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A COVID-19 Induced Shift: From Introducing High School Females to Computing Careers to an Assessment of Technological Readiness Among STEM Teachers

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by

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A dissertation submitted in partial fulfillment of the requirements

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We hereby certify that this dissertation, submitted by Jareau Almeyda conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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Prior to the global COVID-19 pandemic, this study aimed to explore how exposure to information systems (IS) project management impacts perceptions of computing careers among high school female participants. Given the demand for computing professionals continues to grow, enrollment in some computing disciplines across institutions of higher education have experienced declining enrollments. Studies have shown that one of the reasons high school students do not enroll in computing disciplines is because they perceive computing as difficult, boring, and irrelevant.

As a computing discipline, information systems is focused on developing professionals who are able to integrate technologies into systems that run our organizations and societies. In addition to system integration, IS organizational alignment and project management are important skills for IS professionals. Information systems project management focuses on competencies, processes, tools, and techniques that can be used to manage computing projects. Project managers who work on IS projects integrate the project management lifecycle with the systems development lifecycle to create project objectives that include software, hardware, and telecommunications components. Therefore, to achieve successful outcomes, IS project managers must work effectively with a variety of professionals in other computing disciplines such as software engineering, computer science, information technology, and cybersecurity.

To address the research goal, a series of IS project management workshops were developed and partially implemented with a group of ten high school females. These workshops were designed to develop project management competencies, meet computing professionals, and create authentic project deliverables. The plan was to apply qualitative research methods such as collection and analysis of workshop artifacts, interviews, and the researcher's reflexive journal, to determine how this experience impacted participants' awareness and interest in computing careers.

The emergence of the COVID-19 global pandemic, however, had irrevocable effects on this study. With the closure of schools across the nation, the original study abruptly ended after two of six workshops were conducted. As a result, a new study was designed. The new study aimed to understand the lived experiences of teachers and the readiness and sustainability concerns they had after being abruptly transitioned from an in-person teaching environment to a fully online teaching environment. A questionnaire comprised of ten open-ended question was presented to a group of fifteen STEM teachers of the same school where the original workshops took place. Thirteen completed questionnaires

were returned; data were then analyzed using a three-pronged approach: descriptive analysis, machine learning-based psycholinguistics analysis, and qualitative content analysis.

The descriptive analysis revealed verbosity among every participant and for every question. The machine learning-based psycholinguistics analysis produced rich psycholinguistic tone scores across seven dimensions: Analytical, Anger, Confident, Fear, Joy, Sadness, and Tentative. The qualitative content analysis reduced data from thirteen participants across ten questions to 11 primary codes, 26 secondary codes, and four thematic constructs: student needs, teacher needs, the role of school officials, and parent needs.

The study has practical implications for school officials, parents, students, and policy makers–specifically related to the technological impact of an unforeseen and widespread disruption of the education system.

Dedication

To the memory of the nearly 3,000 lives taken on September 11, 2001. May this work serve as a worthy contribution to your enduring legacy.

For E.R., D.M.M., J.A.M., and S.A.M, you are my reason, my light, my drive.

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Chapter 1

Introduction

Background

The 2015 Programme for International Student Assessment (PISA), a triennial test administered by the Organization for Economic Cooperation and Development (OECD) to more than half a million 15-year-olds around the world, noted that less than one percent of girls interested in pursuing science careers chose information technology (OECD, 2016). At the university level in the U.S., less than 16% of females graduate with a computer science-related bachelor's degree (Zweben & Bizot, 2015). Moreover, the 2016 Global Gender Gap Report, published annually by the World Economic Forum, in a research collaboration with LinkedIn, found that women in the workforce are strongly under-represented in fields such as engineering, manufacturing and construction, and information communication and technology. The study noted females participate in the global software and information technology (IT) services industry at a rate of 27% compared to their male counterparts, with only two other industries, engineering and mining, and manufacturing, showing weaker female participation. The report highlighted existing gender biases as the reason talent pools are disrupted and underscored the emerging technology sector as one of the fields most affected by the loss of diversity (Schwab, et al., 2017). Here in the U.S., Tracy Chou (2013), a Pinterest software engineer, created a public, crowd-sourced, spreadsheet that has accounted for the otherwise officially unknown gender disparity in Silicon Valley technology firms. Of the documented 285 U.S.-based companies with in-house software engineering teams, there

are an average of 67 software engineers, with an average of 13 (20%) being female. Some top firms, such as Foursquare, Yelp, and Mozilla employ just seven, eight, and nine percent females, respectively. Chou's file is continually being updated, with the most recent entry dated October 11th, 2018. Additionally, when Facebook and Twitter went public in 2012 and 2013, respectively, neither had any females on their board of directors (Guynn, 2013). On the east coast of the United States, as of 2017, less than 15% of the 1,642 board seats available at 184 publicly traded IT companies in the metro Washington D.C. area were held by women (DeLorenzo, Solutions, Klein, & Bloecher, 2017).

Interest in expanding computing education has been made clear at every level: from the top office in the U.S. government, to the academic community, to the boardroom of some of the world's largest tech companies. In his 2016 State of the Union address, President Barack H. Obama spoke of "helping students write computer code" (Obama, 2016), a nod to the academic community's "interest to make computer science a core academic subject and integrate computational thinking into other STEM subjects in K-12 schools" (Menekse, 2015, p. 345). Apple's CEO Tim Cook, speaking to the notion of increasing the presence of women in IT, said "We haven't done enough to reach out to show young women that it's cool to do it and how much fun it can be" (Warren, 2015, para. 12). In reference to computing and computing careers, it is important to identify what these terms encompass. As Yardi and Bruckman (2007) pointed out, "Computing is more broad than CS, programming, or software engineering and educators may need to revamp existing perceptions of computing to reflect this broader definition" (p. 48).

IBM's CEO Virginia Marie Rometty wrote an open letter to U.S. President-Elect Donald J. Trump and referenced "new-collar" jobs, a role where technical and

professional skills take precedent over a college degree (Rometty, 2016). These so-called new-collar jobs are not entirely new; these jobs have traditionally been known as middle-skill jobs. The National Skills Coalition defines middle-skill jobs as those "which require education beyond high school but not a four-year degree." The coalition also finds that these jobs make up the largest part of the labor market in the United States, as well as in each of the 50 states (National Skills Coalition, 2017, para. 1). With the emergence of the high-tech industry, the term "middle-skill" has evolved to "new-collar," and most recently to "mid-tech." The Brookings Institute found that mid-tech jobs comprise nearly one-third of current jobs in IT (Muro, Whiton, & McKenna, 2018).

One example of a job role that fits the mid-tech description is the role of "project coordinator." The U.S. Bureau of Labor Statistics (BLS) describes the role of a project coordinator as a subordinate role of the project manager role; where the main focus is to organize the project: track dates, budgets, communicate with the project team and clients, and prepare and give presentations, among other duties. The BLS describes project coordinators as organized, self-motivated, conscientious, adaptable, possessing good communication skills, having basic math, word processing, and spreadsheet skills, and at least a high school diploma (Green, 2015). The Project Management Institute (PMI), a not-for-profit professional membership association for the project management profession, delivering education, certifications, and professional career-building value to nearly three million professionals around the world, asked hiring managers what skills Generation Z lacked. Twenty-six percent of hiring managers said Gen Z lacked project management skills (PMI, 2017a).

In information systems (IS), some of the most important skills include "system integration, IS organizational alignment and project management" (Outlay & Krishnan, 2010, p. 131). With regard to project management, IS projects are unique in several ways and require project managers to interface with a variety of computing professionals and possess a unique skillset. For example, Schneider, Fuller, Valacich, and George (2020) identified characteristics including changing technological context, difficulty hiring IS personnel, and importance of understanding systems development methodologies, among others. There are also many challenges inherent in IS projects ranging from continuous increases in required functionality of software, which leads to increases in labor costs, and complexities in testing software source code, which increases the risk of errors, defects, and cyberattacks (Schneider, et al., 2020).

Problem Statement

From teen-aged girls, to college-aged young women, to the women in the work force, to females sitting on the board of major technology firms, there is a quantifiable and documented shortage of females at every level in the computing field–noted at both the global and at the national level. One study found 74% of high school students who participated in an introductory CS course indicated interest in taking another CS course and also majoring in CS in college; interestingly, nearly half of those students were female (Dettori, Greenberg, McGee, & Reed, 2016). In a sample of 346 students, Lishinski, Yadav, Good, and Enbody (2016) found that "female students respond to performance feedback early" in direct relation to their levels of engagement in computing-related coursework (p. 218). Additionally, in a longitudinal study undertaken by Outlay, Platt, and Conroy (2017), of thirty middle school girls participating in a two

day IT career camp over a two year period, the authors found that while only 7% of participants surveyed said they were initially aware of project management as a career choice before the start of camp on year one, 43% them–when surveyed at the end of camp on the second year–demonstrated interest in pursuing careers in project management.

Relevance and Significance

The OECD noted low self-confidence of school-aged girls–in subjects related to science, technology, engineering, and math (STEM). This low self-confidence comes from gender stereotypes about STEM-related occupations, which in turn leads to their diminished interest in STEM-related careers (OECD, 2016). Exploring the effectiveness of introducing a group of female high school students to IS project management as a viable entry point into computing disciplines may shed some light on how to systematically increase the number of females who enroll in computing majors in colleges and universities.

Moreover, the significance of gender diversity in the business community cannot be overstated. The 2012 OECD PISA noted "increasing the number of girls at the highest levels of performance in problem solving, and improving their ability to handle complex, unfamiliar problems, may help more women attain leadership positions in the future" (OECD & PISA, 2014, p. 35). Hewlett, Marshall, Sherbin, and Gonsalves (2013) showed that a diverse workforce is an effective source of innovation and drives business growth. The Bureau of Labor Statistics (BLS) projected by the year 2022 computer and math related jobs in the U.S. would increase to an estimated 1.3 million, an 18% increase over the prior decade (Richards & Terkanian, 2013). The PMI reported that by 2027 U.S.

employers are expected to have 8.8 million project-oriented jobs available, up from 6.7 million in 2017 (PMI, 2017a). In addition, the Bureau of Labor Statistics (2018) projected a 13 percent growth in the employment of computer and information technology occupations, which is above average for all occupations. This 13 percent increase translates into about 557,100 new jobs (BLS, 2018). Efforts to increase the number of females interested in computing disciplines and careers add significant and tangible value to the business community, at the national level, and also at the local South Florida level.

With the issue of gender diversity in the computing fields being rather well documented and understood–from school-aged girls, through college, into the workforce, and further into the C-suite–there is an opportunity to study the effectiveness of a skills-based, project management-centric introduction to computing careers. Additionally, while research work related to students within the computing academic pipeline tends to focus on the traditional, technically focused student–that is, students participating in coursework related to coding and abstractions–this study aimed to focus its attention on a group of female high school students who may or may not have an interest in computing careers.

Dissertation Goal

The goal was to discover how exposure to IS project management impacts perceptions of computing careers among high school female participants. As an extension of Outlay, et al.'s (2017) work, this qualitative descriptive case study included introducing a group of Florida's Palm Beach County female high school students to IS project management in an attempt to pique their awareness and interest in computing careers, and studying the effectiveness of this approach at the pre-college level. A series

of IS project management workshops were scheduled to be held with a group of eight to twelve participants. The plan was that through interactive and hands-on activities, participants would learn project management competencies, interface with various computing professionals, and create authentic project deliverables.

For six weeks, during weekly one-hour sessions, a group of eight to twelve female high school students would assume the role of a team of project coordinators. Guided by a business professional with experience in project management and the systems development lifecycle, the cohort would learn authentic project management skills used today to deploy information systems solutions. Together they would work towards–and complete–the build of a functional, modern, and public facing website. Participants would learn a form of a generic project management lifecycle as well as the generic system development lifecycle. Components of the project management lifecycle included initiate, plan, execute, and close; and, components of the generic system development lifecycle included plan, analyze, design, and implement (Schneider, Fuller, Valacich, & George, 2020).

Research Question

The research question that guided this study was: How can an authentic, hands-on introduction to project management within a computing context facilitate participants' awareness of and interest in computing careers?

Barriers and Issues

Barriers that were considered for the successful completion of this research included the researcher's inability to guarantee access to study participants for more than

the time allotted by school officials. Additionally, the start date of the workshop–in relation to the end date of the school year–was predicated upon finding a suitable time within the school year to complete the study. A related potential issue was the researcher's reliance on the support and availability of a third party to facilitate the data collection process. It was assumed the school selected would provide an adequate cohort of students available to fully participate. It was further assumed all students would participate in the data collection process. A limitation to consider with research work of this scale is the limited generalizability of its findings. The fact that a finite group of students, in a single school, of a specific category, in a particular location in Florida would be used as the focus of this study limits the research findings to a smaller sampling of the overall female high school student population. A delimitation was the researchers' choice to explore the cohort's awareness of and interest in the computing disciplines. Also, the level of prior computing-related experience each student brought the workshop was not considered; nor would every construct or related perspective already documented in the literature be tested.

Definitions and Acronyms

Following are definitions of key terms and a list of acronyms.

Definitions of Terms

Awareness: Knowledge of the existence, exposure to, and the general understanding of computing career options, job styles, working environments, and the associated academic and career preparation needed (Pollock, McCoy, Carberry, Hundigopal, & You, 2004).

Computing: A broad inter- and intra-disciplinary field, fundamentally about the design, creation, use, interpretation and understanding of how models, languages, and machines provide the methods and tools necessary to manage large amounts of data to solve problems at scale (Isbell, et al., 2010).

Computing Careers: Occupations which plan, coordinate, build, make use of, and direct the use of computer networks and systems to solve organizational problems (BLS, 2018).

Computing Disciplines: Academic and career paths including computer engineering, computer science, information systems, information technology, software engineering, cybersecurity, and data science (Topi, 2019).

Information Systems Development Lifecycle: A four-phase process that includes systems planning, systems analysis, systems design, and systems implementation (Schneider, et al., 2020).

Information Systems Project Management: Projects that have unique characteristics that differentiate them from non-IS projects. Some of these characteristics include rapid evolution of information technology, difficulties associated with hiring experienced IS personnel, difficulties related to managing end-user involvement during requirements analysis, use of the systems development life cycle in coordination with the project management life cycle (Schneider, et al., 2020).

Interest: The extent to which a student goes from merely using technology to developing an interest in understanding how it works (Denner, 2011)

Project Coordinator: The U.S. Bureau of Labor Statistics describes the role of a project coordinator as a subordinate role of the project manager role (Green, 2015).

Project Management: "…the application of knowledge, skills, tools, and techniques to project activities in order to meet project requirements" (PMI, 2017b, p. 10)

Project Manager: "…the person assigned by the performing organization to lead the team that is responsible for achieving the project objectives" (PMI, 2017b, p. 52).

Software Development: A set of technical processes used to deliver technical projects (Blake, 2004).

Systems Development Life Cycle: An iterative cycle used in information systems that includes systems planning, systems analysis, systems design, and systems implementation. After a system has been built, systems maintenance is used to modify the system based on changing business conditions (Schneider, et al., 2020, p. 41).

Acronyms

APCS–Advanced Placement Computer Science

AP-CSA–Advanced Placement Computer Science A

AP-CSP–Advanced Placement Computer Science Principals course

BLS–The U.S. Bureau of Labor Statistics

CS–Computer Science

ECS–Exploring Computer Science program

IS–Information Systems

IT–Information Technology

K12CSF–K-12 Computer Science Framework

OECD–Organization for Economic Cooperation and Development

PISA–Programme for International Student Assessment

PM–Project Manager

PMI–Project Management Institute

PMP–Project Management Professional

SDLC–Systems Development Life Cycle

Summary

Chapter 1 presented background information about introducing an all-female cohort of high school students to computing careers through the frame of information systems project management. The problem statement, goal, and research question were established, followed by an exposition of supporting relevance and significance, as well as, a discussion of barriers, issues, assumptions, limitations, delimitations, a definition of terms, and list of acronyms. In order to better understand the state of current and relevant research, the next chapter provides a review of topically related literature, including research articles, conference proceedings, books, and official government filings, among others.

Chapter 2

Review of the Literature

Academic literature–including research studies, conference proceedings, articles, and other scholarly publications–as well as books, official government filings, and published reports from non-government organizations are among the myriad types of literature presented herein. Topically, all included literature was directly or indirectly related to pre-college aged students and the computing-related educational pipeline they are a part of–inclusive of teacher capabilities, and school, local, state, and federal support for the learning environment. This chapter is organized into the following sections: justification of the criteria used for the literature review process, a synthesis of existing literature, an analysis of research methods used, an overview of gaps in the literature, and a concluding summary.

Justification of Criteria for the Literature Review

The process by which the literature was selected and synthesized was informed by Bruce's (2001) work on interpreting the scope of a literature review. In order to justify the criteria used in the literature review process, Bruce identified eight ways for focusing and narrowing the scope of a dissertation work through adequate application of topicality, comprehensiveness, breadth, exclusion, relevance, currency, authority, and availability. Taking into consideration these eight categories while examining the literature from a broad perspective, inclusive of analogous research, purposefully and thoroughly guides the synthesis of literature towards the best available evidence as well as a smaller, more

focused group of conceptual ideas to work with. In following Bruce's (2001) eight categories for synthesizing literature, 55% of papers reviewed as part of the literature review process matched Bruce's Topically category, 45% matched the Comprehensiveness category, 55% matched Breadth, 45% matched Relevance, 73% matched Currency, and 77% matched Authority. It is worth mentioning, 91 other documents reviewed matched Bruce's Exclusion category. Considering the premise of the Exclusion category is to eliminate documents from consideration, the match rate for those documents need not be calculated. Similarly, given all documents reviewed were available for review, 100% of documents reviewed match the Availability category. Furthermore, literature was categorized as a match to either Topicality or Relevance, and, as a match to either Comprehensiveness or Breadth. Also, all papers were rated for Currency and Authority.

Using various online databases, including the ACM Digital Library, the IEEE Xplore® Digital Library, Google Scholar, and ERIC, among others, all accessible though Nova Southeastern University's (NSU's) electronic library, searches were performed for literature published within the last five years. Queries included "information systems education," and "computing education," and "computer science in schools." Additionally, work cited within papers that were reviewed were then subsequently sought out and evaluated for inclusion here. The geographic focus of papers was limited to developed, western, and industrialized nations; as well, papers were limited to work published in English. Table 1 includes a definition of each of Bruce's eight categories and how each category was applied in this literature review.

Table 1

Bruce's Eight Categories for Synthesizing Literature

Category	Description	Match Rate
Topicality	Focuses the topic area to a particular subject matter.	55%
Comprehensiveness	Guides an exhaustive consideration of the totality of existing and prior knowledge.	45%
Breadth	Expand to broader areas of research to provide context and background.	55%
Relevance	Expands to off-topic, albeit relevant, literature.	45%
Currency	Guides the selection of literature to review based on timeliness.	73%
Exclusion	Informs the exclusion of information, helping to narrow the scope.	0%
Authority	Calls for a critical assessment of literature that encompass related general interest topics and specificity.	77%
Availability	Encourages the use of literature that is readily available to the researcher.	100%

Note. Match rate for each category was calculated by dividing the total number of papers reviewed for the literature review, by the number of papers that were identified as a match for each category.

Topicality "is the most elementary view of the scope of the literature review" (Bruce, 2001, p. 4). Plainly, it specifies the topic area, and guides the literature view towards the body of knowledge on a particular subject matter. The following were used: information systems, information technology, computer science, high school-aged students, and females in information systems.

Comprehensiveness informs the scope of the literature review by guiding the retrieval of "the full sum of the literature in the area of interest" (Bruce, 2001, p. 5). It is an exhaustive consideration of the totality of existing and prior knowledge, inclusive of

both primary and secondary literature related to the topic of interest. Articles considered for this literature review were those published in scholarly journals, books, conference proceedings, magazine and online publications from various national and international scientific, computing, industrial, and educational membership organizations, government and non-governmental organization documents and archives, as well as professional whitepapers and crowd sourced documents.

Breadth "permits exploration beyond the confines of the specific" (Bruce, 2001, p. 6) encouraging the literature review to expand to broader areas of research in order to provide context and necessary background information. For this review, additional studies related to early childhood development, intrinsic and extrinsic motivational theory and personality and social psychology were included.

Relevance enables the literature review to expand to literature that can "be considered relevant, whilst not being 'on the topic'" (Bruce, 2001, p. 6). This literature review process included the examination of material related to teaching languages to young learners, teaching information systems to adults, instructional design, and, emerging perspectives on learning, teaching and technology.

Currency, the fifth of Bruce's (2001) eight categories, "represents an interest in timely information" (p. 6). This literature review favored up-to-date literature, encompassing both the aforementioned topicality and comprehensiveness categories, published in the last five years. Literature associated to the breadth category was not evaluated for its currency.

Exclusion "makes explicit the need to exclude a particular range of information" (Bruce, 2001, p. 6), which serves to narrow the scope. This literature review process

excluded from consideration literature related to college-aged students, primary school-aged students, and adult-level education.

Authority, the penultimate category of Bruce's (2001) eight, guides the review process towards literature that explores "more general interests in relevance and specificity" (p. 7), and also calls for a critical assessment of the significance of material. This literature review process explored literature written by authors and published by outlets who have made significant and valuable contributions to areas such as case study strategies for IS research, female interest in computing, increasing interest in computing among teenagers, stereotypes, measuring creativity and exploration during computer interactions, the importance of non-technical job skills, and, the effects of gender diversity when teaching computing-related competencies to K-12 students.

Availability, Bruce's (2001) eighth and final category, refers to literature that may be "physically and locally available" (p. 7). Specifically, Bruce noted that potential costs and time delays can come from attempting to obtain literature outside of readily accessible channels such as local libraries. Literature directly available and freely accessible to the researcher via online channels, including the university's digital library was included in the review.

Synthesis of Existing Studies

Computing education is a key component to helping students acquire skills such as critical thinking and problem solving. These are fundamental skills, which are necessary to succeed in the twenty-first century, tech-centric business environment (Yadav, Hong, & Stephenson, 2016). In fact, even The Executive Office of the President of the United States encouraged "anyone to learn computer science and see that it's fun,

creative, and challenging" (Kalil & Jahanian, 2013, para. 1). In 2016, Megan Smith, the U.S. Chief Technology Officer, released details of a federal plan that would provide U.S. states with $4 billion dollars in funding, and $100 million dollars directly for school districts, in support of "training teachers, expanding access to high-quality instructional materials, and building effective regional partnerships" (Smith, 2016). International efforts are also underway to increase young people's digital literacy (McGillivray, McPherson, Jones, & McCandlish, 2016), the process however, is still undergoing refinement.

The National Science Foundation, an independent federal agency in the United States charged with promoting science, health, prosperity, and welfare, funded the development and implementation of high school-level Advanced Placement Computer Science courses with the aim of having "rigorous, academic computing courses taught in 10,000 high schools by 10,000 well-prepared teachers" (Evaluation Working Group, 2017). As part of that effort, in 2016 The College Board offered a first-semester level programming course, the Advanced Placement Computer Science A (AP-CSA), which teaches high school students object-oriented programming and algorithm development. In that course, only 23% of enrolled students were female, for an average of three female students per school offering the course.

In 2017, The College Board then introduced the Advanced Placement Computer Science Principles course (AP-CSP), which offers a broader view of the technology industry, including problem solving, working with data, general use of the Internet, and an introduction to cyber security and programming topics. This broader view of the technology industry by the College Board also serves to substantiate the prescribed

definition of IS used in this dissertation work. Recognized computing disciplines include computer engineering, computer science, information systems, information technology and software engineering, cybersecurity and data science (Topi, 2019, p. 4). The inaugural AP-CSP course saw a 30% nationwide female participation rate, and an increase to an average of five female students per school offering the course (The College Board, 2014; The College Board, 2017a; The College Board, 2017b).

The academic community–including The Association for Computing Machinery, Code.org, the Computer Science Teachers Association, the Cyber Innovation Center, and the National Math and Science Initiative–created the K-12 Computer Science Framework (K12CSF), a set of guidelines that aim to inform the creation of standards and course work to help support computer science education (Wright, 2017). The K-12 Computer Science Framework Steering Committee weaved four themes throughout the framework, (1) equity: directly addressing diversity and inclusion, an effort to broaden participation in CS education; (2) powerful ideas: evoking powerful, authentic ideas that cross disciplines and help solve real-world problems (Papert, 2000); (3) computational thinking: bridging abstract thinking and modeling with algorithms, simulations and automation (Wing, 2006); and (4), breadth of application: exploring the impact of computing on society.

In order to teach concepts in the computing disciplines, competent educators must be available to engage students in the learning process. Bernier and Margolis (2014) investigated the factors that have threatened staffing and retention of computer science teachers in Los Angeles schools, particularly, schools with high numbers of underserved students. Bernier and Margolis, in collaboration with an expanded team, including

secondary computer science teachers and college professors, created the Exploring Computer Science program (ECS). The programs' main objective is to introduce students "to the problem solving, computational practices, and modes of inquiry associated with doing computer science" (p. 2). Over the course of six weeks students learned the concepts of human computer interaction, problem solving, web design, an introduction to programming, computing and data analysis, as well as robotics. In the five years before their paper was written, nearly 2,500 students had enrolled in Bernier and Margolis' ECS program across 33 schools in the Los Angeles area. Girls enrolled at nearly double the enrollment rate for girls in their state of California's College Board offered Advanced Placement Computer Science (APCS) courses–43% enrollment in ECS versus 22% for state-level APCS enrollment.

Additionally, the program also prepared teachers via a week-long summer intensive course, followed by four face-to-face sessions throughout the school year, in-classroom coaching, monthly meetings, by encouraging peer observations, providing teachers with opportunities to speak at conferences. In the same five-year period, ECS had 81 teachers participate in the program, with only 40 still teaching–at the time of publication. Bernier and Margolis noted this turnover rate shines a light on the need for "stable and well-prepared teachers to enable equitable opportunities for students" (p. 8). The authors wrote,

Until our society figures out how to increase funding to schools, professionalize teaching and compensate teachers with a professional salary, give teachers time to collaborate and think big (along the Google model of employees having 20% time to work on their personal projects), teachers are going to leave the profession and years of

wisdom will be lost from the classroom. And, who is hurt the most is the children in the schools with the “revolving doors.” (p. 10)

In an effort to gain a big picture understanding of teachers’ pedagogical and content knowledge needs across the United States, Yadav, Hong, and Stephenson (2016), interviewed 24 high school teachers across the United States. Thirty-eight percent of participants teaching licensures contained the word “business,” these also had an average of 10.4 years of experience teaching computer science. Fifty percent of the study’s participants had STEM-related words in their licensure, along with 7.4 years of experience teaching computer science. Additionally, 92% of study participants identified as Caucasian. The authors found teachers did not “have adequate content knowledge or pedagogical knowledge to teach computer science” (p. 12). Specifically, teachers who had a formal background in teaching did not have subject matter knowledge, and teachers with subject matter experience did not have a teaching background.

McGillivray, McPherson, Jones, and McCandlish (2016), on the other hand, addressed the integration of "making" and "thinking critically," in the frame of digital media, as opposed to coding. The authors discussed the use of technology by youth, and their affinity towards it, specifically, how the social aspect of the Web has created “the potential for simultaneous learning and leisure, [where] both educational actors and young people have to adapt their pedagogical practices to deal with a collapsing of spatial and temporal boundaries of schooling and leisure” (p. 736).

In the mid-western region of the United States, Outlay, Platt, and Conroy (2017) performed a longitudinal study linking girl’s interest in technology-based careers to lessons the students learned in middle school camps, across two years. The study polled

girls' knowledge of technology-based career such as careers "Project Manager, Business Analyst, Quality Assurance Analyst, Database Analyst, Software Engineer, Graphics Designer, and Technical Writer[,] and the impact of gendered attitudes on their perceptions" (p. 4). Results from a poll taken before camp started in 2013 showed two out of thirty girls were aware of the role of project manager. At the end the second camp session, held one year later in 2014, the same students were polled again and asked their interest in pursuing a project manager role as a career choice, thirteen of thirty students expressed interest.

Babes-Vroman, et al. (2017), in a study spanning three and a half academic years and 8,078 Rutgers University students–about 50% of which are women–found that nearly 48% of female students who intend to major in computer science and have taken a computer science introductory course, do not go on to take a second level computer science course. They also found that upwards of 32% of females who do not intend to major in computer science do go on to take a second level computer science course. The implication in their finding is that "a large part of the retention task is attracting these women to further explore the major" (p.51). Contrastingly, despite a fragmented and less than favorable learning environment, survey results from 57% of the 616 female students polled in Malaysian secondary schools "provide evidence that there is a high level of interest in IT education and careers" (Sien, Mui, Tee, & Singh, 2014, p. 102).

Yardi and Bruckman (2007) noted that while "87% of youth in America between the ages of 12 and 17 use the internet" (p. 39), "the majority of the teenagers [they] talked to expressed a lack of interest in computing related careers, citing the field to be boring, difficult, and tedious" (p. 41). In exploring contrasting teenagers' lack of interest in

computing with graduate students' interest in computing, Yardi and Bruckman suggested that educators include three factors in when designing "computing curriculum in order to engage students: (1) The curriculum should be personally relevant to the student. (2) Students should be able to recognize a specific purpose for working on an assignment. (3) Students should perceive a real-world implication or relevant social application for an assignment" (p. 46). Moreover, in addition to piquing interest and engaging students, Wilkerson (2012) found personal and interpersonal skills to be a high priority item for curriculum adjustment. These skills include "managing time effectively, listening to others, accomplishing assignments, oral communications skills, and dependability" (p. 95). While technical competencies, such as database usage and computer programming skills, are important for technical jobs, Wilkerson noted personal and interpersonal skills carry an overall importance for both employers and alumni.

In two experiments that looked at whether the gender of the role model–i.e. the classroom instructor's gender–had an effect on girls' anticipation of success, authors Cheryan, Siy, Vichayapai, Drury, and Kim (2011) found "across both studies, female role models were no more effective in increasing women's beliefs about their potential for success than male role models" (p. 661). The authors found the projection of stereotypical cues, not the gender of the role model, interfered with girl's beliefs that they would be successful. Master, Cheryan, and Meltzoff (2016) further suggested that "creating nonstereotypical classroom environments may be a valuable way for teachers to signal to girls that they belong in and should enter that environment" (p. 434).

Analysis of Research Methods

Given Bernier and Margolis (2014) collected data from a convenience sample of teachers who participated in their own program, replicating their effort would inherently involve replicating their teacher professional development program as well. Furthermore, while demographical and participation data were collected for teachers who participated in their program, qualitative data were not collected. Bernier and Margolis' research could benefit from additional data, such as survey or interview data.

One methodological, albeit resource intensive, strength of Yadav, Hong, and Stephenson's (2016) qualitative work is their use of semi-structured interviews, some taking place face-to-face. A weakness in the authors' method is the decision to pilot test the interview questions with only two teachers, whose licensure details were also omitted from the paper. Additionally, although appendix one in their paper does present the reader with participant profiles, the table lacks locality; that is, the region or school district each participant represented. Given a claim to represent the United States was made in this paper, being able to track back not only the region each participant represents, but also the background, experience, and region of pilot testers would increase the methodological sophistication of Yadav, et al.'s (2016) work.

McGillivray et al.'s (2016) methodological choice of action research afforded them qualitative data generated from interviews and as well as from a formal evaluation of their program from 585 student participants and 57 teacher participants, across 57 schools. In reporting their findings, the authors cite "disparities exist in access to audio and video equipment, tablets and smartphone devices and especially in relation to desktop computers for editing, surfing the internet or uploading media content" (p. 732).

While correlating their findings with findings from other authors who have done similar work, McGillivray et al. (2016) omit numeric specificity surrounding which schools lack those resources and which students were negatively impacted. With a wealth of qualitative and descriptive data at their disposal, the authors could strengthen their work by providing readers with a comprehensive view of not only how the data were collected–i.e. interview questions–but also the results from their analysis of that data.

While Outlay, Platt, and Conroy's (2017) longitudinal study noted a significant increase in interest over awareness, from before students participated in camp on year one, to the after camp concluded on year two, the study also found students' interest had declined when they returned to camp at the start of year two. Furthermore, the study, made use of only Likert-scale measures, and did not include any qualitative measures. Outlay, et al. (2017) worked with a small sample of 30 students, which limited their perspective to that of the student. Their work could have benefited from having collected data from teachers, supporting staff, school officials, and parents.

Babes-Vroman, et al. (2017) analyzed quantitative data from two primary sources, the university's registrar database, and from surveys completed by students of the same university. Although the data collected spanned multiple school years, and thousands of students, the dataset lacked qualitative measures. For example, while chi-square tests found statistical significance for findings such as a drop in women who took the CS1 course but did not take the CS2 course, qualitative data are lacking from the study to better understand why. Moreover, Babes-Vroman, et al. go on to offer suggestions "to improve the recruitment and retention of female students" (p. 55), yet, their research lacks the qualitative data that could serve to directionally guide their suggestions. One

strength of their work is that it can serve as a model to future researchers who could replicate the work at the high school level.

Sien, Mui, Tee, and Singh (2014), collected quantitative data from 616 Malaysian female secondary school children on both the east and west side of the peninsula; in doing so, the authors ensured representation across the Malaysian population, including indigenous students. Seventeen questions were asked of the students, with a mix of demographic questions, questions limited to yes and no answer choices, as well as questions using five-point Likert-scale level of agreement. Survey participants were asked about their prior use of technology, their experience with learning about technology in school and at home, and, their opinion of technology-based careers. Students were not asked what they know about what technology-based jobs exist, nor were they asked about their knowledge of technology-based academic options. Additionally, although their work presented descriptive statistical findings, it could have benefited from the inclusion of more complex inferential statistical analysis.

Yardi and Bruckman (2007) coded interview and observation data collected from teenagers in an after-school technology program, and cross-tabulated that with interview data collected from graduate students in a computing program. The authors learned about teenager's perceptions of computing, as well as the factors that motivated graduate students to pursue degrees in computing. From their findings, the authors proposed a secondary school curriculum which portrays "computing as an innovative, creative, and challenging field with authentic, real-world applications" (p. 39). Yardi and Bruckman interviewed teenagers ranging from 11 through 20 years of age. The authors' work could

have benefitted from grouping results by age range, given that perceptions of an 11-year-old could vary greatly from that of a 20-year-old.

Taking one step forward in the talent pipeline, Wilkerson (2012) created a 117-item survey by synthesizing the work of nineteen studies and derived 96 usable responses from alumni who graduated with a bachelor's degree in Management and Information Systems from a northeastern U.S. university. The survey assessed the importance of–and gaps associated to–104 technical and non-technical job skills. Results from Wilkerson's study found "the largest skill gaps and the highest priority items for curriculum adjustment are in the areas of Personal and Interpersonal skills" (p. 95). One limitation of this study is the homogeneity of its responses, 67% of responses "were received from alumni who are currently employed in the same state as the university at which the study was conducted" (p. 89).

In the first of their two studies, Cheryan, Siy, Vichayapai, Drury, and Kim (2011) investigated whether interacting with a computer science role model influences women's success belief in computer science. The study looked at results from a 2 x 2 ANOVA, stereotypicality x role model, stemming from data collected from 85 female participants who were not computer science majors. The authors found "perceptions of dissimilarity to stereotypical role models compared to nonstereotypical role models accounted for women's lower success beliefs in computer science" (p. 659). In their second study, the authors tested how computer science role models would influence both women's and men's success beliefs. The authors second study was moved to a virtual environment, which enabled control and standardization of role model behavior. In a 2 x 2 x 2 ANOVA, stereotypicality x participant gender x role model gender, the authors found

that for the 40 women and 28 men who remained in the study, women's "perceived dissimilarity was a significant mediator of the relationship between stereotypicality and success beliefs … whereas for men, this mediation was not significant" (p. 661). Both of Cheryan et al.'s studies were fully quantitative in nature. The authors work could have benefited from qualitative data, especially considering the number of participants they recruited for each study.

Master, Cheryan, and Meltzoff (2016) also ran two field experiments; theirs looked at if stereotypes influence "high-school girls' lower interest than boys in enrolling in computer science courses", and "if stereotypes can be communicated by the physical classroom environment, and whether changing this environment alters girls' interest" (p 424). In their first experiment, the authors collected quantitative data from 165 students in two U.S.-based high schools, one public and one private. Participants were presented with photos of two classroom environments and asked a series of Likert-scale questions related to enrollment interest, belonging, negative stereotype concerns, and fit with stereotypes. In a 2 x 3 ANOVA, participant gender x classroom environment [premeasure, stereotypical, and nonstereotypical], and through the use of descriptive statistics, the authors founds that "girls reported significantly more negative stereotype concerns than boys … when the classroom was stereotypical" (p. 429), and an "interest in enrolling in an introductory computer science course was significantly increased when the classroom environment was altered so that it did not fit high school students' current stereotypes of computer science" (p. 430). In their second experiment, leveraging the same 2 x 3 ANOVA, participant gender x classroom environment [premeasure, stereotypical, and nonstereotypical], as well as similar descriptive statistics–this time

without the use of photos–the authors demonstrated again that "girls were less interested in the stereotypical classroom" (p. 433). Limitations of their work include small sample sizes and some of their scales used few items. Also, their work could have been strengthened by incorporating qualitative data measures.

Gaps in the Literature

While large initiatives like K12CSF and the College Board's AP courses generally aim to promote computer programming and coding to the technically inclined student, Iversen, Smith and Dindler (2018) argue that computational empowerment, that is, the "concern for how children are empowered to make critical and informed decisions about the role of technology in their lives[,] shifts [the] focus from programming skills as an end in themselves towards providing children and young people with the means necessary to take part in technological development' (p.1). Additionally, the literature discusses the need for increasing the number of teachers who are qualified to teach not just computer programming–as often students can be much more advanced in coding than their teachers–but rather, teaching computational thinking which provides "opportunities for students to struggle with strategies to organizing their approach to solving a problem rather than the teacher providing the structure and students being assigned step by step processes" (Ouyang, Hayden & Remold, 2018, p. 166-167)

Moreover, while strides are being made in advancing teacher capabilities, Babes-Vroman, et al. (2017) made it clear that women who take an introductory computer science course early in college tend to not go on to take a second course, even though Outlay, Platt, and Conroy (2017) pointed out that efforts such as an extra-curricular

technology-career camp have helped increase middle school girl's knowledge and interest of technology-based careers.

Despite the work that had been done, there existed a gap in the literature that this dissertation work aimed to explore. Rather than teach computer science–strictly speaking–to students or teachers, this dissertation work explored teaching learners the processes by which information systems related projects come to fruition. That is, teaching students the fundamentals of–and how to manage–the software development lifecycle, the processes, the resources, the people, and the timelines, rather than teaching them how to code.

Summary

Chapter 2 served to rationalize the practical and scholarly significance by reviewing topically related and relevant scholarly research, discussing the criteria used to justify the selection of related research, providing a synthesis of the literature, analyzing the research methods used, and, exploring gaps and limitations in prior literature. Chapter 3 describes the research methodology and design.

Chapter 3

Methodology

In chapter 2, the literature review served to establish a baseline of work other researchers had done in related areas, including any barriers and issues they may have faced. Additionally, the literature review facilitated the identification of strengths and weaknesses of related existing studies, gaps in body of knowledge, and, served as a reference for the research methods used in similar studies–and whether those methods were reliable and valid. In March 2020, the COVID-19 global pandemic directly affected this study. The pre-pandemic version of this study was predicated upon in-classroom instruction, however, because Palm Beach County school district decided to move all in-classroom instruction to remote instruction, the original version study was no longer viable. This chapter describes the original research plan–a qualitative descriptive case study (Yin, 2017), including the chosen research paradigm, philosophical rationale, methodological approach, and research design–which is then followed by an explanation of how COVID-19 impacted the study and what modifications were made to the original research approach.

Dubois and Gadde (2002) noted three approaches to a thesis: deductive, inductive, and abductive. Miller (2010) described how proper selection of a methodological approach directly influences the research design. The deductive approach "proves that something *must* be" (p. 194). This approach sets out to generalize and leverages quantitative measures in order to develop or test theoretical constructs or hypotheses. Additionally, the approach discounts people's interpretation of their social interactions.

The inductive approach "shows that something *is*" (p. 194). This approach leverages small samples of qualitative measures, and accounts for people's interpretations with no room for alternative explications. Last, the abductive approach leverages both deduction and inductive reasoning, and thereby "suggests that something *may* be" (p. 194).

Originally established by Charles S. Peirce (1839-1914), abductive reasoning starts with the observation of a phenomena, and then forms logical inferences from those observations in an attempt to arrive at the simplest and the most plausible explanation for the observed phenomena. Miller (2010) noted "Peirce emphasized the critical importance of abductive reasoning in science, particularly in the initial discovery stage that precedes induction and deduction" (p. 194). Additionally, Dubois and Gadde (2002) found abductive reasoning, as its dimensional logic flows between the empirical and the theoretical, to be more useful than either deductive or inductive, exclusively. They also argued that "abduction is about investigating the relationship between 'everyday language and concepts'" (p. 555), where the successive refinement of the in-depth insights derived from observing the phenomena in context can give way to new concepts and new discoveries. Given the purpose was to understand the impact the workshops had on the participants inclination towards embarking on an information systems-based career, the abductive methodological approach was preferred for this dissertation work.

Originally established by Charles S. Peirce (1839-1914), abductive reasoning starts with the observation of a phenomena, and then forms logical inferences from those observations in an attempt to arrive at the simplest and the most plausible explanation for the observed phenomena. Miller (2010) noted "Peirce emphasized the critical importance of abductive reasoning in science, particularly in the initial discovery stage that precedes

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Philosophical Rationale

All research is structured upon a foundational philosophical framework, which guides assumptions, abstract ideas, inquisitive perspectives, and informs the research process (Denzin & Lincoln, 2011). In qualitative research there is no single theory or paradigm, which can directly guide it. In fact, "multiple theoretical paradigms claim use of qualitative research methods and strategies, from constructivism to cultural studies, feminism, Marxism, and ethic models of study" (p. 6). This qualitative study was based on interpretive hermeneutic phenomenology from the perspective of social constructivism.

The classical and logical positivist researcher emphasized empiricism, quantitative methods, and the use of hard data to explicate the physical and social world. Post-positivist augment empirically based quantitative methods with qualitative methods, including data derived from–and subject to–interpretation, and reality-defining assumptions (Lapid, 1989). Interpretivism, as a subset of post-positivism, is not a single paradigm; rather, it is a collection of diverse paradigms including hermeneutics and phenomenology. Hermeneutics, the philosophical interpretation of meaning, was for

centuries considered an extension of philology, the structural and historical study of language in text and oral form, including linguistic interpretation and critique (Butler, 1998).

Hermeneutics has its roots in the ancient Greek verb ‘hermeneuein,’ which was later translated into the Latin equivalent ‘interpretari’. Both terms essentially mean to utter, to explain, or to translate. In modern times, hermeneutics has been ascribed two meanings. First, it is considered an activity aimed at understanding written or verbal communication and establishing proper rules for their interpretation. Second, as a branch of philosophy, it delves into the very nature of understanding, concerning itself with the study of how language, its words, symbols, and concepts, serve as a contextual medium within which to understand not just texts, but life as a whole (Oxford Academic, 2016; Zimmermann, 2015). A basic tenant of modern hermeneutics is that understanding is attained by an iterative process known as “the hermeneutic circle,” The 19th-century German philologist Georg Anton Friedrich Ast (1778-1841) may have been the first to describe the iterative process when he wrote “the same way that the whole is, of course, understood in reference to the individual, so too, the individual can only be understood in reference to the whole” (Mantzavinos, 2016, para. 10). The hermeneutic circle–possibly more accurately described as a spiral, rather than a circle–is “an effective tool for working within the philosophically and experientially complex research approach of hermeneutics” (Paterson & Higgs, 2005, p. 354). The spiral approach enables the qualitative researcher to progressively and iteratively cycle between the parts and the whole of the phenomena, allowing for deep immersion in related text and dialog.

Phenomenology, as a research discipline, aims to clearly and accurately describe a particular aspect of human experience. It “seeks to explicate the essence, structure, or form of both human experience and human behavior as revealed through essentially descriptive techniques including disciplined reflection” (Valle & Halling, 1989, p. 379). Creswell (2012) in citing Moustakas (1994) affirmed that phenomenological research should emphasize intentionality of consciousness, where experience is a combination of both the outward appearance of that lived experience, and an inward consciousness of it, “based on the memory, image, and meaning” (p. 236).

Irrespective of the myriad paradigms–and combinations of paradigms–available to researchers throughout history, Guba (1990) categorized and characterized research paradigms by how researchers address their inquiry through the lens of three dimensions: ontology, epistemology, and methodology. Ontology questions the nature of reality, epistemology explores the nature of the relationship between the inquirer and the known or the knowable, and methodology informs how the researcher should go about discovering knowledge (p.18). Denzin and Lincoln (2011) contended that axiology, a discussion of the ethical and value-laden nature of a study, should be added to the list of Guba’s paradigmatic dimensions. Specifically, because it “is one way of achieving greater confluence among the various interpretivist inquiry models” (p. 116). Further, Denzin and Lincoln considered the ontological, epistemological, axiological, and methodical premises are fundamental to–and are woven into–the interpretive framework used in qualitative research.

Qualitative research, loosely defined as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of

quantification" (Strauss & Corbin, 1990, p. 17), enables researchers to “provide thick, detailed descriptions of actual actions in real-life contexts that recover and preserve the actual meanings that actors ascribe to these actions and settings. Qualitative research can thus provide bases for understanding social processes” (Rynes & Gephart, 2004, p. 455). Qualitative research, however, is not a direct synonym for interpretivism. Chua (1986), as referenced by Orlikowski and Baroudi (1991), suggested that qualitative research need not be paradigmatically interpretive. Epistemologically, qualitative research can assume a positivist, interpretivist, or critical underlying philosophy (Myers, 1997).

Orlikowski and Baroudi (1991) expounded on these three epistemological categories of qualitative research, noting “positivist studies are premised on the existence of a priori fixed relationships within phenomena which are typically investigated with structured instrumentation” (p. 5). That is, positivist studies aim to test theories via formal propositions, quantifiable variables, and the testing of hypotheses. The authors further noted “interpretive studies assume that people create and associate their own subjective and intersubjective meanings as they interact with the world around them” (p. 5). These types of studies are approached from a nondeterministic perspective and examine the phenomena from the viewpoint of its participants, within their naturally occurring cultural and contextual situation. Additionally, Orlikowski and Baroudi contended that “critical studies aim to critique the status quo, through the exposure of what are believe [*sic*] to be deep-seated, structural contradictions within social systems” (p. 6). Studies in this category adopt a critical position when attempting to understand existing social practices. Interpretive researchers “adopt the position that our knowledge of reality is a social construction” (Walsham, 1995, p. 376), built from the subjective

experiences of individuals. Gephart (1999) posited that interpretivism is the assumption that knowledge and sense-making are acts of individual interpretation. Consequently, objective knowledge cannot be divorced from the interpretations of a reasoning individual. Rynes and Gephart (2004) noted the goal of interpretivism is to arrive at an understanding of local, intersubjective, socially constructed realities, which are composed from the subjective and objective meanings held by societal members as they experience everyday life. This understanding of human behavior motivates the "capturing [of] actual meanings and interpretations that actors subjectively ascribe to phenomena in order to describe and explain their behaviour" (Johnson, Buehring, Cassell, & Symon, 2006, p. 132). Moreover, whereas quantitative research is grounded in a mathematical and statistical base, focused on the codification and quantification of phenomena, the interpretive paradigm, and thus qualitative research, is highly descriptive, provides a narrative of people's views, and exposes how wide-reaching concepts operate in particular cases (Rynes & Gephart, 2004). Orlikowski and Baroudi's (1991) characterization of the three epistemological perspectives of qualitative research–positivist, interpretivist, and critical–as supported by Gephart (1999) and Rynes and Gephart (2004), served as the base for having chosen the interpretivist research paradigm as the philosophical underpinning of this study.

With its roots in the phenomenology of existential understanding and in the hermeneutic experience, the interpretive approach "attempts to understand how and why individuals, through their socialization into, interaction with, and participation in, a social world, give it a certain status and meaning" (Orlikowski & Baroudi, 1991, p. 13). On the one hand, phenomenology focuses on studying an individual's direct experience–taken at

face value–in specific contexts, rather than studying the external, objective, and physically described reality which is external to the individual (Cohen, Manion, & Morrison, 2000). On the other hand, the hermeneutic experience, as seen by the 20th-century German philosopher Hans-Georg Gadamer (1900-2002), is an iterative process where "language ceases to be a mere system of sounds and symbols–it becomes the expression of meaning" (Hirschheim, 1985, p. 12). When taken together, hermeneutic phenomenology from the Gadamerian viewpoint suggests language plays an ontological role, as an emissary between actual experiences and the process of understanding (p. 12).

The categorical worldview of interpretivism that best suited this dissertation was social constructivism. Constructivism extends the interpretivist approach by asking both broad and general questions of participants, allowing them to socially construct the meaning of a situation through interactions and discussions with other persons (Creswell, 2012). The social constructivist worldview seeks understanding of the world we live and work in, and "emphasizes the importance of culture and context in understanding what occurs in society and constructing knowledge based on this understanding" (Orey, 2010, p. 6). Moreover, Guba (1990) summarized the constructivist belief system as follows:

Ontologically, a relativist position is taken, such that realities exist in the form of multiple mental constructions, socially and experientially based, local and specific, dependent for their form and content on the persons who hold them. Epistemologically, a subjectivist position is held, such that the inquirer and inquired are fused into a single (monoistic) entity. Findings are literally the creation of the process of interaction between the two. Methodologically, a hermeneutic/dialectic position is sustained, such that individual constructions are elicited and refined hermeneutically, and compared and

contrasted dialectically, with the aim of generating one (or a few) constructions on which there is substantial consensus. (p. 27)

Axiologically, Ponterotto (2005) asserted that the values and own lived experience of the researcher should be recognized, acknowledged, and described–but not eliminated–as these cannot be detached from the research process. Similarly, Creswell (2012) added, "the researcher's intent, then, is to make sense (or interpret) the meanings others have about the world. This is why qualitative research is often called 'interpretive' research" (p. 25). When looking to challenge structural or normative assumptions, the use of phenomenological strategies can be an effective method of "bringing to the fore the experiences and perceptions of individuals from their own perspectives" (Lester, 1999, p. 1). In this respect, the philosophical rationale for this qualitative study was based on interpretive hermeneutic phenomenology from the perspective of social constructivism. The philosophical framework for this research study is illustrated in Figure 1.

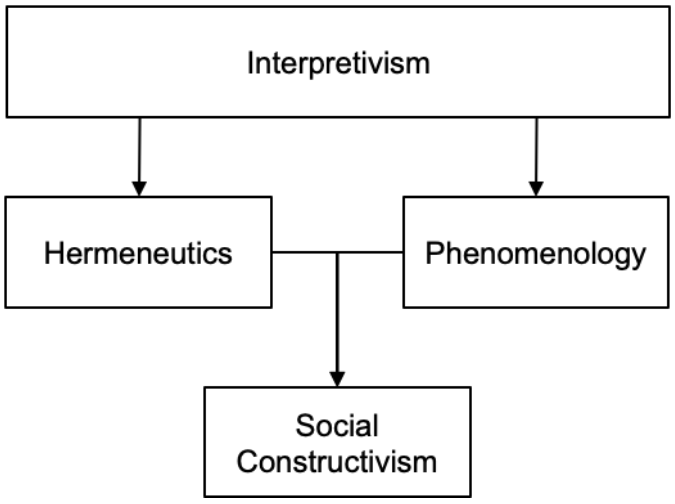


Figure 1. Philosophical Framework. This chart illustrates the foundational philosophies that guided this study and the relationships between them.

Theoretical Framework

A theoretical framework, derived from existing formal theory, communicates the theories that support the researcher's perspective, the research plan, as well as relevant concepts and definitions in the dissertation inquiry. Grant and Osanloo (2014) noted the theoretical framework is developed a priori and is akin to a "blueprint" for the dissertation inquiry (p. 13), which then helps build and support the research design and subsequent work. The formal theories that served as a foundation for this dissertation included: Cognitive Evaluation Theory and Social Development Theory.

Cognitive Evaluation Theory.

The first theory underpinning this dissertation is Cognitive Evaluation Theory (CET), popularized by Ryan and Deci (2000). The authors considered CET to be a sub-theory of the broader self-determination theory, and argue "that interpersonal events and structures (e.g., rewards, communications, feedback) that conduce toward feelings of competence during action can enhance intrinsic motivation for that action because they allow satisfaction of the basic psychological need for competence" (p. 58). In essence, CET, as seen through the lens of autonomy and competence, outlines the contextual, social, and environmental dynamics that modify intrinsic motivation. Ryan and Deci clarified, though, that for people to judge their own behavior to be self-determined, a sense of autonomy must be accompanied by an increase in perceived competence, "in order for the enhanced feelings of competence to result in increased intrinsic motivation" (p. 59). One limitation of CET to bear in mind is that intrinsic motivation can only manifest itself when the activity being performed has some inherent intrinsic value for a person. The main reason for using CET in this dissertation work was rooted in Ryan and

Deci's fundamental tenant of CET, that intrinsic motivation is a function of an individual's need for competence and autonomy and is increased when feedback is timely, informational, and non-controlling.

Social Development Theory.

The second supporting theory is Vygotsky's (1896-1937) sociocultural approach to cognitive development of the early 20th-century. Vygotsky's Social Development Theory (SDT) "posits that social experience shapes the ways of thinking and interpreting the world" (Jaramillo, 1996, p.135). In essence, the process of socialization among various actors, inclusive of the social environment, precedes awareness, reasoning, and knowledge building in the learner. The More Knowledgeable Other (MKO), a Vygotskian classification which groups some of the actors in the shared social learning experience, can be anyone, or anything, with a more advanced understanding or ability level than the learner. For example, peers or younger people with more knowledge or ability than the learner, adults, teachers, coaches, and even various forms of computing technology can be considered an MKO. The More Knowledgeable Other provides learners with scaffolding or assistance, which helps learner complete tasks they could not otherwise accomplish on their own (Hammond & Gibbons, 2005).

The gap between a learner's ability to accomplish a task independently, and the learner's ability to accomplish a task with scaffolding from an MKO, is known as the Zone of Proximal Development (ZPD). Vygotsky developed ZPD as an extension to the concept of intelligence; rather than gauge intelligence on an individualized level, Vygotsky suggested intelligence can be seen through the lens of what a learner can accomplish with some skilled assistance (Cameron, 2001). Additionally, Vygotsky

believed “student's development cannot be understood by a study of the individual; we must also examine the external social world in which that individual's life developed” (Jaramillo, 1996, p. 136). One limitation of ZPD is its concept of upper and lower bounds which are, in effect, zonal boundaries that are “co-constructed through tasks that occur between the teacher and the students” as they engage in the learning process (Hammond & Gibbons, 2005, p. 13). Notwithstanding, the main reason for using Vygotsky’s social development theory was because Vygotsky argues that knowledge is co-created and cognitive development emerges from shared, and guided social interactions.

It would have been an injustice to look at the problem posed herein from the lens of a singular theoretical perspective. In an effort to ensure a thorough and objective attempt was made at explaining and interpreting the way subjective and interpersonal preconceptions and perceptions of learners change as a result of the proposed educational experience, two theoretical constructs were used in this dissertation research work. The combined strengths of cognitive evaluation theory and social development theory are key to establishing a strong pillar from which to build upon. The expectation was to braid together (a) the cognitive evaluation theory proposition that autonomy and competence, in the proper social and environmental context, can positively modify intrinsic motivation, with (b) social development theory’s suggestion that relationship building and behavior modeling–by key social actors such as peers, teachers, and adults, among others–can influence a person’s behavior.

Research Method

According to Sekaran and Bougie (2016) a research design is “a blueprint or plan for the collection, measurement, and analysis of data” (p. 95) specifically designed to

address a research inquiry. Sekaran and Bougie's research design framework consists of six elements, including:

- Type of Investigation, which entails identifying the type of research, for example an exploratory, descriptive, or causal study.
- Extent of Researcher Interference, which provides an understanding of the extent to which the aspects of the study are controlled and manipulated by the researcher, that is, the extent of the researcher's interference in the study.
- Study Setting, which considers the location or setting of the study, be it contrived, non-contrived, or a field study.
- Research Strategy or Approach, such as an experiment, action research, a case study, or other.
- Time Horizon, identifies and outlines the temporal aspects of the study, whether data are collected once, or over a period of time.
- Unit of Analysis, which elaborates on the level at which data are aggregated and relationships are analyzed.

The following is an exposition of how each of these six elements were addressed.

Type of Investigation

A benefit of qualitative description design, as noted by Sandelowski (2000), is that "qualitative description is especially amenable to obtaining straight and largely unadorned (i.e., minimally theorized or otherwise transformed or spun) answers to questions of special relevance to practitioners and policy makers" (p. 337). By presenting a case in colloquial language, rather than leveraging technical or academic parlance, descriptive qualitative studies offer a comprehensive summary and an accurate

accounting of observed events, which convey the facts of a case, and the meanings participants ascribed to those facts. By selecting qualitative description as the type of investigation for this research, this study aimed to explore the "five basic "W" questions—who, what, why, when, and where—and an implicit sixth question, so what?" (Grimes & Schulz, 2002, p.145).

Researcher's Stance

Professionally, the researcher had nearly two decades of experience in computing, mostly at large, multi-national, publicly traded organizations. The vast majority of his career had been spent working for either IT departments or marketing departments, both of which make extensive use of project management methodologies and systems and software development lifecycles. As a student, the researcher had taken computing-related courses at the undergraduate, graduate, and doctoral level. A shared characteristic the researcher had seen among a near two-decade long professional career, and at all levels of higher education, was the gender disparity favoring men over women in computing-related professional settings and in academia, including both students and instructors. Moreover, the researcher's interest was rooted in the years-long juxtaposition of his professional and academic experiences in computing, with having been raised in a disproportionally female, multi-generational matriarchy; and most recently, with having married a woman who built a successful and high-level career in computing. These professional, academic, and personal experiences characterized what Corbin and Strauss (2014) called the researchers' "theoretical sensitivity." That is, awareness of subtleties, and capacity of "being more in tune to the meaning of data" (p. 266).

The researcher's role in this study was be limited to that of guest speaker in the classroom. The researcher aimed to administer six sessions and keep a reflexive journal of each workshop session. Given the researcher would facilitate the sessions, it was important to recognize that "the extent of interference by the researcher has a direct bearing on [the] study" (Sekaran & Bougie, 2016, p. 99). Qualitative research, with its idiographic nature, is at risk for what is called the observer effect, which is the potential for the researcher's involvement in the case to affect participant's behavior (Wilson, 1977). In an effort to minimize the extent of interference by the researcher, including the observer effect, a third-party would conduct the post-workshop interviews; see Appendix A for the interview questions.

Study Setting

The study took place in a non-contrived setting–in the field, in a high school classroom environment, where learning and teaching events proceed normally (Sekaran & Bougie, 2016). A Title I school in West Palm Beach, FL, was selected as the study site.

Approach

A descriptive study can have at its center one of two foci: individuals or populations. The former can take the form of a case report, a case study, or cross-sectional study. The latter may take the form of a correlational study (Grimes & Schulz, 2002). The difference between a case study and a case report is important. The first is a "case *of* something," and it includes a description and analysis of the case. The second is the demonstration or the presented example of a case, and it lacks a thorough description or analysis of the case itself (Hyett, Kenny, & Dickson-Swift, 2014, p. 6). A case study, as a methodology, rather than a method–as described by Creswell (2012), Stake (1995),

and Yin (2017)–implies the establishment of a logical and coherent argument, the definition and adherence to a research paradigm, a discussion of a chosen methodological position, and, the clear selection of study methods. Each of these components is included herein. Yin further categorized case studies as explanatory, exploratory, or descriptive. An explanatory case study, Yin contended, aims "to explain how or why some condition came to be," an exploratory case study aims "to identify the research questions or procedures to be used in a subsequent research study," and a descriptive case study aims "to describe a phenomenon (the 'case') in its real-world context" (pp. 286-287). In light of the definitions provided by these principal authors, this study used a qualitative descriptive case study design and followed Yin's (2017) methodological guidelines.

Case Description. The goal was to discover how exposure to IS project management impacted perceptions of computing careers among high school female participants. Specifically, the overarching research question was: *How can an authentic, hands-on introduction to project management within a computing context facilitate participants' awareness of and interest in computing careers?* The relevancy of this case cannot be understated; the historic, current, and forward-looking trends are well documented, and are prognosticated to have a global impact (PMI, 2017a).

Case Selection. This particular case had been selected because the researcher was, at a professional level, intimately familiar with the project management methodology in the context of software and systems development, and had convenient access to both project management professionals, project management-related educational material, and a cohort of high school students. Moreover, this case was

selected because of its potential for affecting positive change in the technology industry, as well as in students' lives.

Type of Case Study. The type of case study selected was a single, holistic, representative case. Creswell (2012) noted three variations to the qualitative case study: first, a case study focused on a single instrumental case; second, a study centered around a collective, or multiple cases; and third, an intrinsic case study. Creswell described the single instrumental case study as one that focuses on a particular issue or concern, and then explores and provides insights on a single, illustrative, and bounded case. A collective case study, on the other hand, addresses a singular, instrumental case; however, the researcher leverages multiple case studies to illustrate the issue. And finally, Creswell noted the intrinsic case study has at its core an unusual or a unique issue, the particulars of which are, unto itself, the focus of the case study.

Additionally, Cavaye (1996, p. 230) described four strategies with which to approach a case study: field study, action research, application descriptions, and ethnographic research. Field studies are conducted in natural environment when the phenomenon naturally occurs. As an observer with no intention of manipulating variables, researchers begin with a priori definitions of constructs and relationships, and leverage questionnaires and interviews to collect data. Action research affords researchers the ability, in addition to observing and recording data, to actively participate in attempting to solve the issue being studied. Application descriptions divorce the researcher from the physical setting where the phenomenon naturally occurs. Instead, researchers leverage descriptive accounts, written or otherwise, of actual events to illustrate the case. Ethnographic researchers typically assume a longitudinal approach to

observation and data collection, sometimes doing so for over a year. Interpretation of findings is centered on the viewpoint of the participants, not from theoretical, nor the researcher's perspective.

Yin (2017) took a slightly different approach to Stake (1995) and discussed four additional types of case study design: types one and two focus on a single case study, and are either holistic or embedded, respectively; types three and four are centered on multiple case studies, and are also, respectively, holistic or embedded (p. 47). Yin further described the holistic approach to be when the case itself is the unit analysis of the study. In contrast, he explained the embedded approach is when several units of analysis are used in the study.

Yin (2017) defined five major rationales for adopting the single-case study approach including critical cases, unusual cases, common cases, revelatory cases, and, longitudinal cases (p. 49-51). A critical case study is one that can test a particular theory or theoretical proposition. Unusual cases should be considered extreme or unique case, those which specifically diverge from theoretical norms or everyday situations, for example, a study of a rare disorder. A common case, also called a representative case, is one that is representative, or typical, of the circumstances and conditions of a common, everyday situation. Revelatory cases afford researchers "an opportunity to observe and analyze phenomena previously inaccessible to social science inquiry" (p. 50). And finally, longitudinal cases include an associated time element and associated changes that may occur; such as studying a case at two or more periods in time or studying a trend as it flows over time. In response to Creswell's (2012), Cavaye's (1996), and Yin's (2017)

characterizations of the various types of case studies available to qualitative researchers, the type of case study selected for this research was a single, holistic, representative case.

Binding the Case. In addition to establishing the foundational design elements of a case study, binding the scope of the design is of equal importance. Well-established boundaries delineate what is included and excluded from the research project. Baxter and Jack (2008) referenced key qualitative research and case study authors when suggesting a triad of spatial, temporal, or contextually bound techniques to limit the scope of a case study. First, binding the case by place and time (Creswell, 2012), second, by time and activity (Stake, 1995), and third, by establishing clear definitions of terms used and adequately delineating the context of the study (Miles & Huberman, 1994). The setting for this case study was a high school classroom, in Palm Beach County, Florida during the 2019-2020 school year. This setting provided spatial and temporal boundedness in the form of an institutionalized setting in which participants are already comfortable. This setting included an accessible-to-all schedule, a shared learning space, as well as the implicit and shared understanding of expectations and outcomes on the part of both student participants and instructors that are customary of this setting. In order to address the potential for perspectival variability from participants, lock-step curriculum was implemented, particularly to ensure students participated in learning activities at a controlled pace. All technical terms used in the curriculum were accompanied by clear, written definitions so as to avoid ambiguity among participants. Just the same, codified themes, concepts, and other analysis or research specific vernacular were clearly defined. Last, while consistency in the aforementioned time and place bind also served to establish context, particularly as it relates to the environmental setting of this research, during the

analysis phase a context chart further facilitated the understanding of critical "interrelationships among the roles and groups to go to make up the context of individual behavior" (Miles & Huberman, 1994, p. 102). The collective of these boundaries served to inform the circumscription of the case study's design, thereby enabling the researcher to focus on the structures and relationships that were critical and of most interest to the case study.

Participants and Sampling. A purposive sample of female high school students in Palm Beach County, Florida–excluding all males, as well as non-high school students–was used. Participants, in a non-random, stratified fashion, were invited to take part in the study. Two primary stratification criteria were considered: demographic and gender. Demographically, age–as a bracketed function of school grade level–was a primary stratification category and a key characteristic of the target sample. Essentially, students in the 11th grade were included in the sample, all other grade levels were excluded. The rationale behind choosing this grade level category was that students in this grade are of a particular age and are soon to make meaningful academic and career decisions. Students in higher grade levels would have already undergone the thought processes associated with that decision-making; in contrast, students in lower grade levels may not yet have incentive to do so. Also, the female gender was the only gender included in the study. The rationale for this gender-specific sampling frame was fairly straightforward: this study was wholly related to high school females and not their male counterparts.

Maintaining sample universe homogeneity helped the study remain contextually sound in relation to its setting; however, it should be noted that generalizations from the study should remain localized, and not push to other speculative or abstract levels

(Robinson, 2014). Insomuch as time and resources played a limiting role in this research, and considering the nature of the study setting, a provisional sample size of eight to twelve participants was targeted. Robinson (2014) noted research based on a single study with an idiographic aim are recommended to have no less than three participants, and no more than sixteen; such that this constrained sample size "is sufficiently small for individual cases to have a locatable voice within the study, and for an intensive analysis of each case to be conducted" (p. 5). There existed the possibility that students might exit the workshop before data collection was complete, and, that students would be added to the workshop once the sessions begin. While new students would indeed benefit from the remainder of the sessions, their data, as well as the data of those who exit early, would be excluded from the final analysis.

The participant sample was sourced from a Title 1 high school in Palm Beach County, Florida. Matters of advertising participation in the workshop were handled by school officials. The only incentive offered to potential participants was their personal takeaways from participating in the workshop.

A sampling of high school students was not without its own set of limitations. For instance, the cohort being from a single school, of one district, with one particular regional socio-economic makeup conjures up inherent generalizability concerns. Additionally, the participating cohort was not expected to be representative of a larger population, be it at the regional level in South Florida, at the state level, nor at the national level. The re-accessibility of this population by future researchers, however, was not considered a limitation. Also, a study with a small sample size may see participants who decline to take part in the data collection process, effectively weakening the sample.

Just the same, some respondents may not answer all questions or, wittingly or unwittingly, give incorrect answers (Cohen, Manion, & Morrison, 2000).

Time Horizon

A critical component of the research design process is the temporal aspect with which data collection is undertaken; namely, across two primary time horizons: cross-sectional and longitudinal. The former, "gathered just once, or perhaps over a period of days or weeks or months" (Sekaran & Bougie, 2016, p.104), and the latter repeated over an extended period of time, routinely surpassing a year. Moreover, Cohen, Manion and Morrison (2000) noted cross-sectional studies can also see different respondents studied at different points in time. A cohort study, for example, is one where measures are taken from the same respondents over a period of time. In citing Borg and Gall (1979), Cohen, Manion and Morrison (2000) noted some members of a cohort may not be included in the data collection process each time data are collected, essentially enacting a sampling process of the original sample. In contrast, a panel study is one where "each same individual is tracked over time" (p. 212). In the research where change over time is a focal point, the cross-sectional time horizon can take the form of a trend study, where measures are taken at different points in time, with identical samples, in order to facilitate equitable comparisons over the time horizon. While trend studies do not traditionally include the same respondents over time, in citing Gorard (2001), Cohen, Manion and Morrison (2000) suggested "this problem can be attenuated by a 'rolling sample' in which a proportion of the original sample is retained in the second wave of data collection" (p. 213). Given the primary research interest was the exploration of the phenomenon at a particular period in time of the students' lives, and data was collected

from the same respondents on more than one occasion, in a relatively short timeframe, with little to no change in the purposive sample, a cross-sectional trend study was used.

Unit of Analysis

Miles and Huberman (1994) abstractly "define a case as a phenomenon of some sort occurring in a bounded context. The case is, in effect, [the] unit of analysis" (p. 25). Further, the unit of analysis and the object of the proposition are recommended to be at the same level (Gerring & McDermott, 2007). In this study, the unit of analysis was defined as a case of high school-aged females and their interest in computing disciplines. Moreover, the three propositions discussed below–increasing girls' interest in computing disciplines, positively influencing their attitudes towards careers in computing, and encouraging them to consider computing-related disciplines–aligned with the unit of analysis.

Research Strategies and Procedures

Qualitative research strategies and procedures facilitate the process of arriving at an understanding of otherwise unquantifiable facts about people, their environments, their daily activities, and the meaning they ascribe to their lives. Social scientists can employ a variety of procedures to fit their individual research needs, ranging from observing and collecting data in a natural setting, to a doing so in a fully controlled environment, or in somewhere in between. The methods, frameworks, strategies, and procedures used can vary, and merit detailed consideration (Berg, 2001).

A lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.), consisting of six lessons commensurate with the four phases of the project management cycle: initiating, planning,

executing, and closing. See Appendix B for the lesson plan design document, and Appendix C, D, E, F, G, and H for details of each workshop session. The scope and design of each of the workshop's six sessions was delineated and focused based on Catalano et al.'s (2004) suggestion that intrinsic motivation can only manifest itself when the activity being performed has some inherent intrinsic value for a person. Furthermore, just as it is important to counterbalance weak points with strong points, it was of equal importance to address the question at different levels. For example, through post-workshop interview questions, the research strategy aspired to gain an understanding of students' perspectives both before and after the educational experience concluded.

Instrumentation

Baxter and Jack (2008) noted a variety of data sources are available for use to the qualitative researcher who is leveraging case studies; these include "documentation, archival records, interviews, physical artifacts, direct observations, and participant-observation" (p. 554). The value of incorporating multiple data sources in case study research is seen at the point of conversion of that data; that is, the point where data from different sources intersect and overlap, and then define and support the analysis. One common limitation to this approach is "the collection of overwhelming amounts of data that require management and analysis. Often, researchers find themselves 'lost' in the data" (p.554). Baxter and Jack also noted "the more a study contains specific propositions, the more it will stay within feasible limits" (p. 551). In line with that recommendation, in conjunction with the research question already presented, and in an effort to inform the development of the instrument, and control the data it derived, the following propositions were presented.

Proposition 1: Social and cultural depictions that defy negative socially-held communal ascriptions towards women in the technology industry should increase girls' interest in participating in the computing-related talent development pipeline.

Proposition 2: A workshop lead by a positive role model, who also embodies the real-world success that is possible in the technology industry, should positively influence girls' attitudes towards computing-related disciplines.

Proposition 3: An increased understanding of the many types of jobs available in the technology industry should encourage female students to consider computing-related fields as a viable career option.

The careful consideration of a study's propositions, as well the thorough development and evolution of its emic and etic issues (Stake, 1995, p. 20), are a necessary component of quality research. Stake (1995) noted qualitative research can be tainted with unchecked issues that "emerge, grow, and die" (p. 21). He contended that emic and etic issues–issues which arise from the perspective of the subject, and those which arise from the perspective of the observer, respectively–are "not simple and clean, but intricately wired to political, social, and historical contexts. All these meanings are important in studying cases" (p. 17). As researchers methodically focus their inquiry, more concentrated attention is given to the emerging issues, "this 'progressive focusing' permits unique and unpredicted phenomena to be given due weight" (Parlett & Hamilton, 1972, p. 18). In that light, the following issues were presented:

Issue 1: The participant cohort may have various levels of familial, academic, or social exposure to computing.

Issue 2: The participant cohort may have various English language skills levels–oral, written, audible and reading comprehension–vis-à-vis computing-related jargon.

Issue 3: The participant cohort may have varying degrees of key intrinsic personality traits, known as the five-factor model: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience (McCrae & Costa, 1987).

The original research plan was to collect data in the form of post-workshop interviews and reflexive journaling. The post-workshop interview guide (Appendix A) consisted of fifteen semi-structured interview questions. The interview questions were created by modifying interview questions sourced from two studies by Silverman and Pritchard (1993) and Master, Cheryan, and Meltzoff (2016); a publication from an ACM academic newsletter by authors Graham and Latulipe (2003); and, proceedings from academic conferences by Yardi and Bruckman (2007) and Thanapornsangsuth, Holbert, and Chan (2018). For the most part, modifications consisted of adjusting the authors' original focal point on computer science, towards the focal point of this research work, which was project management. The interview questions consist of six direct questions, three probing questions, two follow-up questions, two interpreting questions, and two indirect questions (Harvard University Department of Sociology, n.d.). Questions were also grouped into three primary topics: use of technology, perceptions of the information systems profession, and, perceptions of the project management workshop. All questions were also aligned to the aforementioned propositions and constructs (Table 2).

Table 2

Semi-Structured Interview Questions Matrix

Question	Type	Topic	Proposition	Construct
1	Indirect	A		1, 3
2	Direct	A	2	
3	Probing	A		1
4	Probing	A		3
5	Direct	B	1, 3	1, 2, 3
6	Follow-up	B	1	
7	Follow-up	B	1, 2	
8	Direct	B	1, 2, 3	1, 3
9	Direct	B	1, 3	1, 3
10	Direct	C	1, 2, 3	1, 2, 3
11	Interpreting	C	2	
12	Direct	C	1	1, 2, 3
13	Probing	C	3	
14	Indirect	C	1, 2, 3	1, 3
15	Interpreting	C	2	

Note. Topic A = use of technology, Topic B = perceptions of the information systems profession, Topic C = perceptions of the project management workshop.

Ethical Considerations

The Institutional Review Board (IRB) at Nova Southeastern University (NSU) provides guidelines and oversight over dissertation studies involving human subjects, as is the case with this study. These protections are in response to United States federal law mandates from the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, established in 1974, The National Research Act Public Law 99-158, and The Health Research Extension Act of 1985. As per U.S. federal regulation, the NSU IRB will (1) assure that "the welfare and rights of human subjects" are protected and "informed consent given, if necessary," (2) "human subjects are not placed at unreasonable physical, mental, or emotional risk as a result of the research," (3)

"the necessity and importance of the research outweighs the risks to the subjects," and (4) certify "the researcher(s) is/are qualified to conduct research involving human subjects" (NSU, 2019). The NSU IRB reviewed the research protocol and determined that this study was exempt (Appendix I) from further IRB review under 45 CFR 46.101(b) (Exempt 2: Interviews, surveys, focus groups, observations of public behavior, and other similar methodologies).

Data Collection

There are two fundamental ways of collecting data, the first is a nomothetic method, based primarily on numerical or quantitative data; the second method, by contrast, is ideographic in nature, primarily based on verbal or qualitative data. Cavaye (1996) noted "a qualitative investigation is interested in distilling meaning and understand [*sic*] from a phenomenon and is not primarily concerned with measuring and quantification of the phenomenon" (p. 237-238). Unlike the nomothetic approach idiographic data collection techniques are "not routinized," and, as Yin (2017) further noted, requires researchers to (1) "ask good questions–and interpret answers fairly," (2) use effective listening techniques which helps the listener avoid being "trapped by ideologies or preconceptions," (3) be responsive so "newly encountered situations can be seen as opportunities, than threats," (4) "have a firm grasp of the issues being studied," and (5) "conduct research ethically, from a professional standpoint but also by being sensitive to contrary evidence" (Yin, 2017, p. 82). This study used of two types of data, interview data and reflexive journaling.

Yin (2017) suggested interviews as an approach for collecting evidence for case studies, specifically noting it focuses directly on a case study's topics and "provides

perceived causal inferences and explanations" (p. 102). It is important to heed Yin's caution against poorly articulated questions, response bias, inaccuracies due to poor recollection, and reflexivity–that is, the interviewee giving what the interviewer wants to hear (p.102). It was planned that workshop participants who completed all the sessions would be invited to participate in a post workshop interview (Appendix A). The interview questions were designed to elicit open and candid responses from participants, gain insight, and a qualitative understanding of participants' project management learning experience, and their interest in computing. The objective was for the predetermined questions to lead into open-ended conversations and the collection of responses. Galletta (2013) noted, during the semi-structured interview process, an interviewer "relies on two orienting tasks: the first is to listen closely to the participant for points in need of clarification and further generation of meaning; the second is to locate and place on hold points in the interview to which you may return later for elaboration" (p. 77). This researcher-participant exchange was not only an advantage of semi-structured interviews, but also underscored the need for audio recording the interviews. The original research plan was to transcribe the interviews so that they could be analyzed and organized into codes, themes, and categories. Participants would not receive remuneration for taking part in this study.

The second data collection method was in the form of reflexive journaling. Cunliffe (2004) defines reflexivity as the process of engaging in double-loop learning—being open and identifying assumptions and then moving to a critically reflexive questioning of those assumptions and actions and recognizing uncertainty and contradictions. In doing so, we may not only find our own voice but the voice of others

and voices we may silence by our words and actions … this form of journaling means listening to those voices, needs, hopes, and concerns, often at an intellectual and visceral level, as students explore their experiences. It also means being critically reflexive about our own teaching practices and the voices we might silence. (Cunliffe, 2004, p. 419)

One limitation of reflexive journaling is the potential for it to tread into "murky and confusing terrain of self-analysis and self-disclosure rife with … interminable deconstructions of deconstructions" (Probst, 2015, p. 38). Probst continued, "despite its 'messiness,' reflexivity remains a fundamental way, particularly in qualitative studies, to bolster credibility by parsing the research endeavor into its mutually affecting parts and documenting the pathways through which knowledge was generated" (p. 47). Learning through reflexive journaling becomes meaningful when the theoretical and experiential are interwoven and underscored by skill development and constant learning. By selecting a critically reflexive journaling approach as the second data collection method, this research benefited from the ability to (1) "identify personal insights, issues, moments of critical questioning, and revelation/connection with ideas, moments, and comments [that offer] the potential for reflective insight or significant learning" (Cunliffe, 2004, p. 424), (2) describe why these insights were important, the impact they had, and what dilemmas, questions, or possibilities may arise from these, and (3), answer the questions "So what are you going to do now? What issues, questions, and dilemmas are you going to explore further? Why and how? How will this influence who you are and how you relate to others? What relational nets can you construct/ connect with to continue this process of reflective and critical learning?" (p. 424).

Statement of Informed Consent. Section 934.03(3)(d) of the 2019 *Florida Statues*, notes "all of the parties [have to give] prior consent" to the recording of an oral communication. A consent form was created following the NSU Social Behavioral Template for Parent/Guardian or Legally Authorized Representative (LAR) Informed Consent and Adolescent Assent Form (NSU, 2019). Given participant data were never collected due to the research modifications resulting from COVID-19, the Statement of Informed Consent was not used.

Data Analysis

Darke, Shanks and Broadbent (1998) prescribed three recommendations for the data analysis phase, with the objective of arriving at an analysis, which can "present the critical evidence judiciously and effectively" (p. 287). First, the data need to undergo a transformation process known as data reduction, whereby data are selected, simplified, and abstracted. The second phase of data analysis, known as data display, involves preparing the visualization of narrative data, graphical, and tabular data. The third phase, the conclusion drawing and verification phase of data analysis, includes the use of matrices, clustered diagrams, and causal networks showing causal dependence.

The data analysis phase was not expected to be linear. Baxter and Jack (2008), in citing Yin (2003) suggested the researcher iteratively "return to the propositions" (Baxter & Jack, 2008, p. 555) during the data analysis phase; they describe three benefits to this approach. First, this approach keeps the research within scope by ensuring a steady focus on, and alignment with, the stated propositions. Second, this approach affords the researcher an opportunity to explore competing and alternate propositions, which may provide further clarity and refinement of the questions being asked of the phenomena.

Third, this approach builds confidence in the analysis phase of the study as alternate and competing propositions are documented, explored, accepted, and rejected. Baxter and Jack further caution against treating case study data sources as independent sets, and proposed that "the data are converged in an attempt to understand the overall case, not the various parts of the case, or the contributing factors that influence the case" (p. 555).

Yin recommended "start modestly, work thoroughly and introspectively, and build your own analytic repertoire over time" (Yin, 2017, p. 175), and offered five techniques to perform the analysis of data: (1) pattern matching, which is linking data to propositions; (2) explanation building, which is linking data to plausible explanations; (3) time-series analysis, examines the "how" and "why" questions of a relationship over time; (4) logic models, which compares a pre-built a conceptual scheme to track measures over time; and, (5) cross-case synthesis, which examines and synthesizes results from other cases studies. It was planned to use one or more of the first four. The fifth proposition, however, does not apply given it looks at more than one case study.

A guiding research paradigm informs the research design, which is then supported by research strategies and procedures, and is then subject to measures for achieving trustworthiness. Anney (2014), in citing Schwandt, Lincoln and Guba (2007) considered that "dependability, credibility, transferability, and confirmability as trustworthiness criteria ensure the rigour of qualitative findings" (p. 273). Schwandt, Lincoln and Guba (2007) further noted these criteria are analogous to the conventional "scientific" notions of reliability, internal validity, external validity, and objectivity, respectively. In addition, the authors noted the concept of criteria of trustworthiness is "itself a parallel to the term rigor" (p. 18). Achieving trustworthiness, as suggested by Baxter and Jack (2008), entails

(1) clearly written research and substantiated research question(s) and propositions, (2) an appropriately selected case study design, (3) the employment of purposeful sampling strategies, (4) systematically collected and managed data, and (5) correctly and accurately analyzed data. Moreover, the researcher personally experienced "prolonged or intense exposure to the phenomenon under study within its context" so that "multiple perspectives can be collected and understood" (p. 556).

Presentation of Results

Stake's (1995) interpretive approach to case study research suggests storytelling and the use of vignettes–or short illustrative descriptions–to write the report. Contrastingly, Yin's (2017) positivist approach to case study research suggests six structural methods for reporting a case study: linear-analytic structure, comparative structure, chronological structure, theory building structure, suspense structure, and an unsequenced structure. Linear-analytic report writing, Yin posited, can be the most advantageous when a dissertation committee is the main audience, as the report writing structure is logical, comfortable, and is commonly seen in journal articles, in experimental science papers, and in case study research. In this method, the problem is clearly stated and substantiated at the outset, data collection is then outlined, followed by an analysis and review of findings, and concludes with the substantive significance of the study. Comparative structure is when the case is repeatedly described from multiple perspectives, with each interpretation focusing on a different way of analyzing the data. Chronological structure reports on events in their order of occurrence. Yin cautioned against "giving disproportionate attention to early events and insufficient attention to later ones" (p. 231). Theory building structure is when the report is written in a theory-

building order. That is, a new part of the theoretical argument is presented as the report progresses and new details unfold. Suspense structure inverts the aforementioned linear structure in that the conclusion and its implications are presented first, followed by progressively developing details, which explain the stated outcome. Unsequenced structure is when no specific order is followed when composing the various sections of the report. A complete description of the case, however, is needed and must be followed by a discussion of all key topics related to the description. This study followed the linear-analytic structure to report writing.

Resource Requirements

Basic personal resources such as computer hardware, word-processing, spreadsheet, and data analysis and data visualization software, as well as access to library networks and its resources, were all available, actively connected, and functional. Related materials necessary for the creation of workshop curriculum, including methods, tools, and worksheets, were sourced from the Project Management Institute website (Liegel, 2007).

How COVID-19 Affected This Study

In December 2019, 425 cases of a novel respiratory disease were reported in the city of Wuhan in Hubei province, China. The virus was identified and cataloged by the International Committee on Taxonomy of Viruses as a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Gorbalenya et al., 2020). The SARS-CoV-2 virus is structurally similar to the virus that causes severe acute respiratory syndrome (SARS), as well as its close relative the Middle East respiratory syndrome (MERS). First reported in Asia in 2003, SARS spread to 26 countries, infected over 8,000 people, and took the lives

of 774 people. Eighty percent of the 2,519 MERS cases since 2012 were reported in Saudi Arabia, and there have been 866 deaths; about 1 in 3 die from the disease (Fauci, Lane, & Redfield, 2020; National Institute of Allergy and Infectious Diseases. (n.d.)). According to the World Health Organization (n.d.), the SARS-CoV-2 virus, as of September 21, 2020, has spread to 216 countries and territories, infected 30.9 million people, and taken 959,116 lives. The World Health Organization has designated the epidemic disease caused by the SARS-CoV-2 virus as COVID-19 (WHO, 2020). The impact of COVID-19 is undeniably global and has directly affected this dissertation.

By mid-March 2020, at the onset of the COVID-19 pandemic here in the U.S., two of six prescribed weekly workshops for this study had already been administered. Students were engaged during the sessions and excited about the material and its utility for their post-high school prospects. Just three days after the second workshop, on Friday, March 13th at 1:00 pm, in response to the nation's growing concerns over COVID-19, Palm Beach County school district announced all campuses would close for two weeks as of that Monday, March 16th, 2020 (Marra, 2020). Initially the two-week closure would not have adversely affected the delivery of the remaining four workshops – considering one of those two weeks was already a prescribed recess for spring break. However, by this time in the COVID-19 timeline, 142,095 cases were confirmed globally across 121 countries with 5,373 worldwide deaths–2,197 deaths were outside of China–and mounting global concerns saw that one fifth of all students worldwide were out of school (Kantis, Kiernan, & Bardi, 2020). Ultimately, Palm Beach County schools did not reopen for the rest of the school year, moreover, "nearly every state either ordered or

recommended that schools remain closed through the end of the 2019-20 school year" (Peele, Riser-Kositsky, & Kim, 2020).

When schools initially closed on March 13, 2020, Palm Beach County was seeing less than 70 new confirmed cases of Covid-19 per day. As of July 15th, 2020, Palm Beach County was seeing over 400 new confirmed cases per day. By that date, just 26 days before the 2020-2021 school year was scheduled to reopen, Palm Beach County school board determined that schools would reopen in a distance learning only mode for grades PK through 12 (The School District of Palm Beach County, 2020, p. 43). There was no opportunity to administer the remaining four workshops in the 2019-2020 school year, and with Palm Beach County schools opening for distance learning only, there was no opportunity to restart the six-session workshops in the 2020-2021 school year. A collective decision was made by the researcher and the dissertation committee to halt all work done up to this point and redirect the focus of this dissertation to the study of the teachers' experience with having been shifted, rather abruptly, to distance learning. The following sections describe the changes made to this dissertation.

New Study Design

Given the study designed before the COVID-19 pandemic could no longer be pursued, a new study was designed; Appendix K shows a comparison of the pre-COVID-19 research methodology and the post-COVID-19 research methodology. The research paradigm did not change in the revised research methodology. An interpretivist philosophical paradigm still guided the updated research question and approach. Likewise, the philosophical rationale, based on interpretive hermeneutic phenomenology from the perspective of social constructivism, remained unchanged. In consideration of

the originally prescribed theoretical framework, neither cognitive evaluation theory nor motivational design theory are applicable to the revised version of the research methodology. The methodological approach, abductive reasoning, remained a core underpinning of this study.

New Research Method

The type of investigation proposed in the former methodology research remained unchanged. A qualitative description design shed light on participants' perspectives by the identification and organization of themes that developed from data collected via questionnaires. While the generalizability of findings that resulted from questionnaires was often limited by small sample sizes with homogeneous characteristics, the approach allowed the nuanced and complex perspectives under investigation to be explored without making assumptions, ignoring, or discarding relevant information. Exploring rich and unfiltered data ensured that the resulting analysis was able to provide a holistic understanding of the phenomena in question. The revised research method did not alter the prior researcher's stance of subjectivism; in fact, this new approach emphasized "the *sine qua non* is a commitment to seeing the social world from the point of view of the actor" (Bryman, 1984, p.77). The prior role of the researcher, as a guest speaker in the classroom, was no longer applicable in the updated research method.

The extent of research interference saw a modest change. In the former research method, the researcher was a guest speaker in the classroom and was not going to be present during the interviews. In the updated research method, the researcher's role was limited to analyzing data. The revised research method saw minimal, if any, interference from the researcher, considering primary data were collected via a self-administered

online questionnaire. Similarly, the study setting saw a minor change. Rather than a non-contrived field setting in a high school classroom where student participants were comfortable, each teacher participant in the revised research method submitted the online questionnaire from a location and setting of their choosing. Considering the governmental mandate to self-quarantine, it was assumed participants responded to the survey from the comfort of their own homes, inherently striping the study setting of its in-the-field characteristics, while remaining non-contrived.

The research strategy remained unchanged: a qualitative descriptive case study, guided by Yin's (2017) methodological guidelines which aims "to describe a phenomenon (the 'case') in its real-world context" (pp. 286-287). The prior case study was described as an exploration of how an authentic, hands-on introduction to project management within a computing context affects awareness of and interest in computing careers among high school female participants. The revised goal aimed to understand the lived experiences of U.S.-based teachers at the onset of the COVID-19 pandemic, particularly their experience with going from an in-person teaching environment to teaching in a virtual environment.

New Research Question

A new research question was formulated: *What insights can teachers provide from their first-hand experience with an unforeseen and widespread disruption of their teaching environment?* By studying the results of a qualitative questionnaire and understanding the lived experiences of teachers, policy makers, school officials, students, and parents can better understand the readiness and sustainability concerns that were seen

at the onset of the COVID-19 pandemic, and develop strategies to mitigate the impact of a future unforeseen and widespread disruption of the education system.

New Approach

The former case study was selected because of researchers' familiarity with project management in information systems and for its potential to positively affect change in the technology industry and in students' lives. The revised case was selected for its contextual importance and relevance. The type of case study selected for the original version of this study was a single, holistic, representative case. Considering Yin's (2017) distinction between a representative case–one that is typical of the circumstances and conditions of a common, everyday situation–and a revelatory case, which affords researchers "an opportunity to observe and analyze phenomena previously inaccessible to social science inquiry" (p. 50), the type of case study used in the revised research approach shifted slightly. The revised type of case study was a single, holistic, revelatory case.

In terms of binding the case, the spatial, temporal, and contextual bounds have shifted somewhat with the new research design. The questionnaire was administered to teachers electronically, and not in a classroom setting. This updated setting, although a shift from the originally designed spatial bound, was one with which teacher participants were comfortable. Temporal bounds shifted from the previous duration of six in-person workshops and pre-scheduled interviews, to a seven-day period within which participants were to submit their responses to the questionnaire. No special arrangements were needed to explain the context of the questionnaire, nor technical or specialized terms contained within. The adjusted boundaries negligibly impacted the circumscription of the case

study's design and did not alter the researcher's focus on the structures or relationships that are critical and of most interest to the case study.

The participants and sampling design were revised. A purposive sample of high school teachers in the same school where the original study was taking place was used in the new research strategy. Participants, in a non-random, stratified fashion, were invited to complete the online questionnaire. Two primary stratification criteria were considered: teachers who shifted from in-person teaching to virtual teaching due to the COVID-19-related school closures, and teachers who teach STEM subjects. Matters of advertising participation in the study, potential for re-accessibility by future researchers, and generalizability concerns remain unchanged. The only incentive offered in the prior design, the students' personal takeaways from participating in the workshop, no longer applied.

Whereas the time horizon was originally identified as a cross-sectional trend, the new approach–given data were collected once–remained cross-sectional and discards the trend. Similarly, the unit of analysis negligibly shifted with the new approach. The prior approach defined the unit of analysis as a group of high school-aged females and their interest in computing disciplines, the new approach defined the unit analysis as a group of STEM teachers who made the transition from in-person teaching to online teaching during the onset of the COVID-19 pandemic. The conceptual framework in the original research plan focused on belonginess, intrinsic motivation, and interest, as seen through the lens of the project management lifecycle. In the revised research methodology, no preconceptions drove the research.

New Research Strategy and Procedures

The research strategy and procedures underwent necessary modifications as well. In the former research strategy, a lesson plan for students was adopted from PMI and modified to focus on information systems and fit within six face-to-face sessions. The revised strategy eliminates that effort and leverages a computer-based questionnaire to collect free-text data anonymously. The instrumentation that was intended for the interviews in the former version of this study was replaced with a ten-item qualitative questionnaire comprised entirely of open question (Appendix L). The primary qualitative data collected was aligned to a revised set of propositions:

Proposition 1: Increased school or district involvement in the technology aspect – software, hardware, Internet connectivity, and accessibility – of the education process should increase the overall success of the online education environment.

Proposition 2: Well prepared instructors could positively affect the transition to a virtual leaning environment.

By the same token, the issues presented in the prior research design have been updated as follows:

Issue 1: The participant cohort may have varying levels of emotional ties to their work, their students, or how the nation, the school district, or their school handled the response to the pandemic.

Issue 2: The participant cohort may possess different levels of prior computing skills, Internet connectivity speeds, or have access to different software or hardware.

Issue 3: The participant cohort may have had varying amounts of their work – including materials and processes – in digital form prior to the shift to a virtual teaching environment.

The ethical considerations have not been affected. The IRB exempt status that was granted to the prior version of this study applies to the updated research strategy. The fact that the unit of analysis changed from underaged students to anonymous adult teachers has no bearing on the IRB exempt status.

In the prior research strategy, data were to be collected in the form of audio recorded interviews, responses were to be transcribed ensuring anonymity, and text data were going to be collected in the form of a reflexive journal. In the revised strategy, free-form text data from the questionnaire were collected using a webform over a seven-day period, where anonymous responses were compiled and exported into a spreadsheet. The standard NSU Social Behavioral Template for Parent/Guardian or Legally Authorized Representative Informed Consent and Adolescent Assent Form used in the prior research strategy no longer applied to this revised research strategy. Data analysis was going to be guided by Yin's (2017) data analysis techniques of pattern matching, explanation building, time-series analysis, and logic models. The revised strategy leveraged descriptive analysis (Sandelowski, 2000), machine learning-based psycholinguistics analysis (IBM, 2020a) and content analysis (Auerbach & Silverstein, 2003; Schreier, 2014). The linear-analytic structure to report writing, used in the presentation of results, has not changed. Similarly, resource requirements for the execution of this revised research strategy have not changed.

Summary

Prior to the COVID-19 related disruption, Chapter 3 suggested an interpretivist research paradigm as the philosophical underpinning for this dissertation work. Based on an abductive approach, guided by hermeneutic phenomenology, from the perspective of social constructivism, the theoretical framework for this study was comprised of two theories: cognitive evaluation theory and motivational design theory. The conceptual framework included three constructs–belongingness, intrinsic motivation, and interest–as seen through the lens of the project management lifecycle and the systems development lifecycle. The study aimed to leverage a single, holistic, qualitative descriptive case study as the research design, a cross-sectional trend time horizon, and a group as the unit of analysis. Qualitative data was to be collected in the form of interview data and reflexive journaling, and then discussed using a descriptive reporting style.

Given the COVID-19 disruption, the research methodology had to be revised, the prior theoretical and conceptual frameworks no longer apply. The updated methodology leveraged a single, holistic, revelatory case, a cross-sectional time horizon, and a group of purposively sampled teachers as the unit of analysis. Qualitative data were collected from an online questionnaire and analyzed using descriptive analysis, machine learning-based psycholinguistics analysis, and qualitative content analysis (Auerbach & Silverstein, 2003; IBM, 2020a; Sandelowski, 2000; Schreier, 2014).

Chapter 4

Results

In chapter three, the methodology provided details on the qualitative descriptive case study including the chosen research paradigm, philosophical rationale, methodological approach, and research design. This chapter discusses the results of that methodically guided inquiry of evidence, with an explicit account of procedures, the application of methods, techniques, and the strategies that were used in the execution of this scientific work.

Before the COVID-19 Disruption

On January 6, 2020, the signed site approval letter was received from the high school (Appendix M). The first workshop was held on Tuesday, March 3, 2020 at 3:30 p.m., and lasted one hour. Students arrived on time, with none leaving early, and no one taking a break during the session. Ten student participants on the first day were distributed among four large tables. The back-most table had four students, the right-front table had three students, the center-front table had two students, and the left-front table had one student, who sat on the side closest to the center table with her chair turned towards the center table.

The first session started with general ice-breaker topics which included asking students if anyone in their family works in front of a computer on a daily basis. One participant commented that her stepfather is a project manager and would hear him on calls asking people for the status of their work, another student commented that her sister

was studying marketing in college, and a third student shared that she has a cousin who is a nurse. In the first instance the researcher confirmed that line of work is exactly what would be discussed in the workshop. For the second and third student comments, the researcher was able to relate those to project planning and the use of software that was created used project management. A printed six-page project cycle document was then distributed to each student (Appendix N), and the researcher used a PowerPoint presentation to discuss the contents of the project cycle document. The session progressed well and while not all students contributed to the session in the form of asking questions or making comments, comments and questions did come from all four tables. Participants were asked at the end of the session if they intended on returning the following week, among the myriad affirmative head nods, there were four verbal yeses.

The second workshop was held on Tuesday, March 10, 2020 at 3:30 p.m. While two participants from the prior week were unable to attend the second session for personal reasons, they did communicate to their teacher that they intended on coming back for the remaining sessions. Additionally, one new student was recruited by a student who participated in the first workshop the week prior–for a total of nine student participants in the second session. Considering its prominence in the world's news cycle, the introductory ice-breaker conversation briefly centered around the topic of COVID-19 and the not yet confirmed school closures. The conversation then shifted to a brief review of the prior week and three printed handouts were distributed to all students: a glossary of key terms, a project plan worksheet that was blank, and project plan worksheet that was populated with sample data–see appendices O, P, and Q, respectively. The new student was also given a printed copy of the project cycle document from the prior week. The

second workshop session also progressed well, with students engaged during the prior week review and throughout the lesson. At the end of the session the teacher and students alike commented that that the following week the school grounds would be closed. The school was going to be used as a polling place for a general election, which included the presidential primary. Thus, workshop number three would be postponed until March 31, 2020, given that the week of March 17 was spring break.

Only two of six workshops were given because of school closings as a result of the COVID-19 pandemic. Palm Beach County schools announced all campuses would close as of Monday, March 16, 2020 (Marra, 2020), and then ultimately not reopening in the 2019-2020 school year (Peele, Riser-Kositsky, & Kim, 2020). Therefore, no additional data were collected, and no further data analysis was warranted.

After the COVID-19 Disruption

In the revised version of this study the systematic examination, deriving of patterns, and extraction of value from the collected qualitative questionnaire data was performed using three methods: descriptive analysis, machine learning-based psycholinguistics analysis, and content analysis. The importance of leveraging a combined linguistic analytical approach was validated by Goodwin and Goodwin (1992) when they noted “particular interpretations of events in the world may be far less important than the structures used to accomplish such congruent interpretations as a social activity in the first place” (p.182).

The objective of the descriptive analysis was to describe the facts of the dataset in a “low-interference” (Sandelowski, 2000, p. 335) manner, using everyday language, without the use of re-presentational methods. By leveraging basic statistical concepts,

"the end result of counting is not a quasi-statistical rendering of the data, but rather a description of the patterns or regularities in the data that have, in part, been discovered and then confirmed by counting" (p. 338). A more thorough statistical rendering of the data was accomplished with the machine learning-based psycholinguistics analysis.

Psycholinguistics, an interdisciplinary field linking linguistics and psychology, aids in "determining how the pragmatic aspects of meaning are produced and understood" (Garnham, Simon, & Sanford, 2011, p. 8). The machine learning-based psycholinguistics analysis used in this study was facilitated by IBM Watson's Tone Analyzer service, which was used to analyze emotions and communication style in all text provided by respondents (IBM, 2020a). The text analysis service helped deduce "personality characteristics, their thinking and writing styles, their emotions, and their intrinsic needs and values from the words that they write" (para. 7). Fast and Funder (2008) found a strong correlation between the words a person chooses to use and their emotions, attitudes, values, and thought processes.

IBM's machine learning model "is based on the theory of psycholinguistics, a field of research that explores the relationship between linguistic behavior and psychological theories" (IBM, 2020a, para. 1). The service uses linguistic analysis to detect tone in text over seven dimensions, Analytical, Anger, Confident, Fear, Joy, Sadness, and Tentative. (See Appendix R for tone definitions.) Each of the seven tones is associated to either an emotional or a language dimension type.

Emotional tones anger, fear, joy, and sadness were "benchmarked against standard emotion data sets such as ISEAR and SEMEVAL" (IBM, 2020a, para. 11). The International Survey on Emotion Antecedents and Reactions (ISEAR) and the Semantic

Evaluation (SEMEVAL) datasets are well known evaluative datasets for benchmarking textual affect recognition (Mac Kim, Valitutti, & Calvo, 2010).

The language tones analytical, confident, and tentative, were derived from "an in-depth study of more than two hundred thousand sentences that were collected from sources such as debate forums, speeches, and social media" (IBM, 2020a, para. 12). Humans were then asked to analyze the results of 1,330 sentences identified as analytical, and 1,000 sentences identified as confident by the Tone Analyzer service. An analysis of the results from the human-based validation compared with the results from the Tone Analyzer service found that differences between the two were not statistically significant, indicating the machine learning-based approach performed well.

The machine learning-based psycholinguistics analysis leveraged deductively prescribed analytical codes, while the content analysis inductively revealed codes through the iterative analysis of text. More specifically, the machine learning-based psycholinguistics analysis served to establish a tonal and an emotional foundation for the text analysis, while the subsequent content analysis afforded the researcher a coding frame, general categorical definitions, and segmentation of the data.

The content analysis, defined as "any systematic reduction of a flow of text (or other symbols) to a standard set of statistically manipulable symbols representing the presence, the intensity, or the frequency of some characteristics relevant to social science" (Roberts, 2009, p. 14) then employed a combination of both deductive and inductive analysis methods. A thorough content analysis leverages a combination of intuition and formalization. Informally structured approaches "go into the data (or the field) and find out what is interesting about them", while formalized methodological

structures aim “to set up more or less exact rules for how to apply a specific method” (Flick, 2014, p. 12).

The content analytic approach was used because it added a layer of “sensitivity to the usage of words and the context in which they [were] used” and because it adopts a positivistic approach given the process of coding leads to the fundamental use of statistical analysis. It is this quasi-statistically analytical base that “makes explicit, and more precise, the implicitly numerical nature of claims such as that a particular activity, theme, or pattern is common, rare, or prevalent” (Maxwell & Chmiel, 2014, p. 545). Characterized by a triad of key features, “qualitative content analysis reduces data, it is systematic, and it is flexible” (Schreier, 2014, p. 170). The reduction of data leveraged a coding frame that assigned categories to passages, iteratively taking the meaning of a passage “to a higher level of abstraction, resulting in categories that [applied] to a number of concrete, slightly different passages” (p. 170). That iterative process was highly systematic, in that every passage was assessed more than once, with modifications made to the coding frame during each assessment. The third key feature, flexibility, was beneficial in that categories and subcategories evolved from the specific to the abstract, which afforded retroactive changes to passages that were already categorized. Qualitative content analysis uncovers prevailing patterns in content which has “the potential for a variety of valuable gains, from producing a more informed, nuanced, complex or useful analysis, to creating new, perspective-transcending knowledge, or, indeed, to individual learning on the part of researchers” (Cornish, Gillespie, & Zittoun, 2014, p. 90)

In summary, this study used descriptive analysis to numerically describe the questionnaire responses, machine learning-based psycholinguistics analysis to understand

how responses were emotionally and linguistically framed, and qualitative content analysis to understand what was said.

Preparing the Data

Fifteen STEM teachers were invited via email to submit a ten-item questionnaire through the SurveyMonkey service. The questionnaire comprised exclusively of open-ended questions which allowed participants to contribute as much or as little to each response as they saw fit. Participants were allowed a seven-day window to submit responses. Although it was possible that an unacceptable percentage of participants would not respond to the questionnaire, in this case 13 of 15 participants returned the questionnaire with an overall completion rate of 87%.

The questionnaire was administered to anonymous STEM teachers of the same school where the original study was taking place. Considering open questions can produce unexpected responses, they are a useful method of collecting exploratory qualitative data which contributes the originality and value of the research (Reja, Manfreda, Hlebec & Vehovar, 2003). Exploratory questionnaires, early in the process of researching a topic, can aid in clarification of concepts, the formulation of problems, and the formation of a hypothesis (Sue & Ritter, 2007). The questionnaire's items were grouped into three primary topics: preparedness to make the transition from in-person to virtual teaching, support needed to make the transition, and gauging success of the transition.

Data processing and cleansing were executed over several iterations. First, the collected data were exported from the SurveyMonkey service in the form of an 11 column by 14 row Microsoft Excel spreadsheet. As an immediate precaution, a backup of

that original file was made and stored in a separate folder. The left-most column contained a randomly ordered 11-digit participant ID of unknown origin–presumably, an artifact of the SurveyMonkey system; and the top-most row contained the question text. During a cursory overview of the collected data, empty values were identified, and responses were scanned for personally identifiable information–of which none were found. Next, cell colors and borders were added to highlight overtly positive or negative comments, 29 hidden notes were added to individual cells with additional detail, and key text elements were highlighted or bolded. This first iteration of data analysis quickly served as a lesson in documenting and data organization for the researcher, as this format proved to be unsustainable for further in-depth analysis. To illustrate, Figure 2 depicts the unworkable formatting structure of the initial content analysis.

Respondent ID	How well were you personally prepared to change from the traditional to the online environment? Why or why not?	How well do you believe students were prepared to change from the traditional to the online environment? Why or why not?	What was necessary for you to do in order to actually make the transition?	How successful do you think you and your students were after changing to the online environment?	What would you do differently if we start next school year in an online environment?	What would help you teach better in an online environment? This includes both training, equipment needed, etc.	What do students need to be successful in an online learning environment? This includes equipment needed, training, etc. Please provide suggestions and examples.	How should administrators be better prepared to manage an online learning environment?	Do you feel that teachers in the STEM fields face obstacles that might not be an issue for teachers in other disciplines?	Do you have any other comments, questions or concerns?
11648696076	Somewhat personally prepared because it happened so sudden. I didn't	Somewhat, again it was all sudden and although students can use technology	a Good team, sending out resources, having a google chrome notebook, providing	About 80% successful, some students do not have internet or a computer, or are not	Provide an instructional video on how to work google classroom.	Laptop, site or resources to help give a good lesson online, instructional videos	They need a good environment where wifi is available, a laptop, videos on	Maybe ask veteran teachers or other educational systems that provide online	Perhaps, because they can not be there face to face to provide assistance, or	Students need to be provided with assistance on how
11646560492	Not very well prepared. I knew how to use Google Classroom for grading and	Again, not very well. They were used to using Google Classroom to check their	I had to learn the intricacies of Google Classroom. With the help of the Power Points	I feel that I was successful, and so were the students who put in the time and effort to	Now that I understand how to use Google Classroom properly, I	To be honest, I think I have all the necessary equipment now. But I had trouble	With the school providing Chromebooks, I think most of the students had what they	Actually, I feel that my school's administrators did a good job managing the	Yes, because it's difficult to find good online substitutes for actual labs and	No, I don't think so.
11646492000	I was well prepare as my previous school had a laptop for each student. I was used	Students were not well prepared because they had limited interaction with	Had recorded tutorials on how to navigate and complete online assignments.	Not as successful as face to face and hands on activities.	Have a better rigor for the students	Each student have access to a device and internet.	Having a personal or school issued laptop.	Ensure all the students and parents take online school seriously. Also, there needs	Don't know	All students need to have a laptop and access to internet.
11646283164	I was more prepared than many because I already used google classroom and had a	Not very. The technology is an issue. Small chrome books are not sufficient to	Time. A lot of time designing and preparing virtual lessons.	We made it through... but in terms of comprehension and knowledge Acquisition, I	Students need to be held **accountable** for work (submitting work	Training is always good if it's targeted.... mostly time to developer new teaching	They need technology upgrades at home. Also good internet connection.	Without in-person behavioral issues... help support teachers by	Of course but there are options. I created virtual labs... but I would need	No, but thank you.
11646071052	I felt very prepared. I am a Google Certified Educator. I became a Trainer in	My students were pretty prepared since we've been using chromebooks all year.	I did a lot of training because it made me feel comfortable and like I had	I think most of my students were very successful. I also feel like I've taken a good	I feel like this year I had the opportunity to really learn about my	I think I've had what I need. I love being able to help others succeed and find the	I think for students, all students to really be successful, they should each	that's why they get paid the big bucks	Probably, since sometimes they have a lot of materials that students might not have	Feel free to share about the South Flori Florida Google Educ
11645931629	Pretty well but I wasn't prepared for how much communication was	I answer this in one question: how you do if at let say 14 you were solely responsible	Lots of calls home.. I set up my own google voicemail. I had learn and adapt to a	We had success but nothing can change the technology gap.	Not much but I now have lots experience under my belt.	Parent support and buy in. Maybe people that go out into the community to check	Excellent technology, private spaces, rewards: maybe even money??	I am not sure. I felt well supported. However, I did fell like I learned or they	Possibly. The course I taught this year was biology. There were labs but I felt it was	Everyone in the district in our district, as far as I
11645908201	Pretty prepared. I used a lot of online tools in the traditional classroom so I felt	In my class, very prepared. In other classes, they told me they were not prepared more	Not a whole lot different, except for A LOT of reaching out to families and	The students that would work in the classroom, worked online. I feel that	I would hope to create more interactive lessons. I made several	My computer broke on the last week, so that was a challenge, but having a	Working devices and organization strategies	Supporting teachers and setting higher expectations for students and teachers	Yes, hands on labs are so much more engaging than some of the virtual lessons.	I am truly hoping to be back in the classroom, I miss
11645893800	I felt prepared regarding the technology as that is something I do on my own;	It was a mixed bag. Majority preferred being in school regardless of their tech	Rework a plan And be consistent and transparent with that plan for students.	85%	Not sure	I'm good. I'm a self starter and usually run the PD for this kinda stuff.	Accountability and more connection. Equipment and training wasn't an issue for	Idk	Being in the STEM field I cannot answer what other teachers obstacles were or	No
11637837828	I already used Google Classroom and am pretty tech savvy, so I was	Both the teachers and students did not find out that we were out of school until a	I had to create new lessons, curriculum, learn the new procedures required by the	For those that had technology/internet issues, they were very unsuccessful	Have more Google Meets so the students can see me "In person".	If all my students had better computers and internet, I could teach my engineering	Good internet, a computer, a workspace, time to use the computer (especially if they	I have no idea. Our admin were teachers on our GC pages, but I don't exactly	Yes, I teach Engineering and Science and had to fully change my engineering	
11636186404	Pretty well prepared, I am a Google Certified educator. Hardest part was make all	So So. My students knew how to use Google Classroom but they did not	Convert my in class lesson to digital lessons.	I believe we were successful. I had very good attendance from my students and a lot	Redisign my lessons to be more collaborative and interactive.	While Google Classroom is great it is no the best platform for distance digital	They need a chromebook or laptop. They also need to know how to trouble shoot	They need to be the ones contacting parents, rather then the teacher. The	Yes, its is hard to teach science digitally. Even with all the virtual labs is it	Digital, distance learning will never of as effective at in
11634344287	I was prepared. I use google suite in my classrooms. I don't think google is the best	Most students are familiar with google suite. But not all students had personal device	I had to make sure all of my students had devices at home that they could use.	We were successful in getting by. Our school set lots of parameters that made	**Standards** on the outset have to be higher. So I would try to work with	More notice and prep time would be helpful.	They need proper computer equipment. They need support and expectations of	We need administrators to support a normal school day with similar	Not in my experience because there are so many online simulations and	
11630355179	Not as prepared as I could have been. All of my files are saved to Microsoft	Students are familiar with the online process, just overwhelmed by teachers	Convert all my files and learn the Google ways of online teaching.	50% successful; I wasn't in front of them to see their mistakes and provide	I'm going to plan over the summer and have everything ready.	I'm not sure to be honest.	This is hard to say. You can have all the training and equipment, but if the desire	I think our administrators did a good job.	Yes, it's hard to do labs.	No
11630305125	Pretty well prepared since a lot of my work can be done online	Not too much because they are use to learning at school, not sure if they were about	To show my students that I am adjusting to a new way of teaching! I showed them	I believe we were pretty successful	Work on time management and make sure they check in	Do some google training, using some equipment that I can use as a white board to	A laptop with a webcam or a chrome book. They are able to use this to contact	Students are present that day by checking in google classroom, if they were	No	No

Figure 2. Initial Attempt at Content Analysis. This screenshot shows the initial version of the Excel document used by the researcher to analyze the data. The figure is intended to illustrate the impracticable and unsustainable format of the initial version of the Excel file. Screenshot by author.

In an effort to make a fresh start, all response data were copied into a new sheet and subject to font family, size, text decoration, and cell format consolidation. Specifically, Times New Roman, 12-point, no bold, underline, italics, or color, all cells were converted to the text type with borders removed, and content aligned to the middle and left. Cells were then scanned for ill-formed data and values; for example, responses that may have been split into separate cells or improper character encoding. In that regard, a few cells were flagged as containing emojis within the text, as these would require special focus later in the analysis. Once all data were normalized, separate columns were created with sequentially unique identification numbers for every question, every respondent, and every response. Similarly, a left-most column was created and designated the order control column for the sheet. In the event sorting, ordering, or filtering of the data occurred, the order control column would be used to revert the data back to its original ordering. The column was judiciously maintained as new rows were added to the spreadsheet. At this point the data were ready for ongoing analysis.

Data Analysis

Once the data cleansing and preparing process was complete, the three types of data analysis–descriptive analysis, machine learning-based psycholinguistics analysis, and qualitative content analysis–were then systematically performed.

Descriptive Analysis

A descriptive analysis was an appropriate first step in working with the qualitative data that was collected. The process fundamentally reduced line-item level data into meaningful numerically based, categorical attributes. Specifically, formulas were created to count the number of sentences, words, and characters in each response. These

descriptive counts gave way to duplicating all responses into a new column and then splitting these by sentence. Each sentence was given its own row in the spreadsheet and new columns for the word and character counts in each sentence were created. All unique identification numbers were then adjusted accordingly, including creating a new unique identifier for each sentence. Summary statistics were then created for the new columns, including totals, central tendency, and dispersion. These, in turn, assisted in understanding the data and enabled a consolidated and concise presentation of their respective values. Having created the various count-columns enabled the descriptive analysis to focus on the following six areas (1) an analysis of participants and questionnaire submissions, (2) an analysis of responses, (3) an analysis of sentences used in the responses, (4) an analysis of words used in the responses, (5) an analysis of characters used in the responses, and (6) an analysis on the use of emoji in the responses.

The target participant population comprised fifteen STEM teachers who were invited via email to anonymously submit a one-time SurveyMonkey online questionnaire consisting of ten questions; thirteen participants submitted completed questionnaires. The submission rate shown in Table 3, 86.67%, was computed as the number of invitees divided by the number of completed questionnaires received. The high submission rate indicated data were collected from a representative sampling of the targeted population and confirmed the dataset warranted further analysis.

Table 3

Descriptive Analysis of Participants and Questionnaire Submissions

Participants and Submissions	Value
Total number of invited participants	15
Total number of completed questionnaires received	13
Submission rate	86.67%
Number of questions in the questionnaire	10

The total number of possible responses shown in Table 4, 130, was computed as the number of completed questionnaires received, multiplied by ten questions in the questionnaire. The total number of possible responses divided by two blank responses yielded a high 98.46% questionnaire completion rate. The tenth question, which asked participants to write in any additional questions, comments or concerns they may have had, was left blank by two participants, which contributed to the 1.54% incomplete rate.

Table 4

Descriptive Analysis of Responses to the Questionnaire

Responses	Value
Total number of possible responses	130
Number of non-blank responses	128
Completion rate	98.46%
Incomplete rate	1.54%

Dividing 128 non-blank responses into distinct sentences resulted in 235 individual sentences, each in their own row in the spreadsheet–representing a growth factor of 0.81 over the original number of analyzable data points. The number of sentences used in a response ranged from zero to eight, with a high positive skewness value of 1.94 and a Leptokurtic kurtosis value of 5.04. Figure 3 shows the positively skewed distribution of number of sentences per response, demonstrating the propensity for respondents to provide one or two sentence responses to the questions in the questionnaire. Appendix S contains additional descriptive statistics specifically related to sentence count.

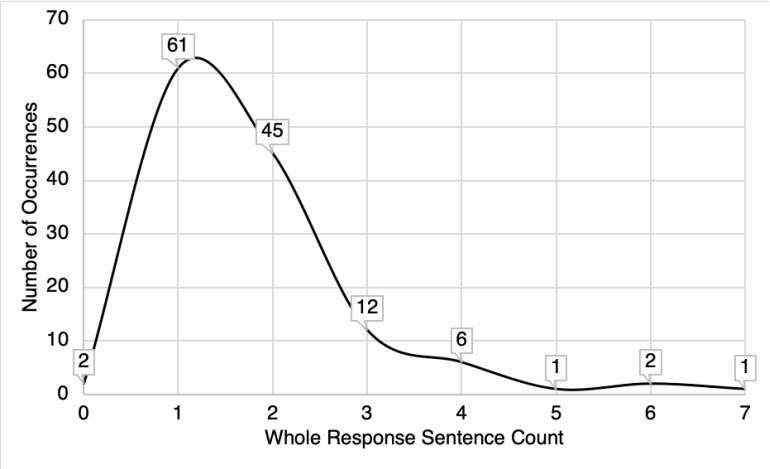


Figure 3. Sentence Count by Number of Occurrences. This figure illustrates the positively skewed distribution of number of sentences per response with a mean of 1.8 and a standard deviation of 1.13.

The total number of words contributed by all participants was 3,212. The mean number of words per response was 25, with a range of 89 and a moderately positive skewness value of 0.94. The mean words per sentence was 13.6, with a range of 40 and a moderately positive skewness value of 0.99. Forty-three percent of sentences, 102 of 235, contained above the mean word counts. Cutts (2020) noted 15-20 words per sentence is average for U.S.-based writing, with higher word counts typically seen in government, scientific, and essential information documents; 45 sentences in the dataset fit this above-average characterization. Additionally, Figure 4 depicts the symmetrical skewness value of 0.38 for word count per participant. Appendix T contains additional descriptive statistics specifically related to word count.

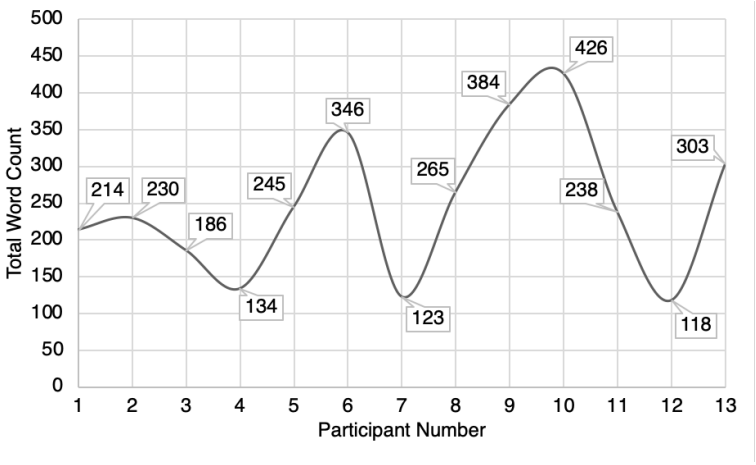


Figure 4. Word Count per Participant. This figure illustrates the total word count distribution for each participant. There was a mean word count of 247.1 and a standard deviation of 93.7.

Forty-nine of 130 responses (38%) contained word counts that were above the mean. Figure 5 illustrates the moderately positively skewed distribution of word count per response.

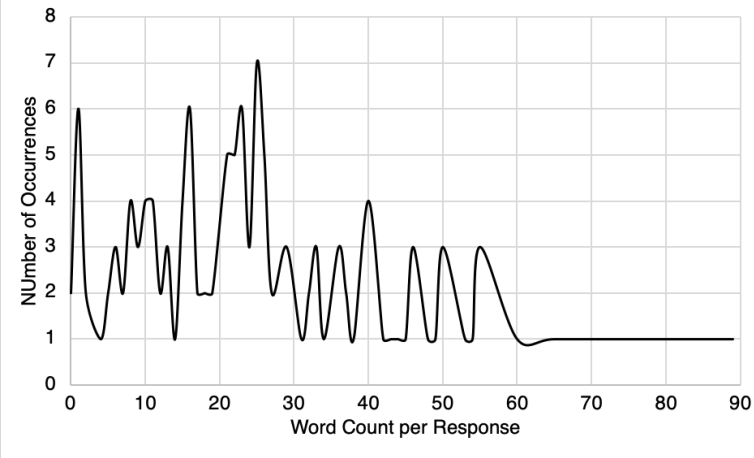


Figure 5. Word Count per Response by Number of Occurrences. This figure illustrates the distribution of word count per response by number of occurrences for all data. There was a mean of 25.1 words per response, with a standard deviation of 17.6.

The number of sentences with a word count above the mean was 102–that is, 43% of 235 sentences were composed with a word count greater than 13.6. Figure 6 shows the moderately positively skewed distribution for number of words per sentence.

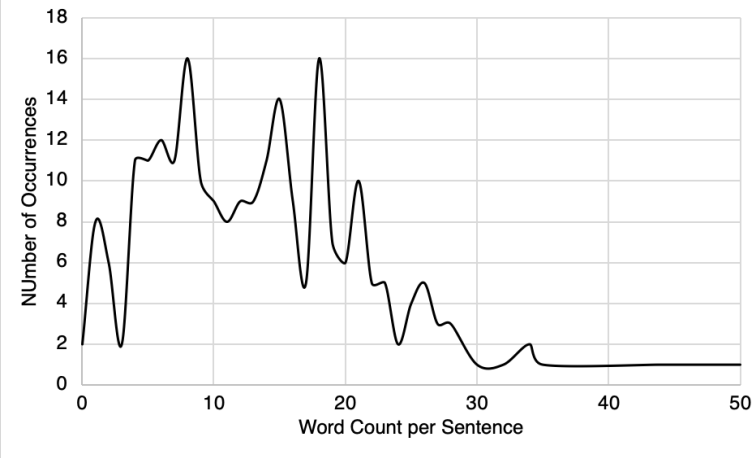


Figure 6. Word Count per Sentence by Number of Occurrences. This figure illustrates the distribution of word count per sentence by number of occurrences for all data. There was a mean of 13.6 words per response, with a standard deviation of 8.4.

The total number of characters typed by all participants was 17,948, inclusive of three emojis which were counted as one character each. The mean number of characters typed was 140, which is exactly the character limit Twitter used to have before the character limit was changed to 280 characters (Gligoric, West, & Anderson, 2018). Interestingly, the max number of characters in a sentence was 293, just over Twitter's new limit. Skewness values were 0.88 for characters per response and 0.92 for characters per sentence. Figure 7 shows the moderately positively skewed distributions for number of characters per response. Figure 8 shows the moderately positively skewed distributions for number of characters per sentence. Appendix U contains additional descriptive statistics specifically related to character count.

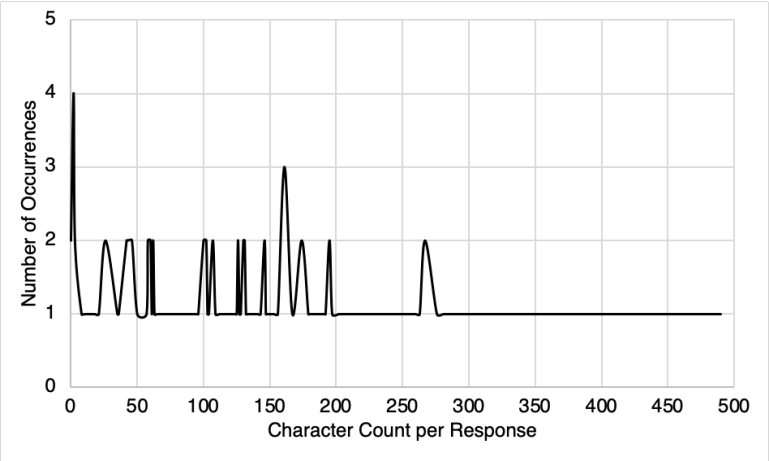


Figure 7. Character Count per Response by Number of Occurrences. This figure illustrates the distribution of character count per response by number of occurrences for all data. There was a mean of 140.1 characters per response, with a standard deviation of 93.3.

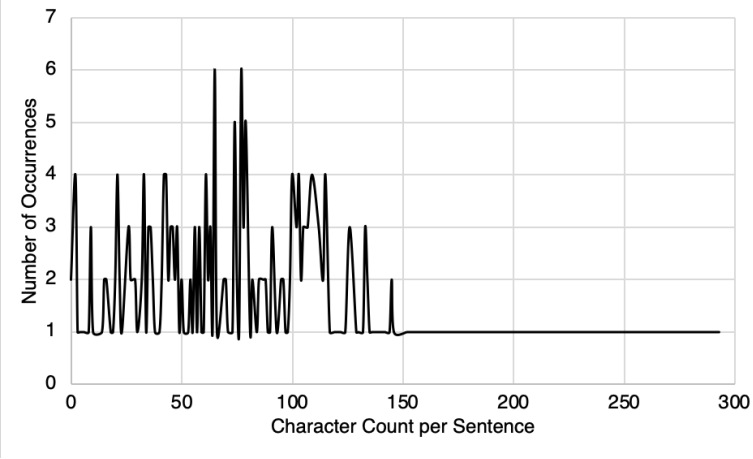


Figure 8. Character Count per Sentence by Number of Occurrences. This figure illustrates the distribution of character count per sentence by number of occurrences for all data. There was a mean of 75.9 characters per sentence, with a standard deviation of 46.2.

The use of emojis, “two-dimensional pictographs that were originally designed to convey emotion between participants in text-based conversation” (Kelly & Watts, 2015,

p.2) was limited in the dataset. Only one participant used three distinct emoji in just two responses, no other emoji or special characters were found in the dataset. Table 5 lists the emoji that appeared in the dataset, along with their title and description as per emojipedia.org.

Table 5

Emoji Definitions

Emoji	Name	Description
	Woman Shrugging	"The Woman Shrugging emoji is a ZWJ sequence combining  Person Shrugging, Zero Width Joiner and ♀ Female Sign. These display as a single emoji on supported platforms" (Emojipedia, n.d.-c, para. 1).
	Rolling on the Floor Laughing	"A yellow face with a big grin and scrunched, X-shaped eyes, tilted on its side as if rolling on the floor laughing (the internet acronym ROFL). Sheds two tears and tilts right on most platforms. Often conveys hysterical laughter more intense than  Face With Tears of Joy" (Emojipedia, n.d.-b, para. 1).
	Beaming Face with Smiling Eyes	"A yellow face with smiling eyes and full-toothed grin, as if saying Cheese! for the camera. Teeth may be smoothed-over or crosshatched. Often expresses a radiant, gratified happiness. Tone varies, including warm, silly, amused, or proud" (Emojipedia, n.d.-a, para. 1).

Note. Emojipedia is an emoji reference website where people organize "emoji into a pre-defined set of categories based on how similar the concepts are represented by each emoji" (Wijeratne, Balasuriya, Sheth, & Doran, 2016, pp. 4-5).

The descriptive analysis provided rich insight into the categorical make-up of the qualitative data. The original 130 datapoints collected from 13 questionnaire submissions, when expanded by sentence, yielded 235 analyzable datapoints; and comprised a total of 3,212 words. In general, participants' range of typed text was from as little as a word or

two, to about as much text as a full tweet; this strict–albeit coincidental–range helped ensure digestibility of the data. Additionally, the limited use of emoji, while just another coincidence, ensured data could be analyzed without the need for subjective inferences as to the intended meaning behind the use of emoji. As the descriptive analysis was developing, it became abundantly clear the data would indeed benefit from a machine learning approach.

Machine Learning-based Psycholinguistics Analysis

The machine learning-based psycholinguistics analysis focused specifically on the tones found within the text that was submitted to the analysis engine. Tone analysis was performed at five distinct levels: (1) for all text, (2) all text for each participant, (3) all text for each question, (4) all text for each response, and (5) all text for each sentence in a response. Watson's Tone Analyzer service returned decimal values for tones found within the text; values less than 0.5 were considered by IBM to be low and are omitted from result sets, values between 0.5 and 0.75 were considered to be medium, and values greater than 0.75 were considered strong (IBM, 2020b). The translation from numerical value to text value, as prescribed by IBM, meant the text label low could not be used in this analysis, as numerical values that indicate low were simply omitted from results of the analysis. To work around not having a label for low, an Excel formula was created to derive lower-, middle-, and upper-third percentile cutoff points for the range of values present in each dimension. Results were then labeled as low, medium, or strong in newly created columns. This re-labeling yielded three benefits. First, a label corresponding with low was now possible. Second, a grouping of three textual labels afforded the researcher a cleaner workspace with which to work with, as opposed to working with a spreadsheet

displaying with hundreds of decimal points into the hundred-thousandth place. Third, percentile ranking considered the range of existing values for a given dimension at all of the aforementioned five levels and were then labeled accordingly, thereby weighing tone scores as low, medium, or strong in the context of other scores within the same dimension, and specific to the level of analysis in question. This, for example, yielded a more representative low, vis-à-vis medium or strong, for each dimension at each of the five levels of analysis. In an effort to consolidate the size of tables in the following analysis, L, M, and S, will be used in lieu of low, medium, or strong, respectively.

The entirety of the dataset, excluding question text, was analyzed by the Tone Analyzer service as a single document. The analysis returned numerical values for four dimensions, Analytical, Joy, Sadness, and Tentative. As shown in Table 6, the corresponding text label for each of the four tones in consideration was medium. Considering the machine learning service omits values less than 0.5, and only one value per tone was returned for the entirety of the dataset, the custom Excel formula-based percentile ranking calculation was not possible in this scenario. As such, the text labels seen in Table 6 are based on IBM's prescribe text label definition.

Table 6

Tone Scores for All Text

Tone	Analytical	Anger	Confident	Fear	Joy	Sadness	Tentative
Score	0.715372	–	–	–	0.550295	0.586218	0.55722
Label	M	–	–	–	M	M	M

Note. All text was compiled and processed by the Tone Analyzer service as a single unit. Resulting numerical tone score values were then converted to these text labels: L = low, M = medium, S = strong.

Although the Analytical tone is labeled as medium, the tone score is much significantly closer to the .75 threshold for the strong label, as compared to the other three tones. The dominant tone in the dataset, Analytical, is considered a language tone, and indicates the text is comprised of intellectual, rational or systematic language indicators (IBM, 2020b).

Next, data were analyzed on a per participant basis–meaning all text for each participant was compiled and analyzed as an individual document. Table 7 depicts the results of the per participant analysis and used the Excel-based formula to derive the tone strength labeling. The Analytical tone was detected in 100% of participants' text. Joy was detected in over three quarters of participants text, 77%. Sadness was detected in more than half, 62%. Tentative and Confident were detected in 38% and 8% of participants text, respectively. Anger and Fear did not meet the 0.5 threshold and thus did not register in this analysis. Fifty-one percent of tones were of the language type while 49% were of the emotional type.

Table 7

Tone Score for Each Participant

Participant ID	Analytical	Anger	Confident	Fear	Joy	Sadness	Tentative
1	M	–	–	–	L	S	S
2	S	–	–	–	–	S	–
3	L	–	–	–	–	M	–
4	S	–	–	–	–	–	–
5	L	–	–	–	S	–	–
6	S	–	–	–	M	L	M
7	S	–	–	–	S	S	L
8	M	–	–	–	S	–	L
9	M	–	–	–	M	L	–
10	S	–	–	–	M	L	–
11	L	–	–	–	L	–	–
12	L	–	S	–	L	M	–
13	M	–	–	–	S	–	S

Note. All text provided by each participant was compiled and processed by the Tone Analyzer service as a single unit, resulting numerical tone score values were converted to these text labels: L = low, M = medium, S = strong.

Analyzing the data at the participant level uncovered the Confident label, which as not present in the analysis of all text. Additionally, this level of analysis exposed the distribution of tones across participants. For example, participant number 4 had only one tone associated, Analytical, whose score was labeled strong. Responses from participant number 5 were detected as Analytical and Joy, with Joy being strong–coincidentally this is the only participant who use emoji in their responses. Conversely, participant number 2 scored strong for Sadness and strong for Analytical.

Next, tone scores were individually generated for all response data when grouped by question; Table 8 displays the results. The dominant tone, Analytical, once again saw 100% distribution, with four of ten questions scoring strong for Analytical.

Table 8

Tone Scores for Each Question

Question Number	Analytical	Anger	Confident	Fear	Joy	Sadness	Tentative
1	L	–	–	–	L	S	L
2	S	–	–	–	–	–	–
3	L	–	–	–	M	–	–
4	M	–	–	–	S	S	S
5	M	–	–	M	M	M	–
6	L	–	–	–	S	–	L
7	M	–	–	–	L	L	–
8	S	–	–	–	L	–	S
9	S	–	–	–	–	L	M
10	S	–	–	–	S	–	–

Note. All text associated to each question was compiled and processed by the Tone Analyzer service as a single unit, resulting numerical tone score values were converted to these text labels: L = low, M = medium, S = strong.

The Fear tone was detected for the first time, specifically in responses to question number 5, "What would you do differently if we start next school year in an online environment?" The Joy tone was detected in eight out of ten questions. It was not detected in responses to question number two, "How well do you believe students were prepared to change from the traditional to the online environment? Why or why not?" or in responses to question number 9, "Do you feel that teachers in the STEM fields face obstacles that might not be an issue for teachers in other disciplines?" In the former, the Analytical tone was dominant; in the latter, while the Analytical tone was also dominant, Sadness and Tentative were detected. Question 4, "How successful do you think you and your students were after changing to the online environment?" saw strong indicators for Sadness, Tentative, and Joy–all emotional tones. Sadness was a dominant tone in

responses to the previously noted question 4, and in responses to question 1, “How well were you personally prepared to change from the traditional to the online environment? Why or why not?” Additionally, when analyzing response data that was grouped by question, there was a near even split between the detection of language and emotional tones, 52% and 48% respectively.

The analysis of all text in all responses meant 130 distinct responses were individually submitted for analysis to the Tone Analyzer service; Table 9 illustrates the tone and the number of responses that were identified as either low, medium, or strong for each tone.

Table 9

Tone Scores for All Responses

Tone Label	Analytical	Anger	Confident	Fear	Joy	Sadness	Tentative
L	23	–	7	–	11	7	16
M	22	–	8	–	11	6	16
S	23	–	8	–	11	7	16

Note. All text associated to each question was compiled and processed by the Tone Analyzer service as a single unit, resulting numerical tone score values were converted to these text labels: L = low, M = medium, S = strong.

The Analytical tone was present in 68 responses, accounting for 53% of all responses. Tentative was the next most dominant tone, detected in 38% of responses. Joy, Confident, and Sadness were detected in, 33, 23, and 20 responses–26%, 18%, and 16% of all responses, respectively. Figure 9 illustrates the distribution of total word count for each of the seven tones. Whole responses containing the Analytical tone accounted for 35% of all contributed text, denoting verboseness in intellectually inclined responses.

During the analysis of all text by response, neither Anger nor Fear tone scores reached the 0.5 threshold for detection.

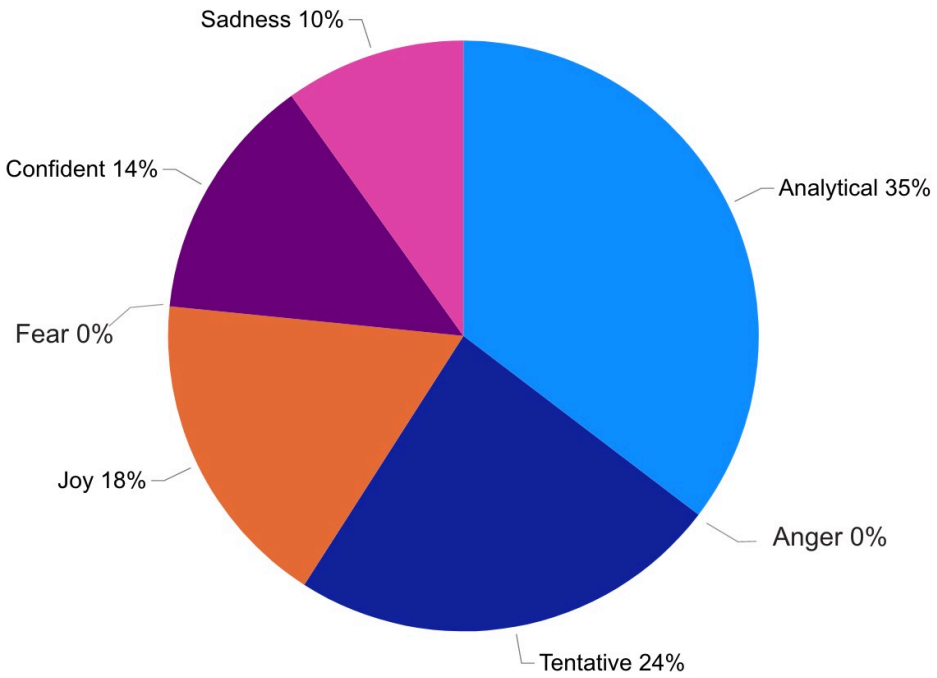


Figure 9. Word Count per Tone for All Responses. This figure illustrates the distribution of total word count attributed to each of the seven tones; neither Anger nor Fear tone scores reached the 0.5 threshold for detection.

Last, all 235 non-blank sentences were individually processed in the Tone Analyzer service. Considering the granularity of this approach, it yielded tone scores for all seven tones as opposed to the detection of only five tones when whole responses were analyzed. Table 10 shows the dominant tone at the sentence level the remains the Analytical tone, with 40% of sentences, 93 of 235, being identified as Analytical. Tentative, similar to the analysis of all text in all responses, was the next dominant tone. Twenty-five percent, 58 of 235, sentences contributed by participants were labeled as

Tentative, more than a third of these were scored as strong. The language tones, Analytical, Confident, and Tentative, accounted for 71% of all tones detected in all sentences, indicating thoughtfulness and mindfulness on the part of participants as they composed their responses.

Table 10

Tone Score for All Sentences

Tone Label	Analytical	Anger	Confident	Fear	Joy	Sadness	Tentative
L	31	1	10	1	16	8	19
M	31	1	11	1	16	7	18
S	31	–	11	–	17	8	21

Note. All non-blank sentences were individually processed by the Tone Analyzer service, resulting numerical tone score values were converted to these text labels: L = low, M = medium, S = strong. This table illustrates the sum of L, M, and S counts for each tone.

The machine learning-based psycholinguistics analysis provided insightful details regarding the degree to which participants responded from either an emotional or rational perspective. While the content submitted by participants was dominated by intellectually inclined tones, the revelation of emotional tones provided much needed context for the subsequent content analysis, none of which would have been reliably possible without machine learning. Additionally, having analyzed the data from five distinct levels–for all text, all text for each participant, all text for each question, all text for each response, and all text for each sentence in a response–ensured the detection of all seven of Watson's Tone Analyzer service tones, which greatly enriched the dataset. After the machine learning-based psycholinguistics analysis was complete, the analysis shifted to the

identification of repeating ideas, thematic dimensions, and thematic constructs within the text using data-driven coding and content analysis.

Content Analysis

The third and final analysis that was performed on the data was content analysis. In consideration of guidance taken by authors Auerbach and Silverstein (2003) and Schreier (2012), a hybrid approach to content analysis was taken. Auerbach and Silverstein's "Six Steps for Constructing a Theoretical Narrative from Text" (Auerbach & Silverstein, 2003, p.43) grouped six steps into three phases: making the text manageable, hearing what was said, and developing theory. Similarly, Schreier (2012) suggested an eight-step approach to content analysis: deciding on a research question, selecting the data that will be analyzed, constructing a coding frame, segmentation of the data into categories, testing the coding frame, evaluating and modifying the coding frame, executing on the main analysis, and presenting and interpreting the results of the investigation. For this content analysis, Schreier's sixth step, evaluating and modifying the coding frame, was adopted and combined with Auerbach and Silverstein's (2003) six steps. The hybrid steps taken were then (1) clearly stating the research question, (2) selecting relevant text that warranted further analysis, (3) documenting recurring ideas and identifying related passages, (4) organizing repeating ideas into coherent categories, (5) evaluating and modifying the coding frame, (6) developing constructs by grouping themes into abstractions, and (7) creating a narrative that retells the participant's story in light of the thematic constructs.

The research question, *What insights can teachers provide from their first-hand experience with an unforeseen and widespread disruption of their teaching environment?*

is the bedrock of this content analysis, specifically for its contextual importance and relevance to the post-COVID-19 era educational landscape. The underlying concern of the researcher was to understand the experiences of teachers, and the readiness and sustainability concerns teachers had after being abruptly shifted from an in-person teaching environment, to an on-line teaching environment.

Given all of the collected data directly related to the research question, no data were excluded from the content analysis. To prepare for the documentation and identification of relevant passages, all data were first grouped by participant ID–as it was in the original dataset–and then ordered by question number. Visible columns in the spreadsheet included question number, question text, participant ID, and response text. Specifically, in one column there were whole responses in individual cells and in an adjacent column there was the copy of the whole response, split into individual sentences. All prior columns related to the descriptive analysis and tone analysis were hidden. A new column was created which would hold the researcher's comments in cells that were adjacent to those containing the individual sentences. This view served three purposes. First, to ensure no participant data would be left without analysis. Second, the individual sentences allowed for increased granularity and separation of the researcher's notes. Third, it served as a visual aid to ensure and maintain spreadsheet integrity. All 29 comments made in the hidden note field of individual cells from the initial analysis were then copied into the newly created column, with minor spelling, formatting, and content changes; in the process, an additional 19 comments were added.

The first iteration of the content analysis yielded a total of 48 researcher comments, equivalent to 37% of all participant responses. To illustrate the researcher

commenting processes, question 2 asked “How well do you believe students were prepared to change from the traditional to the online environment? Why or why not?” Participant 3 responded with “Students were not well prepared because they had limited interaction with technology and few assignments online”. The researcher commented “This point argues in favor of training students on how to use technology before an emergency situation.” Similarly, in response to question 10 which asked “Do you have any other comments, questions or concerns?”, participant 1 responded with “Students need to be provided with assistance on how to navigate their google classroom etc.” The researcher’s comment for this line item was “This point argues in favor of preparing students with the technology and how to use it.”

In addition to the recurring focus on student technology needs, there were noted concerns over teachers’ technology needs. For example, question 3 asked “What was necessary for you to do in order to actually make the transition?”, participant 12 responded with “Convert all my files and learn the Google ways of online teaching.” The researcher’s comment for this response was “This point talks about digital teaching materials and using technology to teach.” Upon completion of the initial analysis of all responses, it became clear a number of recurring ideas were present in the dataset.

The second iteration of the content analysis began with the creation of a new column to hold the researcher’s second iteration of comments. All descriptive and tone analysis columns were hidden, while the column created for the first iteration of the content analysis was left visible. An additional 109 researcher comments were added, which amounted to a research comment being present for 84% of all responses in the dataset. Additionally, 38 of 109 comments made in the second iteration had a

corresponding comment written during the first iteration of the analysis. The second iteration of the analysis provided more specificity in the researcher's comments. To illustrate, in response to question 3, participant 8 commented "Rework a plan and be consistent and transparent with that plan for students." The first iteration of the researcher's comment was a rather verbose "Time spent re-working, time spent communicating. It's probably fair to say the communications plan of each teacher differed and lacked consistency across other teachers, grades, etc." The researcher's comment during second iteration of the content analysis was a succinct "This comment points to preparation and practicing that plan." This is a prime example of the effectiveness of iterative reductive analysis. Conversely however, this next example shows the researcher's second iteration comment was actually more verbose than the first, albeit more specific. In response to question 5, "What would you do differently if we start next school year in an online environment?", participant 10 said "Redisign [*sic*] my lessons to be more collaborative and interactive." The researcher's first comment was a brief "pre-planning." While the second comment was a more descriptive "Plan, practice, and design specifically for the new online environment."

The third iteration of the content analysis saw the creation of the first coherent categorical codes. The process of coding, a key element in qualitative analysis, involved "the pragmatics of breaking down or dissecting one's data into manageable and meaningful analytical units" (Bong, 2002, p. 8), this in turn also facilitated the expedient retrieval of relevant data at later stages of the analysis. A new column was created in the spreadsheet to hold the codes; all descriptive and tone analysis columns were hidden, while the columns created for the first and second iterations of the content analysis were

left visible. While the machine learning-based psycholinguistics analysis used codes that were prescribed by IBM (IBM, 2020b), the content analysis underwent a process of data-driven coding. The process was performed inductively and from the standpoint of *tabula rasa* as Gibbs (2014b) put it, "The idea is to put aside any pre-existing theory or understanding of the data and use coding to allow new ideas, themes and theories to emerge." (p.284). Gibbs (2012a) further suggested "The principle way of ensuring that the coding is thorough and consistent is the constant comparative method." (p.2) where each analyzed datapoint is labeled with as many categories as necessary.

The dataset originally started at a manageable 130 datapoints. Having expanded responses by sentence yielded 235 sentences, for thirteen participants, across ten questions. The process of adding descriptive statistics to every line item in the dataset, as well as tone analysis data and two rounds of researcher comments was followed up with the addition of 99 codes stemming from the constant comparative method, as suggested by Gibbs (2012a). Many of these codes contained comma delimited duplicates of previously used codes in order to denote a nested or sub-categorical relationship. Upon completion of the third iteration of the content analysis, 100% of all sentences were coded. The fragmentation seen in the researcher comment and code fields was embraced and gave way to the implementation of Schreier's (2012) sixth content analysis step, evaluating and modifying the coding frame.

The fourth iteration of the content analysis was specifically guided by Schreier's (2012) suggestion to "take a step back, look at the structure of the coding frame once again, and 'tidy up' any loose ends" (p. 177). Schreier specifically suggested the collapsing of subcategories and better conceptualization of main categories. Also, Gibbs

(2012a) suggested "writing of 'analytic memos' on the meaning and significance of the code [given that] memos specify the properties of the codes, define relationships between categories and identify gaps, such as potential related codes" (p. 2). This resulted in the creation of a new sheet in the Excel document which would serve as a dictionary for codes and general terms that were generated during the three phases of the data analysis. The dictionary sheet also aided in the process of preventing coder variance–essentially ensuring reliability and consistency across all codes as they evolved and matured.

The process of evaluating and modifying the coding frame began with the creation of a pivot table to display all codes in use up to that point in the content analysis. For example, the codes "general preparedness, preparedness", and "overall preparedness" were listed as three separate codes. This imprecision can be exemplified by the codes assigned to sentences contained in participant 2's responses to questions 1 and 2 "Not very well prepared." and "Again, not very well." These sentences were coded as "general preparedness" and "preparedness", respectively. Moreover, the text string "prepare" appeared in various forms of the researcher's entries in 27 of the 99 codes. There were also 18 instances, or 8% of all sentences analyzed, where coding was not possible. For example, participant responses like: "85%", "No", or blank responses were assigned various versions of N/A as a categorical code. The pivot table–and the ability to efficiently and confidently sort, order, and filter the spreadsheet–was repeatedly used to address variances in spelling, tense, and word combinations in all codes. Additionally, during the process of code evaluation and reduction, codes that were no longer in use were deleted from the dictionary sheet.

Next, the column containing the 99 comma delimited codes was copied and divided into five new columns in the spreadsheet. These were titled Primary Code, Secondary Code-A, Secondary Code-B, Secondary Code-C, and Secondary Code-D. An iterative data cleansing process was once again used to ensure consistency in spelling, tense, case, and wording across all values in each of the five columns. Additionally, values were moved and grouped where the first column became the primary categorical code, and subsequent columns took the form of a collection of unordered sub-categorical codes. The main reason the sub-categorical columns were unordered is because a nested value such as "Accountability, Motivation" had motivation in the second position, while a nested value such as "Digital Lessons, Planning, Motivation" had motivation in the third position. The primary codes in these examples were Accountability and Digital Lessons. Excel's text to columns function positioned Motivation in two distinct columns, e.g. second and third positions, making the use of column positioning to hierarchically order categories imprecise and unnecessary. Table 11 outlines the 11 primary codes that were generated during the fourth iteration of the content analysis.

Table 11

Primary Content Analysis Codes

Primary Content Analysis Code	Count
Teacher Preparedness	76
Technology Preparedness	54
Student Involvement	27
Administrative Preparedness	24
N/A	18
General Preparedness	17
Technical Support	7
Student Support	6
Time Management	4
Parental Involvement	3
Work Environment	1

Note. Two blank responses were assigned the N/A code.

With 100% of sentences having been assigned a consolidated primary code, the top four most widely assigned themes were: Teacher Preparedness, 32% of all codes; Technology Preparedness, 23% of all codes; Student Involvement, 11% of all codes; and Administrative Preparedness, 10% of all codes. Those four codes alone accounted for 76% of all primary code assignments. Table 12 shows the 26 secondary codes and their usage counts; these were all sub-categorically assigned to the 11 primary codes.

Table 12

Secondary Content Analysis Codes

Secondary Content Analysis Code	Count
Hardware	30
Technical Training	24
Training	22
Motivation	20
Accountability	19
Communications Preparedness	17
Digitizing Lessons	15
Connectivity	14
Importance of Face-To-Face Teaching Experiences	14
Standards and Expectations	12
Administrative Support	11
Lesson Planning	10
Software	9
Certifications	7
Teacher Support	6
Technical Support	5
Work Environment	4
Time Management	3
Parental Involvement	2
Student Behavior	2
Student Support	2
Social/Emotional Development	2
Teaching Effectiveness	2
Administrative Preparedness	1
Technical Preparedness	1
Prior Experience	1

Note. The two blank responses were not assigned secondary codes.

The distribution of secondary codes was significantly more fragmented than the distribution of primary codes. While four primary codes accounted for the majority, 76%, of assigned primary codes, with seven other primary codes accounting for the remaining 24% of primary code assignments, in the case of secondary codes, the most widely assigned secondary code, Hardware, was assigned to just 12% of the data; the remaining 25 codes accounted for the other 88% of secondary code assignments.

Thematic Dimensions. Next, the primary code column and the four unordered secondary code columns were further abstracted and consolidated into thematic dimensions. These thematic dimensions were Focus, Topic, Imperative, and Detail. To derive the Focus dimension, all responses–inclusive of their assigned codes–were scrutinized with the following question in mind: "Who is the participant talking about in this response?" The researcher's answer to that question yielded the labeling associated with the Focus dimension. This became the broadest of thematic dimensions, as it associated only one finite, single-word label to each response in the data. This process reduced 11 primary codes, across all responses, to these Focus dimension labels–Teachers, Students, School Officials, and Parents. Given some participant responses were blank or contained vague terms such as "No", or "I don't know", a fifth label of N/A was created. Table 13 shows the five labels for the Focus dimension, and their assignment counts.

Table 13

Focus Dimension

Focus Dimension Label	Assignment Count
Students	147
Teachers	135
School Officials	67
N/A	7
Parents	5

Note. Two blank responses were assigned the N/A code.

To illustrate the Focus thematic dimension labeling process, when participant 2 answered question 9 "Do you feel that teachers in the STEM fields face obstacles that might not be an issue for teachers in other disciplines?" by saying "Yes, because it's difficult to find good online substitutes for actual labs and classroom demonstrations. You Tube videos are good substitutes, though (when you can't actually be in the classroom or the lab).", the first sentence in that response was initially assigned a primary code of Teacher Preparedness, and the second sentence was assigned Technology Preparedness. When looked at from an abstract level, by answering "Who is the participant talking about in this response?", both sentences were assigned the Teachers label for the Focus dimension. The dominant focus across ten questions was on Students, with 41% of responses. Teachers were the focus of 37% of the responses. While School Officials and Parents were the focus 19% and 1% of the time, respectively. An additional 2% of all responses were uncategorizable from standpoint of the Focus dimension.

The second thematic dimension, Topic, was designed as a subgroup of the Focus dimension. The Topic dimension modifies the subject of the participant's response, the Focus dimension, and functions as a participial would in grammar (Purdue OWL, n.d.). All five topic dimension labels shown in Table 14 were assigned as a child values–with a

corresponding parent value–that was present at the Focus dimension level. For example, participant 10, in answering question 7, "What do students need to be successful in an online learning environment? This includes equipment needed, training, etc. Please provide suggestions and examples." said "They need a chromebook or laptop. They also need to know how to trouble shoot computer issues on their own before they simple skip the assignment." The Topic dimension label that was assigned to this response was Technology, which served in a participle form to the label Students that was assigned for its corresponding Focus dimension. Participants referenced Technology as the topic in 40% of responses. Teaching was the topic of 26% of responses, while Administrating and Learning were the topics of responses 17% and 14% of the time, respectively. Lastly, 2% of responses could not be categorized by the Topic thematic dimension and were assigned an N/A label.

Table 14

Topic Dimension

Topic Dimension Label	Assignment Count
Technology	145
Teaching	95
Administrating	61
Learning	52
N/A	8

Note. Two blank responses were assigned the N/A code.

Imperative, the third thematic dimension was designed as a categorical verb and nested as a subordinate to the Topic dimension. Imperative labels used were: Supporting, Training, Acquiring, and N/A. From the standpoint of a verb, the Supporting label related to the action of being supported. Similarly, the Training and Acquiring labels directly related to the need for training, or the need for something to be acquired. For example,

when participant 1 responded to question 3 “What was necessary for you to do in order to actually make the transition?” with “a Good team, sending out resources, having a google chrome notebook, providing instructions on how to work google classroom, uploading assignments, etc.”. In this example the Focus dimension label assigned was School Officials, the Topic dimension label assigned was Administrating, and the Imperative label assigned was Acquiring. Acquiring, in this example, is referring to the action of acquiring google chrome notebooks. Table 15 outlines the four Imperative dimension labels, and the number of times each was assigned.

Table 15

Imperative Dimension

Imperative Dimension Label	Assignment Count
Supporting	182
Training	93
Acquiring	77
N/A	9

Note. Two blank responses were assigned the N/A code.

Overall, the dominant Imperative label assigned was Supporting, with 50% of responses abstractly referring to needing support. The Training label and the Acquiring label were each assigned to 26% and 21% of responses. Two percent of responses were assigned an N/A value for lacking an imperative.

The last thematic dimension, Detail, was designed as a direct object of the verbs in the Imperative dimension. A total of 16 Detail labels were assigned and linked to corresponding labels in the Imperative dimension. For example, in response to question number 6 “What would help you teach better in an online environment? This includes both training, equipment needed, etc.”, the first sentence in participant 6’s multi-sentence

response read: “Parent support and buy in.” This sentence was first assigned the Parents as the Focus dimension label, Administrating as the Topic dimension label, Supporting as the Imperative dimension label, and then Accountability as the Detail dimension label. Accountability acts as the abstracted direct object of the verb Supporting. Figure 10 illustrates the grammar-based relationship between the four thematic dimensions assigned to this particular participant’s response.

Thematic Dimension	**Focus**	**Topic**	**Imperative**	**Detail**
	↑	↑	↑	↑
Participant 6’s response to question 6	Parents	Administrating	Supporting	Accountability
	↓	↓	↓	↓
Grammar Equivalent	**Subject Noun**	**Participle**	**Verb**	**Direct Object**

Figure 10. Example of Nested Thematic Constructs. This figure shows an example of Focus, Topic, Imperative, and Detail thematic dimension label assignments, and the grammar equivalent of each thematic dimension.

Table 16 lists the 16 Detail dimension labels that were assigned to each sentence in the dataset. The top three were Software, assigned to 20% of all sentences; Hardware was assigned to 16% of all sentences; and Digital Lessons, assigned to 11% of all sentences. These three labels accounted for 47% of all Detail dimensions label assignments. The remaining 13 labels accounted for the remaining 53% of all Detail dimension label assignments, while the N/A label was assigned to 5% of all data.

Table 16

Detail Dimension

Detail Dimension Label	Assignment Count
Software	73
Hardware	56
Digital Lessons	41
Motivation	34
Connectivity	20
Accountability	18
N/A	17
Communication	16
Organization Strategies	16
Face-To-Face Teaching	14
Standards and Expectations	13
General Resources	10
Time Management	10
Teaching Methodology	8
Workspaces	8
Certifications	7

Note. Two blank responses were assigned the N/A code.

The clustered column chart in Figure 11 shows the distribution of Detail dimension labels when listed by Imperative dimension; this view exposes a number of interesting points. For example, the top three Detail dimension labels assigned to sentence-level responses were Software, Hardware, or Digital Lessons; assigned to 20%, 16%, and 11% of all sentences, respectively. These three accounted for 47% of all sentence-level Detail dimension label assignments.

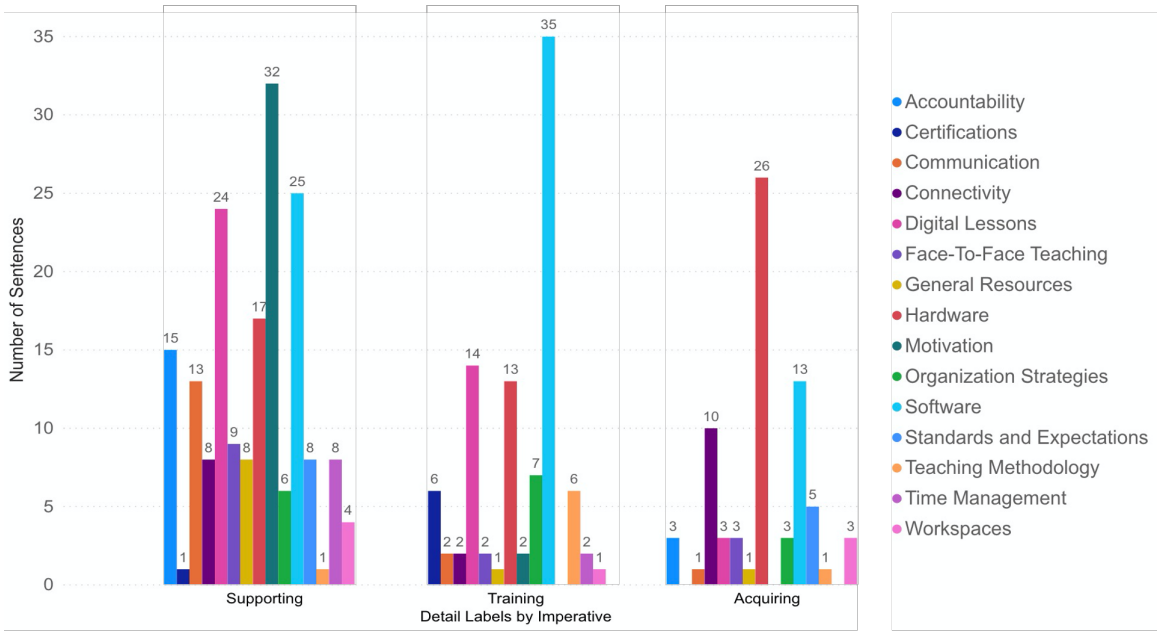


Figure 11. Detail Dimension Label by Imperative Label. This figure illustrates the distribution of Detail dimension label assignments as a grouping of their respective Imperative dimension label assignments. Empty spaces in the Training cluster are due to a lack of Detail dimension values for Accountability and Standards and Expectations. Empty spaces in the Acquiring cluster are due to lack of Detail dimension values for Time Management, Motivation, and Certifications. N/A values were excluded from the clustered column chart.

Software was a key talking point for participants in relation to Training. For example, participant 2 commented “During the past 9 weeks, I lost time, because I had to learn the intricacies of Google Classroom myself, before I could use it effectively.” Additionally, this response scored strong for Analytical, and strong for Sadness. Software was the most assigned label in the Details dimension, followed by Hardware. To illustrate the point on Hardware, participant 9 commented “I teach Engineering and Science and

had to fully change my engineering curriculum because the computer programs needed high end computers to run and the equipment is all based at school." Interestingly, participants wrote about Motivation almost exclusively from the standpoint of the Imperative labeled Supporting–91% of all Motivation labels were assigned to the Supporting category. Participant 6, for example, in response to question 5 "What would you do differently if we start next school year in an online environment?" responded with "School is not [only] how to learn academics it huge on social/emotional development. I don't think technology can overcome that." This response was assigned the Motivation label and received tone scores for Analytical and Joy.

The tree map seen in Figure 12 offers a wholistic view of the Detail dimension, and it tells a comprehensive story about what the participants were thinking about as they composed their responses. The top five themes on the left side, Software, Hardware, Digital Lessons, Motivation, and Connectivity, account for more than half, 62%, of all responses.

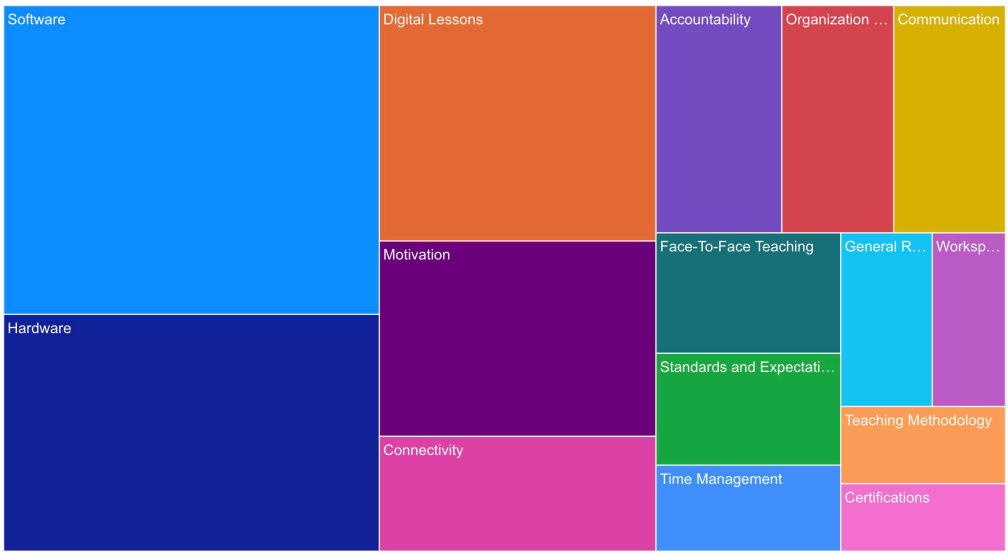


Figure 12. Detail Dimension Tree Map. This figure illustrates the distribution of Detail dimension labels assigned to every sentence; N/A values were excluded.

The right side of the tree map, however, is not without its qualitative merits. For example, one of the only two examples of the Anger tone in the dataset was present in a response labeled Time Management. Participant 12's last sentence in this response "Not as prepared as I could have been. All of my files are saved to Microsoft formats and I had to transfer everything to Google formats. It was very time consuming and frustrating." scored strong for Anger and strong for Confident.

The process of thematic dimension labeling concluded with the creation of the Sankey diagram seen in Figure 13. The relationships visualized between the nodes are weighted based on the assignment counts of related labels for all sentences across all participant responses.

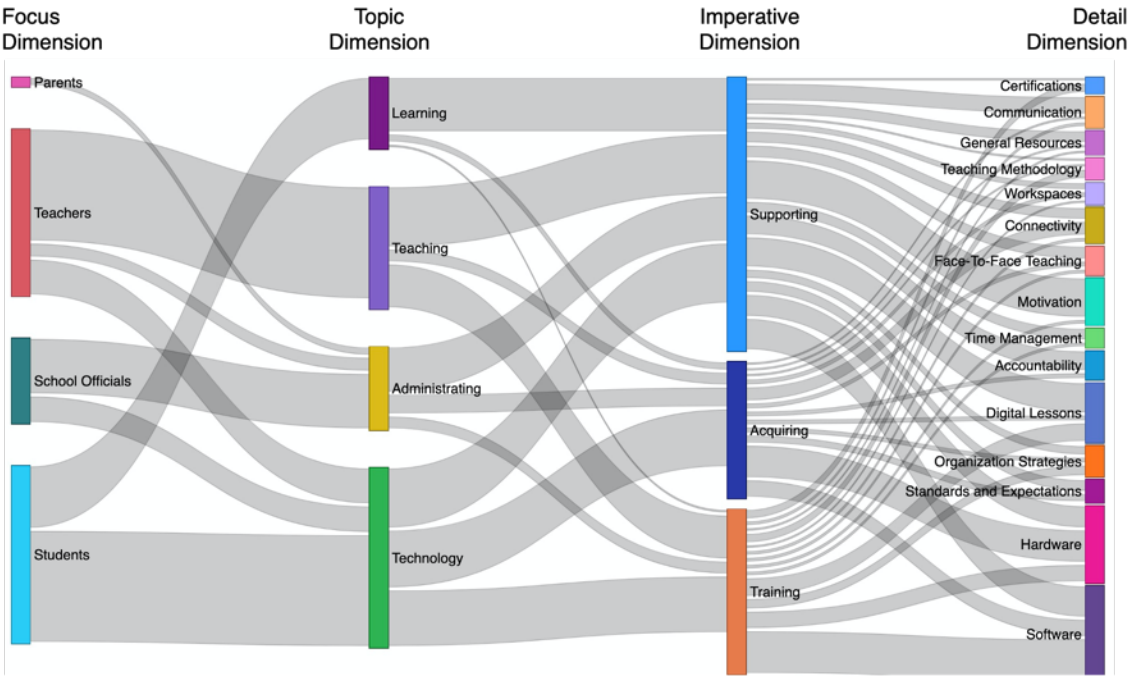


Figure 13. Thematic Dimensions. This figure illustrates the weighted relationship between the labels of each thematic dimension. N/A values were excluded.

Thematic Constructs. After the repeating ideas were reduced and coded, the next step was to "organize the themes into larger, more abstract ideas" (Auerbach & Silverstein, 2003, p. 39). This iteration of the content analysis saw the emergence of four thematic constructs that described the participants concerns with abruptly transitioning from an in-person teaching environment to a fully virtual teaching environment: (1) student needs, (2) teacher needs, (3) the role of school officials, and (4) parent needs. Each of these was predicated upon the Imperative dimensions that were identified in the content analysis: the acquisition of resources, the provision of support and the need for training.

Content Analysis Narrative. The final step in the content analysis process, the interpretive narrative, "provides the bridge between the researchers' concerns and the participants' subjective experience" (Auerbach & Silverstein, 2003, p. 40). To the understand the richness of the data provided by participants, particularly "by illuminating the background against which this [data] is set" (Willig, 2014, p. 139), Willig suggested the use of an 'Empathetic' interpretation approach. The data collected from IBM Watson's machine learning-based psycholinguistics analysis served to shine a figurative emotional and rational light on the less apparent aspects of the dataset. Willig also suggested a key challenge of interpretation is that "parts of a whole can only be understood on the basis of an understanding of the whole, while the whole itself can only be grasped on the basis of an understanding of the parts" (p. 140). While the development of an exhaustive qualitative analysis can overwhelm readers with detail and large passages of text, an abbreviated account–which may highlight a researcher's editing, data analysis, or data visualization skills–may come at the cost of context (Timulak, 2014). It

is in consideration of this guidance that the following discussion of relevant findings is offered.

Student Needs. The dominant focus of all participant text was students, with 41% of all response sentences identified as relating to student needs. Additionally, these responses saw the only two scores for the Fear tone. To illustrate, the whole response "Not much but I now have lots [of] experience under my belt. Expectations have to [be higher] but unfortunately there are a lot of [emotional issues] to overcome and battle. School is not [just where] to learn academics it huge on social/emotional development. I don't think technology can overcome that.", did not specifically yield a Fear score when analyzed as a single unit by the tone analyzer service. However, when each sentence was analyzed individually, the last sentence in that passage received a strong Fear score of 0.766. The Fear tone is an emotional tone and is associated with "a response to impending danger. It is a survival mechanism that is triggered as a reaction to some negative stimulus. Fear can be a mild caution or an extreme phobia." (IBM, 2020b, para. 3).

Visualizing the student needs thematic construct by isolating the Sankey diagram seen in Figure 13 for the Students node revealed the imperative of the construct, Supporting, is linked to 11 of 13 Detail dimension labels. Figure 14 illustrates these relationships, as well as the heavily weighted links between the Supporting imperative dimension and the Learning and Technology topics.

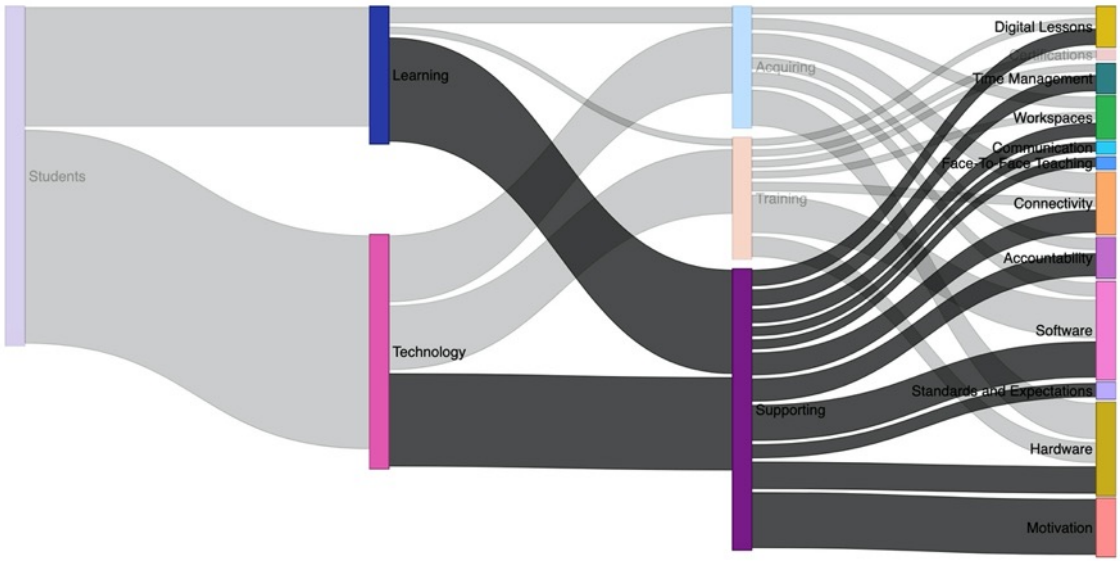


Figure 14. Student Needs Thematic Construct. This figure isolates the Focus dimension label on Students and highlights the weighted relationships between the Topic dimension labels, the Imperative dimension labels, and the Detail dimension labels–specifically centered around the Supporting Imperative label. N/A values were excluded.

Careful consideration of the Figure 14 shows students were in need of hardware and software support; more so than the acquisition of these. To illustrate this point, participant 1 commented “some students do not have internet or a computer” and participant 2 commented “During the past 9 weeks, I lost time, because I had to learn the intricacies of Google Classroom myself, before I could use it effectively.” Additionally, participant 4 commented “Small chrome books are not sufficient to see and experience classes (I know because I’m using a big monitor). Also many of the students had connectivity issues and are generally not skilled in using computers to actually do work.” These comments exemplify the need for the acquisition of modern hardware, easy to use software, and reliable Internet connectivity, while underscoring a clear need for support

and training for both students and teachers. Moreover, from the standpoint of the machine learning-based psycholinguistics analysis, these three comments speak from the strong Tentative, medium Sadness, and strong Analytical perspectives–with scores of 0.959, 0.588, and 0.916, respectively.

Teacher Needs. Participant responses labeled with Teachers as the Focus dimension were primarily linked with responses labeled Teaching for the Topic dimension. To illustrate this link is question 4, which asked "How successful do you think you and your students were after changing to the online environment?" Participant 4 answered, "We made it through... but in terms of comprehension and knowledge Acquisition, I could tell by many indicators that students were. It performing at the typical level." The fragment "students were. It performing" was understood to mean "students were [not] performing". The researcher's first comment about this response was "Success was low, and, the school/district set limits." In a second iteration of analysis, the researcher reduced that first comment to "Teaching Effectiveness." As content analysis progressed into coding, the participant's response was then labeled with the Teacher Preparedness primary code and secondary codes for the participant's response included Teaching Effectiveness, Lesson Planning, and Training. These primary and secondary codes were then reduced and abstracted to the label Teachers for the Focus dimension and assigned the label Teaching for the Topic dimension. It is worth noting, the participant's comment in this example had the highest Analytical score, 0.985, of the Teachers Focus dimension, and it was the third highest overall Analytical score in the dataset.

Visualizing the teacher needs thematic construct by isolating the Sankey diagram seen in Figure 13 for the Teachers node revealed the need for support and training–more so than the acquisition of–Digital Lessons. Figure 15 illustrates these relationships, as well as shows the heavily weighted link between the Training label and Software label; second in weight to the Supporting and Digital Lessons relationship.

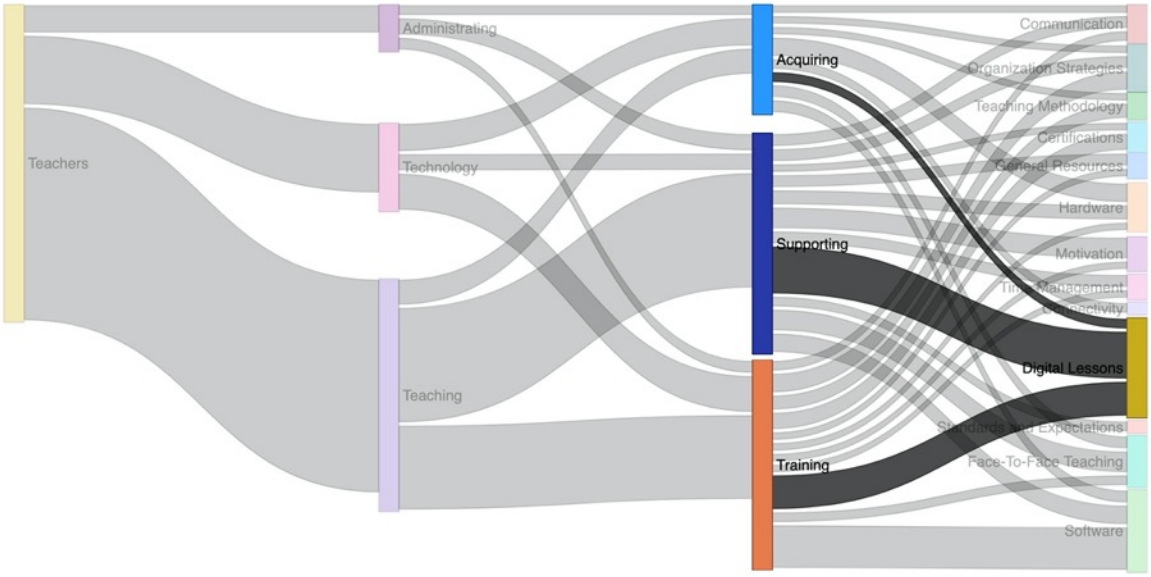


Figure 15. Teacher Needs Thematic Construct with a Focus on Digital Lessons. This figure isolates the Focus dimension label on Teachers and highlights the weighted relationships between the Imperative dimension labels and the Detail dimension labels–specifically stemming from the Digital Lessons Detail dimension label. N/A values were excluded.

Contrastingly, when looking at the Hardware Detail dimension label, Figure 16 shows the acquisition of hardware carried more weight than hardware training or hardware support.

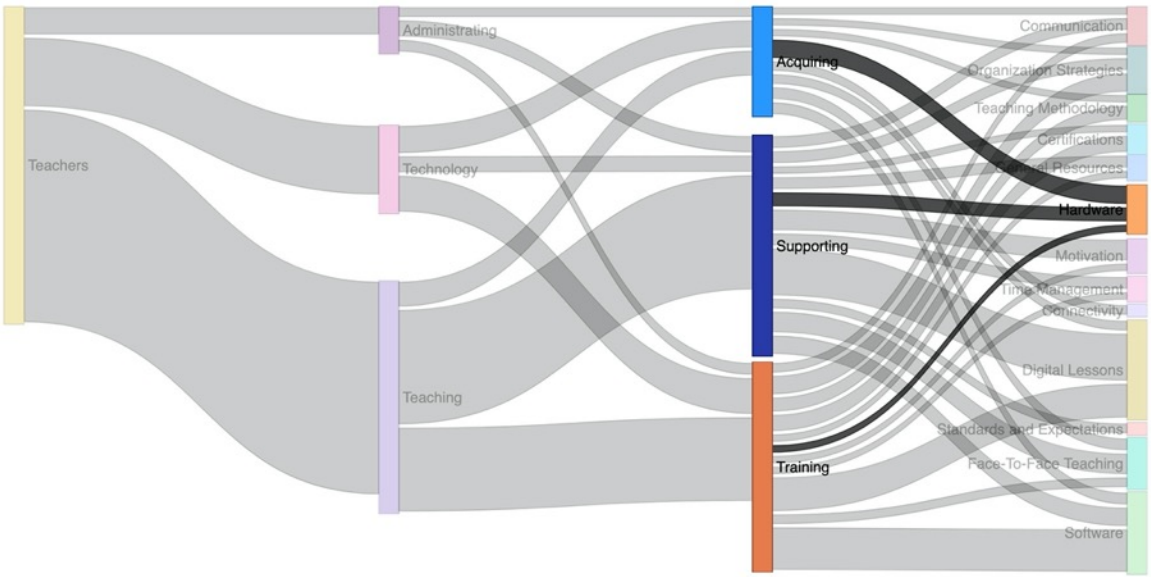


Figure 16. Teacher Needs Thematic Construct with a Focus on Hardware. This figure isolates the Focus dimension label on Teachers and highlights the weighted relationships between the Imperative dimension labels and the Detail dimension labels–specifically stemming from the Hardware Detail dimension label. N/A values were excluded.

The Role of School Officials. The only participant response assigned the School Officials label in the Focus dimension that expressed sadness was in response to question 4 "How successful do you think you and your students were after changing to the online environment?" Participant 7 responded "I feel that our school could have raised the bar a bit on class expectations." That comment was labeled with Analytical, Tentative, and Sadness; with corresponding low, medium, and strong weights. Also, in response to question 8, "How should administrators be better prepared to manage an online learning environment?", participant 5 responded with "🤷‍♀️that's why they get paid the big bucks 🤣." While use of the laughter emoji, in context with the shrug emoji and the "big bucks" phrasing, can be construed as sarcasm, no tone scores were returned the Watson Tone

Analyzer service. The researcher did assign School Officials as the Focus dimension label Supporting as Imperative dimension label.

Visualizing the role of school officials thematic construct by isolating the Sankey diagram seen in Figure 13 for the School Officials node revealed the imperative of the construct, Supporting, is linked to nine out of ten Detail dimension labels. Figure 17 illustrates these relationships, as well as the heavily weighted link between the Supporting imperative dimension and the Administrating topic.

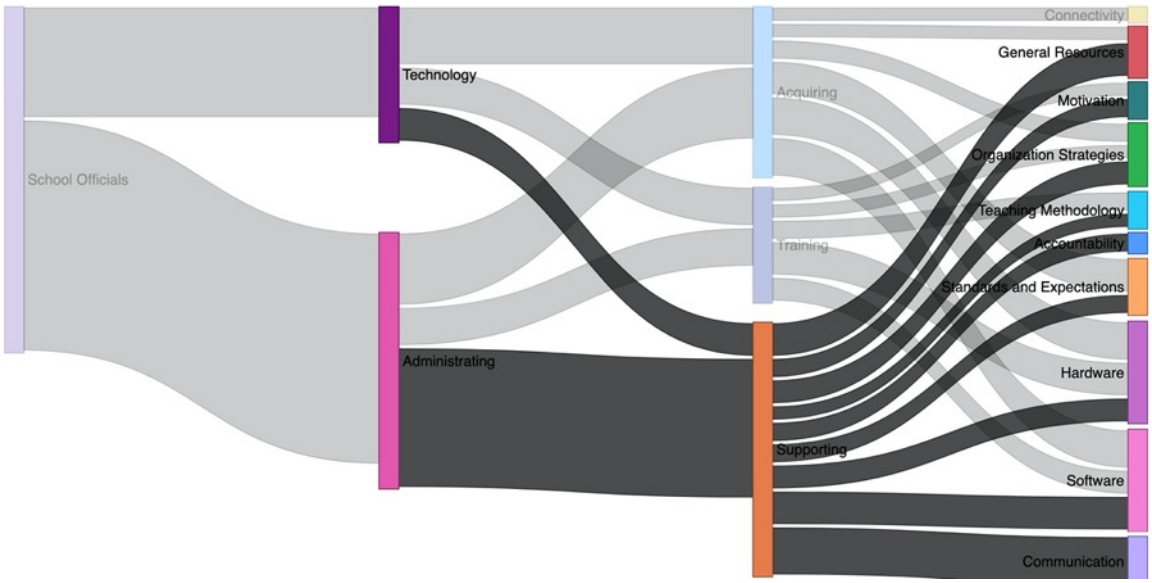


Figure 17. The Role of School Officials Thematic Construct. This figure isolates the Focus dimension label on School Officials and highlights the weighted relationships between the Topic dimension labels, the Imperative dimension labels, and the Detail dimension labels–specifically centered around the Supporting Imperative label. N/A values were excluded.

The dominant concern for the role of school officials was communication. Participant 9 commented “Both the teachers and students did not find out that we were

out of school until a few hours before, and it was only by word of mouth.", which scored for both Analytical and Tentative. While that comment referred to school officials communicating with teachers, in response to question 8, "How should administrators be better prepared to manage an online learning environment?", participants 10 and 13 both suggested school officials should communicate with students and their families. For instance, participant 10 said "They need to be the ones contacting parents, rather then the teacher. The teacher can send email but admin needs to be calling so that teachers do not have to use their personal cell phones to makes calls." Participant 13 said "Students are present that day by checking in google classroom, if they were marked absent they should get a call or email stating their child didn't check in". Both of those responses scored for the Analytical tone 0.849 and 0.543, respectively.

Parent Needs. The small focus on Parents shown in Figure 13 is not indicative of a lessened level of importance. Related participant's responses which were assigned the label Accountability in the Detail dimension saw strong Analytical scores. For instance, participant 3 said "Ensure all the students and parents take online school seriously. Also, there needs to be consequences for students that miss online school." This response scored 0.959 for the Confident tone, 0.888 for the Analytical tone, and 0.580 for the Sadness tone. In support of that response, Participant 6 called for "Parent support and buy in. Maybe people that go out into the community to check up on issues & reward students for doing a great job.", which scored 0.810 for Tentative. Additionally, participant 11 added "They need support and expectations of parents to comply.", which scored 0.901 for the Analytical tone.

The participants' mention of parents was linear across the Focus, Topic, Imperative, and Detail dimensions, with five instances of each relationship link. The 5 total comments do not warrant a focused Sankey diagram to depict weighted relationships between nodes. However, from a psycholinguistics analysis perspective, the five parent-focused comments in the dataset related contributed valuable tone labels. To exemplify, participant 3 noted the need for parents to "take online school seriously"; this comment scored a strong 0.928 for the Confident tone. Similarly, participant 11 called for the "support and expectations of parents", this comment scored a strong 0.901 for the Analytic tone. Also, participant 4's comment "Teachers with 130+ students may have a hard time calling the large percentage of parents that need help.", was echoed by participant 6's comment "Lots of calls home.."– both of these comments scored 0.553 and 0.889, respectively, for the Tentative tone.

Answering the Research Question. While a broad answer to the research question at the heart of this study, *What insights can teachers provide from their first-hand experience with an unforeseen and widespread disruption of their teaching environment?*, can be gleaned by studying the various flows depicted in the Sankey diagram seen in Figure 13, as well as the isolated views offered by Figures 14, 15, 16, and 17, Table 17 lists the participant's top thematic concerns and the sentence count for related thematic dimension labels.

Table 17

Thematic Constructs by Thematic Dimensions Label

Thematic Construct	Thematic Dimensions and their Label Counts							
	Focus	*n*	Topic	*n*	Imperative	*n*	Detail	*n*
Student Needs	Students	147	Technology	95	Supporting	40	Software	13
Teacher Needs	Teachers	135	Teaching	95	Supporting	50	Digital Lessons	18
The Role of School Officials	School Officials	67	Administrating	46	Supporting	27	Communication	8
Parent Needs	Parents	5	Administrating	5	Supporting	5	Accountability	5

Note. N/A values were excluded.

None of the issues presented (1): *the participant cohort may have varying levels of emotional ties to their work, their students, or how the nation, the school district, or their school handled the response to the pandemic*, (2) *the participant cohort may possess different levels of prior computing skills, Internet connectivity speeds, or have access to different software or hardware*, and (3) *the participant cohort may have had varying amounts of their work – including materials and processes – in digital form prior to the shift to a virtual teaching environment*, were disproportionally represented in the dataset. Of the two propositions presented, (1) *increased school or district involvement in the technology aspect – software, hardware, Internet connectivity, and accessibility – of the education process should increase the overall success of the online education environment,* (2) *well prepared instructors could positively affect the transition to a virtual leaning environment*, both were well represented in the dataset.

Participants who experienced the abrupt transition from an in-person teaching environment to a fully virtual teaching environment were primarily concerned with

supporting student's technology needs, specifically related to software. These concerns were voiced with Analytical, Sadness, and Tentative tones. Digital lessons were also a primary concern for teachers, these concerns were voiced in Analytic, Confident, Joy, Sadness, and Tentative tones. Concerns related to the role of school officials were centered on the provision of communication by school officials, these concerns were voiced with Analytical tones. Last, participant's concerns related to parents had to do exclusively with accountability; these concerns were voiced with Analytical, Confident, and Tentative tones.

Summary

Chapter 4 discussed the results of the descriptive, machine learning-based psycholinguistics, and content analyses with an explicit account of procedures, the application of methods, techniques, and the strategies that were used in examination of 130 text-based responses received from thirteen anonymous respondents to a ten-item questionnaire. After the qualitative data were cleansed and organized, the descriptive analysis derived word, sentence, and character counts for whole responses, and also for individual sentences within whole responses. A machine learning-based psycholinguistics analysis produced seven psycholinguistic tones: Analytical, Anger, Confident, Fear, Joy, Sadness, and Tentative. The analysis was then performed for all text, all text for each participant, all text for each question, all text for each response, and all text for each sentence in a response. The content analysis was then executed using a hybrid approach with guidance taken by Auerbach and Silverstein (2003) and Schreier (2012). Finally, the linear analytic method was used to report findings and answer the research question.

Chapter 5

Conclusions, Implications, Recommendations, and Summary

The COVID-19 pandemic was an unprecedented global event for myriad reasons, not least of which was its impact to the world's education system. The pandemic "created the largest disruption of education systems in history, affecting nearly 1.6 billion learners in more than 190 countries and all continents" (United Nations, 2020, p. 2). Given the recency of the pandemic, it will take a considerable amount of time before the global disruption to education is fully understood. In that light, this dissertation work shifted its focus towards understanding the abrupt transition from an in-person teaching environment to a fully virtual teaching environment. Similar work is taking place around the world where, for example, Bergdahl and Nouri (2020) studied the transition to distance learning in Swedish schools. The first version of this study was unable to proceed beyond two of the planned six in-person workshops due to Palm Beach County school closures. As a result, a new study was formulated. The goal of the revised version of the study was to understand the lived experiences of U.S.-based teachers who were abruptly transitioned from an in-person teaching environment to a fully virtual teaching environment, particularly at the onset of the global COVID-19 pandemic in Palm Beach County, Florida. This chapter comprises discussions of these five areas, (1) the conclusions which resulted from the data analysis, (2) the strengths, weaknesses and limitations of this study, (3) the implications of the derived results, (4) recommendations for improvements to this study, and (5) suggestions for future research.

Conclusions

The data collected and the ensuing three-level analysis–descriptive analysis, machine learning-based psycholinguistics analysis, and qualitative content analysis–were in service of the research question: *What insights can teachers provide from their first-hand experience with an unforeseen and widespread disruption of their teaching environment?* Conclusions drawn from the descriptive analysis indicate verbosity among every participant as well as for responses contributed to every question. A sentence word count higher than 20 is above average for U.S.-based writings and is commonly found in government, scientific, and essential information documents (Cutts, 2020; Plain Language Association International, 2017). The descriptive analysis revealed every participant had at least one instance of a sentence word count higher than 20 words, and each of the ten questions in the questionnaire also saw at least one response with this above-average sentence count. Indeed, while there was a variety of sentence word count length–from as few as zero and one word, to as many as 50–this is an important finding because it frames the participants' responses in a writing style that is characterized by complexity and thoughtfulness.

The principal conclusion drawn from the machine learning-based psycholinguistics analysis served to augment the conclusion derived from the descriptive analysis. While the descriptive analysis quantifiably concluded that teachers were being verbose in their responses to every question in the questionnaire, the machine learning-based psycholinguistics analysis revealed that responses were linguistically framed 72% of the time and emotionally framed 28% of the time. This finding is significant because it

empirically qualifies the participants' responses as logical and rational, rather than emotionally driven.

The qualitative content analysis concluded participants were primarily concerned with four thematic constructs: student needs, teacher needs, the role of school officials, and parent needs. More specifically, participants' concerns were related to supporting students' technology and software needs. This is important because by understanding the participants' collective views, policy makers, school officials, students, parents and other teachers can better understand the readiness and sustainability concerns that were seen at the onset of the unforeseen and widespread disruption of the education system. This understanding can aid in the development of strategies to mitigate the impact of future disruptions.

Strengths, Weaknesses, and Limitations

If interpretation is indeed an art, then perhaps "the art of interpretation produces understandings that are shaped by genre, narrative, stylistic, personal, cultural, and paradigmatic conventions" (Denzin, 2009, p. 102). The understandings derived by the analyses undertaken in this study invariably carry their own strengths, weaknesses and limitations. One strength of the descriptive analysis was that it led to the expansion of the original dataset from 130 analyzable datapoints to 235 analyzable datapoints. The newfound data granularity then served to support both the machine learning-based psycholinguistics analysis and the qualitative content analysis. Conversely, however, the sentence-level granularity came at a cost of diminished contextual value of the fragmented datapoints, which required careful consideration from the researcher as subsequent analysis unfolded. Another weakness of the descriptive analysis was that

character, word, and sentence counts can be misleading; participants need not be verbose to convey profound ideas. Additionally, the descriptive analysis was limited to descriptive statistical computations, and did not explore advanced statistical models. The rationale for leveraging a quasi-statistical rendering of the qualitative data was based on the need to objectively describe the data before additional analysis took place.

A strength of the machine learning-based psycholinguistics analysis was the ability to leverage a research-based machine learning service to analyze the qualitative data at five distinct levels: for all text, for all text for each participant, for all text for each question, for all text for each response, and for all text for each sentence in a response. The depth and breadth of this analysis would not have been reliably possible without machine learning. On the other hand, though, that strength comes at the cost of context, given the machine learning service was limited to processing responses without the context of the question being asked. A common weakness of machine learning-based approaches is susceptibility to the philosophical ideology known as *dataism*, that is, a belief and trust in data-based techniques where "human behavior [is] measured, analyzed, and predicted on the basis of large sets of metadata" (Van Dijck, 2014, p. 204). The rationale for employing a machine learning-based psycholinguistics analysis was based on the need to look beyond a quasi-statistical rendering of the qualitative data, and reliably extract meaningful linguistically and emotionally based insights from the complex qualitative data provided by participants.

A strength of the qualitative content analysis was that iterated, five times, through every datapoint, which took into consideration both whole responses and individual sentences. Primary and secondary codes were developed over the course of four iterations

and the thematic constructs were developed on the fifth iteration of the analysis. A weakness was the qualitative content analytics approach is that it is inherently reductive in nature, focusing on isolated words, phrases, sentences, or passages that have been reduced to abstractions with little regard for the surrounding content or meanings associated to nearby passages. A limitation of the approach taken in this particular study is that the subjective interpretation of only one researcher was employed.

Overall, a clear strength of the study was the application of three levels of analysis which stacked upon each other to provide a deep and rich view of the qualitative data. The primary weakness of this study was the inevitable loss of context and dimensionality of the data due to the quantizing and abstracting processes undertaken during each of the three analyses. The main limitation of the study was the limited sample size, which limits generalizability of results.

Implications

The findings presented herein have practical implications for school officials, parents, students, and policy makers; that is in addition to its historical and academic contribution. The data studied and the ensuing results were rich with detail, suggestions, explications, consequences, logic, and emotion. In consideration of the unexpected nature of the global pandemic, its unforeseen impact to the education system's technical resources, and the exposure of the education system's lack of preparation for such a catastrophic event, the lessons to be learned from the teachers' lived experiences presented here are invaluable. School officials, teachers, and policy makers can benefit from these findings in order to plan the necessary key personnel, resources, services, and actions required to effectively support the availability of critical technical operations in

the event of future short- or long-term disruptions. Equally, students and parents alike could benefit from planning for, adopting, and maintaining preparedness measures at home. Taking into account the unexpected depth and breadth of the COVID-19 global pandemic, this study served to document and describe the pandemics' impact on U.S.-based teachers in Palm Beach County, Florida. Additionally, the study served as an early contributor to what will invariably be an abundance of forthcoming academic work related to the impact COVID-19 had on technology dependent education, professional, and government systems.

Recommendations

The researcher did not have the opportunity to follow-up with participants, nor was he able to explore the viewpoints of teachers from other districts, other grade levels, or other locales–these are areas were future studies can focus. This study can be enhanced with the incorporation of qualitative data from semi-structured interviews–specifically with the goal of acquiring additional depth, breadth, rationale, and sentiment from participants. Alternatively, a quantitative survey could be employed to expand the sample size and reach beyond the Palm Beach County locale in order to enhance generalizability of the findings. Further, future research should take into consideration the fact that students of differing ages have differing technological needs and capabilities; just the same, schools in different socio-economic districts will have differing technological needs and capabilities. Additionally, future research could collect data from school officials, parents, students, and policy makers to get their distinct perspectives on what aspects of technology each group deems critically important for the continuity of education.

Summary

Chapter 1 presented the contextual background for the original version of this study, which was introducing an all-female cohort of high school students to computing careers through the frame of information systems project management. The original problem statement, goal, and research question were established; followed-up with discussions about relevance, significance, barriers, issues, assumptions, limitations, and delimitations. The goal of the original version of the study was to discover how exposure to IS project management impacts perceptions of computing careers among high school female participants.

Chapter 2 included a justification of the criteria used for the literature review process, a synthesis of existing literature, an analysis of research methods used, and an overview of gaps in the literature related to the original version of the study. The chapter served to establish a baseline of work other researchers had done in related areas, and to rationalize the practical and scholarly significance of the study. Topically related and relevant scholarly work included research studies, conference proceedings, articles, and other academic publications–as well as books, official government filings, and published reports from non-government organizations. All literature reviewed was either directly or indirectly related to pre-college aged students and the computing-related educational pipeline they comprise.

Chapter 3 began with describing the research methodology and design related to the prior version of this study. An interpretivist research paradigm was chosen as the philosophical underpinning for the original qualitative descriptive case study. Based on an abductive approach, guided by hermeneutic phenomenology, from the perspective of

social constructivism, the theoretical framework comprised two theories: cognitive evaluation theory and motivational design theory. The conceptual framework comprised three constructs: belongingness, intrinsic motivation, and interest. Qualitative data, in the form of interview data and reflexive journaling, were to be collected and discussed using a descriptive reporting style. Given the COVID-19 disruption, however, the research methodology was revised. The new version of the study employed a single, holistic, revelatory case, with a cross-sectional time horizon, and a group of purposively sampled STEM teachers as the unit of analysis. Qualitative data, collected from thirteen participants using a ten-item online questionnaire, was analyzed using descriptive analysis, machine learning-based psycholinguistics analysis, and qualitative content analysis.

Chapter 4 discussed the results of the triad of analyses, including an explicit account of procedures, techniques, and strategies that were used in the examination of 130 text-based questionnaire responses. The descriptive analysis produced word, sentence, and character counts for whole responses, as well as for individual sentences within whole responses.

The descriptive analysis concluded every participant had at least one instance of verbosity, and every question was responded to with at least one verbose response. Verbosity was characterized as a sentence word count higher than 20, which is above average for U.S.-based writings and is commonly found in government, scientific, and essential information documents (Cutts, 2020; Plain Language Association International, 2017).

The machine learning-based psycholinguistics analysis produced psycholinguistic tone scores across seven dimensions: Analytical, Anger, Confident, Fear, Joy, Sadness, and Tentative. Individual scores were tallied at five distinct levels: for all text, for all text for each participant, for all text for each question, for all text for each response, and for all text for each sentence in a response. At the all-text level, tone scores were returned by the Tone Analyzer for Analytical, Joy, Sadness, and Tentative. However, when individual sentences were analyzed, scores for all seven tones were returned. While the data were dominated by intellectually inclined tones, Analytical, Confident, and Tentative, the revelation of emotional tones provided much additional context for the subsequent content analysis.

The qualitative content analysis was then iteratively executed, resulting in the development of 11 primary codes, 26 secondary codes, and four thematic constructs: student needs, teacher needs, the role of school officials, and parent needs. The linear analytic method was subsequentially used to report findings which revealed participants were primarily concerned with (1) supporting student's technology needs specifically related to software, (2) supporting teacher's digital lesson needs, (3) concerns regarding the communications aspect of the role of school officials, and (4) concerns with providing parent accountability support.

The study concluded with Chapter 5 which discussed the conclusions that resulted from the three-pronged data analysis; the strengths, weaknesses and limitations of the study; the implications of the derived results; recommendations for improvements to the study; and suggestions for future research.

Appendices

Appendix A

Interview Questions

In-depth semi-structured interview questions are intended to encourage interviewees to engage in a descriptive narrative.

1. How would you describe how you and your peers use computers, the Internet, and general technology in your everyday lives?
2. Do you consider yourself as someone who is good with technology? What technology are you good with? What technology are you bad with?
3. Who do you usually ask for help with computer, Internet, or technology-related problems?
4. Can you describe the circumstances in which you helped someone who was having computer, Internet, or technology problems?
5. Generally speaking, what do you think about computing-related jobs?
6. What is your perception of someone who works in information systems? How would you describe them?
7. What is your perception of the information systems industry? How would you describe it?
8. Do you see yourself pursuing a degree or a career in a computing-related discipline?
9. Before the workshop, did you know the project management profession existed?
10. What did you learn at the workshop? What was your favorite session?
11. Would you say you are confident in managing projects, both for yourself and for other people? Do you enjoy managing projects?
12. How many computing-related classes, training, or workshops have you taken before this one?

13. Do you plan to take additional information systems courses after this workshop? Did those plans change as a result of this workshop?
14. Do you think other girls in your age group would be interested in learning Project Management?
15. What are your plans after graduating from high school? Are you going to college? Are you going to look for a job? Are you going to take a gap year, and travel? Or Do you have something else planned? If you are planning a gap year, what would come after that?

Appendix B

Lesson Plan Design Document

The lesson plan has been guided in large part by the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.). This workshop design document outlines the purpose of the sessions, the instructional strategies adopted, what participants will learn by the end of the six sessions, and what skills each workshop will teach.

Session Title:	An Introduction to Project Management
Document Name:	Workshop Design Document
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Course Objective

Participants will learn authentic project management skills that are currently used to deploy information systems and solutions.

Course Resources, Timing, and Materials

- A projector and a surface to project on will be needed. The researcher can furnish a projector and a screen, if need be.
- There are six sessions scheduled.
- Each session will need 60 minutes to complete.
- Participants need only bring materials to take notes.
- Printed handouts will be provided to participants. All handout materials will also be distributed in electronic format.

Course Administration

The course instructor will provide an initial lecture style introduction into each session, supported by visuals aids in the form of PowerPoint slides, Word documents, and Internet pages. The course instructor will then lead participants through a collaborative, hand-on working session where project management documents will be discussed, explained and filled out. Each session will conclude with a review of topics covered, an introduction of the next sessions' topics, and time allotted for question and answers.

Course Learning Objectives

By the end of this workshop, participants will be able to:

1. Explain what project management is, including how project management fits within an organization, and what it takes to becomes a project manager.
2. Initiate a project, including getting a project underway; coming to a common understanding of the components and boundaries of a project.
3. Plan a project, including establishing the scope of the project, clarifying the objectives and the course of action necessary to successfully achieve the objectives.
4. Execute a project, including managing and performing the project work and providing the project deliverables.
5. Close a project, including reviewing project outcomes, team processes, and lessons learned.

Course Competencies

By the end of this workshop, participants will have engaged in activities that enable them to develop skills in the following areas:

1. Critical Thinking & Problem Solving
2. Creativity & Innovation
3. Written & Oral Communication
4. Teamwork & Collaboration
5. Leadership & Initiative

Theoretical Alignment

The following two theories have been selected to underpin the course objectives:

1. Cognitive evaluation theory, which propositions that autonomy and competence, in the proper social and environmental context, can positively modify intrinsic motivation.
2. Social development theory, which suggests that relationship building and behavior modeling–by key social actors such as peers, teachers, and adults, among others–can influence a person's behavior.

Assessment Strategy

In lieu of a formal assessment of the teaching effectiveness of the workshops, a post-workshop interview will be conducted, see Appendix A.

Workshop Outline

The table below provides a title for each workshop session, a brief description of what will be covered in each workshop, and what learning objectives the session aligns to.

Session	Session Title	Session Description	Learning
1	Introduction to Project Management	Introduce the course objectives and provide an overview of project management; including what it is, what it takes to become a project manager, and a look at current and future job prospects.	1,2
2	Initiating Phase	Participants will learn how to establish project goals; identify resources, constraints, and assumptions; create a scope document; identify deliverables and dependencies; name stakeholders; assign managers; and, monitor and control the project initiation process.	2
3	Planning Phase	Participants will learn how to plan success measures; develop a sequence and schedule, identify resources and learn the acquisition process, plan for risk management, and monitor and control the project planning.	3
4	Executing Phase	Participants will learn how to assign team and individual responsibilities, and establish monitor and control cycles for the project execution phase.	4
5	Closing Phase	Participants will learn how to create documentation, develop a presentation, and reflect on the project management process.	5
6	Course Wrap-up	All documents used in the course will be provided to participants in both print and cloud-based electronic versions, the project the participants worked on will be unveiled as a live and functioning website, resources with additional information about project management-related jobs will be discussed, and post-workshop interviews will be scheduled.	

Theoretical Alignment

The table below outlines specific workshop activities and their alignment with the two theories that underpin this research.

Session Activity	Theoretical Alignment #
Introduce participants to every aspect of the project lifecycle, including providing them with documents, a walk-through of those documents, and delivery of a final product.	1
Provide participants with glossary documents and sample forms, prefilled and blank.	1
Present participants with income earning potential, income and role growth potential, and explain the position of leadership a project manager holds within an organization.	2
Present participants with an overview of current and expected job market for project managers.	
Affirm participants the methodology they will learn is indeed the industry standard.	

Appendix C

Session 1 – An Introduction to Project Management

The following lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.).

Workshop Title:	An Introduction to Project Management
Session Number:	1 of 6
Session Title:	Introduction to Project Management Lesson Plan
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Description

This session will introduce the workshop goals, objectives, and also introducing project management.

Agenda

- Workshop Overview
- Introductions
    - Workshop leader
    - Students
- Overall Objectives
- An Introduction to Project Management
    - What is Project Management?
    - What does it take to become a project manager?
    - Overview of the Project Management Phases
- Why does this matter?
    - Current job market
    - Forward looking job and career outlook
    - Societal and industry specific impact
- Hand-on Activity
    - The Project Cycle Diagram
- Conclusion
    - Recap the current session
    - Introduce the next session: Initiating Phase
    - Q/A

Appendix D

Session 2 – Initiating Phase

The following lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.).

Workshop Title:	An Introduction to Project Management
Session Number:	2 of 6
Session Title:	Initiating Phase
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Description

This session will introduce the first of four project management phases, the initiating phase.

Agenda

- Review the last session: An Introduction to Project Management
- What is Initiating a project?
- Initiating Phase Steps
    - Step One: Establish Goals
    - Step Two: Identify Resources, Constraints, and Assumptions
    - Step Three: Creating a Scope Statement
    - Step Four: Identify Deliverables and Dependencies
    - Step Five: Name Stakeholders
    - Step Six: Assign Project Managers
    - Monitoring and Controlling
- Hands-on Activity
    - The Initiate Phase worksheet
    - Review the Glossary file
- Conclusion
    - Recap the current session
    - Introduce the next session: Planning Phase
    - Q/A

Appendix E

Session 3 – Planning Phase

The following lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.).

Workshop Title:	An Introduction to Project Management
Session Number:	3 of 6
Session Title:	Planning Phase Lesson Plan
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Description

This session will introduce the second of four project management phases, the planning phase.

Agenda

- Review the last session
- What is Planning a Project?
- Planning Phase Steps
    - Step One: Planning Success Measures
    - Step Two: Developing a Sequence and Schedule
    - Step Three: Identifying Resources and Acquisition Process
    - Step Four: Planning for Risk
    - Monitoring and Controlling
- Hands-on Activity
    - Complete the Planning Phase worksheet
    - Hangout the Project Schedule worksheet
- Conclusion
    - Recap the current session
    - Introduce the next session: Executing Phase
    - Q/A

Appendix F

Session 4 – Executing Phase

The following lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.).

Workshop Title:	An Introduction to Project Management
Session Number:	4 of 6
Session Title:	Executing Phase Lesson Plan
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Description

This session will introduce the second of four project management phases, the executing phase.

Agenda

- Review the last session
- What is Executing a Project?
- Executing Phase Steps
    - Step One: Assigning Team and Individual Responsibilities
    - Step Two: Establish your Monitor and Control Cycle
- Hands-on Activity
    - Complete the Executing Phase worksheet
- Conclusion
    - Recap the current session
    - Introduce the next session: Closing Phase
    - Q/A

Appendix G

Session 5 – Closing Phase

The following lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.).

Workshop Title:	An Introduction to Project Management
Session Number:	5 of 6
Session Title:	Closing Phase Lesson Plan
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Description

This session will introduce the second of four project management phases, the closing phase.

Agenda

- Review the last session
- What is Closing a Project?
- Closing Phase Steps
    - Step One: Documentation
    - Step Two: Developing a Presentation
    - Step Three: Reflection
- Hands-on Activity
    - Complete the Closing Phase worksheet
- Conclusion
    - Recap the current session
    - Introduce the next session: Course Wrap-up
    - Q/A

Appendix H

Session 6 – Course Wrap-Up

The following lesson plan was adopted and modified from the PMI Educational Foundation's Project Management Toolkit for Teachers® (PMIEF., n.d.).

Workshop Title:	An Introduction to Project Management
Session Number:	6 of 6
Session Title:	Course Wrap-Up
Course Instructor:	Jareau Almeyda
Instructor Contact Information:	Mobile: 917-856-2595
Target Start Date:	To Be Determined
Target Completion Date:	To Be Determined

Description

This session will focus on concluding the workshop.

Agenda

- Course review
- Project Management Continuing Education
    a. Books, YouTube
    b. The CAPM Certification
- Searching for a Job
    a. Using Search Engines
    b. Engaging Recruiting Firms
    c. Going directly to Agencies and Consultancies
    d. Job Fairs
- Website Reveal
- Conclusion
    a. Hand out print and electronic versions of all materials used
    b. Q/A
    c. Thanks, Acknowledgements, and Farewells

Appendix I

IRB Exempt Letter

NOVA SOUTHEASTERN

MEMORANDUM

To: Jareau Almeyda

From: Ling Wang, Ph.D.,

Center Representative, Institutional Review Board

Date: January 14, 2020

Re: IRB #: 2020-16; Title, "Introducing High School Females to Computing Careers Through Information Systems Project Management"

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review under **45 CFR 46.101(b) (Exempt 2: Interviews, surveys, focus groups, observations of public behavior, and other similar methodologies)**. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

3301 College Avenue · Fort Lauderdale, Florida 33314-7796

(954) 262-0000 · 800-672-7223, ext. 5369 · Email: *irb@nova.edu* • Web site: www.nova.edu/irb

NOVA SOUTHEASTERN

1) CONSENT: If recruitment procedures include consent forms, they must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE EVENTS/UNANTICIPATED PROBLEMS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and Ling Wang, Ph.D., respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

NOVA SOUTHEASTERN

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Marti Snyder, Ph.D.

Ling Wang, Ph.D.

3301 College Avenue · Fort Lauderdale, Florida 33314-7796

(954) 262-0000 · 800-672-7223, ext. 5369 · Email: *irb@nova.edu* • Web site: www.nova.edu/irb

Appendix J

Consent Form

College of Computing and Engineering
NOVA SOUTHEASTERN UNIVERSITY | NSU Florida

Parent/Guardian or Legally Authorized Representative (LAR)
Informed Consent and Adolescent Assent Form
NSU Consent/Assent to be in a Research Study Entitled

Introducing High School Females to Computing Careers Through
Information Systems Project Management

Who is doing this research study?

College: College of Computing and Engineering, Nova Southeastern University

Principal Investigator: Jareau Almeyda, B.A., MBA

Faculty Advisor/Dissertation Chair: Martha M. Snyder, Ph.D.

Co-Investigator(s): none

Site Information: Forest Hill Community High School, 6901 Parker Ave, West Palm Beach, FL 33405

Funding: Unfunded

What is this study about?

The purpose of this research study is to explore how an authentic, hands-on introduction to project management within a computing context can facilitate participants' awareness of and interest in computing careers.

Participants will learn project management skills, interface with project management professionals, and create authentic project deliverables.

Project management is the application of knowledge, skills, and resources to accomplish activities that are intended to achieve a specific goal. Project management it is often as much an art as a science, because each project is different and every project is dynamic. The world runs on projects—everyday life projects like planning and planting a garden, school projects like devising and performing experiments for a science fair project, and work-world projects such as developing and delivering a software.

College of Computing and Engineering
NOVA SOUTHEASTERN UNIVERSITY | NSU Florida

Why are you asking me to be in this research study?

As a female in high school, your participation in this study will help us understand if learning project management skills may help high school girls such as yourself expanded their career and academic interests.

This study will include about ten people.

What will I be doing if I agree to be in this research study?

There are six weekly sessions, about 1 hour each. While you are taking part in this research study, a professional project manager will teach you the various aspects of project management, including what it takes to become a project manager, and what makes a project (and a project manager) successful.

You may have to come back to Forest Hill Community High School every Monday for six weeks.

Research Study Procedures - as a participant, this is what you will be doing:

- Six weekly sessions are schedule. Each session will last for 1 hour. The sessions include:
  - Session 1: An Introduction to Project Management
    - You will be introduced to the course objectives and provided with an overview of project management; including what it is, how it fits within an organization, and what it takes to become a project manager. Additionally, this workshop will briefly introduces the first of four project phases, the Initiate phase.
  - Session 2: Initiating Phase
    - You will be introduced to the workshop and its objectives and the workshop leader. The workshop leader will then discuss what project management it, what it takes to become a project manager, what makes a project and a project manager successful, and, why project management matters.
    - The workshop leader will discuss the steps of the Initiating Phase, walk you through a hands-on activity, and you will receive printed documents related to the workshop.
  - Session 3: Planning Phase
    - The workshop leader will review the previous session, and then discuss the steps of the Planning Phase, walk you through a hands-on activity, and you will receive printed documents related to the workshop.

  - Session 4: Executing Phase
    - The workshop leader will review the previous session, and then discuss the steps of the Executing Phase, walk you through a hands-on activity, and you will receive printed documents related to the workshop.
  - Session 5: Closing Phase
    - The workshop leader will review the previous session, and then discuss the steps of the Closing Phase, walk you through a hands-on activity, and you will receive printed documents related to the workshop.
  - Session 6: Course Wrap-up
    - This session will serve as a course wrap-up session where all documents used in the course will be provided to you in both print and cloud-based electronic versions, the project you worked on will be unveiled as a live and functioning website, resources with additional information about project management and project management jobs will be distributed.
- In addition to the six sessions, you will be asked questions about your experience in the workshop. The time and place for these questions will be coordinated with you at a later date.
- There will be no screening procedures used to determine eligibility to participate in this research study, participation is voluntary.

Are there possible risks and discomforts to me?

This research study involves minimal risk to you. To the best of our knowledge, the things you will be doing have no more risk of harm than you would have in everyday life.

Risks	Description
Physical risks	Nothing more than what is to be expected in a typical classroom setting.
Psychological risks	Nothing more than what is to be expected in a typical classroom setting.
Privacy risks	Nothing more than what is to be expected in a typical classroom setting.
Legal risks	Nothing more than what is to be expected in a typical classroom setting.
Social risks	Nothing more than what is to be expected in a typical classroom setting.
Economic risks	Nothing more than what is to be expected in a typical classroom setting.
Group or community risks	Nothing more than what is to be expected in a typical classroom setting.

What happens if I do not want to be in this research study?

You have the right to leave this research study at any time or refuse to be in it. If you decide to leave or you do not want to be in the study anymore, you will not get any penalty or lose any services you have a right to get. If you choose to stop being in the study before it is over, any information about you that was collected **before** the date you leave the study will be kept in the research records for 36 months from the end of the study and may be used as a part of the research.

What if there is new information learned during the study that may affect my decision to remain in the study?

If significant new information relating to the study becomes available, which may relate to whether you want to remain in this study, this information will be given to you by the investigators. You may be asked to sign a new Informed Consent Form, if the information is given to you after you have joined the study.

Are there any benefits for taking part in this research study?

There are no direct benefits from being in this research study. We hope the information learned from this study will help you better understand how computing-related project management skills can expend your future career and academic options.

Will I be paid or be given compensation for being in the study?

You will not be given any payments or compensation for being in this research study.

Will it cost me anything?

There are no costs to you for being in this research study.

Ask the researchers if you have any questions about what it will cost you to take part in this research study (for example bills, fees, or other costs related to the research).

How will you keep my information private?

Information we learn about you in this research study will be handled in a confidential manner, within the limits of the law and will be limited to people who have a need to review this information. No names or other personally identifiable information will be collected. Participants will be assigned a code, and all records will be associated to that code. This data will be available to the researcher, the Institutional Review Board and other representatives of this institution. If we publish the results of the study in a scientific journal or book, we will not identify you. All

confidential data will be kept securely in a cabinet, electronic records will be stored in a password protected, secure cloud-based storage system. All data will be kept for 36 months from the end of the study and destroyed after that time by shredding, and by deleting the files in the cloud-based storage system.

Will there be any Audio or Video Recording?

This research study involves audio recording. This recording will be available to the researcher, the Institutional Review Board and other representatives of this institution. The recording will be kept, stored, and destroyed as stated in the section above. Because what is in the recording could be used to find out that it is you, it is not possible to be sure that the recording will always be kept confidential. The researcher will try to keep anyone not working on the research from listening to or viewing the recording.

Whom can I contact if I have questions, concerns, comments, or complaints?

If you have questions now, feel free to ask us. If you have more questions about the research, your research rights, or have a research-related injury, please contact:

Primary contact:
Jareau Almeyda, B.A., MBA can be reached at 917-856-2592

If primary is not available, contact:
Martha M. Snyder, Ph.D. can be reached at 305-799-5662

Research Participants Rights
For questions/concerns regarding your research rights, please contact:

Institutional Review Board
Nova Southeastern University
(954) 262-5369 / Toll Free: 1-866-499-0790
IRB@nova.edu

You may also visit the NSU IRB website at www.nova.edu/irb/information-for-research-participants for further information regarding your rights as a research participant.

All space below was intentionally left blank.

College of Computing and Engineering
NOVA SOUTHEASTERN UNIVERSITY | NSU Florida

Research Consent & Authorization Signature Section

Voluntary Participation - You are not required to participate in this study. In the event you do participate, you may leave this research study at any time. If you leave this research study before it is completed, there will be no penalty to you, and you will not lose any benefits to which you are entitled.

If you agree to participate in this research study, sign this section. You will be given a signed copy of this form to keep. You do not waive any of your legal rights by signing this form.

SIGN THIS FORM ONLY IF THE STATEMENTS LISTED BELOW ARE TRUE:

- You have read the above information.
- Your questions have been answered to your satisfaction about the research.

Parental/Guardian or Legally Authorized Representative (LAR) Signature Section

I am voluntarily giving my consent for another person to participate in this study because I believe this person would want to take part if able to make the decision and I believe it is in this person's best interest.

*Person giving Consent must select whether they are a Parent/Guardian or a LAR

Printed Name of Participant	Signature of Participant, indicating Assent for Adults and Children over the age of 13	Date

Appendix K

Pre and Post COVID-19 Research Methodology Comparison Matrix

A side-by-side comparison of all methodological elements contained in chapter 3 and how they were each affected, or not, by COVID-19.

Methodological Element			Pre COVID-19	Post COVID-19
Research Paradigm			Interpretivist.	No change.
Philosophical Rational			Interpretive hermeneutic phenomenology from the perspective of social constructivism.	No change.
Theoretical Framework			Cognitive evaluation theory, motivational design theory.	No longer applicable.
Methodological Approach			Abductive reasoning.	No change.
Research Method				
	Type of Investigation		Qualitative description.	No change.
	Researcher's Stance		Subjectivism	No change.
	Extent of Researcher Interference		Guest speaker in the classroom.	Minimal. Primary data collected via self-administered questionnaire.
	Study Setting		Non-contrived setting in a high school classroom.	Non-contrived, participants responded to an online questionnaire from the location of their choosing.
	Research Strategy		Case study.	No change.
		Case Description	Explore how an authentic, hands-on introduction to project management within a computing context affects awareness of and interest in computing careers.	Explore what insights teachers can provide from their first-hand experience with an unforeseen and widespread disruption of their teaching environment.
		Case Selection	Selected because of researchers' familiarity with Project Management in information systems, and for its potential to positively affect change in the technology industry and in students' lives.	The case was selected for its contextual importance and relevance.
		Type of Case Study	Single, holistic, representative case.	Single, holistic, revelatory case.
		Binding the Case:		

			by Place and Time	A high school classroom setting, in Palm Beach County, Florida during the 2019-20 school year.	Participants responded to a questionnaire from the location and time of their choosing in a non-contrived manner.
			by Time and Activity	A six-session, lock-step curriculum.	Participants were allotted seven days to submit their responses.
			Definitions of Terms, Delineating Context	Technical terms used in the curriculum were accompanied by written definitions.	No technical or specialized terms were used in the questionnaire and context was clearly identified.
		Participants and Sampling		Purposive sample: female students in Palm Beach County, Florida high school.	Purposive sample: STEM teachers at the same school.
		Time Horizon		Cross-sectional Trend.	Cross-sectional.
		Unit of Analysis		A group.	No change.
Conceptual Framework				Belongingness, intrinsic motivation, and interest.	Preconceptions do not drive the research.
Research Strategies & Procedures					
	Description & Limitations			A lesson plan for students was adopted from PMI and modified to focus on information systems and fit within six face-to-face sessions.	A computer-based questionnaire was sent to fifteen participants, free-text data was collected anonymously over a seven-day period.
	Instrumentation			Interview data, reflexive journaling	A ten-item, self-administered questionnaire.
		Proposition 1		Social and cultural depictions that defy negative socially held communal ascriptions towards women in the technology industry should increase girls' interest in participating in the computing-related talent development pipeline.	Increased school or district involvement in the technology aspect – software, hardware, internet connectivity, and accessibility – of the education process should increase the overall success of the online education environment.

		Proposition 2	A workshop lead by a positive role model, who also embodies the real-world success that is possible in the technology industry, should positively influence girls' attitudes towards computing-related disciplines.	Well prepared instructors could positively affect the transition to a virtual leaning environment.
		Proposition 3	An increased understanding of the many types of jobs available in the technology industry should encourage female students to consider computing-related fields as a viable career option.	No longer applicable.
		Issue 1	The participant cohort may have various levels of familial, academic, or social exposure to computing.	The participant cohort may have varying levels of emotional ties to their work, their students, or how the nation, the school district, or their school handled the response to the pandemic.
		Issue 2	The participant cohort may have various English language skills levels–oral, written, audible and reading comprehension–vis-à-vis computing-related jargon.	The participant cohort may possess different levels of prior computing skills, internet connectivity speeds, or have access to different software or hardware.
		Issue 3	The participant cohort may have varying degrees of key intrinsic personality traits, known as the five-factor model: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience.	The participant cohort may have had varying amounts of their work – including materials and processes – in digital form prior to the shift to a virtual teaching environment.
	Ethical Considerations		IRB exception granted.	No change.
	Data Collection			
		Interviews	Fifteen semi-structured interview questions, recorded audio responses were to be transcribed.	Data from the questionnaire was collected in tabular (Microsoft Excel) form.

		Reflexive journaling	Post-workshop notes were collected.	No longer applicable.
		Statement of Informed Consent	The standard NSU Social Behavioral Template for Parent/Guardian or Legally Authorized Representative Informed Consent and Adolescent Assent Form.	No longer applicable.
	Data Analysis		Data reduction, data display, and conclusion drawing guided by Yin's (2017) data analysis techniques: pattern matching, explanation building, time-series analysis, and logic models.	Descriptive analysis, Machine learning-based psycholinguistics analysis, and content analysis.
	Presentation of Results		Linear-analytic report writing, descriptive reporting style.	No change.
	Resource Requirements		Personal computer, word-processing, spreadsheet, data analysis, and data visualization software; and, access to university library networks and its resources.	No change.

Appendix L

Questionnaire: The Classroom Transition from Traditional to Online

Ten questions administered to thirteen teachers asking for their experience during the transition from traditional to online classes at the onset of the COVID-19 pandemic

1. How well were you personally prepared to change from the traditional to the online environment? Why or why not?
2. How well do you believe students were prepared to change from the traditional to the online environment? Why or why not?
3. What was necessary for you to do in order to actually make the transition?
4. How successful do you think you and your students were after changing to the online environment?
5. What would you do differently if we start next school year in an online environment?
6. What would help you teach better in an online environment? This includes both training, equipment needed, etc.
7. What do students need to be successful in an online learning environment? This includes equipment needed, training, etc. Please provide suggestions and examples.
8. How should administrators be better prepared to manage an online learning environment?
9. Do you feel that teachers in the STEM fields face obstacles that might not be an issue for teachers in other disciplines?
10. Do you have any other comments, questions or concerns?

Appendix M

Workshop Site Approval Letter

SITE APPROVAL LETTER

Nova Southeastern University
3301 College Avenue
Fort Lauderdale, FL 33314-7796

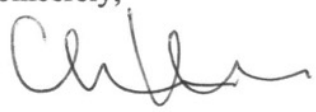
Subject: Site Approval Letter

To whom it may concern:

This letter acknowledges that I have received and reviewed a request by *Jareau Almeyda* to conduct a research project entitled *"Introducing High School Females to Computing Careers through Information Systems Project Management"* at Forest Hill Community High School, 6901 Parker Ave, West Palm Beach, FL 33405, and I approve of this research to be conducted at our facility.

When the researcher receives approval for his research project from the Nova Southeastern University's Institutional Review Board/NSU IRB, I agree to provide access for the approved research project. If we have any concerns or need additional information, we will contact the Nova Southeastern University's IRB at (954) 262-5369 or irb@nova.edu.

Sincerely,



Christine Williams
Science Faculty - Forest Hill Community High School
(561)-540-3025
christine.williams.1@palmbeachschools.org

Appendix N

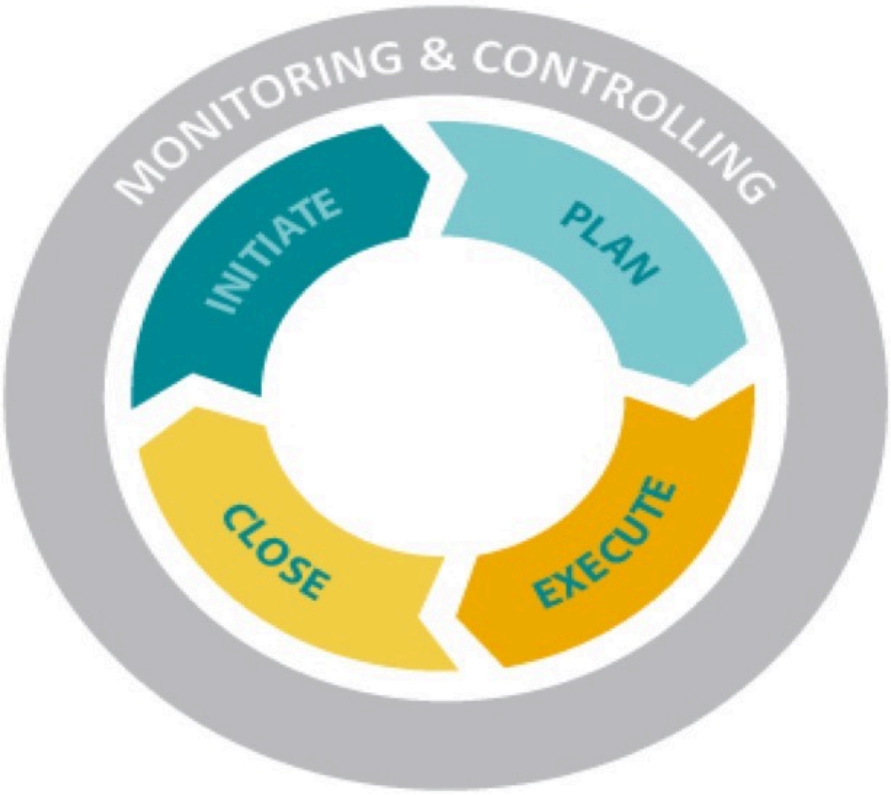
The Project Cycle

An Introduction to
Project Management
The Project Cycle

The Project Cycle

Every project goes through a multi-phased cycle which includes:

Initiating, **Planning**, **Executing**, **Closing**, and **Monitoring & Controlling**



In more basic terms, a project consists of these phases:

- **Defining**
- **Planning**
- **Doing**
- **Closing**
- **Monitoring & Controlling**

Initiating

The Initiating Phase, or Defining Phase is the first part of every project cycle. Getting a project underway can be very simple or very complex, depending who is involved, what the end goal is and what people expect. The Initiating phase give us the opportunity to define what we need in order to reach our goal, and also set boundaries. This helps ensure that the size and shape of the project are all understood and agreed upon by everyone before beginning work.

Planning

Planning is critically important because the amount of time and energy dedicated to planning directly helps the project stay on schedule and on budget, and avoid unnecessary risks.

Executing

Executing, or Doing, is the core of the project. A successful execution phase, that is, successfully doing the project, depends on having a well-defined project and an achievable project plan.

Closing

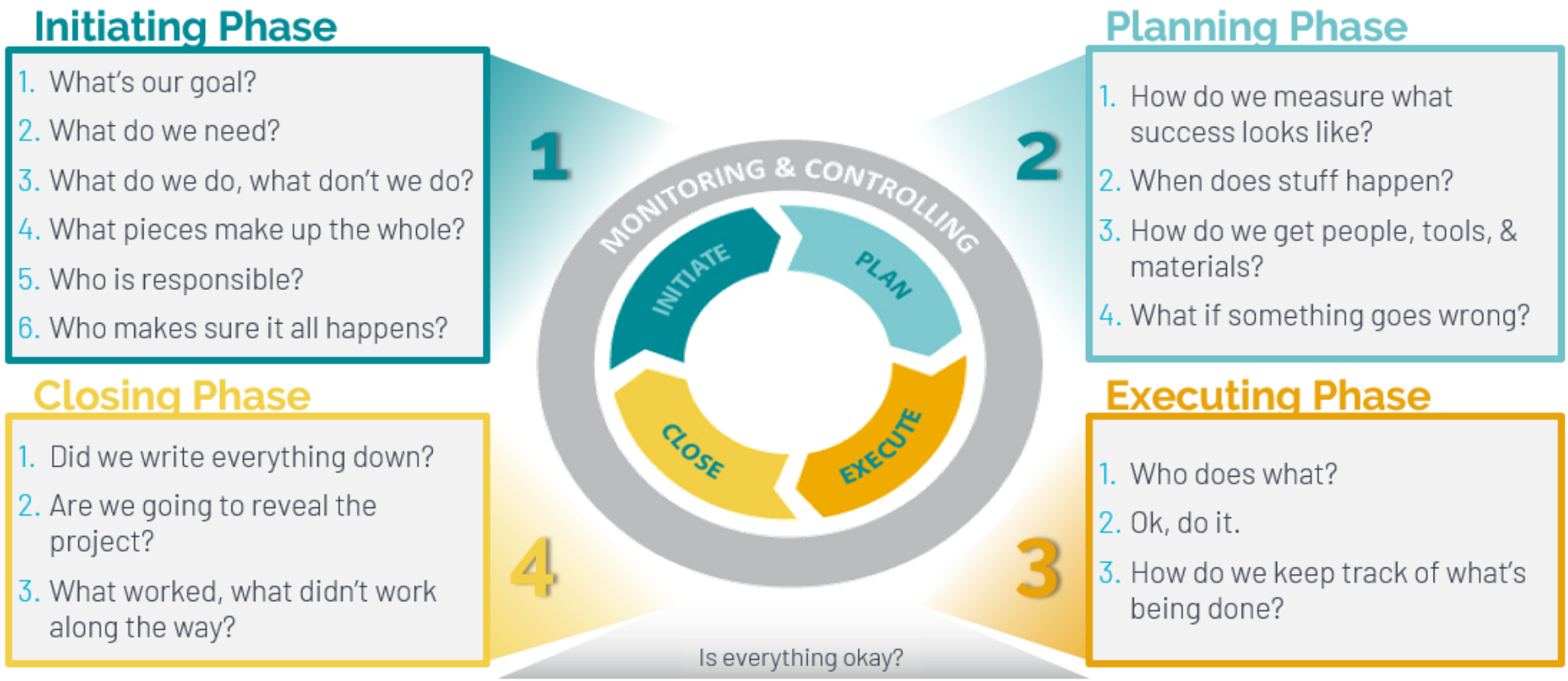
The last step in every project is the closing phase. The closing phase gives us the opportunity to look at the quality of the project that was delivered, how well processes we used worked, and effectiveness of the teams. It is also the time to document lessons learned, and archive information.

Monitoring & Controlling

The Monitoring and Controlling phase is a required phase that helps track, review, and regulate the progress and performance of the project. It helps identify changes to the plan, and helps those changes happen properly. Monitoring and controlling is a continuous phase that happens concurrently with the other four project phases.

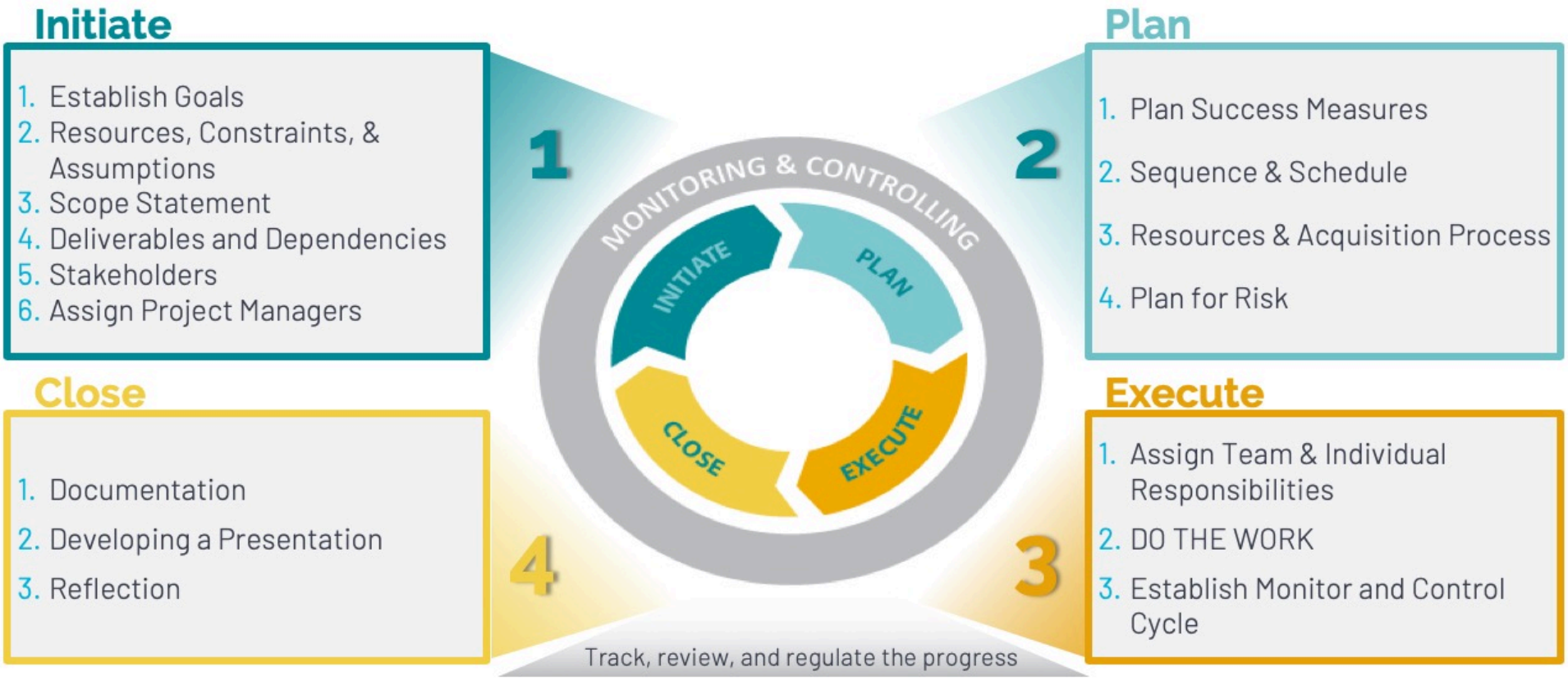
The Project Cycle

and the questions that each phase answers:



The Project Cycle

and the steps of each phase:



Appendix O

Glossary – Initiating Phase

An Introduction to

Project Management

Glossary – Initiating Phase

Initiating Phase

Term	Definition
Assumptions	The elements that are known to be true about the project before the project begins.
Constraints	Things that limit what can be accomplished in the course of the project.
Deliverables	Deliverables are the end product or products of the project. If a project has one very specific goal, it may only have one deliverable.
Deliverables, Concurrent	In some projects, it will be possible to work on two or more deliverables at the same time (in parallel). There can be both sequential and concurrent deliverables within any one project. See also: Deliverable, Sequential.
Deliverables, Sequential	Sometimes one deliverable cannot begin until a previous deliverable is complete; these are sequential dependencies. There can be both sequential and concurrent deliverables within any one project. See also: Deliverable, Concurrent.
Dependencies	Dependencies describe the relationships between two or more deliverables, and how they interact with each other.
Goals	Goals explain what will be achieved by the end of the project, answering the question, "How do I know when I'm done?" Goals should clearly state, at a high level, what the project will deliver. Goals are measurable and observable outcomes.
Initiate a Project	Initiation is the first part of every project cycle—the point at which a project is defined. Defining a project is the opportunity to identify who is involved, what the end product will be, what the end user can expect and other considerations. See also Planning Phase**,** Executing Phase, Closing Phase, and Project Cycle.
Monitor and Control	This part of the project cycle is an ongoing check-in on both the process itself as well as the progress toward the end goal. Every step of the Project Cycle includes Monitor and Control processes.
PMBOK	The Project Management Body of Knowledge is a book containing standard terminology and guidelines (a body of knowledge) for project management. (Pronounced PIM-bock)
Project Plan	This document can be used as the backbone of any class project. It walks users through the steps of Initiating, Planning, Executing, and Closing, and can be included in the final portfolio. It is customizable,

	so each project can be tracked and managed appropriately. See also: Project Cycle.
Resources	All of the things that are available to be used to achieve your project goals, which may include money, people's time, or goods and services.
Scope Statement	This is a written description that establishes project boundaries, both for what the project will do and just as importantly what it will not do. See also: Initiating Phase.
Scope Creep	This is when small changes are made while the project is underway, potentially taking the project off track
Stakeholders	The people that have an interest in your project and its goals.

Appendix P

Project Plan Worksheet – Initiating Phase (blank)

An Introduction to

Project Management

Project Plan Worksheet – Initiating Phase

(blank)

Project Plan: Initiating Phase

Project Name	
Team Member Name	

Step One: Establish Goals

Each project begins with a question, issue, problem, or perspective that drives the project. This is sometimes called the Essential or Guiding Question.

What is the question, problem, or issue that is driving this project?	

Goals
Describe your measurable or observable goals for the project's end result.

Step Two: Identify Resources, Constraints, and Assumptions

Identify and describe the resources, constraints, and assumptions associated to your goals. Categories can include people, technology, time, money or other general topics. Each line item should be marked as either a (R)esource, or a (C)onstraint, or an (A)ssumption.

Category	R	C	A	Description

Step Three: Create a Scope statement

For the goals listed above, identify and describe what is within scope, and what is out of scope for the project to be successfully delivered.

Related Goal from Step One, above	within the scope of the project

Related Goal from Step One, above	not within the scope of the project

Step Four: Identify Deliverables and Dependencies

Clearly identify and number each deliverable. Categorize each as either as something learned, something delivered, or as part of the process. Note dependencies, if any.

Deliverable #	Deliverable	Learning Gain, End Product, or Project Process?	Dependencies

Step Five: Name Stakeholders

Identify all stakeholders, their stake in the project, and associate them to all deliverables.

Deliverable #s	Stakeholder	Stake in Project	Notes

Step Six: Assign Project Managers

Identify the manager roles needed for this project, name who will assume each role, and assign deliverables to them.

Manager Title	Who	Responsible for Deliverables

Monitoring and Controlling

Every part of the Initiating Phase informs the other parts. For example, as you identify resources, you may need to revise your goals, or, as you consider constraints, you may need to add someone else to your stakeholder list. Properly defining a project from the outset will help you keep track of all the details and identify which decisions may have an impact on other parts of your plan.

Monitoring and controlling is the process where routinely circle back to check your prior steps. By going back often, you'll check-in on both the process itself (to make sure everything is taken care of) as well as the progress the teams are making towards the end goal (to make sure the project is on schedule).

Appendix Q

Project Plan Worksheet – Initiating Phase (sample data)

An Introduction to

Project Management

Project Plan Worksheet – Initiating Phase

(sample)

Project Plan: Initiating Phase

Project Name	*Rosie 2.0*
Team Member Name	*Sansa Sharp*

Step One: Establish Goals

Each project begins with a question, issue, problem, or perspective that drives the project. This is sometimes called the Essential or Guiding Question.

What is the question, problem, or issue that is driving this project?	*Too few women have jobs in information systems.*

Goals
Describe your measurable or observable goals for the project's end result.

1) Design a great looking website to encourage more women to join the information systems workforce.
2) Craft a compelling story to convey that message.
3) Display great images on the website that support this effort.
4) Launch in early Spring of 2020

Step Two: Identify Resources, Constraints, and Assumptions

Once a general vision of the project has been established, we need to make sure the project goals are realistic and attainable. This can be done by identifying available resources, constraints, and assumptions. Resources, Constraints, and Assumptions can be related to time, money, people, information, your audience or the users of your product, your competition or partners, or, other factors. Budgeting is always a critical component of 'real world' projects.

Identify and describe the resources, constraints, and assumptions associated to your goals. Categories can include people, technology, time, money or other general topics. Each line item should be marked as either a (R)esource, or a (C)onstraint, or an (A)ssumption.

- Resources are all of the things that are available to be used to achieve your goals, which may include money, people's time, or goods and services already on hand.
- Constraints are things that limit what can be done.
- Assumptions are the things that are known to be true about the project

Category	R	C	A	Description
Website Hosting	*x*			*Need a reliable hosting company.*
Web developer	*x*			*Need one*
Database developer			*x*	*Might not need one. Web developer might be able to do it.*
Launch date		*x*		*Website needs to be ready for the start of spring 2020.*
Photography		*x*		*Website needs great photography.*
Writer	*x*			*Need a writer.*

Step Three: Create a Scope statement

The next part of initiating the project is determining the scope of work. This involves establishing boundaries, both for what the project will do and just as importantly what it will not do. One of the biggest challenges in managing a project is avoiding something known as "scope creep," which is where small changes are made while the project is underway, and suddenly project is off track. Defining the scope of work will establish criteria for monitoring and controlling the project.

For the goals listed above, identify and describe what is within scope, and what is out of scope for the project to be successfully delivered.

Related Goal from Step One, above	within the scope of the project
Website	*Need a single website that works on computers, phones, tablets, etc.*
Content	*English language content*
Photography	*Still images*

Related Goal from Step One, above	not within the scope of the project
Website	*An app*

Content	*Multiple languages*
Content	*Downloadable files*
Photography	*Animations, GIFs, Videos*

Step Four: Identify Deliverables and Dependencies

Deliverables are created through the course of the project, leading to the goal. If a project has one very specific goal, then it may only have one deliverable. Each deliverable is a discrete part of the project that will often have specific resources, schedule, team members, quality measures, and risk management plan.

Some deliverables have dependencies, which means that in order to get a deliverable done, something else may need to be done before it. Some projects may have only one deliverable and therefore no dependencies.

Deliverables can depend on each other in two different ways:

- Sequential: A deliverable must be complete before work on the next one can begin.
- Concurrent: Two or more deliverables can be worked on at the same time.

Clearly identify and number each deliverable. Categorize each as either as something learned, something delivered, or as part of the process. Note dependencies, if any.

Deliverable #	Deliverable	Learning Gain, End Product, or Project Process?	Dependencies
1	*Website Hosting*	*Delivered*	*none*
2	*Website Build*	*Delivered*	*1*
3	*Photography*	*Delivered*	*2*
4	*Content*	*Delivered*	*1,2*

Step Five: Name Stakeholders

Stakeholders are the people that have an interest in your project and its goals. That interest could be financial. i.e. they paid for the project. Or, the interest could be utility. i.e. they will use what is created.

Identify all stakeholders, their stake in the project, and associate them to all deliverables.

Deliverable #s	Stakeholder	Stake in Project	Notes
1	*Olenna Tucker*	*Financial*	*Approves all funding*
2,3,4	*Margaery Thompson*	*Marketing*	*Responsible for all public facing text and imagery*

3,4	*Brienne Troy*	*Legal*	*Approves all public facing text and imagery*
2	*Elia Miles*	*Technology*	*Responsible for website security and operation*

Step Six: Assign Project Managers

- In the business world, the project's managers are usually assigned before the project is underway so they can lead the initiating and planning phases.
- Every project needs managers—people who lead the process. Managers may be a management team or assigned within groups. The Project Manager is responsible for helping the project stay within the scope, reporting to the stakeholders, and presenting a regular project update to the larger group.

Identify the manager roles needed for this project, name who will assume each role, and assign deliverables to them.

Manager Title	Who	Responsible for Deliverables
Time Manager	*Peggy*	*1,2,3,4*
Quality & Risk Manager	*Peggy*	*2,3,4*
Communication Manager	*Angelica*	*1,2,3,4*
Project Manager	*Eliza*	*1,2,3,4*

Monitoring and Controlling

Every part of the Initiating Phase informs the other parts. For example, as you identify resources, you may need to revise your goals, or, as you consider constraints, you may need to add someone else to your stakeholder list. Properly defining a project from the outset will help you keep track of all the details and identify which decisions may have an impact on other parts of your plan.

Monitoring and controlling is the process where routinely circle back to check your prior steps. By going back often, you'll check-in on both the process itself (to make sure everything is taken care of) as well as the progress the teams are making towards the end goal (to make sure the project is on schedule).

Appendix R

Psycholinguistics Analysis: Tone Definitions

The definitions provided by IBM for the seven emotional and language tones derived by Watson's machine learning service.

Tone Definitions

Tone	Tone Type	Definition
Analytical	Language Tone	An analytical tone indicates a person's reasoning and analytical attitude about things. An analytical person might be perceived as intellectual, rational, systematic, emotionless, or impersonal. (A language tone.)
Anger	Emotional Tone	Anger is evoked due to injustice, conflict, humiliation, negligence, or betrayal. If anger is active, the individual attacks the target, verbally or physically. If anger is passive, the person silently sulks and feels tension and hostility. (An emotional tone.)
Confident	Language Tone	A confident tone indicates a person's degree of certainty. A confident person might be perceived as assured, collected, hopeful, or egotistical. (A language tone.)
Fear	Emotional Tone	Fear is a response to impending danger. It is a survival mechanism that is triggered as a reaction to some negative stimulus. Fear can be a mild caution or an extreme phobia. (An emotional tone.)
Joy	Emotional Tone	Joy (or happiness) has shades of enjoyment, satisfaction, and pleasure. Joy brings a sense of well-being, inner peace, love, safety, and contentment. (An emotional tone.)
Sadness	Emotional Tone	Sadness indicates a feeling of loss and disadvantage. When a person is quiet, less energetic, and withdrawn, it can be inferred that they feel sadness. (An emotional tone.)
Tentative	Language Tone	A tentative tone indicates a person's degree of inhibition. A tentative person might be perceived as questionable, doubtful, or debatable. (A language tone.)

Appendix S

Descriptive Analysis of Sentences in the Questionnaire Data

Various descriptive statistical values calculated during the analysis of sentences from the questionnaire data.

Descriptive Analysis of Sentences in the Questionnaire Data

Sentences	Value
Total number of sentences in all responses	235
Mean number of sentences in a response	1.84
Skewness value	1.94
Skewness label	High Positive
Kurtosis value	5.04
Kurtosis label	Leptokurtic
Min number of sentences in a response	0
Max number of sentences in a response	7
Mode of sentences in a response	1
Range of sentences in a response	7

Note. To calculate the mean number of sentences in a response, the total number of sentences in all responses was divided by the number of non-blank responses.

All skewness values less than -1 were labeled as High Negative, values between -0.5 and -1 were labeled as Moderate Negative, values between 0.5 and -0.5 were labeled as Symmetrical, values between 0.5 and 1 were labeled as Moderate Positive, and values greater than 1 were labeled as High Positive. Kurtosis values less than 3 were labeled as Platykurtic, values that equaled 3 were labeled Mesokurtic, and values greater than 3 were labeled as Leptokurtic. It is worth noting, kurtosis values were rounded to the nearest whole number in order to produce the Excel formula-based labeling.

Appendix T

Descriptive Analysis of Words in the Questionnaire Data

Various descriptive statistical values calculated during the analysis of words from the questionnaire data.

Descriptive Analysis of Words in the Questionnaire Data

Words	Value
Total number of words in all responses	3,212
Mean number of words in a response	25.09
Mean number of words in a sentence	13.67
Skewness value in responses	0.94
Skewness label in responses	Moderate Positive
Kurtosis value in responses	0.97
Kurtosis label in responses	Platykurtic
Skewness value in sentences	0.99
Skewness label in sentences	Moderate Positive
Kurtosis value in sentences	1.89
Kurtosis label in sentences	Platykurtic
Min number of words in a response	0
Min number of words in a sentence	0
Max number of words in a response	89
Max number of words in a sentence	50
Mode of words in a response	0
Mode of words in a sentence	8
Range of words in a response	89
Range of words in a sentence	50

Appendix U

Descriptive Analysis of Characters in the Questionnaire Data

Various descriptive statistical values calculated during the analysis of characters from the questionnaire data.

Descriptive Analysis of Characters in the Questionnaire Data

Characters	Value
Total number of characters in all responses	17,930
Mean number of characters in a response	140.08
Mean number of characters in a sentence	75.86
Skewness value in responses	0.88
Skewness label in responses	Moderate Positive
Kurtosis value in responses	0.96
Kurtosis label in responses	Platykurtic
Skewness value in sentences	0.92
Skewness label in sentences	Moderate Positive
Kurtosis value in sentences	2.01
Kurtosis label in sentences	Platykurtic
Min number of characters in a response	0
Min number of characters in a sentence	0
Max number of characters in a response	490
Max number of characters in a sentence	293
Mode of characters in a response	2
Mode of characters in a sentence	65
Range of characters in a response	490
Range of characters in a sentence	293

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