wakeman-Linn (1991) found that STEM subjects tended to have lower grades, and women were more easily discouraged by low grades. However, this explanation was refuted by Rask (2010), who looked at different majors and found that men were more sensitive to grades than women in terms of being discouraged from continuing in STEM subjects, and STEM subjects had grade distributions that were lower than those for non-STEM subjects. In another study, Ost (2010) found that women were more sensitive to grades than men, but only in physical sciences, not in life sciences. Ceci and Williams (2011) found that women tended to have different resources due to choices they had made. These choices related to preferences for starting a family. Fertility and lifestyle affected their decisions to stay in STEM, and women were constrained in their choices: having a baby can’t wait forever, but going directly into a PhD program and then directly into a career track was somewhat at odds with having a child.

Shapiro and Williams (2011) found a deep influence on STEM persistence coming from stereotype threat. One might think that anxiety about conforming to a negative stereotype would motivate students to perform well, but the anxiety about negative stereotypes can disrupt performance. Cadinu et al. (2005) found that women experiencing stereotype threat were more likely to have intrusive negative thoughts. Stout, Dasgupta, Husinger, and McManus (2011) found that role models helped moderate the effect of stereotype threat for women in calculus classes. Another view of motivation came from Smith, Lews, Hawthorne, and Hodges (2012), who found that women were more likely than men to feel a lack of belonging when they perceived that they needed to put in more effort than their classmates, which led to a reduction in motivation. They also found that the perception that a field was male dominated increased women’s belief that they would need to put in more effort than their classmates, and that if a
program stressed the need for hard work, women perceived their effort as normal, leading to an increased sense of belonging and motivation.

**Perceptions of STEM fields.** If students perceive STEM fields to be a bad match for them, this would reduce their interest in staying in STEM. Heilbronner (2011) looked at students who had left STEM majors and found some commonalities between in why men and women left, especially poor instruction and an unappealing lifestyle. Women left for different reasons than men, including “perceptions of crowded, impersonal classes” (Heilbronner, 2011, p. 879).

Christensen, Knezek, and Tyler-Wood (2014) found that girls in a high school science two-year program had more positive perceptions of STEM careers than the boys, focusing on being able to make a difference.

**Online Education**

**21st century learning.** STEM in general --and health informatics in particular—both require students to become 21st century learners, which can challenge students. The shift into the Knowledge Age in the 21st century requires new skills and new kinds of learning, and some learners may be tempted to believe that “the good old days are good enough” (Jacobs, 2010, p. 15). The world has changed, and the old ways of learning as we have learned in the past are no longer enough. The Internet has changed the way we work, the way we play, and the way we interact. Schoolrooms and conference rooms and living rooms have not gone away, but they have been supplemented by --and in some cases supplanted by-- Internet technologies such as email, video chat, and the World Wide Web. The Internet shifts our sense of time and distance, and it requires new skills.

This shift can be difficult; difficult for both educators and their students. What we are learning has changed. How we are learning has changed. As Jacobs (2010) described, new
kinds of schools create insecurities. Teachers are challenged to incorporate new instructional techniques into their pedagogy. Students must learn to negotiate new methods of learning and incorporate new skills into the learning process. For example, collaboration and innovative thinking have become highly prized thinking skills with the revision to Bloom’s taxonomy (Sedita, 2003). Gone are the days of rote memorization and “skill and drill.” Many students returning to school for a master’s program in 2016 (the year this research was done) had completed the last of their schooling before or barely in the start of the 21st century. Now they must face the new kinds of instruction and the insecurities that come with such changes in the learning process. Learning science in the 21st century has put an increased focus on context. This reflects the increased importance that the application of knowledge holds in 21st century learning. “Supplying a more authentic context for learning increases the chance that a lesson will be remembered and can be used in similar situations” (Trilling and Fadel, 2009, p. 31). Additionally, the ability to use learned material in various settings and in differing situations demonstrates the learner’s movement between the concrete and abstract understanding of concepts. Online education may provide a less authentic context for many learners, particularly those learners who did not grow up with online communication as the norm. These learners who grew up socializing without the Internet may also feel that online learning is less social. They may have less affinity for learning communities that are primarily online, and “learning in a community of learners who share knowledge, questions, skills, progress, and passion for a subject is exactly how adults learn” (Trilling and Fadel, 2009, p. 34). Instructors of online classes must seek to make the learning experience authentic in this new context.

**Development of online education.** Online education has deeply changed education in general. Online education has many definitions and goes by many names, including e-learning,
e-education, and Internet classrooms. This paper uses the term online education, defined by Ally as: “The use of the Internet to access learning materials; to interact with the content, instructor, and other learners; and to obtain support during the learning process, in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience” (as cited in Anderson, 2008, p. 17). Online education is a subset of distance education, a term which also has many definitions. Schlosser and Simonson (2009) define distance learning as “institution-based, formal education where the learning group is separated, and where interactive telecommunications systems are used to connect learners, resources, and instructors” (p. 1). By focusing on telecommunications systems and institutions, this definition excludes correspondence classes. Correspondence classes must be mentioned, even if they are not included as true distance education. Correspondence classes offered instructional material, often broken into weekly assignments, sent through the mail (Mason, 2000).

Correspondence classes used a simple technology of paper and mail, and as technology developed, distance education began using telecommunications technology to connect learners and instructors, which gave rise to Internet-based online education. In 1983, some courses were offered using expensive, dedicated audio/video transmission systems to connect a network of classrooms, beaming the audio and video from one site to another (Schwier & Balbar, 2002) using technology that is quaint by modern standards (Olesinski, 1995). The first undergraduate courses using this technology were offered in 1984, with the first graduate courses starting the next year, and the first degree using this technology was in 1986 (Harasim, 2000). With the invention of the Internet in 1989 and the invention of the World Wide Web in 1992, education moved online, with individual students connecting through the Internet (Harasim, 2000). Online education experienced rapid growth, with corresponding growth in investment in education
technology. Investments in educational technology companies hit $429 million in 2011 (DeSantis, 2012). During the rapid development of online education, the technology and tools used also developed. Distance education started with networks of classrooms that were connected together using audio-video telecommunication systems, and as this developed into online education, the technology for education has moved toward individual students connected together through the Internet.

MOOCs. A very recent development in online education was the development of Massive Open Online Courses (MOOCs), online courses that were open to anyone for free and attracted massive numbers of students (Chtena, 2015). Fundamentally, MOOCs use similar technology as other online courses, and they involve the basic arrangement of individual students connected through the Internet (albeit a massive number of them). MOOCs use the same basic arrangement as other online courses.

Communication tools in online education. Not only has online education changed education, but online education itself has gone through a substantial evolution, changing how students work together and find support. With the rise of the Internet, online education turned toward classes offered to students who are each in their own homes (or workplace) rather than co-located in networked classrooms. With this shift toward students who were connecting individually, the communication modalities for online education were often broken into synchronous and asynchronous categories (Murphy, Rodriguez-Manzanares, & Barbour, 2011 is a representative example). As defined by Angeli and Schwartz (2016), synchronous communication “relates to the exchange of messages between the communicants at the same time” (p. 1109), while asynchronous communication “consists of a progression of messages communicated at different times” (p. 1109). Research literature focused on student preferences
for synchronous or asynchronous communication tools and the effectiveness of these tools (Davidson-Shivers, Muilenburg, & Tanner, 2001; McBrien, Jones, & Cheng, 2009; Wang, 2004). There was a decent amount of research showing that women and men tended to prefer different communication modalities in online education (Ching & Hsu, 2015; Miller & Webster, 1997), with women preferring synchronous tools. The literature focused on preferences for different communication modalities among men and women, not on differing sources of student support for men and women in the online classes.

Online education did not move universally forward from students co-located in networks of interconnected classrooms to individual students connected through the Internet. In research and in some practice, there has been a return toward older models of online education, and recent efforts in online education focus on a single instructor or team of instructors communicating with many students and the students communicating among themselves, and the literature followed this (Lorenzetti, 2012; McBrien, Jones, & Cheng, 2009). With women showing different preferences for communication modality, these changes in delivery format may have influenced women’s affinity for online classes, and the literature followed these changes without looking at sources of support for online students. Some schools grew to multiple locations and were also increasingly going online, such as the KIPP Schools (Robelen, 2006) and the Big Picture Learning Schools (Rumberger, 2011). These schools were setting the stage for networks of connected classrooms that were connected site to site (rather than individually connected students) However, the research on site-to-site communication for classes is older, based on site to site arrangements that appeared to have been left behind (Beyth-Marom & Saporta, 2002; Grasinger, 1999; Keast, 1997; Olesinski, 1995; Tsuchitani, 1999). In recent research, there were hints of a return to site-to-site communication (Li, Amin, & Uvah, 2011; Parry, 2010). Current
research on community building and socialization in site-to-site structures is nonexistent. For online courses—but not for site-to-site online course—there is research on social presence (Akayoglu, Altun, & Stevens, 2009; Jolivette, 2007) and socialization (Dawidowicz, 2000; Landa, Holman, O’Neill, & Stuart, 2007; Lesniak & Hodes, 2006) and community-building (Schwier & Balbar, 2002). For engaging guest lecturers in communication with site-to-site classes, there appears to be no research, as this model is currently too rare. There exists a large assortment of online courses with different structures, some following the new pattern of individual students accessing courses, while other courses follow the old pattern that is regaining popularity, where students are grouped together at various sites.

In summary, much has changed in online education, and the literature documented the changes:

- the range of synchronous communication tools and asynchronous communication tools
- co-located students in networks of classrooms and individual students connected through the Internet

**Gender and online education.** Some of the research distinguished between men and women, but the focus was on preference of synchronous or asynchronous communication tools and on learning efficacy. There was no shortage of women in online education. Kramarae (2003) found that more women than men were taking online classes in about the same proportion by which women outnumbered men as college students. With the focus on preference and learning efficacy, there was no examination of differing sources of student support for men and women in online classes. The research did not provide much guidance for a practitioner designing a STEM program that would support women. The master’s-level health informatics
program examined in this study offered online courses with students connecting individually through the Internet, using a mix of synchronous and asynchronous tools.

**Conclusion**

The current research illuminated three areas that serve as a foundation for this research study:

1. The development of health informatics and the health informatics workforce
2. Persistence within the field of STEM and the experience of women persisting in STEM education.
3. The development of online education.

The literature provides many ideas for providing support to women in a master’s level database class in a health informatics program, but there are also many large gaps, especially at the master’s level, and this research will seek to add to this knowledge.
Chapter III: Methodology

This chapter presents the study context and design of the research study, inclusive of the research questions, the research tradition, the identification and recruitment of participants, data collection and data analysis. Trustworthiness of the data and the protection of the human subjects in this study are also discussed.

Study Context

The Program. The purpose of the master’s program that was studied was to educate the health informatics workforce, the people who will work in health informatics departments in hospitals, and other health care provider organizations (collectively called “providers”); consulting companies and equipment manufacturers (collectively called “vendors,”) and health insurance companies (collectively called “payors”). As quoted earlier in this paper, health informatics is “an evolving scientific discipline that deals with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge… for the purposes of problem solving, decision making and assuring highest quality health care” (Hovenga, Kidd, Garde, & Hullin Lucay Cossio, 2010, p. 9). Handling the data and information requires technical skills to understand how the data is represented and stored, as well as how it can be retrieved and analyzed. Handling the knowledge relates to a field more generally called knowledge management, and it requires technical skills regarding systems that turn information into knowledge (for example, a system that can flag a particular medication as probably being inappropriate for a patient due to the patient’s known allergies or other information). Problem solving and decision making require knowledge about the clinical context (how can we improve care for our patients who have diabetes?) and business processes (how can we improve our workflows to better serve patients?).
The program culminated in a Master of Science in Health Informatics. The program was designed with a deeply flexible curriculum to educate students who range from those who will be taking entry level positions in health informatics upon graduation to those who already have leadership positions in health informatics. Entry level positions were usually analyst positions. Middle positions included senior analysts, project managers, and informatics managers. Senior positions included hospital CIOs (chief information officers) and CMIOs (chief medical information officers). The positions that students took when they graduated after the program depended in large part on their education and experience when they entered the program. For example, a fresh college graduate was able to become an analyst with the master’s degree in health informatics, or a medical doctor (MD) may have become a CMIO with the master’s degree.

**The database course in the context of the Health Informatics program.** Students in the master’s program in health informatics that was studied undertook many of the same activities that working professionals in health informatics undertook: using tools to store, manipulate, retrieve, and analyze data; problem solving and making decisions based on the data analysis; and an examination of the clinical issues involved and the business issues involved, culminating in written reports with recommendations. Many of these reports were generated by teams made up of people with different backgrounds (technical, clinical, and business).

For technical courses and for technical work as professionals, several activities were involved: collecting and storing data; managing data; and retrieving and analyzing data. This involved database tools, data management tools, and data analysis tools. The first step—and in many ways the backbone of the entire system—involved databases. The course in database
design taught students how data is represented (e.g. a blood pressure of 120/80 is not the same as 1.5), how data is organized, how data is stored, and how data is retrieved.

**Teaching the database design course**

Learning database design requires a new way of thinking. Thinking like a database designer (I call it *thinking like a geek*) is the key lesson in the database design course, which I always explained at the start of each semester in the database design course. As described earlier, students who had technology backgrounds were usually steered away from database design in favor of more-advanced technical courses, and the database design course was designed for students who did not have a technology background. These students had not learned to think like a database designer. A good illustration of this new way of thinking is the example that I have used in the database design course. After briefly telling the students about moving into my new house and discovering that a previous owner had painted the electrical outlets, I have asked the students what they think the most important step is before replacing an electrical outlet. They have always had the same answer: turn off the power. This showed their non-technical thinking. A strongly technical person would have a different answer: test the old electrical outlet to see if it works. To explain the difference, I have asked students to imagine that I had replaced the outlet without testing it, only to discover that the new outlet did not work. Testing the old outlet would bound the problem in a way that technology practitioners already understand. Through the semester, students in database design have learned to apply this logical approach of bounding the problem to the process of uncovering problems in the database code that they have written. Learning this new way of thinking has often been challenging for students. In addition to this challenge, students have also been challenged by the need to recall old math concepts.
Graduate students who do not have a technology background have usually taken a few math classes at some point. They often vaguely remember talk of integers and decimals from math class, or they vaguely remember substituting a value for X in algebra. They find it challenging when asked to recall these concepts and apply these concepts in the database design course. For example, 120/80 is an integer numerator and an integer denominator. It is not a single ratio, and it is not a decimal (1.5). Another example: Instead of substituting a value for X, database design students substitute one SQL subquery in place of a result table. Database design also involves the use of Boolean algebra that would be familiar to a technology practitioner (or a philosopher), but Boolean algebra is a subject that can be quite challenging for the un-initiated. Bad memories of math classes often discourage students, who are thus quick to believe that they can’t handle database design.

Students in database design were thus faced with two challenges: a logical approach to a problem and applying math concepts. When faced with challenges in database design, students who did not have technology backgrounds turned to different sources of support. Study groups were formed. Discussion boards within the course allowed students to help and support each other, along with input from the instructor. Direct communication with the course instructor was available. Looking outside the course, a myriad of online examples could be found with a quick Google search, and online help websites that were not part of the course allowed people to ask questions and get answers from others.

**Research Questions**

The primary research questions of this study were:

1. What challenges did women in an introductory online graduate database design course perceive as challenges to their learning?
2. What self-identified sources of support did women pursue and find helpful in support of their participation in an introductory online graduate database design course, and how did they find them helpful?

3. What sources of support did women wish they would have been provided within their participation in an introductory online graduate database design course, and how did they perceive those sources of support being of personal value?

**Research Design**

This was a qualitative study. Although there was a large quantity of research on STEM education, women in STEM education, and online education, there was very little known about combining these together at the master’s level. “If a concept or phenomenon needs to be explored and understood because little research has been done on it, then it merits a qualitative approach” (Creswell, 2014, p. 20). At first glance, it might have seemed better to use a mixed methods approach, but this would not have been appropriate. In an approach to mixed methods research, “researchers may first survey a large number of individuals and then follow up with a few individuals to obtain their specific views and their voices on the topic” (Creswell, 2014, p. 20). The quantitative portion of a mixed-methods design that looked at a large number of individuals would have provided a quantitative comparison, but the point of this research was to explore the student experiences and sources of support, not to rank a “winner” for best support. A qualitative study allowed participants an equal voice with no single story singled out above others, and the researcher had the opportunity to understand a deep exploration of their experiences and perspectives.
Research Tradition

This research used Interpretive Phenomenological Analysis (IPA). IPA examines how subjects of the study make sense of their own experiences, using thick, rich description (Smith, 2004). The common phenomenon explored was the experience of the students within a master’s-level database design course. IPA draws upon phenomenology, hermeneutics, and idiography to create an approach that is both descriptive and interpretive (Pietkiewicz & Smith, 2012). However, contrary to phenomenology, which examines collective experience, IPA chooses to focus and understand the individual experience. IPA was a good fit for this research because this research sought to describe and find the essence of the individual students’ experiences, while also understanding commonalities from the data.

Participants

The population for this research included students who graduated from a master’s-level health informatics program at Northeastern University. From this population, a convenience sample was chosen, consisting of the students with whom the researcher had direct email contact, so as to not use any contact information from educational records, whom the researcher remembered from the database design course being studied. An email invitation was sent to this sample (see appendix A) that explained the research, including the requirement that any study volunteers not have a degree in STEM prior to taking the database design course being studied. This included any STEM degree at a bachelor’s, master’s, or doctoral level. Due to the lack of research on women in master’s-level STEM programs, this was an exploratory study, so six subjects would have been sufficient (Miles, Huberman, & Saldaña, 2014) to provide an in-depth analysis of the phenomenon (Pietkiewicz & Smith, 2012), but seven volunteers were interviewed and analyzed. This was not a qualitative study to measure and rank known sources of student
support. Instead, this study used qualitative analysis to focus on exploring an unknown area with “richness and holism, with strong potential for revealing complexity” (Miles, Huberman, & Saldaña, 2014, p. 11).

The population from which this sample was drawn had limitations that should be noted. All participants were graduates from a master’s-level health informatics program that offered online and campus courses, who took a course in database design. A large focus of this research was to fill in the gap in knowledge about women in online STEM programs at the master’s level, but while a health informatics program does include technical subjects, the students in the program may be different from—and use different sources of support than—women in other STEM subjects, even those that are online and at the master’s level (just like this program). The recruitment email asked people to volunteer, and people may have chosen to volunteer because they had characteristics or experiences that are different from non-volunteers. The exploratory nature of this study made recruitment biases less critical, but it was possible that entire voices could have been lost in the recruitment process. While everyone studied had graduated within four years of the study, it is possible that their memories of being a student differed from the reality of being a student.

**Recruitment and Access**

Participants were recruited from a pool of alumni who have graduated with a master of science in health informatics from Northeastern University within the past four years who took the database design course online. An email was sent to the pool from the researcher, explaining the research and inviting them to schedule a telephone interview. No financial compensation was offered. The section on protection of human subjects explains the protective steps that were taken.
Data Collection

The data for this research was collected by responsive interviews conducted by telephone, which were digitally recorded. Responsive interviewing was a good fit for this study because the research looked for nuance and subtlety (Rubin & Rubin, 2012). Telephone interviews made it more difficult to establish a relationship with the person being interviewed (Rubin & Rubin, 2012), but everyone interviewed had attended the master’s program in health informatics while I was the director of the program and the instructor of the database design course, so there already was some rapport between the researcher and participant. Telephone interviews were used rather than Skype interviews because many people in the program use laptops issued by their employers, and it was important that the participants could trust the privacy of the interviews. All participants were informed of the data management and privacy procedures, and after the initial introduction, they were informed that recording was starting. Beginning the recording after the introductions kept personally identifiable information out of the recordings. In health informatics, privacy of health data has long gotten a heavy focus, so all interview subjects were familiar with the concepts of anonymous versus personally identifying information. An unsigned consent script was read (see section on protection of human subjects) before each participant was individually interviewed using a framework of open-ended questions (see appendix B). Recordings were marked with coded identifiers and transcribed by a commercial transcription service. Information relating the coded identifiers to the individual interviewed were maintained securely as described in the data storage section. At the end of each interview, the subjects were informed that the recording was ending and thanked for their participation.
Data Storage

Interviews for this research were stored as digital audio files on an encrypted drive of a password-protected computer. An electronic file stored coded identifiers for all interviews that matched them with information about the person being interviewed, and it was stored with the digital audio files. The interviews without personal identifiers were sent to a commercial service to be transcribed, and the electronic transcripts were kept in the same manner as the digital audio files. Encrypted backups of all files were kept off-site. Recruitment emails contained written information about the research, which was echoed with an oral unsigned consent script during phone interviews. The time and date of the subject’s consent was recorded electronically for each phone interview. A follow-up email was sent to each participant after the interview offering thanks and repeating the information about the use of the interviews for research, emphasizing that no personally identifiable information will be published and including contact information for any questions about the research or the use of the interviews. Any paper generated during the work was locked up or shredded. All digital files and papers from the interviews were destroyed three years after the conclusion of the research. The digital audio files were sent to a commercial transcription service without any personal identifiers (only coded identifiers), and all other files and papers were accessible only to me.

Data Analysis

Interviews. The interviews from this research were digitally audio recorded and transcribed by a commercial transcription service. The researcher reviewed the transcripts for transcription errors, but no corrections were made for grammatical errors or broken speech. The intent of this process was to get the transcripts to best reflect what the participants actually said.
Analysis of the transcripts followed the six steps for Interpretive Phenomenological Analysis laid out by Smith, Flowers, and Larkin (2013):

1. A transcript was examined line by line.
2. Initial comments were made on the transcript.
3. Emerging themes were developed.
4. Connections between themes were identified.
5. The transcript was set aside for another transcript, starting with a clear mind.
6. Patterns across interviews were identified.

Trustworthiness

The data was coded for themes for the purpose of identifying patterns across interviews. This provided triangulation between the different interviews. “When qualitative researchers locate evidence to document a code or theme in different sources of data, they are triangulating information and providing validity to their findings” (Creswell, 2013, p.251). An attempt was made to provide thick, rich description (Creswell, 2014).

As with all qualitative research, there was a high potential for researcher bias, and the interpretive aspect of IPA only increased this potential. As described in the positionality statement, I am not a woman, which could have skewed my interpretation of the lived experiences of women. As instructor of the online database design course that was studied, and as director of the health informatics program that contains the course, there was further potential for bias because of pre-existing beliefs about the course or a desire to dismiss criticism. I was careful to heed Jupp and Slattery (2006), who cautioned against “deficit understandings of student differences” (p. 199). This meant that I listened carefully for the ways students found support without seeing the women as having a deficit that needed to be specially addressed.
Protection of Human Subjects

All study subjects gave informed consent to participate. I emailed an unsigned consent form (appendix C) with the recruitment email to participate in the research (appendix A). The unsigned informed consent was read to each participant at the beginning of each phone interview, and participants verbally consented. The recruitment email and consent form contained information about the purpose of the research, the methods used, and the risks and benefits involved. Participants were informed that their participation was confidential and completely voluntary and could be terminated at any time.

This study was reviewed and approved by the Northeastern University Institutional Review Board (IRB), including the use of unsigned consent, and the investigator provided evidence to the IRB of completing the required training for research involving human subjects.
Chapter IV: Findings

The purpose of this study was to answer the question of what supports female students in an online database design course in a health informatics master’s program sought out and found of value in the context of learning in this class. It was hoped that knowledge gleaned from this investigation might also inform the practice of faculty and administrators in similar programs.

An Interpretive Phenomenological Analysis (IPA) research design was used to examine the lived experiences of the study participants. IPA involves interpretation by the researcher as the researcher makes sense of the experiences. The study used a small sample size to focus on in-depth interviews, and thick, rich description of each participant’s story was included here to give voice to their experiences.

Three research questions guided this study:

1. What challenges did women in an introductory online graduate database design course perceive as challenges to their learning?

2. What self-identified sources of support did women pursue and find helpful in support of their participation in an introductory online graduate database design course, and how did they find them helpful?

3. What sources of support did women wish they would have been provided within their participation in an introductory online graduate database design course, and how did they perceive those sources of support being of personal value?

Seven participants were interviewed in depth. They were all graduates of the health informatics graduate program at Northeastern University who responded to an email invitation for women who had taken the online database design course in the program. Each participant
was interviewed in one semi-structured interview on the telephone. The interviews lasted from 65 to 82 minutes.

Transcripts of the interviews were analyzed in two different stages. First, each transcript was reviewed separately to record the individual responses and emergent themes. Second, the transcripts were reviewed as a whole to find common themes that emerged from the participants’ answers. Summaries of the individual interviews are presented here using pseudonyms to protect the privacy of the participants. No details have been changed, but some details have been presented in a less specific manner, especially the work histories, in order to protect the privacy of the participants.

Interview Summaries

**Angela.** Before beginning the health informatics master’s program, Angela was a trainer for an electronic medical record system at an academic medical center. This involved training clinicians to use the electronic medical record system. Before starting the master of science in health informatics, her degree was a bachelor of science in health administration. She chose the master of science in health informatics because she wanted to dive deeper into computer science and learn more about computer science and what it entailed. After earning her master’s degree, she worked as a clinical analyst for a different academic medical center, focusing on a different electronic medical record system. She later started consulting.

Prior to the database design course, Angela had no experience with databases. Angela reported that in previous math and science courses, she needed to put in extra work to “feel up to par.” She was initially nervous about her lack of knowledge in this area as well as excited to learn about databases. Angela stated that she initially anticipated the course would be difficult because she did not know much about databases. She assumed that she would have to do extra
work to learn compared to other people in the course. Angela said that once in the course, she did struggle at times, but she got a clear boost in self-confidence when she found out that other students were also struggling. She used the phrase “it’s not just me” five times during the interview in reference to the boost in self-confidence to proceed when she could see that other students were also struggling. When speaking about the result of finding out that other students were struggling, she stated: “It’s not just me… It’s not like I don’t know anything… it gives you a boost of confidence… Okay, it’s not just me, so I’m not going to give up. I’m going to continue.” The sense of support she felt from not being the only one struggling was evident throughout Angela’s interview.

Angela clearly expressed her belief that her hard work in the course would pay off. Angela described herself as an extrovert who had no trouble reaching out to the instructor, and she emphasized the importance for students to reach out to the instructor for help so that the hard work would be productive rather than “digging yourself in a deeper hole.”

Angela was motivated to study in the database design course. Angela confirmed that the material was challenging. She also had the belief she was better at reading and writing than STEM subjects. This was evidenced when she said, “since I’m good at reading and writing, that’s why I am not as good at math and science.” Yet this did not seem to have discouraged her. Instead, she repeatedly emphasized that she knew she would have to work harder, and she did so, in part because she feels the need to be as good as she can be. To her, this meant working harder if she was not up to par. When there were times that she couldn’t understand the material, she responded that “I know that’s impossible.” Upon further questioning, it was clear that she was not referring to database design material (or math and science material) as impossible. She believed it was impossible that she could not be able to learn the material.
Since Angela knew most of the people in the course, she anticipated being able to reach out to classmates or the instructor, and this was comforting. Angela recalled that she had anticipated that the online format would be a challenge for this course. From the perspective of having finished the course, she stated that the online format did not make learning harder than an on-campus course would have been. She explained that the online format led to a stronger support system because in an online course, “you actually get to hear from every single person because people have to post,” and hearing from other students clearly was supportive for her. In addition, Angela sought study sessions with classmates, which she reported were very helpful for her. When asked what she would give as advice to a new student in the course, she expressed the importance of a study group. She stated that a study group was important even if “you know what you’re doing, because you’ll learn more.” When describing how she would deal with challenging material, Angela included the step of talking to someone else who would know what she did not know. For Angela, classmates provided both support for self-efficacy as well as direct support for understanding the material.

Although Angela entered the course with a belief that she would need to work harder than others, she had a strong internal motivation. This was well captured by her statement, “Nothing is really that hard where you can’t accomplish it. It just may take longer.” Despite her clear extroversion and willingness to speak up and confidence that any problem was tractable if she just worked hard enough, Angela did express a general hesitation in all her classes to speak directly to an instructor because she didn’t want to be embarrassed by not knowing the material. Having other people ask questions made her feel more comfortable asking questions. It showed her that the challenge understanding the material was not due to her deficit. As she said, “it’s not me.” She expressed in several different ways a comfort that came from seeing that other
students were also struggling. Her repeated words, “it’s not just me,” drive home the importance she put on this. This belief that “it’s not just me” boosted her confidence, and confidence enabled her to continue. Yet she also stated that she “didn’t need people to be like a cheerleader. [She] really needed people who could be helpful [in understanding a difficult problem].” This was an interesting contrast. Feeling like she was not the only one having problems was helpful for her self-confidence and persistence, but having people directly cheer her on she said was not helpful when her self-confidence needed a boost.

The interview with Angela ended with an interesting discussion. She stated that in person, it might be harder to speak to a male professor, but online, gender is less important. She did however turn toward female classmates when seeking help, which she directly explained was because “women are more nurturing… women will give you more time, and they’re more patient.”

**Bethany.** Before starting the health informatics master’s program, Bethany worked in a medical office. Prior to the master’s degree, she had earned a bachelor’s degree in psychology. The medical office where she worked was adopting an electronic medical record, and Bethany was “fascinated with what we were doing with the technology and how it would help patients who came to the practice.” Additionally, she wanted to further her career and stay in healthcare, so she decided to pursue a master’s degree in health informatics. After earning her master’s degree, she worked as a trainer for electronic medical records, helping clinicians learn the system.

Prior to the database design course, Bethany had no real experience working with databases. She reported that back in high school and college, “Math was not something I was very strong in.” She reported being intrigued by science and technology, but had not taken many
classes in science or technology. When first registering for the database design course, she was very concerned that she did not have the background knowledge needed. Bethany reported having thought, “I was nervous about not having as much computer science skills as probably some of my classmates.” Due to this belief, she left the database design course until the end of the program. She stated that she was “really nervous to take it [database design].” It became apparent in this interview that Bethany’s sense of self-efficacy was clearly influenced by Bethany’s comparison between herself to her sister, who had a degree in Information Technology and was “very fluent in SQL.” (SQL is the language used in the database design course; being fluent in SQL is a way of saying that someone is good with databases.) It was clear that Bethany saw her sister as the person who was good with technical subjects, and that Bethany saw herself as the one who was not good with technical subjects. Bethany stated that by the end of the course her sense of self-efficacy with databases had improved. In her words: “I felt like accomplishing database design really didn’t make me a technical guru by any chance, but it definitely made me feel this is something that isn’t an area of fear anymore. I can accomplish these things.”

Bethany expressed episodes of doubt as to whether she could figure out the problems in database design even if she kept working at them, which interacted with her sense of self-efficacy. She described having hit a wall thusly: “Ugh, this is just not the way my brain works… This is obviously something that makes so much sense to someone else. It just does not make sense to me.” She explained that non-technical courses in the master’s program came easily to her, and when she was struggling in a technical course like database design, it was obviously because her brain didn’t work that way, and she said that when she had trouble, “I was gonna beat myself up that it was my brain.” There was clearly a strong interaction between her sense of
self-efficacy (the way she believed that her brain worked) and the outcome she expected (being able to understand the material if she kept working at it).

Bethany was motivated to tackle material that she found challenging, and she saw mastering the material as important for her career. Even when she had hit a wall and needed help, she described wanting help in understanding the material, not just getting an answer.

Bethany described a strong internal drive that seemed to both help and harm her persistence. The harmful side of the motivation was shown in her statement, “I’m hard on myself, so I was nervous that if I didn’t pick it up right away that [the course] might be a little daunting to me.” She went on to talk about times that it was daunting. The helpful side of her internal drive was shown in her statement, “Once I dive into something, I dive in 100%, so I knew once I signed up for [the course], it was kind of like ripping off the Band-aid. I was extremely motivated as soon as I signed up for it. I knew it was something you had to learn.”

One significant influence that emerged in Bethany’s interview was the relationship she had with her sister. Bethany’s sister was “very supportive” of Bethany during the course, and Bethany’s sister had encouraged Bethany to take the course. Bethany reported her sister’s words: “You have to take it. You’re gonna love it. You’re gonna love it.” However, as described earlier, Bethany’s sense of self-efficacy appeared to have been negatively influenced by her sister’s mastery of the topic. Her sister provided a supportive environment while registering for the course and taking the course. Bethany said, “Her support really made me feel like I could accomplish it.” Conversely, Bethany’s sister also provided a model of database mastery that excluded Bethany, leaving her with a low sense of self-efficacy. Bethany also got support from her class partner for the group project in the course. She described this in her statement: “My partner and I worked closely, [she] and I, throughout the creation of the database
Bethany talked about support from her sister and her project partner, but her largest source of support reportedly came from inside the course, as evidenced in her statement: “It was frustrating when I didn’t feel like I was understanding, but the fact that you [the instructor] took the time for an online course to really make sure your students understood was amazing, and that, I think, is what was the biggest help for me.”

Bethany stated that “it would have been more beneficial to take this course face to face with you,” and further discussion revealed that this was due to the asynchronous nature of email and discussion boards and the delays in getting answers, even when responses were coming “within the hour.” When asked about a synchronous online session, she replied, “That would have been awesome” and “I think that would have been very beneficial.” Bethany’s responses made evident that she felt that synchronous communication would have better supported her.

**Catherine.** Before starting the health informatics master’s program, Catherine worked at an academic medical center as a registered nurse. Prior to the master’s degree in health informatics, she had a bachelor’s degree in nursing. When asked why she chose the health informatics master’s program, Catherine said that it was because “I love computer science and health information technology, and secondly because I just needed another outlet for a career.” After earning her master of science degree in health informatics, she began work as a trainer for electronic medical record systems, helping clinicians learn and use the system.

Catherine had no prior experience with databases before the database design class. Even without previous experience, she reported feeling very confident about her ability to take the database design course. She also reported having done well in math and science courses. Referring to her belief about her ability to do database design, she stated: “My theory was if I
could do math and science, I could do this.” Later, she used Statistics as an example of a very challenging course that required effective teaching, and she appeared to view the database design course as another example of a challenging course. The fact that she had ultimately done well in the statistics course seemed to have added to her self-confidence. However, as she got into the material of the database design course, she said, “I thought I bit off more than I could chew,” and that “getting stuck was very disheartening.” When asked directly what she did when she felt like that, she said that she called me because I was the instructor.

When Catherine had trouble with the material, she talked to a particular classmate whom she knew from other courses. Catherine reported that she and this other classmate were good sounding boards for each other. Catherine gave strong indications that they helped reduce each other’s self-doubt. Catherine reported getting technical help from a work colleague who had an engineering background. As Catherine stated, “He thought it was quite simple.” Although she did not say so directly, I had the sense that his easy mastery of the material made Catherine feel very different from him. She stopped going to him for help. She reported that she got much of her support from me, the instructor.

Catherine remembered being the only registered nurse in the course, which challenged her sense of self-efficacy by comparison. She described seeing everyone else as more advanced, and she did not feel that she was their equal. Speaking generally, rather than referring directly to her experience, Catherine described how thinking “they’re better than me” could set a student up for a self-fulfilling prophecy of failure. Her comparison to her peers was not based on gender, as evidenced by her direct statement that “It didn’t occur to me that because I’m a woman that I can’t do something.” The comparison was rooted in her conception of herself as a nurse in a class full of technical people. She said, “I have the mindset of a nurse, not that of a computer
programmer or database analyst.” She clearly saw herself as needing to put in extra effort, even in preparation for asking a question on the online discussion board. In her words, “I did a lot of work for discussion board, researching stuff so that I could actually come up with stuff that sounded like I knew what I knew I was doing. Because they were technical, and I was not.”

While Catherine at times described her sense of having different abilities from her classmates in a disheartening way, she also stated that when classmates posted something on the discussion board that she did not understand, “I researched everything so that I would know more. Because I was bound and determined to get it and understand what they were doing.” On further questioning, she clarified that she did this for her own learning, and she needed help understanding and learning, not in reassurance that she could do it. She clearly believed that with enough work, she could learn the material despite the challenges. The end result of the database design course was that she now feels much more confident in her technical abilities. She said, “I got through database design; I can get through anything now.”

As described earlier, Catherine entered the database design course feeling confident that she could handle the course, but her struggles with the material and her perception of being a nurse in a class full of technical people did cause her to feel behind her classmates. She felt that she needed to put in extra work. However, she was ready to put in this extra work and did so. Catherine clearly had a strength and perseverance that enabled her to persist through the course, even when she needed to do extra work just to prepare to ask a question on the discussion board.

In response to a question about the effect of the online environment of the database design course, Catherine directly stated, “I should have taken that course in person.” The online format clearly seemed sub-optimal to her, but when this was explored more deeply, it was the
asynchronous nature of the course that bothered her, and the idea of a synchronous online session appealed to her.

**Deborah.** Before starting the health informatics master’s program, Deborah worked as an administrator for a picture archiving and administration system (PACS) and as a clinical information systems analyst at an academic medical center. PACS is used to store and transmit health images. Some examples of such images are: digital x-rays, CT scans, and MRI images. Deborah had a bachelor’s degree in psychology and had completed pre-medicine requirements. She chose the health informatics master’s program because she was learning a lot about health informatics from co-workers, but she wanted to fill in some gaps in her knowledge, particularly the business and computer science knowledge that she said had not been the focus of her undergraduate degree. After earning her master of science degree in health informatics, she worked as a PACS administrator.

A report for the American Psychological Association (2010) argued that psychology is a STEM field, but it also acknowledges that this designation is not consistently recognized, and psychology is not a technology field. I decided to keep Deborah in the research pool despite her bachelor’s degree in psychology. Her undergraduate studies did give her a stronger sense of self-efficacy with science, which became an interesting comparison against the other research participants who did not have the same experiences with science. More importantly, she clearly had learned much from her work and her coworkers and had been motivated by them. In contrast to the other research participants, Deborah felt the database design courses went well, and the pace was good, and she didn’t feel lost in the course. She said, “I didn’t struggle much.”

Prior to starting the database design course, Deborah had not worked directly with databases, but she knew that databases were inside many of the products that she administered,
and she had a sense of the structures that were used in the databases. She reported that she felt very confident in her ability to learn about databases. She described herself as “very strong verbal-wise.” She also described how math and science had not been terribly hard for her in the past, but she had never really excelled at them. In regards to math and science, she said, “I do have to spend more time studying,” but she had good experiences in her undergraduate coursework that had bolstered her confidence. As she described it, these good experiences rested primarily on the fact that her professors “were good at teaching,” and she was able to get more assistance if she needed it. Describing her experience in the database design course, she stated, “I was gonna be whatever it was that I was, as far as my ability with it or my knowledge set.” Showing a similar attitude, when she was later asked why she didn’t spiral into hopelessness when faced with a challenge in database design, she explained: “I had gone in with a sort of humble sense that knowing that I just didn’t know, and everything was going to be new.” These two quotes reflect an attitude that she showed in her interview, a relaxed attitude with an optimistic streak, even when it was mixed with acknowledgement that she would have to work harder than others.

Deborah reported that she looked forward to the database design course more than other courses because she expected to learn about the databases that formed the foundation of the PACS systems that she administered. She made some connection of learning databases to her career in the interview, but she more often connected the learning to her curiosity about what was inside “the guts” of the PACS that she administered.

Deborah was very motivated to study database design. She explained that this was due to her desire to learn how to directly access and manipulate the data in the databases that the PACS tools created. She also had the goal to move beyond her current career as a PACS administrator.
Deborah expressed a desire to help radiologists and cardiologists with their research. She also mentioned that she had gone to college as an undergraduate because it was the thing to do “without really choosing” to go to college, whereas she had chosen the health informatics master’s program, and she was also paying for the health informatics courses out of her pocket. Both of these factors were motivating for Deborah.

Deborah described her personality as “naturally wanting to do well,” and seeing “some value in working hard to try to at least learn something new that is not necessarily natural.” From her undergraduate experience, she described: “the caliber of students was high, and so the expectation was…you are going to work hard and share information.” In the database design course, Deborah described being hard on herself and being frustrated if she did not understand a concept quickly, but this motivated her to work harder rather than give up. She traced this directly to her undergraduate experience.

Deborah described how her work with PACS systems exposed her to some of the concepts and structures of a database that she later learned in the database design course. She described working closely with coworkers (particularly analysts) who worked directly with the databases, and she learned from them. She also described getting support from a close male relative, who was a programmer. It is unclear how much this affected her experience in the database design course, but her interview gave the sense that this family member provided her with frequent assistance, which may partly explain why she did not struggle in the course. Possibly influenced by the fact that she did not struggle in the database design course, Deborah did not find the online format to have had a strong positive or negative effect. She did express a dislike of the discussion board use in other classes that required students to post, as this lead to
“a lot of B.S. posts.” She expressed a preference for a synchronous online session that was offered in a different online course in the health informatics master’s program.

**Elizabeth.** Before starting the health informatics master’s program, Elizabeth worked as a clinical analyst for a health insurance company, interfacing between the technical and clinical people. She had a bachelor’s degree in nursing. Elizabeth chose to get a master’s degree in health informatics because she had heard the term “health informatics” thrown around at work, and upon investigating it, discovered that it involved, in her words, being a “hybrid clinical-technical person.” She also described jobs that involved technology as paying better than nursing jobs. After earning her master’s degree in health informatics, Elizabeth took a new job at a health care provider that was in the process of implementing electronic medical records and then a job in population health management. Population health involves data analytics and relies upon data and databases. In this role, she reported that she often used “actual programming and database stuff, pretty extensively” because she was organizing and analyzing data “to help our leadership make business decisions.” Prior to taking the database design course, she had limited experience with databases, mostly using Microsoft Access as an end user, sometimes running queries that were already written for her. (In the database design course, students learned to design and create queries in environments that are usually much more complex than those seen with Microsoft Access.)

Elizabeth reported that she often worked with programmers and with nurses. Elizabeth clearly described herself as feeling less skilled at technical matters than the programmers, which made her nervous when starting the database design course. She said, “Science classes I always gravitated toward,” but she was “hot or cold” about math. When she elaborated on this, she described the “cold” as having been more theoretical math topics. She was enthusiastic about
algebra, where “there was always a definitive answer.” Despite her initial nervousness about database design, completing the course clearly boosted her confidence, and she went on to take other courses about databases and data analytics, including a course in statistical analysis software (SAS). Regarding the database design course, she explained, “The knowledge that I gained in the class about how data’s usually organized gave me a good framework for future classes I wanted to take, as well as skills that I wanted to develop. I may not have tried to learn SAS had I not taken that class.”

During the discussion of SAS and how the database design course helped her feel ready for the SAS course, Elizabeth spoke of things that made her feel like she might not have been able to handle the SAS course. “The people that I knew [at work] who were SAS programmers, truthfully, were all guys. They were like older guys that had been doing SAS programming for like years and years, and they liked to talk in jargon. They had a kind of like… a secret code going on.” In the ensuing discussion, this clearly made Elizabeth feel that she did not have the same skills or attributes that the SAS programmers had, which diminished her confidence. In contrast, with her project group in the database design course, “we were all pretty much at the same skill level,” which she described as making her comfortable about her own abilities. She also described how data analysis was exploding as a field, and the dominance previously held by older men was giving way to a lot of younger people and women.

Despite her nervousness, Elizabeth was excited about taking the database design course because she was “excited to learn about it and then have that commonality with my team [of programmers and nurses].” She expected that the course would go well.

Elizabeth was very motivated to study database design because she “would gain from the craft something that would be immediately usable.” She also said, “I just felt like this was really
going to help in my career.” Late in the interview, she stated, “I knew, having already had exposure to people who did this type of work [at her job], like I could see why it [understanding databases] was important, and why it was a valuable skill to have.” She wanted to have this skill, too.

Elizabeth described herself as an optimist, “even when things were challenging.” She linked this to her persistence when the database design material was challenging. Her personal traits also seemed to drive her interest in math and database design, which she described thusly: “I really enjoyed those classes where you could get an answer, like algebra, and you could prove the answer was correct…the rules are consistent. It just feels like you can replicate things, and they have a pattern. It’s kind of like an OCD characteristic.” As clear evidence of this personality characteristic, Elizabeth chose an accounting elective during her nursing studies because of the pattern and rules of accounting. Writing queries for the database design course results in specific answers (e.g. 54 patients), and there is a pattern and logic to the work that would appeal to someone with an OCD characteristic. Elizabeth also talked about personality traits when she explained the appeal of using databases and data models during her work in health insurance: “We were looking at ways to design programs that could do good for people, the most number of people with the least resources possible, and so having that side of my personality that, like, is the nurturer, the caregiver, but then also have this kind of, like, intellectual curiosity about how to manage to do good for a lot of people with limited resources.” She went on to explain that analyzing data made sense from both a conceptual standpoint and from a human standpoint. She used the word human instead of nurturing, but she clearly was engaged by analytical work that also appealed to her “nurturing side” as a nurse. Similar to this, she expressed a magical moment when statistics came alive for her as it was being explained by
a coworker: “I didn’t really necessarily understand what some of these statistics were. He started explaining it, and then as he correlated it to with what we were trying to do with program development [to improve care for certain patient populations], I remember sitting in the classroom, thinking, ‘Oh my gosh, this is so cool’.”

Elizabeth described trying to “connect” with the older male programmers who “sat at their desks all day and talked to nobody and typed on their keyboards.” She described initially trying to connect with them because she was their manager and needed to understand what they were doing. Given more time in her job, she said, “Leaving them alone to kind of be on their own and just keep producing work, that felt like not supporting them at all from an interpersonal level. I just really had no idea until I started taking the [database design] class and starting those conversations, that many people actually did want to talk about the work they were doing. It was just that they didn’t necessarily have someone outside of their circle to talk to about it.”

Elizabeth described a desire for a supportive environment where she could get questions answered more quickly than in the online course environment. “It was just really a little bit difficult to not always have somebody like right there to help.” She described herself as “really struggling with that part.” She also was challenged by working remotely with her project group for the database design course. Describing the challenge of working remotely with her group, she stated: “It’s just a lot easier to work on that stuff when you can kind of see what each other is doing.” She went on to express a wish for screen sharing software to use with her group. She also explained: “In a real brick and mortar classroom, I would have gone to someone at the program, whether it was you, or a TA, or a student, or something. I wouldn’t have immediately looked for an external source for help.” When questioned about this, she responded positively to the idea of a synchronous online session, and she added a suggestion of providing recorded
videos, which would allow playback and pausing to review something repeatedly. The repeated review was important to her because in a synchronous session or classroom “there’s only going to be so many times that a person asks, like, to see it again before they get embarrassed.”

Elizabeth directly addressed women’s participation in data science. She started by describing how data science was splitting away from computer science:

“You don’t have to go to a computer science master’s program to understand the inner workings of a processor, or understand abstract algebra, or anything like that… You can simply go into an informatics program and learn all this data management and immediately use it, and I think that is going to shake up some of the perception of, ‘Oh, it’s too hard,’ or, ‘Oh, it’s for computer geeks.’ I feel like it could become more approachable because it’s not associated with that really rigorous, scientific type of education.”

Elizabeth went on to describe how seeing men sit at their desks to program without talking to anybody could discourage women who “didn’t want to be like that [lone man at his desk all day].” She also described how data analysis shifted the role of an analyst from the lone man writing code at his desk to the analyst who interacted with the team. Then she stated that “having appreciation for what I do with this information” would help a student be more motivated in a database design or SAS course. She capped this insight with: “If people were able to see the awesome dashboards or visualizations that were, like, beautiful, and insightful, and stuff like that, whereas I think if it had been pure [coding], there would have been people lost.”

Francesca. Before starting the health informatics master’s program, Francesca worked as a registered nurse at an academic medical center. She had a bachelor’s degree in nursing. She chose to get a master’s degree in health informatics because the academic medical center where
she worked was implementing an electronic medical record system, and she saw a health informatics degree as a way to learn more about this and to become “sort of like a translator between the clinical person and the technical person,” which she saw as a good fit for her. She also saw health informatics as a growing field because more hospitals would be implementing electronic medical records and other systems. After earning her master’s degree in health informatics, Francesca took a job as a clinical informaticist at a different academic medical center, and she described her job as being a translator and facilitator between clinicians and the system builders and analysts. Prior to starting the database design course, she had no experience with databases.

Francesca described herself as “not very strong in mathematics.” Based on this, she developed a belief that database design would not come easily to her. When later faced with challenges in the course, she would sometimes say to herself, “my brain isn’t wired this way,” a phrase that she said she had used in college, too. Before starting the database design course, Francesca believed there “were a lot of people in the class that had more of a technical background or had been working in Information Technology for 20 years or 10 years or whatever, and then there’s me.” (While this characterization is accurate for many students in the health informatics program, it is not actually true of students in the database design course, but whether or not this was literally true is not the point.) This made her feel “intimidated.” From further discussion around this, I suspected that her perception of being a lone nurse in a sea of technical experts caused her to question whether she had the necessary ability to handle the course, despite her use of the word “optimistic” later in the interview. The interview turned to her younger sister, who was a skilled engineer, and who at a younger age had understood Francesca’s math homework better than Francesca did. Francesca didn’t directly connect this to
her sense of intimidation in the database design course, but the repeated mixing of the two topics suggested that there was a connection. On a more positive note, Francesca described her experience with more challenging courses in nursing school as having taught her that even if she did not get a top grade, she could still “find the material interesting and learn something.” She found that the course provided her with confidence on technical subjects. She went on to explain, “What I felt like it gave me was a knowing that I had this street cred, where I could go to analysts and if they say, X, Y, and Z, then I can say, ‘Well, have you tried A, B, or C?’ and they’re like: Oh, you have RN after your name, but you might know what you’re talking about.”

Francesca expected that the database design course would be challenging, but she was an optimist, so she was optimistic that she could handle it. Francesca was very motivated to do well in the database design course because she believed: “The level of work that I was looking for would likely require a master’s degree along with having experience with database design.” She reported that this drive “really helped me to kind of get through it.”

Francesca described her intrinsic competitiveness as driving her to overcome challenging problems in the database design course. She described her competitiveness as competing mostly with herself or the problem at hand, not with other people. However, she later described herself as competitive with her two sisters, one of whom was taking a course similar to the database design course. Francesca described that relationship as both supportive and competitive. Based on her competitiveness, Francesca explained that rather than give up when faced with a difficult problem in the database design course, she was driven to keep working to figure out the problem, and she believed that even if she couldn’t figure everything out, she “might not get an A, but she would still learn something in the class.”
Francesca expressed her belief that the online format of the course contributed to her sense of intimidation described earlier, but the discussion board helped facilitate conversations with classmates, so that she felt she “could reach out to someone, which was very helpful.” She also described how the lack of in-person interaction took away the chance to see the blank stares that would tell her that other people were also struggling. She responded positively to the suggestion of a synchronous online interaction with her classmates. Outside of the class, Francesca received a large amount of support from her father, an engineer with an advanced degree. Her father supported her by helping her through specific problems with the material, but Francesca also described his support of her self-efficacy: “He would definitely help me stay positive and reinforce the fact that I could do it… using the strengths that I do have.”

**Georgina.** Before starting the health informatics master’s program, Georgina worked as a registered nurse at two academic medical centers, and prior to that, she did her clinical rotations in two other hospitals. She chose to get a master’s degree in health informatics because she saw electronic medical record systems and other electronic systems being installed in hospitals. To her, this was a significant improvement over paper charting. She “found it fascinating.” She admired the nursing super users, nurses who had additional training in using electronic medical records and supported clinicians during the transition to electronic systems. Georgina saw these systems as supporting clinicians and improving the care of patients, which appealed to her. Prior to taking the database design course, Georgina described working as a nurse, “never having had to program or know a programmer’s language.” After graduating with her master of science in health informatics, Georgina held a number of part-time roles relating to health informatics while still doing some private duty nursing. As a private duty nurse, she was a user of electronic medical record systems.
Georgina expressed some initial doubts about her ability to learn “a brand new language.” (From the context, she was clearly referring to this as a challenge of learning a language from scratch.) She compared her lack of programming knowledge to her husband’s programming knowledge: “I never even did C++ like my husband. My husband had C++ in high school. I never had that.” In making this comparison, Georgina defined herself as less experienced with programming. She later directly expressed a wish that she had been exposed to computers more in high school. Once she began the database design course, Georgina struggled at times, which she describes well, and her description of her struggles deserves and extended quotation:

Everything made it seem like a foreign language. Everything. Oh, God. Everything. The whole thing. The whole thing. Having to think about what kind of information you want to put in [the database] and then how to retrieve it back out of it – how to retrieve it. And then making sense of it. And then the words and the coding and the symbols and everything you need to use just so precisely in order to retrieve this specific information. I had never, ever done anything like that. And it was like learning German. It was just – I hadn’t done it, not familiar. Um, it wasn’t even anything I could relate to to help me grasp it better… It was tough. It was tough-- it was-- that course was the most challenging course of the entire program for me. But I don’t regret taking it. I learned—in the end I learned a lot. And I was proud I got through. In the end, I felt—it was very rewarding for me.”

(It should be noted that Georgina does not speak German.) Georgina went on to say, “[Database design] was just so foreign to me that it was something else. It was a unique challenge.” This quote and the extended quote show the challenge of learning the thinking involved in database design.
Georgina expressed a clear sense that she believed computers had been something for “other” people in high school. “It’s always been a curiosity for me learn about things you might not have learned. It’s almost like there’s a stigma, like you have to be interested, and you have to be doing this kind of thing already—programming and coding, to be comfortable and to learn it at all. If someone new has an interest, that’s not enough… You need someone to explain it.” She went on to describe how she never had someone to explain computer subjects to her in high school. By the end of the course, she felt better prepared to have constructive discussions about databases with programmers and clinicians together, but she was very hesitant to declare herself ready to take a programming course unless she had some foundational knowledge of that programming language. She even invented a theoretical person who was more ready to compare herself to: “There might be someone else who would just come along and say, ‘You know, yeah, I’m ready. Let’s do this.’ This isn’t to say that I wouldn’t want to try, but I would want to have a little bit more foundation.” Upon further questioning, it became clear that she drew a clear distinction between “database design” and “programming.” She expressed that she felt prepared for a slightly more advanced database design course (a 102 after having taken the 101, not a 201), but this did not make her feel ready for a programming class.

Georgina stated that before starting the database design class, “I did not feel confident about what it would be like, or how successful I would be.” During the course, she experienced moments of doubt about being able to successfully complete the database design course. This was demonstrated in her statement: “I’m not getting this. And then I’m like: what if I can’t do this?” Georgina expressed a feeling of support from the discussion board in the database design course, not just because she could get answers to questions, but because she could see that others
were struggling, to determine: “Is this out of my league, or [classmates] are in the same boat as I am, so if they’re doing this, I can do this to.”

When asked about her motivation, Georgina described the strong women in her family, including her grandmother, who came to the United States with only a suitcase and unable to speak English. Georgina clearly had a strong drive to learn and succeed. She stated, “What are you gonna let stop you? Because for me, I wanted to understand the material. That’s what it’s all about. Education. Nobody can take education away from you.” Georgina described getting a boost in motivation and self-efficacy from nursing school, a rigorous curriculum that left her ready to take on the world and wanting to learn more.

Georgina expressed a personality that helped her through the database design course: “I’m of the school that nothing should stop you. You shouldn’t be afraid of anything, and I always wanted to try that [learning about databases] and what it was all about and challenge myself.” After having described many struggles in the course, she described her personality and a source of self-efficacy: “It kind of goes back to personality and how I am not a person to quit. I went to a nursing program. I always said: if I can do that, I can do anything.” This may have come partly from her education at an all-women’s school. “I did go to an all-women’s college… I never ever thought, I’m a girl, I’m female, and that’s why I’m not getting it. Ever. I just don’t think that way. It comes down to your personality, and I’m just not that way.”

Georgina found a supportive environment at home and from the instructor. Her then-fiancé was able to help with some questions about the material, and she said, “I remember having to call you a lot. I called you a lot. And I think you – you were the reason why I was able to get through that.” She later stated, “The biggest help to me was the one on one.” Georgina also found support in reviewing the course materials. She appreciated the scheduling flexibility of
the online format, and she did not believe that it hindered her learning. She explained that if she were in a traditional classroom, she would have ended up at office hours instead of having been on the phone. In a traditional classroom, she imagined two competing responses from classmates: “Oh, she’s just like me; she’s having some challenges like me” and “Oh, look at that one. He’s frustrated with me because I’m slowing him down.”

**Emergent Themes**

The interviews were examined for themes within each interview, and then the themes were considered together to develop themes across the interviews. I named these: comparing herself to others, not showing weakness, internal motivation, and peer support. A section for each research question lists the themes that emerged in answer to those questions.

**Research Question 1.** What challenges did women in an introductory online graduate database design course perceive as challenges to their learning?

**Comparing herself to others.** In many ways, the participants compared themselves to other people in ways that clearly created challenges for them, making them feel *less than.* Several of the participants believed that they would need to put in extra work compared to their classmates in order to, as Angela put it, “feel up to par.” Elizabeth expected to need to study harder. Deborah also expected to study harder, even though she had been good at math and science in the past. Even before the class started, Bethany compared herself to her classmates and believed that she was less prepared. Catherine described thinking, “they’re better than me,” and she was clearly challenged by her perception of being the only nurse in a class of people she perceived as having technical expertise. Similarly, Francesca described having been intimidated by her perception that she was a lone nurse among technical people in the class. Georgina described how computers were “for other people.” Elizabeth described the programmers who
were “mostly men, and mostly older” who sat at their desks all day without talking to anyone, and she seemed repelled by the thought of becoming one of them. She said that the perception that “it’s for computer geeks” would challenge women in similar topics, not just the database design course.

Several participants expressed comparisons to specific individuals in ways that made them feel less able. Bethany described comparing herself to her sister, who was studying Information Technology, and how this made Bethany feel less able. Catherine described the discouragement of seeing how easily a coworker, who was an engineer, could handle the questions she showed him to get help. Francesca spoke of how discouraged she felt by comparing herself to her younger sister, who had always been better at math and science. Georgina was similarly discouraged by comparing herself to her husband, an engineer.

Not my brain. A repeated theme in the interviews was a belief that the participants’ brains were not suited for database design. Database design requires a logical, structured, methodical approach and precise syntax that can be a shift in thinking for people who do not have strong technology backgrounds. Even for those with some previous exposure to math and science in high school, the change in thinking for database design can be challenging. (For a representation of this type of thinking without taking a course in database design, review the electrical outlet example in the section titled “Teaching the database design course” on page 52) Catherine reported having felt strong in math and science, yet regarding database design she said, “I have the mindset of a nurse, not that of a computer programmer or database analyst.” When Bethany hit a roadblock, she became mired in thoughts that “this is just not the way my brain works.” Similarly, Francesca reported having thought, “My brain isn’t wired that way.”
Georgina described the challenge of the new way of thinking: “I had never, ever done anything like that. And it was like learning German.”

**Not showing weakness.** Three of the participants expressed a concern about showing that they had weaker knowledge or ability in the course, which held them back from seeking help. Despite being a self-described extrovert, Angela expressed a clear hesitation to speak to an instructor and reveal that she didn’t know the material, which she said was easier online than when talking in person to a male instructor. Catherine said that she felt the need to do extra work so that she didn’t appear clueless in the discussion boards, even though they were not graded. Georgina expressed a hesitation to ask too many questions in front of her classmates, and she expressed a strong preference for one on one communication with the instructor, away from the other students.

**Internal motivation.** The theme of internal motivation strongly related to question 2, which is discussed below, but at times internal motivation led to self-pressure, which was actually unmotivating. Bethany said that she was generally hard on herself, which made her nervous about doing well in the database design course. She said, “I'm quite, uh, not a perfectionist but I'm hard on myself so I was nervous that if I didn't pick it up right away that that might be a little daunting for me.” Catherine described her reaction to having trouble with a homework assignment: “I'm never gonna get it ... I paid $3,000 plus dollars for this class and I'm going to blow it." Deborah described being hard on herself when she struggled: “Some days I was frustrated with myself in not understanding how things work together in a certain script we were writing and just being mad at my ... if anything I was ... I'm more hard on myself than, I guess.”
Research Question 2. What self-identified sources of support did women pursue and find helpful in support of their participation in an introductory online graduate database design course, and how did they find them helpful?

Comparing herself to others. While comparing themselves to others was a theme in question one, some of the participants were supported by seeing that classmates were also struggling in the course. Angela stated that her self-confidence was boosted when she could see that “it’s not just me” struggling, a phrase she repeated several times in the interview. Francesca stated that she would have been reassured by the blank stares from classmates in a traditional classroom, and that the online discussion board was less effective for letting her see when others were lost. Georgina described a feeling of reassurance from seeing that her classmates also were struggling.

Peer support. A clear theme of peer support emerged in the interviews. Many of the participants were frequently relying upon others for support in understanding the material, with some of the support being of the “you can do this” variety. Angela sought out study groups with other women, which she described as being supportive either because she would not have to reveal her lack of knowledge in front of men or because women were more supportive and nurturing. In addition to having support from her sister (the information technology specialist), Bethany described a clear sense of comfort by reaching out to her project partner and her work with that partner. Catherine also described receiving significant support from the woman who was her project partner in the course.

Internal motivation. As one might expect in a selective graduate program, a theme of internal motivation recurred as a source of support. Angela described herself as a very motivated person. Catherine describe herself as confident and motivated, even when she believed she
would need to put in extra work, as for the database design course. Deborah described herself as very motivated, and she described an optimistic, humble acknowledgment of what she didn’t know, which left her open to learning. She said that she naturally wanted to do well. Elizabeth described herself as strongly motivated, possibly because of her “OCD characteristic,” which made database design and finding the answer very appealing to her. She said that her motivation was increased when she had “appreciation for what I do with this information,” which related in part to the applied group project in the second half of the course. Francesca described herself as very motivated to learn, even if she wasn’t able to get a top grade. She also talked about her competitiveness, which pushed her forward. Georgina succinctly captured her motivation by stating her belief that “nothing should stop you.”

**Research Question 3.** What sources of support did women wish they would have been provided within their participation in an introductory online graduate database design course, and how did they perceive those sources of support being of personal value?

*When asked, the participants did not have a strong idea or sense of what could have helped them better than what they sought out for themselves already.* The strongest theme that emerged from the interviews on question 3 was that the participants didn’t have a clear idea of what they wished had been provided. Elizabeth suggested recorded videos that could be paused and replayed. In response to my suggestions of a synchronous online discussion session so that they could ask questions in real time, most of the participants were positive in their responses. Both of these ideas had already been implemented before this research began.

**Conclusion**

The findings in this chapter attempted to give voice to the experiences of women in an online database design course in a master’s program in health informatics. Themes were
identified that emerged from the participants’ interviews to answer the research questions. The database design course was challenging for students, and these interviews revealed many of the sources of the challenges, which may lead to improved supports for students, even if they were not able to directly identify the supports they wished for.
Chapter V: Discussion of Research Findings

The purpose of this research was to answer the question of what supports female students in an online database design course in a health informatics master’s program sought out and found of value in the context of learning in this class. In-depth interviews gave voice to their experiences, which are discussed in this chapter to answer the three research questions:

1. What challenges did women in an introductory online graduate database design course perceive as challenges to their learning?
2. What self-identified sources of support did women pursue and find helpful in support of their participation in an introductory online graduate database design course, and how did they find them helpful?
3. What sources of support did women wish they would have been provided within their participation in an introductory online graduate database design course, and how did they perceive those sources of support being of personal value?

Revisiting the Research Problem

In health informatics as well as in general industry, there has been a need to educate STEM workers at the master’s level in online courses. The need for new workers has been large. According to the President’s Council of Advisors in Science and Technology, "Economic projections point to a need for approximately 1 million more STEM professionals than the U.S. will produce at the current rate over the next decade if the country is to retain its historical preeminence in science and technology” (as cited in Xue and Larson, 2015). The need for online master’s-level programs is because master’s-level programs feed the workforce needs, and online programs are more popular with working students (Cameron, 2013). That is for business in general. In health informatics, the need for new workers has been greater. The need for health
informatics workers was expected to grow twice as fast as overall employment (Burning Glass Technologies, December 2014). Meeting these needs today means educating people with non-technology backgrounds at the master’s level, most likely with online courses. In computer science and information science, international students earn 44% of the master’s degrees granted in the United States (National Center for Education Statistics, November 1997), but the health informatics field has focused heavily on a domestic workforce, clinicians in particular. The majority of clinicians entering health informatics are nurses, and about 91 percent of nurses are women (Landivar, 2013). The result of this is that in 2017, 62 percent of the students in the Northeastern University health informatics master’s program are women. Little research is available around the persistence of non-STEM or non-technology background students who enter master’s-level STEM programs in particular, and there is little research on the persistence of women in such programs at the master’s level. Looking beyond master’s programs, many gender gaps in STEM education have been closing, but even in 2006, MacLachlan found that being a woman in a university “affected absolutely everything” (p. 239). We know it is a problem that women have not felt supported in STEM fields in the past. Thus, in an effort to provide information around master’s level STEM education, this research sought to explore what supports work best for women in an online database design course in a health informatics master’s program.

Findings in Relation to Social Cognitive Career Theory

Lent, Brown, and Hackett’s (1994, 2002) Social Cognitive Career Theory was developed to organize career-related interest, choice, and performance. It was built on top of Bandura’s (1986) Social Cognitive Theory, which included the concept of triadic reciprocality. In triadic reciprocality, environment, person, and behavior all contribute to a recursive process of self-
determination in a self-regulating and self-reflective person. A similar interaction was posited between the five sociocognitive elements of Social Cognitive Career Theory, and the findings of this research can be examined in relationship to the framework of the theory. The five elements of Social Cognitive Career Theory along with a summary of each element are presented in Table 1, below.

Table 1

*Five Elements of Social Cognitive Career Theory*

<table>
<thead>
<tr>
<th>Element of SCCT</th>
<th>Summary</th>
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</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Can I do it?</td>
</tr>
<tr>
<td>Outcomes expectations</td>
<td>Will I get a good result?</td>
</tr>
<tr>
<td>Goals</td>
<td>Am I ready to do this? (determination)</td>
</tr>
<tr>
<td>Person variables</td>
<td>Qualities of an individual</td>
</tr>
<tr>
<td>Context</td>
<td>Person’s context</td>
</tr>
</tbody>
</table>

**Self-efficacy.** Many of the participants clearly entered the online database class with questions about their self-efficacy based on the context of previous academic experiences as well as assumptions and experience with the database course context. Angela did not “feel up to par” compared to her classmates. She believed her classmates had skills that she did not and she wondered if her skills would be sufficient for success in this course. Catherine described how her classmates were “better than me.” Bethany’s sense of self-efficacy came into question by what appeared to have been a long history of comparing herself to her younger sister, who had always been better at science and math. Doubts about self-efficacy were evident in expressions that their brains did not work “that way,” the way needed for database design, and this challenge seemed to come from contextual interactions. The participants observed people around them, which challenged their self-efficacy. Bethany looked at her younger sister, the Information
Technology specialist, and this comparison clearly challenged Bethany’s self-efficacy.

Catherine directly stated her sense of self efficacy by contrasting herself with others in the course context: “I have the mindset of a nurse, not that of a computer programmer or a database analyst.” There can be little doubt that this diminished her self-efficacy when she also stated, “They’re better than me” at database skills. Elizabeth was nervous about taking the course when she compared herself to the programmers at her workplace. Francesca compared herself to her younger sister, who had always been better at math and science, and noted that she felt less capable than her sister. This comparison clearly diminished her sense of self-efficacy.

Francesca described how this influence went beyond the course context to a large part of Francesca’s childhood, where Francesca’s younger sister could easily handle Francesca’s math and science homework. Francesca’s sense of diminished self-efficacy was expressed in her statement that, “my brain isn’t wired that way.” Georgina looked at her engineer husband, and she felt a diminished self-efficacy in database design.

In addition to being a challenge, the interaction between self-efficacy and context was also a source of support. Angela’s confidence was boosted when she could see that other people in the course were also struggling. Francesca was comforted by seeing posts on the discussion board that suggested that other students were also struggling, which boosted her self-efficacy. She observed that in a traditional classroom, she would have seen the blank stares and felt even better. Georgina also felt better about her self-efficacy by observing that classmates were also struggling. Being placed in a context where they could see that they were not alone in their struggles appeared to raise the participants’ self-efficacy.

**Outcomes expectations.** None of the participants described directly asking themselves, “Will I get a good result?” However, outcomes expectations clearly mattered, and these
expectations seemed to interact most with self-efficacy. When faced with a threat to self-efficacy from a homework assignment that they struggled to do, some of the participants questioned whether they would get a good result, which seemed to form a feedback loop to their self-efficacy, further threatening their self-efficacy. This was captured well in Bethany’s description of thinking “this is just not the way my brain works” when she hit a roadblock in completing an assignment, which made her question whether she could possibly finish the assignment with a good outcome.

In direct contrast to providing challenges, outcomes expectations were also a positive source of support. Deborah just expected to learn, with little focus on her grade. Francesca specifically described her focus on the outcome of learning, even if she wasn’t able to get a top grade. Several of the participants spoke about how the course would help them in their careers, which appeared to have helped support them. The participants had chosen the health informatics program with the outcome expectation that their career paths would be enhanced through the added opportunities their new knowledge would afford them.

**Goals.** Several of the participants expressed a goal of finishing the course, which seemed to support them as well as have a positive impact on their outcomes expectations. They wanted to improve their careers, so they worked past negative outcomes expectations. They also expressed goals of learning database design, not just finishing the course. They had seen coworkers who worked with databases, and they knew that this work was important to health informatics (which was part of why some of them enrolled in the health informatics program). Ultimately, the participants held the goal of improved career choices as a result of the class. This goal pushed them to complete and pass database design. Nobody actually said, “I will finish this course if it kills me,” but there was a clear sense that this was a common feeling. This was in
evidence when Georgina said, “Nothing should stop you,” she was responding to her own description of being nearly stopped by struggles with the material.

**Person variables.** The person variable of being a nurse seemed to negatively affect the sense of self-efficacy with database design among several participants, as described in the self-efficacy section above. However, the participants expressed strong qualities of self-motivation, which appeared to be a powerful support against threats to self-efficacy and outcomes expectations and goals. Angela described herself as very motivated. Catherine said that she was confident and motivated. Deborah expressed being motivated and optimistic in a way that appeared to be fundamental to her personality, not just her approach to the database design course. Elizabeth described her strong motivation and her “OCD characteristic” that likely increased her motivation. Francesca described being very motivated to learn, even if she didn’t get a top grade, and this seemed to be her general approach to life, not just the database design course. Georgina’s motivation was most powerfully represented in her statement that, “nothing should stop you.” These innate personality traits and individual approaches to life provided positive influences and support for the women.

**Context.** The context of the database design course affected self-efficacy as well as other elements, and so did the context of coworkers and the context of family. Bethany compared herself negatively to her online classmates before the course even started. Catherine recalled being the only nurse in the course, which diminished her sense of self-efficacy and outcomes expectations. Elizabeth compared herself to programmers at work and didn’t want to become one of them. Francesca described the course context as being a lone nurse in a sea of technical people.
In addition to challenges from the course context, the participants drew support from the course context. Seeing other students struggle reinforced the sense of self-efficacy for several participants, and having study groups provided both intellectual support as well as camaraderie. None of the women described specifically seeking out other women in the course, but with a little digging, it appeared that they did. When asked if it was coincidence that her study group was all women, Angela did state that women were more supportive and that she was hesitant to reveal her lack of knowledge in front of a man. This suggested that her choice to turn toward a woman in the course may have been conscious. Bethany, Catherine, and Georgina reported getting support from a classmate or classmates, and when they named these people, they were all women. Upon questioning, all three denied having specifically sought out other women, but they were all quick to explain their choices were based on women being more nurturing or more patient.

**Summary.** Social Cognitive Career Theory provided a framework of five interconnected elements that were used to examine the findings of the study. These were self-efficacy, outcomes expectations, goals, person variables and context. The interaction between these elements was a key part of Social Cognitive Career Theory. *Self-efficacy:* Challenges to self-efficacy included several participants’ beliefs that they were less capable of learning database design than other people, sometimes expressed as a belief that their brains were not wired for database design. Supports to self-efficacy came from the class context by seeing that other students were also struggling. *Outcomes expectations:* When challenged by difficult assignments, some of the participants questioned whether they would do well in the course, which diminished self-efficacy. Some of the participants expected outcomes that focused more on learning than on grades, which helped protect their senses of self-efficacy when the database
design course was challenging. Goals: A common goal of career advancement helped protect self-efficacy and keep the participants motivated when the database design course was challenging. Person variables: Being a nurse (and thus not a technical person) seemed to negatively influence self-efficacy, but personal characteristics of strong self-motivation protected the participants against challenges. Context: Participants often described comparing themselves to people around them who were technically adept, which reduced their senses of self-efficacy. Several participants described finding comfort in seeing that people around them were also struggling with the material, and some found support in study groups or project groups with other women.

Findings in Relation to Literature Review

We know from the literature that there is a shortage of students in STEM, especially in health informatics. However, very little is known about people with non-technical undergraduate degrees who pursue STEM master’s degrees. This study delved into this area by interviewing a small sample and found challenges and supports the participants encountered in the database design course. This section will relate the study findings to themes from the literature, broken into three sections: persistence, gender and STEM, online education

Persistence. The literature on persistence focused mostly on persistence to degree. The persistence to completion of the database design course examined in this research (as well as persistence to complete individual assignments within this course) shared many common elements with persistence to degree. Spady (1970, 1971) examined integration in the social and academic domains of college as drivers of persistence to degree. In this research, integration into the context provided both social and intellectual support. Pascarella and Terenzini (1980) added external environment to the domains that predicted persistence (external was used to mean
external to the student’s college). This aligned with the importance of support from friends, family, and co-workers, as well as threats to self-efficacy that came from the same. Ost (2011) and Rask (2010) found that weaker grades in early STEM classes predicted reduced persistence in STEM. While grades were less frequently explicitly mentioned in this research, the participants clearly expressed that struggling with an assignment reduced their sense of self-efficacy. When looking at the research on PhD level programs, the importance of self-efficacy was emphasized by Litalien and Guay (2015) found that perceived competence was the major predictor of persistence in a PhD program. In this research, self-efficacy was a significant factor for persistence.

**Gender and STEM.** The literature had a long list of explanations for why women were underrepresented in STEM. Maccoby and Jacklin (1974) dispelled some beliefs about women’s inherent attributes as an explanation, but echoes of these beliefs may have been heard in the students’ claims that “my brain isn’t wired that way.” In context, this was expressed as a nurse versus technical “brain” distinction, but it was never clear if beliefs about gender were quietly behind this. Lubinski and Benbow (1972) reminded us that we can address such beliefs without focusing our efforts on only these beliefs or even really accepting that they are true. Lubinsky and Benbo (1992) and Heilbronner (2013) found that the underrepresentation of women in STEM had shifted and that gendered differences in abilities had faded. It would be easy to say that many of the participants in this study were in high school during the period of time that Heilbronner used as the “previous” group. Whether the fact that the participants in this study felt the need to study harder than their classmates was based in a true need or not, and whether their need to study harder (if true) was based in intrinsic characteristics of the women, the reality is
that they doubted their abilities. Therefore, supports in self-efficacy could work even when we
don’t accept the premise that women are actually less skilled.

**Online education.** Ching and Hsu (2015) and Miller and Webster (1997) found that
women were more likely to prefer synchronous communication tools than men. This matched
the results of this study. None of the participants asked for an increase in asynchronous
communication. Several participants expressed a wish for a synchronous discussion. Kramarae
(2003) found that the proportion of women and men taking online college classes aligned with
the proportion or women and men in college, strongly suggesting that women were not shying
away from online education. In this study, when the online format was discussed, it seemed that
it was detrimental. Francesca wished she could see the blank stares of her classmates as she
would in a traditional classroom. Bethany, Catherine, Deborah, and Francesca all struggled with
feeling lost among their classmates, and it is unknown if a traditional classroom would have
allowed them to connect with classmates in ways that would have reduced or reinforced these
feelings. Most importantly, the women all responded positively to the idea of the class being
synchronous.

**Findings in Relation to the Research Design**

This study used Interpretive Phenomenological Analysis to analyze seven in-depth
interviews with women who had taken the database design course as part of their master’s degree
studies in health informatics at Northeastern University. The analysis followed the six steps
described by Smith, Flowers, and Larkin (2013), which involved the reading and re-reading of
the transcripts, making notes, developing emergent themes, searching for connections across
emergent themes, moving to the next case, and looking for patterns across cases. The process
gave voice to the experiences of the participants, which portrayed complex interactions.
As the instructor of the database design course and the researcher, I tried to keep my interpretation focused on the words of the participants. During the interviews, the participants were pondering their own interpretation of their experiences, even as they were speaking. This was particularly noticeable when they were asked about why they had chosen women for study groups or project groups. They did not seem to know why they had chosen women. The participants had trouble answering the third question, which asked them to identify the supports they wished they had. It was at this point in the interviews that I most noticeably inserted myself, offering possibilities such as different communication tools and communication sessions. It appeared that the participants had not really given this previous consideration, and even when giving it consideration during the interview, they did not have suggestions for new supports.

The open exploration of the experiences of the participants led to a finding of a challenge that related to self-efficacy. This was the theme of not wanting to show weakness in knowledge by asking a question that displayed a lack of knowledge, even if it meant putting in a lot of work in order to properly phrase a request for help, as Catherine did. Angela and Georgina also hesitated to ask questions for fear of appearing less knowledgeable. Georgina also gave a description of how foreign and unfamiliar the material felt, as well as her feeling of triumph from having learned it. Even without deeper analysis, her description presented a vivid picture of her experience that may help STEM educators who come from within a particular discipline to understand the experience of students who are new to the discipline.

**Significance of the Findings**

The database design course was described as deeply challenging yet deeply satisfying for the participants. Five significant themes emerged from this research that provide insights into the problem of practice:
• comparing herself to others,
• not my brain,
• peer support,
• not showing weakness, and
• internal motivation.

The first two research questions looked at challenges faced and sources of support sought. Challenges and supports flowed together was two sides of the same coin, and the different themes interacted with each other in complex ways. Participants were challenged by feeling that they were less prepared or skilled than others, which led them to believe that their brains weren’t “wired this way.” They spoke of finding support in small groups with other women, but they also spoke about hesitating to ask questions.

The participants often sought external support outside of the course and course materials. Some did turn to classmates, but there were many descriptions of getting help from family members, friends, or co-workers. While getting final answers for assignments would not help a student learn, talking to other people about database design issues in order to get help is a good thing. As the instructor of the course, I would be pleased to see that students were able to have intelligent conversations about database design with others, as this is one goal of the course. However, the participants rarely described interesting intellectual conversations with coworkers about assignments from the database design course. They described seeking peer support for help with assignments paired with feeling lost on those assignments and feeling disheartened by being lost.

As the director of the health informatics program at the center of this study, I was proud to see that the graduates of the program had strong internal motivation. As the instructor of the
database course, I must acknowledge that the strong internal motivation of these former students appeared to have been a significant factor in their ability to face the challenges of database design and overcome them.

Despite lengthy interviews that covered many topics, the participants had very limited ideas for new supports that they wish they had. I took care to explain that I did not expect them to magically fix the course in ways that I, the instructor, hadn’t been able to come up with, but I was very open to new ideas. There are several possible explanations for why they did not have ideas for new supports. They could have felt that the supports that they did have (including those they found on their own) were sufficient. Another possible explanation is that they may have believed that struggling in the class was a normal state of affairs that came from challenges to their self-efficacy, not from deficits in supports provided as part of the course. Another possible explanation is that it is quite normal for people to be able to react to ideas for new things while not being able to generate completely new ideas; in marketing it is a truism that customers will readily give their opinions on new products but have a harder time envisioning a completely new product without being offered options.

The final finding crossed over the different emergent themes. Quite simply: In the database design course, the participants felt uncomfortable and lost, and they sought out peer support to deal with this. When the students were feeling and uncomfortable and lost, they sometimes turned to the instructor, but they significantly turned to peer groups. The participants were highly motivated, and their motivation and their external supports significantly contributed to them overcoming challenges in the course. Struggling with difficult material can be an important part of learning, but the interviews gave a very strong sense that the students were turning outside the course for support.
Implications for Practice and Recommendations

When I have taught the database design course, I made efforts to remind students that database design was strange and new, and I encouraged them to reach out to me. Many did, and many expressed in their interviews the importance of my help. For students who are taking an introductory technical course like database design, teacher support matters. I will continue supporting students, but now I will be more sensitive to the possibility that students might hesitate to ask questions that would show that they don’t know the material, as well as being more sensitive to the fact that some students may feel uncomfortable and lost.

Based on this research, the most significant change for my practice and recommendation for others is to focus on the peer support. The participants in this study were receiving significant support from classmates, family, friends, and co-workers. Although the participants didn’t have suggestions for new supports, their extensive use of peer support does suggest a solution. That solution is also hidden in a detail of the interviews. When the participants spoke of getting peer support from partners in the group project, this was a project that started in the last weeks of the semester. A possible answer is to bring together students into groups in the class from the beginning of the semester. This could be accomplished with small group assignments or by forming critique groups where small groups of students specifically review each other’s work, staying with the same group through the semester. To take this even bigger, these groups could be continued as small cohorts that continue through a series of courses. This would provide the peer support in a small group that would allow students to be less concerned about showing weakness. Working together from the beginning of the course in small groups would also help students realize that their brains and abilities fit right in with their group mates,
if the groups are formed properly. This probably means groups of homogenous database design abilities.

The findings of this study apply to course instruction beyond my personal practice and beyond database design. I hope all instructors of STEM courses will be mindful of how foreign the topics can seem when students are first introduced to them, and that some students might hesitate to ask questions because they are concerned about seeming unprepared or unskilled. Some of the participants expressed hesitation about signing up for the course and had preconceptions about being behind their classmates before the course started, and practitioners should consider reaching out to students even before they register or before a course starts.

Limitations of the Study

This research used a small sample size, and it examined the experience from just one course. This allowed a deep dive into each participant’s story, but it limits the generalizability of the findings. This research also ended up focusing mostly on nurses due to the nature of the health informatics program being studied. It is possible that something that causes people to pursue nursing makes them different from people in other fields in a way that would cause these findings to not generalize. The participants were master’s students in a selective program, and while this research was pursued in part because of a lack of literature on the master’s level regarding STEM persistence, this research may not apply to non-master’s graduate student or to students who have less strong backgrounds. All of the participants in this study volunteered to participate, so it is quite possible that those who did not volunteer chose not to volunteer because they had different experiences in the course from those who volunteered.

The participants in this research all expressed a strong sense of internal motivation. Whether this is a quality more likely to be found among nurses or more likely to be found among
students in a selective master’s degree program, or some combination of these two or another factor, the fact that all of the participants expressed high levels of self-motivation cannot be ignored when attempting to generalize the results.

This study used in-depth interviews and Interpretive Phenomenological Analysis (IPA), which provided thick, rich description (Smith 2004). This approach is both descriptive and interpretive (Pietkiewicz & Smith, 2012). The description was important to give voice to the participants’ experiences, but the interpretation must not be overlooked because IPA is intrinsically interpretive, with both the participants and the researcher interpreting the meaning of experiences (Smith, Flowers, & Larkin 2013). This paper made extensive use of quotes to try to preserve the participants’ original voices before the researcher interpreted the words, but even the participants themselves were interpreting their experiences as they described them. The researcher who interviewed the participants was the instructor of the database design course, which may have influenced what was said or how things were interpreted.

Further Research

This research was focused on women in an online database design course in a master’s-level health informatics program. Further research could look at campus versus hybrid courses at the master’s level. Research could also focus on technical courses outside health informatics.

Persistence to a STEM degree rather than persistence to completion of a STEM course at the master’s level is an open area in the literature. Persistence within an individual STEM course at the master’s level could also be examined. Due to the nature of the health informatics course at the center of this research, many of the students already had established careers, so most participants went through high school before there was a strong focus on opening STEM studies
to women. Future research could study younger women in a master’s level STEM program who attended a high school that focused on opening STEM to all genders.

It would be very useful to see research on how to better make the leap into database design so that students don’t feel “this is just not the way my brain works,” possibly starting with a course that forms students into small groups from the beginning for peer support. If these smaller peer groups are formed in the database design course, this could be studied to determine if forming these groups really do make a difference.

STEM subjects are commonly grouped together, but further research could examine whether the findings of this study apply to other introductory STEM subjects at the master’s level. Also, research could examine whether studies in one STEM subject would make introductory courses in another STEM subject easier. The database design course was chosen as a pivotal introduction for people with non-technical backgrounds based on the belief that this course would help students learn database design as well as be more prepared for other technical courses, but this assumption has not been rigorously tested.

Conclusion

In this research, it became clear that numerous factors played off each other, and five themes emerged in this research: comparing herself to others, not my brain, not showing weakness, internal motivation, and peer support. Comparisons to others included challenging comparisons to others who seemed more skilled as well as supportive realizations that others were also struggling. Not my brain represents the frequently expressed belief that their brains were not wired for database design, which posed a significant challenge. Not showing weakness was an expression of the participants’ hesitation to ask for help because the question might expose their lack of knowledge in front of classmates. Internal motivation was a clear support
that helped participants overcome the challenges, and these participants were all very motivated. Peer support included getting help on assignments from family, friends, and coworkers, and it also included a sense of camaraderie with selected classmates in study groups or project groups.

Teacher support matters, but that is a confirmation of what is already known, although it helps to have a clearer understanding of the challenges experienced by students who do not have technical backgrounds in a technical course.

In my practice, and in the practice of others, I hope to see attempts to strengthen peer support within a course like the database design course or even across courses in a master’s program. Understanding the lived experience of the participants is an important step, but I hope to directly apply the findings of this study in building better technical courses for students who do not have technical backgrounds.

**Personal Commentary**

Over and over, I have heard from students in the database design course a variant of, “I spent X hours struggling with the material this week,” with X often being a double-digit number. This continued through the years despite my entreaties to students to reach out to me when they were stuck, and I have always wondered why. With my love of writing code, I could certainly sympathize with an urge to focus on the problem and keep narrowing it down step by step until I defeated it, but it seemed as if the students were less likely to reach out when they got more lost. With this research, I have a better understanding of why this happened.

This paper began with a misunderstanding. People who had some experience in technical subjects such as writing code or scripting were directed toward other classes, and I saw the database design course as the gateway into STEM thinking for people with non-STEM backgrounds. I am indebted to Dr. Kristin Greenwood for alerting me to the need to reframe
Database design is a gateway for people with non-technology background into technology thinking. The technology portion of STEM is quickly creeping into the other parts of STEM, as well as into other fields, as evidenced by the learn to code movement. In addition, STEM studies are increasing in K-12. There may be a day that no student will get to the master’s level without a foundation in technology subjects, but we’re not there yet. Until then, I will keep teaching database design and helping students see that their brains do work that way.
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doi:10.1177/1098214005283748


Appendix A

Recruitment Email

Hello Person Name,

You know me as the director of the Health Informatics program from which you graduated and the instructor of the database design class that you took. I am also studying toward a doctoral degree in education, for which I would like to ask your participation in my research. If you are interested to participate, I will interview you on the phone for 50 to 80 minutes regarding your experience as a woman in the database design course, with a possible follow-up phone interview of less than 30 minutes if you are willing. Attached is a PDF with information about the study and your participation. If you agree to be interviewed, I will also review this information with you on the phone. Please review the PDF and decide if you would like to volunteer. The PDF contains information about how to volunteer.

If after reading the below you are willing to participate in the study, please email me back at me Northeastern student email address indicating so, at feinberg.dan@husky.neu.edu

Best,

Dan

Why am I being asked to take part in this research study?
You have been asked to participate because you were in an online section of HINF 6220 Database Design and you are a woman who did not have extensive experience in science or computer science before taking the class.

Why is this research study being done?
The purpose of this research is to give voice to the experiences in a database class of women who did not have an extensive background in science or computer science before taking the class, with the aim of identifying ways to support students in such a class.

What will I be asked to do?
I will ask you to participate in a telephone interview with me that will be recorded. It should last between 50 and 80 minutes. If you indicate your willingness to be involved in a follow-up interview, I may contact you for a follow-up telephone interview of less than 30 minutes to help clarify anything from the first interview (also recorded). Your participation is voluntary, and you can opt out at any time.

Where will this take place and how much time will it take?
Your first interview will be scheduled at your convenience, and it will take 50 to 80 minutes. If a follow-up interview is conducted, it will take less than 30 minutes. These will be scheduled at your convenience.
Will there be any risk or discomfort to me?
There are no significant risks involved in being a participant in this study.

Will I benefit by being in this research?
With your insights, I may be able to improve the database design course, or others may read my research and improve courses.

Who will see the information about me?
Your part in the study will be completely confidential. Pseudonyms will be used for all study participants. Only the researcher will be aware of the participants' identities. No reports or publications will use information that can identify you in any way.

In rare instances, authorized people may request to see research information about you and other people in this study. This is done only to be sure that the research is done properly. The researcher would only permit people who are authorized by organizations such as Northeastern University to see this information.

If I do not want to take part in the study, what choices do I have?
You are not required to take part in this study. If you do not want to participate, you do not have to respond. If you respond and change your mind, you can inform me by email that you are withdrawing. If you begin the interview and wish to withdraw, you can do so.

What will happen if I suffer any harm from this research?
There are no significant risks involved in being a participant in this study.

Can I stop my participation in this study?
Participation in this study is voluntary, and your participation or non-participation will not in any way affect other relationships (e.g., employer, school, etc.). You may discontinue your participation in this research program at any time without penalty or costs of any nature, character, or kind.

Who can I contact if I have questions or problems?
[Redacted]

Who can I contact about my rights as a participant?
[Redacted]

Will I be paid for my participation?
There is no compensation for participation in this study.

Will it cost me anything to participate?
There is no cost to participate in this study.
Appendix B

Questions for Semi-structured Telephone Interviews

1. Icebreaker: Where did you work before starting the MSHI degree? What degrees did you have?
2. Why did you choose the MSHI? What has been your professional path after graduating?
3. What prior experience did you have with databases before taking the database design course?
4. Thinking back to just before you started the database design course, how confident did you feel in your ability to take the course?
   - Did you think the course would go well?
   - How motivated did you feel?
   - Was there anything in your personal attributes or situation that influenced this?
5. How did you feel about math or science or technology classes that you took before database design?
6. During the database design course, were there challenges that caused you to doubt your ability to handle the material or doubt that the course would go well?
   - What did you do to overcome this?
   - How did that work out?
   - Was there anything in your personal attributes or situation that influenced this?
7. How did this being an online course affect the challenges and your response to those challenges?
8. What resources to you wish had been available to overcome the challenges?
9. What advice would you give to someone who is about to start the database design course?
10. Has this course affected your confidence that you could handle other technical topics and have a good outcome?
Appendix C

Unsigned Consent Form
Northeastern University, Department of Education

Name of Investigators: Dr. Chris Unger, Principal Investigator and Dan Feinberg, student researcher

Title of Project: WOMEN’S SELF-IDENTIFIED SOURCES OF STUDENT SUPPORT IN A MASTER’S-LEVEL HEALTH INFORMATICS DATABASE CLASS

Request to Participate in Research
I would like to invite you to take part in a research project. The purpose of the research is to give voice to the experiences in a database class of women who did not have an extensive background in science or computer science before taking the class, with the aim of identifying ways to support students in such a class. You must be at least 18 years old to be in this research project.

This study will place during this phone call, which will take 50 to 80 minutes and possibly during a follow-up phone call which will take less than 30 minutes. If you decide to take part in this study, I will ask you questions about your experiences in the database design course.

The possible risks or discomforts of the study are minimal. You may feel a little uncomfortable answering questions about your experience in the database design course.

There are no direct benefits to you for participating in the study. However, your answers may help me learn more about the ways to support students in a database design course.

Your part in this study will be handled in a confidential matter. Only the researchers will know that you participated in this study. Any reports or publications based on this research will use only group data and will not identify you or any individual as being part of this project.

The decision to participate in this research project is up to you. You do not have to participate and you can refuse to answer any question. Even if you begin the study, you may withdraw at any time.

You will not be paid for your participation in this study.

If you have any questions about this study, please feel free to call Dan Feinberg at 617.373.5005, the person mainly responsible for the research. You can also contact Dr. Chris Unger at 617 390-3450, the Principal Investigator.
If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 490 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

Thank you.
Dan Feinberg