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By: Jewel Altimus

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Fostering Computer Science Career Interest in Fifth-Grade Students Jewel Altimus ABSTRACT Computer Science (CS) is among the fastest-growing fields. To fill the abundance of positions in Computer Science, early learning experiences should be implemented to promote interest in the field. This research aims to observe the impact of a design-based computer science treatment on 5th-grade students' interest in computer science careers. The treatment consisted of nine one-hour lessons in which the researcher introduced computer science content to students. At the end of the treatment, participants developed an application to study for a state-wide science assessment. To measure a change in students' career interests following the treatment,

an adapted version of the STEM Career Interest Survey (STEM- CIS

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), grounded by Social Cognitive Career Theory (SCCT), was implemented using a pre-survey-post-survey design.

Qualitative data was collected using focus groups to explain quantitative findings

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further. The samples' post-survey (39.62) mean was greater than the pre-survey mean (37.17), but the paired t-test was just above the statistical significance level of 0.05, $t(28) = -2.04$, $p = .051$. There was a statistically significant increase for the survey items that align with the SCCT aspects Interest ($t(30) = -2.30$, $p = .028$) and Contextual Support ($t(30) = -2.25$, $p = .032$). The researcher identified several themes related to a positive perception toward the treatment and computer science and general during qualitative data analysis. These findings indicate a design-based computer science treatment can increase 5th-grade students' interest in computer science careers. Keywords: Computer Science Education, Career Interest, Design-Based Learning, STEM Education, Elementary Education, Social Cognitive Career Theory Fostering Computer Science Career Interest in Fifth-Grade Students Jewel Altimus GENERAL AUDIENCE ABSTRACT Learning experiences influence an individual's career development. This dissertation observes the impact of a design-based computer science project in a 5th-grade classroom. The researcher implemented a pre-survey-post-survey design to measure change following the treatment. The researcher calculated the difference between survey means and ran a matched paired t-test to determine the statistical significance.

survey items that aligned with interest and contextual support had a statistically significant increase following the treatment. Additionally, the researcher conducted focus groups to collect qualitative data to explain quantitative findings further. Content analysis of the qualitative data revealed participants had a positive perception of the treatment and computer science in general. These results imply that a design-based computer science treatment can increase 5th-grade students' interest in computer science careers. Keywords: Computer Science Education, Career Interest, Design-Based Learning, STEM Education, Elementary Education, Social Cognitive Career Theory

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vii CHAPTER ONE: INTRODUCTION

How can the demands of the labor force be adequately met now and in the future? In the United States, computer-related occupations are among

the fastest-growing occupations. The U.S. Bureau of Labor Statistics (2020a) projects rapid growth

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in computer-related occupations, including software developers, within the upcoming decade. Recent Bureau of Labor Statistics projections predict computer and mathematical fields to increase 14.1%

from 2020 to 2030 (U.S. Bureau of Labor Statistics, 2021

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). With an upcoming influx of computer-related jobs, the need for an adequately prepared workforce to fill and succeed in these positions is more significant than ever. High-quality early learning experiences can help meet future workforce demands, but is our current education system doing so effectively? Do current computer science education initiatives effectively foster students’ interest in pursuing careers in computer science? Is computer science instruction successfully making students aware of employment in the field? The key to meeting workforce demands through computer science education is to improve accessibility for all students, address barriers preventing students from participating, and foster students’ interest in computer science so that students desire to pursue careers in the field. Problem Statement There is a need to increase those interested in pursuing careers in computer science. High-quality computer science education can help achieve this goal. Positive learning experiences in computer science can help combat negative stereotypes, diminish participation barriers, and foster an interest in the field (Graham & Latulipe, 2003; Bers et al., 2019; Lambic et al., 2020). Further research into computer science instruction’s impact on fostering elementary students’ interest in computer science is necessary to ensure education appropriately prepares students to meet workforce demands. More specifically, a study investigating the impact of a design-based computer science treatment on 5th-grade students’ interests in computer science. Justification This section will further justify the variables used in the problem statement above, computer programming, design-based learning, and 5th-grade students’ career interests. Aside from the variables in the problem statement, several other concepts are relevant to this research problem. For instance, many factors, such as positive

learning experiences, outcome expectations, and self-efficacy beliefs, affect students' career interest development. A deeper dive into the research on these concepts is to follow. Computer Programming In 2017, Virginia adopted Computer Science Standards of Learning, detailing computer science-related content and understanding students should develop from kindergarten through 12th grade. The Virginia SOL states that by 5th grade, students will design, construct and debug programs with sequences, loops, and conditionals to complete tasks. (VDOE, 2017). Technological advancements have made ways of delivering computer science education more accessible. There is a wide variety of online applications for learning how to program, to aid students and educators in developing students' computer programming skills and understanding. These learning applications often utilize block-based or text-based coding languages to teach students how to program. These applications also commonly use game and app development to engage and motivate students to learn how to program. The researcher made the decision to study the effect of a computer programming intervention on students' computer science interests based on simplicity and accessibility. Although computer programming does not capture the whole field of computer science, it is more manageable to study a component of computer science rather than the field as a whole. Ability-appropriate applications for learning computer programming are also easily accessible for students and educators through websites such as code.org. Although computer programming is a small aspect of computer science, using the Virginia Computer Science SOLs as a guide, computer programming instruction can cover most of the computer science competencies students should possess by the 5th grade. Design-Based Learning Accompanying a program learning application, utilizing a design-based learning (DBL) approach can address misconceptions about computer science by allowing students to participate in an authentic learning experience. Design-based learning is an approach that engages students in the engineering design process through authentic design challenges (Wells, 2013). Although effective in promoting engagement in engineering, there is limited research on implementing this approach in the context of learning computer science. Utilizing a DBL approach in computer science will allow students to assume the role of a computer scientist, providing an authentic experience of what an actual computer scientist does. This approach can be beneficial for increasing student engagement, challenging harmful stereotypes, and providing relevant career awareness. Career Interest and Awareness Prior fundamental research by Trice and McClellan (1993) and Seligman, Weinstock, and Heflin (1991) supports the decision to study the impact on 5th-grade students' interest by providing evidence that connects late childhood career aspirations to future occupations attained. In Trice and McClellan's (1993) 15-year longitudinal study of 273 participants, over half of the participants in

the 6-9 age group and 10-13 age group

currently held positions in the general occupational field they had aspired a career in as children. Seligman, Weinstock, and Heflins (1991) specifically studied the career development of 10-year-olds. Analysis of data gathered from interviewing participants revealed that students by age ten often have already developed career aspirations and make academic decisions based on their career goals Seligman, Weinstock, and Heflin, 1991). While Elementary-aged students have several years before entering the workforce, practical career readiness starts with early career awareness and relevant learning opportunities. Early exposure to computer science education can help students develop a lifelong interest in computer

science and learn more efficiently by building upon their prior knowledge (Dougherty, 2013). Positive Learning Experiences To fill the projected influx of computer-related positions, schools must not only prepare students with the skills and understanding necessary to be successful in these positions. However, they must also foster students' interest in pursuing computer-related occupations. To promote an interest in a particular field, students need to have positive learning experiences related to that field. To make instruction more engaging, it should be relevant to students, give them some autonomy, and allow them to experience success (Jones, 2009). Positive educational experiences at the elementary level are vital for students to develop their interests, goals, and career aspirations. If computer science education is unattractive, students may develop a negative perception of computer science. Low-quality computer science experiences may reinforce students' negative preconceptions about the field. These negative experiences can discourage students from pursuing computer science careers in the future. Opportunities to engage in high-quality computer science education can help combat students' negative preconceptions and stereotypes towards computer science. In turn, they are fostering students to develop an appreciation towards the field. Current Research Several studies examine how a specific application for learning computer programming affects Elementary student performance outcomes. Findings across these studies suggest that practicing computer programming at the Elementary level improves students' perceptions of STEM (Meehan, 2019; Tran, 2018). In Mehan's (2019) study, 20 5th-grade students participated in a mathematics course that integrated various online coding platforms. After the intervention, a questionnaire was given to participants to gather information related to the students' math interests. After analyzing the student's responses, the researcher found that coding integration in the mathematics class positively impacted students' perceptions of mathematics (Mehan, 2019). In 2018, Tran studied Elementary students from across 13 classrooms, with a sizeable number of participants belonging to groups underrepresented in computer science. The intervention observed was a programming lesson implemented using a hybrid approach. Students completed coding puzzles during the online portion of the lesson and engaged in a hands-on learning experience during the classroom portion. Students completed a pre-and-post competency assessment and a pre-and post-survey related to their STEM aspirations and beliefs. Analysis of student responses revealed an increase in students' perceptions about the importance of using STEM understandings in their future jobs (Tran, 2018). This study supports using a computer programming intervention to foster positive perceptions towards STEM. This study also provides evidence for using computer programing instruction to promote career awareness and aspirations in STEM. Several studies also examine the impact of a specific computer programming learning application on students' STEM attitudes and understandings (Lambić et al., 2020; Yang & Lin, 2019). In Lambic et al.'s (2020) study, elementary

students ranging in age from 7 to 10 years old participated in

an ability-appropriate coding course provided by code.org. Analysis of the attitude questionnaire, which utilized a five-point Likert scale, revealed that participants in the 9- 10 age range strongly desired to continue learning about computer programming. The research findings of this study support participating in coding activities to improve upper-elementary students' perceptions of STEM and computer science and to foster student interest in computer science. Purpose Statement Although a pivotal time for developing career aspirations, a severe lack of research is relevant to computer

science education and career interests at the elementary level. Several studies examine the impact of computer programming integration on student perceptions of STEM and related career aspirations. However, there is a need for further research on students' computer science career interests.

This study aims to understand **the impact of a** design-based approach **to** computer programming **on**

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elementary students' interest in computer science. A study evaluating this approach to learning computer programming will provide empirical evidence as to its impact on fostering students' interest in pursuing a career in the rapidly growing field of computer science. The data collected from this study will provide evidence that either supports or refutes using a design-based learning approach for fostering students' computer science career interests. Using the results of this study, educators may make better-informed decisions when implementing computer science instruction in their classrooms. On a grander scale, the results of this study can inform computer science curriculum developers to create curricula that better serve students and meet workforce demands. Research Question This study will provide evidence for improving education to meet future workforce demands. The following question will guide this research: How does a design-based computer science treatment impact 5th-grade students' interest in computer science careers? CHAPTER TWO: LITERATURE REVIEW The need to increase those interested in computer science careers is growing. This chapter reviews the literature to understand better the current state of computer science education and career development. In this review, the researcher analyzes several career development theories. The researcher reviewed empirical studies on elementary STEM and computer science, and information relevant to this study is presented. The researcher analyzed the studies to determine the research questions, conceptual framework, methodology, and findings. The research design of this study was constructed using results from the analysis of relevant literature. The conceptual framework that guides this research project is presented at the end of this chapter. Career Development Theories Several theories exist about how and when an individual's career choice comes to fruition. These theories include Parson's (1909) Trait and Factor Theory, Super's (1953) Developmental Self-Concept Theory, Gottfredson's (1981) Theory of Circumscription and Compromise, Holland's (1985) Theory of

Career Choice, and Lent et al.'s (1994) **Social Cognitive Career Theory**

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(SCCT). These theories are commonly used in education and career counseling to guide students' career choice development. Early research on

career development includes **Frank Parson's (1909) Trait and Factor** Theory, **which**

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implies occupations should align with an individual's traits, such as "aptitudes, abilities, interests, ambitions, resources, limitations, and their causes" (p.5). According to Parson (1909), individuals must accurately understand their traits and the labor market to make effective occupational decisions. After having a realistic understanding of these factors, an individual should select an occupation that aligns with their traits. Parson (1909) suggests all individuals should receive career counseling to realize their traits, the needs of the labor market, and the relationship between the two. In his Developmental Self-Concept Theory, Super (1953) proposes a career development model with five distinct

stages: Growth, Exploration, Establishment, Maintenance, and Decline. These stages are

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related to an individual's self-concept, which Super believes changes based on an individual's lived experiences. During the Growth stage, from birth to 14, individuals begin to develop a self-concept. In this stage, individuals develop a general sense of the concept of work, moving from need-based career fantasies to interest-based choices. Super's (1953) career model suggests that between the ages of 11 and 12, individuals' interests begin to influence their career choices. During the second stage, Exploration, individuals aged 15 through 24 begin to develop a realistic self-concept by gathering information through experiences such as class-taking, volunteering, or trying out new hobbies. Individuals explore careers from age 15 to 17 based on their needs, interests, and abilities. During this time, an individual may identify their desired field of work. Individuals specify their career preferences in their early twenties through provisional job trials. By the Establishment stage, between mid-twenties and mid-forties, an individual will settle down and secures a position in their chosen field.

In the Theory of Circumscription and Compromise, Gottfredson (1981) proposes four self -

concept **and occupational**

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preference development stages, presented in Figure 1 (p.547). The stages include "orientation to size and power, orientation to sex roles, orientation to social valuation, and orientation to internal, unique self" (Gottfredson, 1981, p.555). In

the first stage, orientation to size and power , which happens between three and five

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years old, individuals view jobs as being held by grown adults. Between ages six and eight, individuals become aware of career-related gender stereotypes and develop ideas about careers. During the orientation of social values, individuals learn that jobs vary in prestige between the ages of nine and thirteen. In the fourth stage, individuals 14 and older develop career aspirations that align with their interests, values, and abilities. Figure 1 Stages of Theory of Circumscription and Compromise Holland's (1985) Theory of Career Choice suggests that personality type is the most significant factor influencing career choice and job satisfaction, resulting in members of a profession having similar personalities and situational responses. Holland (1985) believes individuals prefer to work positions with colleagues like themselves. To help

individuals better understand their personality type and appropriate career choice, Holland (1997) presented his RIASEC model, defining six different Holland

Types: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. Each type has

associated characteristics and **traits**

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an individual may possess and recommended occupations. Investigative is one of the most prestigious types, in which belonging individuals are critical, analytical, and explorative, and suggested careers include scientists and programmers. Holland developed an explicit model for classifying 17 individuals. Still, a shortcoming of his Theory of Career Choice is a lack of insight into what causes individuals to develop the traits associated with the personality types defined in his model. Bandura’s (1986) Social Cognitive Theory influenced

Social Cognitive Career Theory (SCCT), **proposed by Lent et al. (1994). A** paramount tenet **of**

Social Cognitive Theory **is the** concept **of self-efficacy**

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, or “the belief in one’s capabilities to organize and execute the sources of action required to manage prospective situations” (

Bandura, 1995, p.2). Bandura proposes **that** one’s perceived **self-efficacy is**

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constructed through previous

experiences, vicarious experiences, social persuasion, and physiological factors . According to

Bandura

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, success significantly impacts individuals' perceived self-efficacy, substantially influencing their actions. In their SCCT, Lent et al. (1994) suggest that certain factors influence an individual’s career choice development, strengthening or challenging their career decision process. Three variables: self-efficacy, personal goals, and outcome expectations impact

the development of career interests , choices, **and** performance. **Lent** et al. (**1994**)

proposed **a**

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development model of career interests. Experiences influence

self-efficacy and outcome expectations , leading to **career- related interests and** choices.
Career

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interests strengthen as individuals engage in career- exploration activities that improve their self-efficacy and outcome expectations related to the explored career. After career interests are developed, these interests influence an individual's career-related choices. An individual's choices are substantiated or diminished, depending on their performance. Experiencing success within a field supports an individual's choice by providing positive feedback, while failure may deter an individual from their chosen field. A commonality across the theories mentioned above is the concept of interest. Interest is a critical component in an individual's career choice development. Developing self-concept and self-efficacy are two other recurring concepts across the theories. Researchers agree that individuals create a self-concept, including their interests and abilities, influencing their decision to pursue a career. Positive learning experiences in which individuals may experience success and improve their self-efficacy are necessary for an individual to form an interest. According to Super (1953), between 11 and 12, individuals' interests begin to influence their career choices. By this logic, individuals begin to form their interests before the ages of 11 and 12. This theory supports the need to provide children with career exploration experiences before 14 to help guide their interest formation. Lent et al.'s (1994) theory support using educational experiences to support career interest development. Based on these theories, elementary educators can use classroom instruction to provide their students engaging learning experiences critical to their career development. Although theorists agree that career choice development starts in early childhood, limited studies examine the career development process of elementary-aged participants. There are even fewer specific to STEM careers. Much of the existing career development literature focuses on secondary and post-secondary participants. According to Super (1953), secondary-school individuals use their interests, abilities, and values to explore career options. Individuals who enter post-secondary education use their explorative experiences to develop career preferences. Learning experiences during the elementary years are essential for individuals to develop their career interests and preferences. Self-Efficacy In 1977, Bandura first wrote about

the concept of self-efficacy. Self-efficacy is one's belief in their ability to complete **a** task.
Bandura proposes **that** individuals' **self-efficacy**

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affects everything they do. Self-efficacy is directly related to individual behavior and performance. If individuals have

low self-efficacy in a specific domain , they **are more likely to**

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avoid performing tasks related to that domain. Four different factors influence an individual's self-efficacy. These factors:

states are presented in Figure 2 (Bandura, 1986). Figure 2 Factors Influencing Self-Efficacy Performance accomplishments, or mastery experiences, are the most impactful on an individual's self-efficacy. These include experiences performed directly by the individual. If the individual is successful in the experience, it increases their self-efficacy, whereas being unsuccessful will lower it. Vicarious experience comes from the observation of others. Observing a role model perform a task successfully increases one's self-efficacy related to that task. Self-efficacy can also improve through social persuasions, such as coaching or feedback, from respected figures in an individual's life. The physiological and emotional state an individual is in will impact their self-efficacy. Being in a depressive state can negatively affect one's self-efficacy, whereas a positive condition can increase confidence.

Empirical Studies on Computer Science Instruction This section covers seventeen empirical studies on the impact of computer science integration on elementary-aged participants. The interventions occurred in an elementary school setting, during or after school, or in an informal learning environment. The researcher identified similarities and differences across the studies. Although the research questions differ for each study, similar constructs of interest, conceptual frameworks, and methodologies are used. These studies were used to identify gaps in the literature and inform the methods of this study.

Research Questions Each research question was unique to the studies being conducted, but several common themes emerged. To integrate computer science, many of the studies examined the effects of a specific interface for learning computer science (CS), such as environments for learning to program like Scratch, Hopscotch, A-bricks, and Run Marco (Kalelioglu & Gülbahar, 2014; Wang, 2021; Shim et al., 2016, Giannakoulas & Xinogalos, 2018). Robotics curriculums were also a common way used across the studies to integrate CS (Ching et al., 2019; Sullivan & Bers, 2019a; Noh & Lee, 2019; Sáez-López et al., 2019). In addition to interface-driven studies, several studies investigated the impact of a particular academic approach to implementing computer science. Inquiry-based, problem-based, hybrid, and integrative learning approaches were used across the literature (Playton et al., 2021; Brush et al., 2019; Tran, 2018; Century et al., 2020; Meehan, 2019; Sáez-López et al., 2019). Playton et al. (2021) use an integrative approach by integrating computer science into STEM learning, Sáez-López et al. (2019) integrated computer programming into math and science using robotics, and Meehan (2019) integrated coding during mathematics learning time. Different constructs of interest were observed across the studies. The most common variables investigated across the studies were: students' computer science or STEM interests, perceptions, attitudes, and CS or academic achievement (Giannakoulas & Xinogalos, 2018; Playton et al., 2021; Hur et al., 2017; Wang, 2021; Kalelioglu, & Gülbahar, 2014; Tran, 2018; Bradbury et al., 2019; Sullivan & Bers, 2019a; Shim et al., 2016; Ching

). Critical thinking, computational thinking, problem-solving, and creativity were other standard variables observed in multiple studies (Wong & Cheung, 2020; Sáez-López et al., 2019; Noh & Lee, 2019). A select few also sought to collect data on participants' career aspirations (Tran, 2018; Hur et al., 2017; Andrzejewski & Marghitu, 2017; Playton et al., 2021), and one investigated gender stereotypes related to STEM (Master et al., 2017). Of the research questions analyzed, Tran (2018) and Playton et al.'s (2021) most closely align with the purpose of this study. Tran's (2018) research questions asked, "What are elementary-aged students' attitudes about STEM and career aspirations?" and "What influence does a CS intervention program have on elementary-aged students' attitudes about STEM and career aspirations?" (p. 278). While Playton et al. (2021) used the following questions to guide their study:

1) How does participation in integrated STEM+C learning experiences change students: a. Interest and attitudes towards STEM+C? b. Interest in future STEM+C careers

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? 2) What was the observed levels of engagement and workforce readiness skills among students during inquiry-based learning experiences in integrated STEM+C lessons? (p. 34) Both research questions closely align with this study's purpose, as they seek to assess participants' interests or career aspirations before and after implementing a computer science intervention. By doing this, the researchers may better evaluate the effectiveness of the intervention based on the changes from pre-intervention to post-intervention. Further analysis of the methods and results of Tran's (2018) and Playton et al.'s (2021) studies will help inform the design of a CS treatment intended to promote students' interest in CS. Conceptual Frameworks Although having some similar constructs, the conceptual frameworks vary widely across the studies. Recurring variables defined in the frameworks include self-efficacy (Hur et al., 2017; Tran, 2018), computational thinking (Sáez-López et al., 2019; Tran, 2018; Wong & Cheung, 2020), and 21st-century skills (Kalelioglu & Gulbahar, 2014; Wong & Cheung, 2020). Three studies also discussed stereotypes and how they affect student learning and development (Hur et al., 2017; Master et al., 2017; Sullivan & Bers, 2019a). Several studies used a framework to define the pedagogical approach used in their treatment. These treatments include project-based (Sáez-López

et al., 2019; Ching et al., 2019), inquiry-based (Brush et al., 2019 ; Ching et al., 2019 ; Playton et al

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., 2021), and integrative approaches (Ching et al., 2019; Playton et al., 2021). A study also applied an evaluation model to determine the impact of the treatment used in their research (Giannakoulas and Xinogalos, 2018). Analyzing these conceptual frameworks provides a better understanding of concepts to define in the conceptual framework of this study. Self-efficacy. Hur et al. (2017) investigated girls' experiences, perceptions, and career aspirations, referencing Bandura's (1993) concept of self-efficacy, connecting students' self- efficacy beliefs to their interest in STEM and CS. Tran (2018), who researched programming on students' perceptions and career aspirations, also referenced

self-efficacy and Bandura's (1993) social cognitive theory

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. In Tran's (2018) study, she implements a learning experience where students can apply prior knowledge and make connections to improve their self-efficacy related to STEM tasks. Learning experiences impact students'

self-efficacy or belief in their ability to execute a task

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and influence their interest. 21st Century Skills. Noh and Lee (2019) studied the effect of robotics on elementary students' CT and creativity. They used Wing's (2006) definition of computational thinking and the five components of computational thinking identified

by Selby and Woollard (2013): algorithmic thinking, decomposition, generalization, abstraction
and **evaluation**

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, as a precedent for the design of their treatment displayed in Figure 3 (Noh & Lee, 2019, p.469). Figure 3 Treatment Design Using Five Components of Computational Thinking In Figure 4, Wong and Cheung (2020, p.3) use Brennan and Resnick's (2012)

dimensions of computational thinking: computational concepts, computational practices, and computational perspectives

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to connect

21st-century skills: creativity, critical thinking, and problem-solving

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. They briefly describe each dimension of computational thinking and an example related to computer science learning. Wong and Cheung (2020) also link 21st-century skills students use while developing within each computational dimension. Figure 4 Dimensions of Computational Thinking: Descriptions and Examples In addition to Wong and Cheung (2020), Kalelioglu & Gulbahar (2014) and Meehan (2018) investigated the development of students' 21st-century skills. Kalelioglu & Gulbahar (2014) studied the effects of programming on students' problem-solving skills. They presented research on the importance of learning 21st-century skills and research supporting programming to teach students problem-solving skills

(Ornelas Marques & Marques, 2012). Meehan (2018) examined the effects of coding integration on elementary students' engagement and academic achievement. To support her research, she references prior research that connects coding integration to students' 21st-century skill development (Gresse von Wangenheim et al., 2017). Pedagogical Frameworks. In their study, Wong & Cheung (2020) use a constructionism approach, supported by Papert's (1980) research on using this approach to foster students' computational thinking. Sáez-López et al. (2019) also based their treatment on Papert's (1980) Constructionism, along with Vygotsky's (1978) Constructivism and Ausubel's (1978) theory of meaningful learning. Using these concepts from these theoretical foundations, a student-led, social-learning approach in which students develop meaningful artifacts, Sáez-López et al. (2019) decided to implement a project-based treatment. Ching et al. (2019) also used a project-based framework to integrate STEM learning with robotics. In this approach, teachers act as facilitators of student learning, while student inquiry drives the creation of artifacts (BIE, 2017). Brush et al. (2019), who implemented a problem-based treatment, cited research that supported inquiry-based approaches to improve student engagement, achievement, and CS attitudes (Hoffman et al., 2019). Tran (2018) investigates a computer programming treatment on elementary students' STEM perceptions and career aspirations. She researches the positive relationship between constructivist learning environments and student attitudes and blended-learning approaches to support positive student attitudes, engagement, and motivation (Lou et al., 2012; Kuo et al., 2014). She also presented career development (Gottfredson, 1981; Holland, 1985) and Social psychological research on students' occupational decision-making. Playton et al. (2021) referenced Tran's (2018) research to support their research design. They were interested in studying several variables: engagement, interest, attitudes, and workforce readiness skills. They decided to implement an inquiry-based learning experience; as they work collaboratively, students display workforce readiness skills (Tran, 2018). The authors also use an integrative STEM and computer science (STEM+C) curriculum because research supports integrative approaches to promote students' STEM interests and attitudes (Tran, 2018) Methods Across the studies, both quantitative and qualitative research approaches are used to collect and analyze data from participants, but many of the studies implemented a mixed-methods approach. The researchers decided to implement a specific approach dependent upon the theoretical perspective guiding their study, their research priority, their desired sequence for data collection, and their population. The methods used in each study have their strengths and weaknesses; the researcher will further discuss these methods concerning their appropriateness in this study. Data Collection. To collect quantitative, many of the studies administered questionnaires to participants using a pre-test, post-test design (Brush et al., 2019; Century et al., 2020; Kalelioğlu and Gülbahar, 2014; Meehan, 2019; Noh & Lee, 2019; Shim et al., 2016; Sullivan & Bers, 2019a; Tran, 2018; Wang 2021; Wong & Cheung, 2020). Qualitative data was collected using focus groups, one-on-one interviews, and observations (Bradbury et al., 2019; Brush et al., 2019; Giannakoulas and Xinogalos, 2018; Kalelioğlu and Gülbahar, 2014; Meehan, 2019; Tran, 2018; Wong & Cheung, 2020). The studies most commonly used

a mixed-method approach, combining quantitative and qualitative data collection methods

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. These multi-method approaches include explanatory and exploratory mixed methods and data triangulation using quantitative and qualitative data sources (Ching

et al., 2019 ; Hur et al., 2017 ; Kalelioğlu and Gülbahar, 2014; Playton et al

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., 2021; Sáez-López, 2019; Tran, 2018). Quantitative. Century et al. (2020) implemented an entirely quantitative approach to observe student computer science attitudes and academic achievement. The researchers used a pre-/post-questionnaire with a 6-point scale to assess changes in student attitudes toward computer science after participating in a CS module. The researchers used district and state-wide assessments to identify differences in treatment and comparison group scores to evaluate academic achievement. They used an HLM approach to analyze the data and find associations between intervention to student outcomes.

There was no significant difference between intervention **and** non- **intervention** receiving **groups**

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for all data sources measuring students' academic performance. Qualitative. Bradbury et al. (2019) used a qualitative approach for collecting and analyzing data. The researchers were interested in collecting data from students about their preferences for, and challenges experienced when interacting with two different programming environments. To gather data, they conducted focus groups asking participants questions corresponding to their four research questions. Their first research question was a closed response with two choices; the researchers counted the responses for each option to analyze the corresponding data. The other three questions were open-ended, so the researchers used thematic analysis to identify common themes across participants' responses. Explanatory Mixed-Methods. Kalelioğlu and Gülbahar (2014) used an explanatory sequential mixed methods design, meaning quantitative data were collected and analyzed first, followed by qualitative data. Before and after the intervention, the researchers implemented a Problem-Solving Inventory (PSI) to collect quantitative data on participating students' self- perceived problem-solving skills. Using the PSI data, a paired-samples

t-test was conducted **to determine if there was a** change **from** pre- **to**

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post-test. After analyzing the quantitative data, researcher-led focus groups were performed using a structured interview form to gather qualitative data. Independent-teacher observations were conducted during the intervention using an itemized observation form to collect additional qualitative data on student performance. The researchers transcribed, coded, and identified themes from the interviews. Items performed the least by students were identified using the observation forms.

The results of the t-test revealed **no difference in**

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students’ problem-solving skills from pre- to post-intervention. The focus group interview revealed students’ thoughts about programming, including difficulties experienced, favorite and least favorite aspects, and future aspirations in programming. All the focus group participants expressed wanting to improve their programming skills. During the focus group, a few students stated they found alternative solutions to their problem, and even fewer asked a peer to review their program for any issues (Kalelioğlu & Gülbahar, 2014). This data aligned with the observation data collected while students performed the programming tasks. A strength of using an explanatory mixed-method design

is that the quantitative data analysis provides a general picture of the research problem 24

. The qualitative results further explain the general picture (Creswell, 2012). A weakness of this approach is that it is time-consuming, as both quantitative and qualitative research methods are given equal priority. In Kalelioğlu and Gülbahar’s (2014) study, using an explanatory sequential mixed-method design was effective because the qualitative data provided researchers with better insight into why the quantitative results revealed no difference from pre-to post-test. The researchers could not support their claims about why students’ problem-solving skills were unchanged without qualitative data. Exploratory Mixed-Methods. Unlike the explanatory approach used by Kalelioğlu and Gülbahar (2014), Tran (2018) used an exploratory mixed-methods design. Tran (2018) underwent a qualitative exploration phase to develop appropriate instruments to collect quantitative data. She collected and analyzed quantitative data using a test on computational thinking, 183 paired samples, and a pre-and post-survey about STEM goals, aspirations, and beliefs, 132 paired samples. The researcher worked with the university CS department to develop the computational thinking assessment, and the student attitudes survey was an adaptation of the ASPIRES project questionnaire. Both instruments were pilot tested on third-grade students before the main research project to ensure the instruments were appropriate for elementary-aged participants. During the primary research project, 52 semi-structured student interviews were used to triangulate data further. These interviews allowed for the collection of qualitative data, generating common themes. Data Triangulation. Along with Tran’s (2018) study, four additional studies explicitly mention triangulating data (Hur et al., 2017; Sáez-López, 2019; Playton et al., 2021; Ching

et al ., 2019). In the study conducted by Hur et al . (2017), the researchers used a 67

triangulation-focused, concurrent mixed methods approach. The researchers used three data sets: interviews, pre-, post-, and follow-up surveys, and observation notes. During the qualitative data analysis, codes identified aligned with the guiding research questions. A paired t-test was calculated using survey data to reveal changes in student perceptions. The researchers compared participants’ survey data to their observation notes, and all analyzed data sets were cross-compared to see if the findings supported one another. By using multiple complementary data sources, Hur et al. (2017) expanded on

and better supported their conclusions. Sáez-López et al. (2019) implemented a more complex quasi-experimental approach. They studied three dimensions, programming in science and

mathematics, computational concepts, and robotics and **interactions in the classroom. The**
researchers used multiple **data**

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collection instruments, including pre-and post-tests and participant observations, and data analysis techniques, including calculating t-tests, a scale of estimation, descriptive analysis, and Mann–Whitney U tests. Motivation, interest, and fun were indicators in the “robotics and interactions in the classroom” dimension. These constructs were measured using field observations and further validated using data collected from alternate sources to measure the other dimensions of the study. The researchers used Cohen et al.’s (2000) data triangulation methods using quantitative assessment data. Sáez-López et al. (2019) defended their evaluation methods stating that “The triangulation of data ensures that there is evidence to support the validity of the results and minimum error variance (Goetz and LeCompte 1988)” (p. 1411). While data triangulation can help support the findings of a study, a weakness of Sáez-López et al.’s (2019) study is that it is over-complex and hard for a reader to follow. The researchers used multiple data collection instruments and data analysis methods to study the various variables. Limiting to one or two constructs of interest would make the methods and findings more understandable for the reader. Ching et al. (2019) also used multiple data sources to triangulate data and better understand the variable of interest, students’ STEM attitudes, and perceived learning. Using a pre-and post-test design, the researchers implemented an adapted version of the S-STEM survey to measure students’ STEM attitudes. The researchers collected qualitative data on perceived learning from student focus groups and teacher interviews, and reflections and triangulated using observation notes. The decision to use teacher responses to collect additional data on students’ perceived learning was made considering the potential limitation of student responses due to age and reservedness. Playton et al. (2021) were interested in examining students’ engagement and workforce readiness skills during a STEM+C learning experience and changes in student STEM+C interests and attitudes after the treatment. The researchers used observations, focus groups, and surveys to collect student interest and attitude data. The researchers administered the survey on three occasions;

at the beginning **of the school year** , post-intervention, **and at the end of the school year**

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. The survey was an adapted version of the S-STEM, including a section for computer science and added graphics cues. The researchers used self-reports, observations, and focus groups with graphic cue cards to gather data on student engagement and usage of workforce readiness skills. The researchers added pictorial cues to help young students comprehend the questions. Playton et al.’s (2021, p.34) approach to triangulating their data is displayed in Figure 5. Figure 5 Interest, Attitudes, Engagement, and Workforce Readiness Skills Data Triangulation Data Analysis. Across the studies, the researchers implemented several differing methods for analyzing quantitative and qualitative data. Data analysis methods

should align with the scope of the research. When deciding on an analysis method, a researcher must consider the research design and variables of interest. 32 Quantitative. Along with variables of interest and research design, the researchers must consider data distribution when selecting quantitative analysis methods. Several of the studies reported descriptive statistics, most commonly finding the mean of a data set (

Ching et al., 2019 ; Giannakoulas & Xinogalos, 2018 ; Hur et al ., 2017; Master et al., 2017 44
; Playton et al ., 2021; Saez-Lopez et al ., 2019; Shim et al

., 2016; Sullivan & Bers, 2019a; Wang, 2021; Wong & Cheung, 2020). In some of those studies, descriptive statistics was the only method used to analyze quantitative data, while in others, researchers performed additional statical tests. Besides finding descriptive statistics, matched-pair t-tests were the most common statistical test conducted across the literature (Ching et al., 2019; Hur et al., 2017; Kalelioglu & Gülbahar, 2014; Noh & Lee, 2019; Playton et al., 2021; Saez-Lopez et al., 2019; Tran, 2018). The researchers ran

a matched-pair t-test using pre-test and post-test scores to interpret the 63

intervention's impact or lack thereof. The studies that used paired t-tests examined a range of variables, including problem-solving skills (Kalelioglu & Gülbahar, 2014), computational thinking and creativity (Noh & Lee, 2019), computational thinking and STEM perceptions (Tran, 2018), math and science understanding (Saez-Lopez et al., 2019), perceptions of CS (Hur et al., 2017), STEM attitudes (Ching et al., 2019), and STEM+C attitudes (Playton et al. 2021). Other statistical tests commonly used in the studies were the Mann-Whitney U or Wilcoxon Rank-Sum Test (Saez-Lopez et al., 2019; Sullivan & Bers, 2019a), Wilcoxon signed- rank test (Playton et al., 2021; Sullivan & Bers, 2019a; Wang, 2021), Shapiro-Wilk test (Wang, 2021), independent t-test (Noh & Lee, 2019), ANOVA (Brush

et al., 2019 ; Master et al ., 2017; Sullivan & Bers , 2019a), MANOVA (Master et al 76

., 2017) and ANCOVA (Noh & Lee, 2019). Two other studies, Century et al. (2020) and Meehan (2019) used self-constructed methods for interpreting and analyzing quantitative data. Both studies developed their equations, varying in complexity, for analyzing quantitative data. Qualitative. Across the studies, thematic analysis procedures are commonly implemented to evaluate qualitative data. In thematic analysis, researchers interpret qualitative data to develop themes that describe the data set. (Braun & Clark, 2006). Researchers develop themes that relate to their guiding research questions.

In the studies conducted by Ching **et al** . (2019), Bradbury **et al** . (2019), **and** Tran (2018), **the** 55

researchers explicitly state they used thematic analysis to identify themes from qualitative data. All the researchers transcribed interview data and then analyzed and interpreted the transcriptions to develop themes. Across these three studies, the constructs of interest were STEM perceptions (Tran, 2018), perceptions of different programming environments (Bradbury et al., 2019), and STEM attitudes and perceived learning (Ching et al., 2019). All the above studies sought to investigate student perceptions after a CS intervention. Ching et al. (2019) and Tran (2018) used their themes to organize and present results and added participant quotes to support their findings. Although explicitly stating they conducted a thematic analysis, Bradbury et al. (2019, p. 496) presented their results in the frequency table in Figure 6, displaying themes alongside their number of comments. Frequency tables indicate content analysis, in which quantitative methods are integrated with qualitative ones. Figure 6 Thematic Analysis Comparing Programming Methods In their research, Kalelioglu and Gülbahar (2014) applied content analysis processes to evaluate qualitative data. Like Bradbury et al. (2019), they presented the results of their qualitative analysis in a frequency table. After conducting focus groups, Kalelioglu and Gülbahar (2014) examined

the effects of programming integration **on** 5th-grade students' **problem-solving** skills **and** 28
perceptions **of**

programming. They transcribed the interview data, read it multiple times, and created codes. Using the coded interviews, Kalelioglu and Gülbahar (2014) developed a frequency table using identified themes. Quantitative methods have a subtle influence on content analysis, unlike the approach used by Playton et al. (2021). In their qualitative data analysis, Playton et al. (2021) applied

chi-square analyses of independence to determine the relationship **between the** four **activities** 7
implemented **and the** frequency **of**

the 4Cs (communication, collaboration, critical thinking, and creativity). The researchers used student utterances of the 4Cs during focus groups and observation notes to find the frequency of the 4Cs. Findings. In many studies, the computer science treatment positively impacted students' interest in and attitudes toward STEM or computer science (

Master et al., 2017 ; Playton **et al** ., 2021; Tran, **2018** ; Wang, 2021). Master **et al** 75

.’s (2017) robot treatment increased participants' technology motivation, robotics interest, and self-efficacy more than the control groups. Playton et al. (2021) integrated STEM+C lessons into a 4th-grade classroom and observed increased student interests and positive attitudes towards STEM+C. Wang’s (2021) study found that a programming environment positively impacted students’ attitudes toward programming. Tran's treatment (2018) positively impacted student perceptions of STEM, computer, and engineering career aspirations and understanding of CS constructs. These findings support using computer science learning experiences during elementary to improve students’ interest in STEM and related occupations, which aligns with the purpose of this study. In addition to Tran (2018), other studies positively affected student understanding of computer science or academic concepts (Brush et al.,

2019; Saez-Lopez , 2019). Brush et al. (2019) implemented two treatments, programming lessons and

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a problem-based activity, which positively impacted students' CS understandings. After the robot programming treatment, Saez- Lopez et al. (2019) implemented, students’ mathematical knowledge and computational concepts improved, but science understanding remained unaffected. Students also demonstrated high interest and motivation levels while engaging with the treatment. These studies support programming treatments to increase elementary students' CS and math concept understanding. Across the studies, several other positive impacts related to student learning were observed. After Noh and Lee's (2019) robot programming intervention, students demonstrated a statically significant increase in computational thinking and creativity. Sullivan and Bers (2019a) observed a significant increase in girls reporting they would enjoy being an engineer after participating in a robotics curriculum. Bradbury et al. (2019), who compared paired programming and side-by-side, found that students preferred side-by-side programming because students felt it enabled them to learn more, was more efficient, and provided more autonomy and hands-on experiences. After implementing a robot game environment, Shim et al. (2016) observed positive participant satisfaction and enjoyment of the environment. They also observed an increase in students programming attitudes and understanding of most of the programming concepts assessed. Overall, the findings support elementary computer science implementation to support student learning. While these positive impacts on student learning are promising, unexpected or negative results can help guide future research. Researcher limitations and recommendations can identify areas of improvement for future research. Limited time was a reoccurring limitation across the studies (Ching

et al., 2019 ; Hur et al., 2017 ; Kalelioglu & Gülbahar, 2014 ; Shim et al

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., 2016). In Hur et al.’s (2017) study, the authors proposed the activity implemented was not long enough, so post-intervention, only a small number of participants reported an interest in majoring in CS. Kalelioglu and Gülbahar’s (2014) sought to examine the impact of programming with Scratch on students’ problem-solving skills. After the intervention, there was no significant difference in participants' problem-solving skills and a non-significant increase in students’ self-

confidence in their problem-solving abilities. The researchers suggest the short length of the intervention as a limitation that may have resulted in a lack of change in students' problem-solving skills. Time constraints were identified as a limiting factor in Ching et al.'s (2019) study, and robot building was too difficult for students with no prior experience with robotics. The intervention included 18 90-minute sessions over eight weeks, in which students worked in teams to design, build, and program a robot. Although students' math attitudes improved, there were no changes to students' science and engineering attitudes. Similarly, Shim et al. (2016) interpreted indifference in the concept function as a combination of participants' lack of prior knowledge and the time necessary to fully grasp the concept. These findings provide evidence of the prior knowledge and time required for students to be successful in a computer science treatment. Century et al. (2020) did not observe a significant difference in student attitudes or academic achievement. They identify teacher difficulties implementing the CS modules, inconsistency of scheduling and duration of modules, and student difficulties using the electronic questionnaires as limitations of the study. Computer Science Education Programs Three advocacy groups interested in furthering CS education, the

Code.org Advocacy Coalition, Computer Science Teachers Association (CSTA) , and **Expanding Computing Education Pathways (ECEP)** , have developed the **2021 State of Computer Science Education: Accelerating Action Through Advocacy**

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. In their report, they share policies for improving CS education, including “

Require that all high schools offer computer science; Allow a computer science credit to satisfy a core graduation requirement ; [and] **Allow computer science to satisfy a higher education admission requirement**

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(Code.org, CSTA, & ECEP Alliance, 2021, p. 2). States are continuing to adopt these policies; in 2021, three more states adopted CS as a graduation requirement, and 23 states require high schools to offer CS. Although states are adopting more policies supporting CS education, K-8 CS initiatives are still largely overlooked. The report shares that

30% of K-8 schools across 19 states **offer CS** coursework (**Code.org** , CSTA, & ECEP Alliance, **2021**

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). With K-8 CS initiatives still in their preliminary stages, accessing high-quality CS resources suitable for elementary students is challenging. The commonwealth of Virginia is a leader in CS education initiatives. In 2017, Virginia became

. The Virginia Department of Education (VDOE) website links to instructional resources. These resources include the Computer Science Standards of Learning (2017) and Curriculum Framework (2017) for each grade level. The learning standards present concepts that students should master by each grade level, and the curriculum framework further explains the standards. The curriculum framework also identifies essential questions and vocabulary to guide teachers' lesson development to cover critical understandings needed to master the established standards effectively. The website also includes a document titled: Computer Science Curriculum Alignment, in which recommendations for integrating computer science into the core curriculum are given by presenting grade-level English, Mathematics, Science, and Social Studies standards that educators can connect to the K-8 Computer Science Standards. The VDOE Computer Science web page shares professional organizations educators may look further into, including

Computer Science Teachers Association (CSTA) and Expanding Computer Education Pathways (ECEP) Alliance

. There are also links to code.org and Code VA. Code.org has many resources for engaging students in CS learning. The Code Virginia website site shares resources to improve educators' knowledge of Computer Science and provides registration for teacher training opportunities. External resources on the webpage include CSTA's computer science standards and a K-12 Computer Science Framework written by leaders in computer science education from 14 different states. Although the VDOE website shares a few resources, including guiding documents and links to websites with activities for engaging students in computer science, there are limited resources that provide a complete example of a computer science lesson plan. This lack of resources contradicts the academic subject pages on the VDOE website. For example, the Science page has links to science instructional plans (SIPs) uploaded daily to a resource-sharing website, GoOpenVA.org, and sample enhanced scope and sequence (ESS) lesson plans organized by grade-level and topic that align directly with the 2010 Science SOLs. Access to limited resources may be because computer science education is an emerging content area in K-12 education, specifically in elementary settings. The lack of readily available computer science lesson plans makes it difficult for elementary educators to find and implement effective instruction for promoting computer science learning and career exploration for elementary-aged students. As K-8 CS initiatives progress, additional resources will become available to school districts. Although Virginia does not have a widely accepted program for engaging elementary students in CS and career exploration, several free resources are available online for fostering elementary CS learning. Code.org The website: Code.org is a free educational resource used in several empirical studies to engage elementary students in computer science learning. Code.org offers courses organized by grade level for students to learn how to code. Educational games are also available on the website and may be supplemental activities during computer science instruction. The website also provides curriculum resources for educators integrating computer science into their classrooms. For K-5 educators, the "Computer Science Fundamentals" curriculum is available at no cost (Code.org, 2022).

The website also provides a “Projects” page where students may share and view art, stories, games, websites, apps and other projects created by coding. #GoOpenVA #GoOpenVA provides a platform for teachers to share and borrow resources. The platform also provides a community for educators to interact and collaborate with other professionals. There are several computer science resources available (#GoOpenVA, 2019). Resources can be filtered by grade level, standard, and materials. The available CS resources include unplugged activities, digital activities, and lesson plans integrating computer science into other academic content areas. Unplugged activities are designed to engage students in learning computer science concepts without needing a computer. Digital activities involve computer use and often use online coding platforms such as code.org, scratch, etc. There are also hubs on #GoOpenVA (2019), where groups like school districts can share resources aligned with their common goals. Botetourt

County Public Schools and Virginia Beach City Public Schools are among the school

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districts that have established hubs on #GoOpenVa. Robotics Clubs After-school programs, or clubs, are another way to engage elementary students in CS learning. Robotics clubs allow students to learn computer science through programming and building robots to perform specific tasks. Students can demonstrate what they created at robotics competitions, where teams compete against one another to see which robot performs best. There are a variety of robotics platforms available for elementary robotics clubs to choose from, the most popular being VEX robotics and Lego Mindstorms. Several empirical studies have assessed

the impact of these robotics programs on elementary students’ self-efficacy ,
perceptions, attitudes, and

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STEM competencies (Andic et al., 2015; Barker & Ansorge; Chaudhary

et al., 2016 ; Ribeiro et al ., 2008; Stewardson et al., 2019 ; 2007; Sullivan et al

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., 2019a). There is not a widely accepted tool for assessing the effectiveness of these programs, so many researchers develop or adapt a preexisting instrument. Lego Mindstorm Ribeiro et al., 2008 used observations and student interviews to evaluate the effects of programming Lego Mindstorm on elementary students' CS and academic abilities. Participants successfully programmed robots to perform desire tasked while applying cross-content understandings. Andic et al., 2015 used a 14-question survey to gather data on elementary students’ experience working with Lego Mindstorm. The survey included questions about students’ robotics knowledge and open-ended questions about improving the program. The experience of preparing for a robotics competition increased students' perceived robotics knowledge. All survey respondents rated the robotics competition as excellent and expressed a desire to continue in the robotics field. Barker and

Ansorge (2007) examined the effects of a robotics curriculum, using Lego Mindstorm, on elementary students' science, engineering, and technology (SET) competencies. The researchers developed a pre-test and post-test design instrument to observe changes in participants' understanding of SET concepts before and after the intervention. Barker and Ansorge's (2007) findings support using Lego Mindstorm to teach students mathematics, science, and programming concepts. In Chaudhury et al.'s (2016) study, Lego Mindstorm EV3 was implemented during a summer camp for students aged 7 to 13. The researchers assessed participants' computational and logical thinking skills before and after the robotics intervention. Students played a 14-level, progressively more difficult, Scratch-based game to assess computational thinking. The programming language used to program Lego Mindstorm EV3 is like Scratch. After the robotics curriculum, students were given a letter grade (A to E) corresponding to essential competencies, including computational thinking, programming, project management, and teamwork. The researchers also collected feedback from students about their perceptions of the robotics curriculum. Overall, participants had a positive experience using Lego Mindstorms EV3. Ching et al. (2019) used LEGO Mindstorms and the Life on Mars curriculum to engage 4th through 6th-grade students in programming a robot for a competition. Students took an abbreviated version of the S-STEM before and after the intervention to measure student STEM attitudes. Student focus groups and teacher interviews were used to gather data on perceptions of student learning. Analysis of the S-STEM showed that students' math attitudes increased significantly after participating in the robotics curriculum. Still, there was no difference in student attitudes toward science, technology, and engineering. The qualitative data gathered on students' perceived learning support LEGO Mindstorms to motivate students, foster collaboration, and teach STEM content. VEX Robotics Sullivan and Bers (2019b) investigated student attitudes after participating in a VEX robotics competition. Students had positive perceptions towards participating on their VEX robotics team. Stewardson et al. (2019) piloted an instrument to measure student self-efficacy related to completing tasks necessary for VEX robotics competitions. The researchers observed a positive relationship between students' self-efficacy and prolonged participation in VEX competitions.

Underrepresented Groups in Computer Science Several STEM careers have seen a significant rise in female representation over the last century. However, computer science remains a largely male-dominated field, with less than 22% of computer programmers identifying as women (U.S. Bureau of Labor Statistics, 2020b). In a 2013 study of undergraduates' perceptions of computer scientists, researchers found masculinity, social reclusiveness, and nerdiness common stereotypes associated with computer scientists (Cheryan et al., 2015). These common stereotypes suggest that computer science is catered toward men, discouraging women from pursuing careers in the field. These damaging stereotypes need challenging to increase female interest and representation in computer science. There also exists a lack of racial and ethnic diversity in computer science. In a 2019 employment survey of college graduates, African American and Hispanic responders were disproportionately underrepresented in computer and information science positions (NSF, 2019). In a 2017 study, Black and Hispanic students reported a greater interest in computer science than white students (Wang & Hejazi Moghadam, 2017). Although reporting a more significant interest in computer science, limited access to computers and computer science classes prevented underrepresented racial and ethnic groups from learning computer science (Wang & Hejazi Moghadam, 2017). While initial interest in computer science is influential to meet growing workforce needs, academic interests need fostering to transition into pursuing CS careers. A well-prepared and diverse computer science workforce possesses the capabilities to drive life-altering innovations, shaping the future. However, to meet future workforce demands, an increased emphasis on improving those interested in computer science is necessary. To increase those

interested in pursuing careers in computer science, addressing these barriers preventing underrepresented groups from doing so is vital. Access to high-quality, inclusive K- 12 computer science education across the United States is critical to address the barriers that impede underrepresenting groups from pursuing careers in computer science. Curriculum Treatments Although there is not a widely accepted pedagogy for integrating CS, many studies integrate CS using a multitude of approaches. In their research, Edwin and Prescod (2018) implemented a 10-week career exploration curriculum for 5th-grade students. The students explored college degrees and careers available, and the researchers measured relevant metrics such as student interests and skills. Students created poster boards detailing a job and presented them at a career fair to finish the unit. Playton et al. (2021) observed the impact of a STEM+C learning experience on students' career interests. The intervention implemented in a rural school in central Virginia included four small-group lessons aligned with academic content areas. The treatment had a unit on electricity, moving objects, and animal ecosystems. Robot programming, event sequencing, and video game development integrated with science learning. The researchers used a pre-test/post-test design, observations, and focus groups to gather data. An S-STEM version, adapted to include CS and be accessible to elementary students, was used to collect data on student attitudes toward STEM and students' interest in STEM, related careers, and workforce readiness skills (Playton et al. 2021). Classroom observations and student self-reports were also used to assess student engagement, a construct related to student interest. Tran (2018) implemented a computer program treatment to observe the effect on elementary students' STEM perceptions and career aspirations. The treatment included hybrid lessons involving hands-on CS instruction with online practice. She provided students with coding puzzles from code.org and Unplugged activities. To assess the impact of the treatment on students' computational thinking, they were given a pre-test and post-test created by the research and her associated universities CS department. Participants also completed a survey adapted from the

questionnaire used in the ASPIRES project (Archer et al

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. 2015) to gather data on STEM beliefs and career aspirations. In Peterson's (2020) research on building STEM career interests, she embedded STEM career connections during a 10-day science unit in 5th-grade classrooms. There were three curriculum treatment groups: traditional, scientific inquiry, and design-based treatments. Peterson implemented the county-provided curriculum for the traditional treatment, consisting of PowerPoints and worksheets. For the design-based and inquiry treatments, Peterson integrated opportunities for students to make career connections, such as applying the scientific method to create a lab report or engaging in the engineering design process to develop a solution. To assess the impact of each of the curriculum treatments on students' career interests, Peterson implemented the S-STEM. The S-STEM is an instrument to measure students' career interests, in which students rank their attitudes towards select STEM career areas. Computer science is one of the career areas that the S-STEM covers. Interestingly, in Peterson's (2020) study, students who received the traditional curriculum treatment were more interested (50% reported

interested or very interested) in computer science as a career

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than those who received design-based (47.6%) and inquiry treatments (44.8%) (p. 70). Engineering was the only career area in which the design-based treatment group (76.2%) was significantly more interested than the traditional treatment group (59.4%). She suggests these results are the effect of

a lack of intentional focus on most of the career areas

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and the short time frame. Overall, these treatments positively impacted students’ interest in STEM and CS. Research supports integrating relevant learning experiences to increase students’ interest in STEM and CS careers. The treatments implemented in the studies look promising, but further research on what pedagogy is best for engaging students and fostering their interest in CS is needed. Further research on CS in elementary is necessary so districts can develop and make available a curriculum for promoting student interest in CS. Design-Based Elementary Computer Science Design-based learning (DBL) is the pedagogical approach used in Integrative STEM Education (I-STEM Ed) to integrate mathematics and science concepts with the engineering- design process. In this approach, students apply mathematics and science concepts to design solutions to an identified problem, constructing knowledge along the way (Wells, 2016). This approach is non-linear and iterative, replicating the messy processes that real engineers undergo when designing

innovative solutions to real-world problems. Authentic learning experiences

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, such as real-world problem-solving, are among the most effective in promoting student learning and engagement (Lombardi & Oblinger, 2007). The content should be valuable and relevant to their lives and interests and give students autonomy over what they learn to increase student engagement during DBL (Jones, 2009). The content should also be challenging but still allow students to experience success. Learning opportunities in which students experience success improve student self-efficacy and career interests (Lent et al., 1994;

Wang & Degol, 2013; Wigfield & Eccles, 2000; Wigfield et al

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., 2015). After students complete a CS design challenge, one can anticipate increased interest in CS. In Playton et al.’s (2021) study, the researchers designed an inquiry-based, three-unit STEM+C curriculum. They sought to study the effects of the curriculum on 4th-grade

students' interests and attitudes in STEM +C and students' engagement, workforce readiness skills

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, and understanding of CS careers. The intervention centered on three CS-related activities; design a moving object, circuitry sculpting, and developing video games. The instructor prompted students to create a device to help an animal cross the road for the first activity. Students measured friction, designed a device, and programmed a robot to enter the device. In the second activity, students worked collaboratively to create a playdough sculpture capable of powering lights, then explained the process of creating the sculpture using STEM terminology. In the final activity, students collaboratively selected an animal to research and design a game, including components representing the animal's ecosystem. The results indicate increased science attitudes, perception of math and science performance, and understanding of STEM+C careers. Shim et al. (2016) used a robot game environment with 4th, 5th, and 6th-grade students. In the intervention, participants used an elementary-appropriate programming tool, A-Bricks, to program an educational robot to follow paths on a game board. The programming concepts covered through programming the robot to accomplish specific tasks are displayed in Figure 7 (Shim et al., 2016, p. 167). After completing the treatment, the researchers gathered data on student attitudes and programming concept understanding. The data analysis shows student programming interest, confidence, and value significantly increased from pre- to post- intervention. Analysis of the data also supports using the robot game environment to help students learn programming concepts sequence, repeat, condition and branch, and parameter. Students did not demonstrate growth in understanding the function concept. The researchers suggest this lack of change is due to limited time and prior experience with function and activity. Figure 7 Robot Game Task for Learning Programming Concepts

In Brush et al.'s (2019) study, the researchers piloted an 8-week CS curriculum for 6th- grade students. The curriculum aligned with state CS standards. After a 4-week CS introduction and practice period, on week 5, the instructor prompted students with a problem; "How can we create a culture of kindness in our schools?" (p.112). During weeks 6 and 7, students used Scratch to design an app that addresses the problem. Analysis of quantitative data suggests that the curriculum positively affected students' CS knowledge, including CS concepts and debugging skills. Teacher interview data also indicate the curriculum positively impacted 48 students' engagement with and interest in CS, supported by students asking to explore scratch during free time. In the 5th-grade modules implemented in Century et al.'s (2020) study, students used Scratch and a course in code.org CS Fundamentals to design a solution, given the following prompt: "You work for a blended-learning educational materials publisher. They created games and kits that use hands-on building and computer technologies to teach about a concept. Your team must design a kit that can be sold to families with children in 4th – 6th grade who want to learn more about early explorers and how technological advances in navigational tools, ship building, weather prediction, and climate affected exploration over time." (p. 13). The researchers did not separately evaluate the effectiveness of this module, but they did not mention any modules being too difficult for students. Jun et al. (2017) implemented a design-based CS curriculum for 4th and 6th-grade students. The curriculum followed a computer program developed by MIT, Creative Computing Guidebook (Brennan 2011). It consisted of 12 lessons. The first three lessons introduced participants to Scratch Game Creator and basic programming concepts like sequences and loops. The following three lessons introduced CS concepts; "events, parallel processing, and recombination/reusable skills through storytelling projects" (Jun et al., 2017, p. 46). The lessons continued to cover progressively more difficult CS concepts. Lessons seven through nine covered variables, conditions, calculations, testing, and debugging through game development. Students worked independently during the last three lessons to design and develop a game. The curriculum concluded with student game presentations and peer reflection. Displayed in Figure 8 is the framework they used to guide the DBL portion of the curriculum treatment (Jun

et al., 2017, p. 45). Students that engage in DBL exhibited significantly increased self-efficacy, self-interest, and self-CT, and increased computing skills, expressing, connecting, and questioning. Most of the participants in the DBL curriculum said that collaborating was their favorite step, and reflecting was the most challenging step. Participants in the DBL curriculum also had generally positive responses to using DBL to design and develop games in Scratch. Jun et al. (2017) recommend practices teachers can implement to foster student learning and problem-solving: “(1) emphasize the ability to translate ideas into tangible creations by using the DBL methodology, (2) lead students to interact with each other and share their ideas, and (3) help students learn how to use these skills to solve other problems they encounter in the real world” (p. 46). Figure 8 Design-Based Learning Framework Wong and Cheung (2020) implemented a programming curriculum for 4th, 5th, and 6th- grade students to examine student perceptions of 21st-century skills. They developed critical thinking questions that align with the five stages of programming created by Wong et al. (2018). The questions are displayed in Figure 9 (Wong and Cheung, 2018, p.3). Figure 9 Critical Thinking Questions and Corresponding Programming Dimensions A DBL approach is used frequently in STEM and engineering education but not commonly found in CS

education. There is a lack of research on DBL to teach elementary-aged students

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CS concepts, but these few studies support DBL to engage students in CS learning. Elementary-level robotic treatments are commonly used to engage students in design-based CS learning. While many robotics treatments positively affected student learning, Ching et al. (2017) found that designing and creating a robot was extremely difficult for 4th to 6th-grade students. The researchers felt most participants lacked the time and relevant robotics experience to succeed. Comparatively, participants with prior experience with robotics could build a robot with much fewer difficulties. The intervention spanned eight weeks, including two 90-minute sessions a week. To allow more time for students to practice programming, the researcher recommends providing upper-elementary students instructions to build a robot and allowing students to make modifications. Standards of Learning The design-based project should align with the state-developed 5th-grade CS learning standards. In 2017, Virginia’s Board of Education (BOE) developed Computer Science Standards of Learning (SOL) for each grade level in K-8. Different stakeholders established the standards, including “...input from parents, teachers, administrators, representatives from higher 51 education, and the business community” (BOE, 2017, p.3). The standards cover competencies related to

algorithms and programming, computing systems, cybersecurity, data and analysis, impacts of computing, networking, and the internet

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. The fifth-grade CS standards emphasize program development to accomplish tasks. According to Virginia Computer Science Standards of Learning, 5th-grade students should construct algorithms independently and cooperatively using sequencing, loops, conditionals, and variables that store data (BOE, 2017). The VDOE computer science webpage provides a document, cross-curricular integration alignment, Figure 10, presenting academic standards teachers can integrate with

grade-level CS standards. Because the elementary school day is already so packed, CS activities should also incorporate core academic standards so students can make cross-content connections, deepening their understanding. This document and prior research on design-based CS projects can guide the development of a CS treatment appropriate for 5th-grade students. Figure 10 Cross-Curricular Integration Alignment

Computer Science Standard Opportunity for Integration 5.1 The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively , a) using sequencing ; b) using loops ; c) using variables to store and process data ; d) performing number calculations on variables (addition, subtraction, multiplication and division); and e) using conditionals (if-statements). Mathematics: 5.2a (determining inequalities); 5.3 (classifying prime/composite/even/odd numbers by their characteristics); 5.18 (creating and describing patterns); 5.19 (describing and using variables) Science: 5.1a (defined design problems that can be solved through the development of an object, tool, process, or a system); 5.1b (planning investigations and writing procedures) Social Studies: VS.1c (create a timeline of events in sequence) 5.2 The student will construct programs to accomplish a task as a means of creative expression using a block or text based

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Mathematics: 5.2a (determining inequalities); 5.3 (classifying prime/composite/even/odd numbers by their characteristics); 5.18

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programming language, both independently and collaboratively a) using sequencing; b) using loops; c) using variables; d) using mathematical operations (addition, subtraction, multiplication and division) variable to manipulate a variable; and e) using conditionals (if-statements

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creating and describing patterns); 5.19 (describing and using variables) Science: 5.1a (defined design problems that can be solved through the development of an object, tool, process, or a system); 5.1b (planning investigations and writing procedures) Social Studies: VS.1c (create a timeline of events in sequence

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5.12 The student will create an artifact using computing systems to model the attributes and behaviors associated with a concept (e.g., rocks). Mathematics: 5.6b (solving problems using models) Science: 5.1e (developing and using models); 5.2 (modeling energy transformations); 5.4 (modeling electrical flow); 5.7 (modeling atoms in matter); 5.8 (modeling plate movement) Social Studies: VS.1c (using maps and models to analyze historical change); VS.1j (modeling geographic and demographic differences in Virginia's 5 regions)

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) CS Unplugged Online learning is a significant component of computer science instruction, but in-person activities can engage students in hands-on, collaboratively learning. CS-Unplugged activities (Bell et al., 1998) allow students to learn CS concepts without a computer. These activities use a constructivist approach, in which students learn through completing challenges. The unplugged activities have accompanying documents teachers can read to facilitate student learning. CS Unplugged activities have positively affected student learning in elementary settings (Brush

et al., 2019 ; Century et al., 2020 ; Hur et al., 2017 ; Tran, 2018

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). Brush et al. (2019) used unplugged activities to introduce students to basic CS concepts, followed by other CS instruction. After the treatment, the classroom teachers shared the unplugged activities were the most effective at helping students understand CS concepts. Brush et al. (2019) suggest including more unplugged activities to improve the curriculum they created. These studies support using unplugged and online activities to introduce CS concepts. Online Learning While unplugged activities positively affect student learning, computer work is a critical computer science component. Students will be using activities from code.org to practice concepts introduced during unplugged activities for online learning. Students will also use the APP Lab available from code.org for their final project. The website Code.org has online puzzles designed for K-12. Students practice different CS concepts through game-like challenges. Students complete the puzzle after writing a program that accomplishes the given task. After students create a program, they select run and observe their program in action, providing immediate feedback. The interface offers hints and video tutorials if a student cannot figure out a puzzle. If they continue to run into problems, the student may ask for assistance from a peer or the classroom teacher.

Career Interest The definition of student career interest is different across empirical research. Several variables are interrelated to student career interest, including engagement, motivation, attitudes, self-concept, and self-efficacy. In empirical research, students' career interests are often defined as their attitudes toward a career field. Many instruments are used across the literature to measure student attitudes toward STEM and related careers. There are also instruments designed to measure STEM career interests directly. Because of the gender gap in STEM, many studies gather demographic information to observe differences between boys and girls in STEM interests (Babarović, 2021). Although many studies on measures related to STEM career interest, such as attitudes and interest towards STEM subjects and self-efficacy, few studies investigate students' interest in STEM careers and even less interest in CS careers. In Playton et al.'s (2021) study, they were interested in studying the impact of a STEM+C treatment on students' interests. In the context of their research,

they define interest as “a motivational variable to foster desire for learning” (Playton et al., 2021, p. 32). Their study also investigates student engagement with

and attitudes towards STEM+C and the use of workforce readiness skills

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and knowledge of CS careers. They note the interrelatedness of interest and engagement, defining engagement as “the degree at which a student positively or negatively attends to, or shows an interest in the completion and involvement in a specific classroom activity through constructs of behavior, affects/emotion, and cognition” Playton et al., 2021, p.32). They also highlight the connection between motivation and interest in the sciences: student motivation is a predictor and serves as a precedent for fostering student interest in the sciences, and interest fosters positive attitudes (Osborne et al., 2003). Playton et al. (2021) use this research to support the necessity of well-design learning experiences promoting career awareness in elementary grades to foster students’ interest in STEM careers before middle school when they establish career-related beliefs (Kier et al., 2014). Tran (2018) defines student interest as a combination of attitudes, perceptions, and self- efficacy beliefs. She states that student STEM attitudes and related experiences influence their pursuit of STEM programs in higher education (Correll, 2001; Tai et al., 2006) and career aspirations (Papanastasiou & Papanastasiou, 2004). She references research by Seligman and Weinstock (1991), in which 14-year-old students’ career aspirations are influenced by their interests, values, and competencies. Babarvoic (2021) investigated students’ vocational interest in STEM during elementary and middle school, including changes in interest from fourth to sixth grade. They observed gender differences in interest in STEM over time, referencing

Gottfredson’s (1981) theory of circumscription and comprise, which proposes that

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gender stereotypes influence students' career aspirations. Children from six to eight years of age begin to eliminate career options based on these stereotypes. Shoffner et al. (2015) looked at young adolescents’ outcome expectations related to STEM careers. The author cites

Lent et al.’s (1994) Social Cognitive Career Theory (SCCT) as the theoretical

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framework that guides a lot of the current research on STEM beliefs and career development. Studies on career interest that SCCT guides often examine self-efficacy and ability, but Shoffner et al. (2015) were interested in the effects of outcome expectations. San Miguel et al. (2019) also based their program on SCCT, where they developed and implemented an elementary curriculum treatment to increase student interest in veterinary medicine. To assess the effectiveness of the curriculum, they measure student engagement. After reviewing empirical studies, there was no widely accepted definition of career interests or an instrument and method to measure it. Measuring Interest Empirical research often measures student

attitudes towards a vocational field or academic content area to define their career interests. Researchers often use quantitative surveys to collect data on students' attitudes toward a career area. Researchers often use a pre-test/post- test design to observe a change in student attitudes resulting from an intervention. The S-STEM is a popular tool for measuring students' STEM career interests (Peterson, 2020; Playton et al., 2021). Students read a description of various STEM careers in the S-STEM and then rank their interests. While the S-STEM is a common method to measure student career interest, it was designed to measure student attitudes. In Peterson's (2020) research on students' STEM career interests, the researcher implemented an inquiry-based, design-based, and traditionally taught science unit to examine the effect of each method on 5th-grade students' interests in pursuing careers in STEM. The researcher implemented

the Upper Elementary School S- STEM Survey (Friday Institute for Educational Innovation, 2012)

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to measure the

difference in students' career interests. The S- STEM results revealed that of the 12 career areas assessed, engineering was the only area with a statistically significant difference among treatment groups, with the design-based treatment reporting greater interest in engineering (Peterson, 2020). In the S-STEM Survey, students rank their attitudes towards STEM career areas, including computer science,

using a Likert scale, from 1, not at all interested, to 4, very interested. The

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survey also measures students' STEM confidence and efficacy. To measure student interests and attitudes towards STEM and computer science (STEM+C), Playton et al. (2021) used an adapted version of the S-STEM, with emojis added for ease of understanding for elementary participants. They also measured student engagement by implementing observation summaries and science self-reports engagement. After integrating STEM+C lessons, the authors observed increased interest in and positive attitudes toward STEM+C (Playton et al., 2021). To measure the change in student STEM perceptions and career aspirations after a programming treatment, Tran (2018) developed a survey. The survey was adapted from the ASPIRES project questionnaire (Archer et al. 2015). It measured student STEM-related goals, beliefs, attitudes, aspirations, and enjoyment. The survey revealed that the treatment positively impacted CS knowledge, STEM perceptions, and career aspirations. Shoffner et al. (2015) used focus groups to measure student outcome expectations in STEM careers. The decision to use focus groups was to delineate research-imposed definitions of career development. The focus group data analysis revealed 16 categories that align with five outcome types: physical, social approval, self-satisfaction, generativity, and relational. Physical outcomes, which had the most categories, include academic success or failure, time and energy commitment, and future life: college, careers, and lifestyles. Overall, more positive statements related to STEM career outcome expectations were made by participants than negative ones. San Miguel. (2019) implemented

a shortened version of the Engagement in Science Learning Activities Scale (Chung et al., 2016

). The survey examined three dimensions of engagement: behavioral, cognitive, and effective. Students responded to four items:

1. During this activity, I felt happy. 2. During this activity, I felt bored. 3. During this activity, I was focused on things we were learning most of the time. 4. During this activity, time went by quickly

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. (San Miguel, 2019, p.3) Babarvoic (2021) implemented a version of the STEM-CIS, which they abbreviated and adapted to collect data on student interest in the areas of STEM. They also developed and implemented two additional instruments due to a lack of widely-accepted tests for measuring students' STEM career interests. The STEM Interests Inventory for Children (STEM-IIC; Babarvoic, 2021) measured overall STEM vocational interest. The Children's Vocational Interest Inventory (CVII; Babarović et al., 2019) collected data on students' general vocational interests. The CVII divides occupations by Holland's (1997) RIASEC types. Analysis of the data revealed students had low

interest in STEM -related careers. Kier et al. (2014) designed the STEM-CIS to

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measure 6th to 8th-grade students' STEM career interests. Based on SCCT (Lent et al., 1994), the instrument presents numerous factors directly impacting an individual's interest. These include personal input, goals, supports and barriers, self-efficacy, and outcome expectations. The instrument has students rate their agreement, 1 to 5, to statements related to the SCCT aspects and STEM careers. Figure 11 presents the science sub-scale questions and their corresponding SCCT aspects. One of the STEM-CIS subscales needs to be adapted into a computer science subscale to fit the context of this study. Figure 11 STEM-CIS Science Subscale Babarvoic (2021) found that elementary and middle school students generally have low STEM interests. These findings highlight the need to increase student interest in STEM and support the research's purpose to observe if a CS treatment can positively impact students' STEM and CS vocational interests. For the study, vocational interests is defined as the desire of an individual to pursue a career or occupational field. Although there are many interrelated 59 factors affecting interests, for simplicity, this study will focus on learning experiences, self-efficacy, outcome expectations, and how they impact student interests. In Figure 12, SCCT demonstrates how

learning experiences directly influence self-efficacy and outcome expectations, which

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lead to interest. Because the STEM-CIS was designed based on SCCT, it would be the most effective instrument to measure data related to the impact of a learning experience on students' vocational interests. To fit this study, the researcher must

add a Computer Science section to the instrument and ensure vocabulary is appropriate for 5th-grade reading comprehension. Figure 12

Social Cognitive Career Theory Framework Using Lent et al.'s (199483

) SCCT as a theoretical framework,

Kier et al. (2014) developed the STEM-CIS to assess students' career27

interests in STEM. With an understanding of students' development stages and the impact content and environment have on student career choice development and interest (Hidi & Renninger, 2006; Jones, 2009), curriculum developers may develop a curriculum to foster students' interest in STEM and CS careers. The focus of this study is to provide further research on this topic by implementing a learning experience for upper- elementary-aged students to promote career awareness and foster their interests in computer science. Conceptual Framework For the context of this study,

Social Cognitive Career Theory (SCCT; Lent et al., 1994) would be a pertinent framework18
to guide the

research. SCCT, developed by Lent,

Brown, and Hackett in 1994, is influenced by Bandura's Social Cognitive Theory58

(1986) and the concept of self-efficacy (1977). A tenet of SCCT is that

learning experiences affect self-efficacy and outcome expectations. Outcome expectations88

are an individual's beliefs related to successfully performing a task. Positive learning experiences can increase an individual's

self-efficacy – higher self-efficacy corresponds with an individual's belief that42

performing a task will produce a positive outcome. If individuals are confident in performing a task that produces a positive effect, they are likelier to perform that task. In SCCT, interest is a stand-alone construct, as displayed in Figure 12 (

Lent et al., 1994). Students’ self-efficacy and outcome expectations directly influence25

their interests. Those interests then influence goals, which influence actions. SCCT's (Lent et al., 1994) framework aligns well with the context of this study because learning experiences and interests are two of the primary constructs within the model. This study seeks to examine the impact of a design-based computer science treatment on student interest in CS. There is also a validated instrument, STEM-CIS, for measuring student interest in STEM careers based on SCCT, which can easily be adapted to fit the context of

this study. CHAPTER THREE: METHODOLOGY This chapter will present a description of the36

methodologies used in the study to obtain relevant data to answer the research question. This chapter will cover the methods related to sample selection, instrumentation, the reliability of data,

data collection, and data analysis. The study was designed to answer the40

following research question: How does a design-based computer programming treatment impact 5th graders' interest in computer science careers? Precise research methods that align with the purpose and goal of the study were selected to answer this question. Participants were selected using convenience sampling. The researcher met with the classroom teacher virtually and received approval to conduct research in their classroom. The researcher had no prior experience at the research site before the study. A total of 33 participants were a part of the study. The researcher used a multi-method approach, collecting quantitative and qualitative data from participants. In an explanatory multi-methods design, qualitative findings are used to explain quantitative results further. Participants will complete

the STEM Career Interest Survey (STEM-CIS) before and after the24

computer science treatment using a pre- post design to measure changes in student interests. The researcher selected this instrument because the items align with SCCT, the conceptual framework guiding this research study. A tenet of SCCT is that students' educational experiences impact their self-efficacy, goals, and interests, greatly influencing their career choices. To gather qualitative data, the researcher conducted

focus group interviews. **Stratified sampling was used to** select focus group **participants**
based on **the**

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degree of change from pre- to post-survey. The researcher collected data from four focus groups, one with the greatest increase, one with the greatest decrease, and two groups with participants with no change or a negligible increase or decrease. Each group varied in participants, with three being the smallest group and six being the largest. Descriptive statics

and paired sample t-tests were used **to analyze the** survey **data. The**

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researcher selected

a paired sample **t-test to observe** any **changes from pre** - treatment **to post**

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-treatment, better understanding the impact of the treatment on the sample. Content analysis was used to identify themes in students' focus group responses. These findings will help answer the guiding research question and help educators better understand and develop computer science experiences to increase student interest in pursuing STEM careers. Sample Selection This project observes the impact of a computer science treatment on fifth-grade students' career interests. To achieve this goal, a sample of 33 fifth-grade students from a public institution in a rural Southwest Virginia school district were selected to participate in this study. The decision to investigate the impact of the treatment on fifth-grade students was based on popular careers development theories, such as Developmental Self-Concept Theory (Super, 1953) and

Social Cognitive Career Theory (Lent et al., 1994). These theories propose **that**

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by 14 years old, individuals begin to develop career interests through their experiences, including formal learning experiences. Convenience sampling was used to identify school systems that were easily accessible to the researcher. The most convenient school districts were in rural Southwest Virginia. Although selected for convenience, providing computer science treatments in rural areas can be more impactful for rural school students than for urban students. Students from rural schools are less likely than students from urban school districts to have engaged in computer science learning experiences. They are also less likely to have role models in computer science. Both these factors influence students' interest in computer science careers (Gallup, 2021). Using G*Power (Faul et al., 2009), an

matched paired t-test. To run the analysis, effect size, error of probability, and power were input. A medium effect size was input, 0.5. In educational research, a 95% confidence interval is standard, so the error of probability was input as 0.05. According to Cohen (1988), a statistical power ≥ 0.80 is considered significant, so 0.80 was input for power. The a priori analysis results suggested a total sample size of 34 to achieve a statical power of 0.81 from a matched paired t-test. An email was sent to the principal of an elementary school in Southwest Virginia. The school was located in Southwest Virginia and had at least 34 fifth-grade students enrolled within the school. The email included a description of the research study and the participants needed. After the principal expressed interest in participating in the study, another email was sent to the superintendent for approval. The research study received IRB approval before recruiting participants or collecting data. To receive IRB approval, the researcher described the research project in detail and submitted all associated documents. The researcher obtained IRB approval for all documents, including the assent forms, parental permission forms, and script to recruit participants (See Appendix C, D, and E). The researcher visited the research site to recruit participants, explain the project, and pass out permission forms. The researcher collected data from students who returned assent and parental permission forms and redacted all personal identifiers. The researcher safely discarded all data from students who opted not to participate in the research study. Treatment The treatment in this study consisted of 60-minute lessons, implemented every Monday, Wednesday, and Friday for nine sessions. Due to weather delays, the first two sessions were 45 minutes, and the following 7-sessions were each 60 minutes. Participants received eight and a half instructional hours, in which the researcher introduced students to computer science concepts. The treatment was designed using the VDOE Standards of Learning for Computer Science (VDOE, 2017, p.7). The treatment addresses the following learning standards:

5.1 The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively, a. using sequencing; b. using loops; c. using variables to store and process data; d. performing number calculations on variables (addition, subtraction, multiplication and division); and e. using conditionals (if-statements). 5.2 The student will construct programs to accomplish a task as a means of creative expression using a block or text based programming language, both independently and collaboratively a. using sequencing; b. using loops; c. using variables; d. using mathematical operations (addition, subtraction, multiplication and division) variable to manipulate a variable; and e. using conditionals (if-statements). 5.3 The student will analyze, correct, and improve (debug) an algorithm that includes sequencing, events, loops, conditionals, and variables . By the

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end of the treatment, participants used their knowledge of these concepts to develop applications using the Scratch platform. The lead researcher delivered all instructional material. The researcher implemented the treatment during students' compartmentalized science block in their classroom. The classroom teacher was present during all instruction and available to assist students. On day one of the treatment, participants completed the pre-survey and were introduced to

computer science and different careers that use computer science. The researcher used a slideshow presentation to introduce these concepts, including text, images, and videos. Students were made aware that they would develop applications. At the end of the lesson, the researcher showed students examples of applications developed by Scratch users. On day two of the treatment, the researcher introduced students to computer programming and sequencing. Students started by doing a drawing activity in which they were given vague instructions to create a specific drawing. After students finished their drawings, they were shown what the illustration was supposed to look like. Students revised the previous instructions to reflect the desired illustration. This activity was linked to sequencing and debugging a program. At the end of the lesson, students practiced using the Scratch platform by adding sprites and backdrops. On day three, the researcher introduced students to events. Students started by reviewing what they learned last week by adding sprites and backdrops to a new scratch project. Then the researcher demonstrated how to add an event on Scratch. Students used event blocks to create digital flashcards on a chosen topic. On day four, the researcher introduced students to conditionals. Students played follow the leader and rock paper scissors to connect real-life conditionals to coding. The research demonstrated how to use a conditional in Scratch. The students practiced using conditionals by developing a program in which the user responds to a question and then receives different responses, whether the answer is correct or incorrect. To end the lesson, students shared conditionals that they use daily. On day five, the researcher introduced students to loops and variables. Students watched a video on loops and were given a definition. Students were given a demonstration of how to create a loop on Scratch, then made their program. Then, the researcher introduced students to variables. The research presented a simple definition of a variable, then demonstrated a program that uses loops and variables. Students developed a program that used a variable, in which the program counted the number of correct answers a user input. On day six, students were presented with the design challenge, which defined the criteria and constraints for their applications. Students went through different stages of the engineering- design process as they developed their applications. Students were encouraged to research other applications using the Scratch project library. They planned their applications by sketching out their ideas. By the end of the lesson, some students began to develop their applications in Scratch. On days seven through nine, students continued to develop their applications. Students shared their progress and provided feedback. Students shared their applications to the Scratch Project Library on the final day. Students explored each other's applications and left comments. Day nine concluded with participants completing the post-survey. Instrumentation The STEM-CIS (Kier et al., 2014) is an instrument designed

to measure interest in STEM careers. The instrument was

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designed for middle school, sixth, to eighth-grade participants. Students use a Likert scale to respond to 44 items to complete the instrument. The survey has five sections, an optional demographics section, followed by four subscales, each of the four STEM subjects: science, technology, engineering, and mathematics. The first section of the STEM-CIS, titled Optional Demographic Questions, elicits demographic data, including gender and race, and contains nine items. The second section, Science, includes 11 science-related items. The third section, Technology, includes 11 technology-related items. The fourth section, Engineering, includes 11 engineering-related items. The fifth and final section of the STEM-CIS, Mathematics,

includes 11 math-related items. The instrument links to Lent et al.'s (1994) SCCT. The items align with aspects of SCCT, including two self-efficacy items, two personal goal items, two outcome expectation items, two interest items, one personal inputs item, and two contextual support items. The researcher used a semi-structured format to conduct focus groups. A list of pre-determined questions to guide the interviews was developed using the items on the STEM-CIS. By structuring focus group questions around Lent et al.'s (1994) SCCT, qualitative data may be collected on each aspect that influences an individual's career interests, improving response efficiency. The general sequence of questions was the same for each focus group, but the level of probing differed from group to group. The first area explored in the interviews focused on participants' computer science self-efficacy. Major questions examined participants' perceptions of their ability to perform tasks using computer science. The next area delves into participants' personal goals and outcome expectations. Participants shared their career-related goals and perceptions about the value of learning computer science. After discussing outcome expectations, the conversation was centered around participants' interests in computer science. Participants shared their likes and dislikes to understand better how the treatment impacted students' interests and made recommendations for improving the treatment. The focus groups' structured portion concluded with questions about personal inputs and conceptual supports related to computer science careers. This portion included questions about role models

in computer science and prior **computer science** experiences **in and** out of **school**

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. 68 Adapted STEM-CIS To fit the purpose of this research project, an adapted version of the STEM-CIS (See Appendix A) was given to participants. In this adapted version, a computer science subscale was developed. The

items and their corresponding SCCT aspects **are presented in Table 1. The**

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computer science subscale consists of 11 items that have been adapted from the items in the science, technology, and engineering subscales of the STEM-CIS. The language used in the computer science subscale closely mirrors the language used in the engineering and technology subscale. The only adaptation to most of the items is substituting the term engineering or technology for computer science. This research project aims to assess students' interest in computer science careers, so students only completed the 11 items in the newly developed computer science subscale. The developers of the STEM-CIS determined that it is acceptable to administer each subscale individually (Kier et al., 2014). Several research studies have successfully used a single subscale from the STEM-CIS to measure a specific construct of interest (Heacock, 2016; Hutchinson et al., 2019; Jackson

et al., 2019 ; Vaino **et al** ., 2015). Heacock (2016) **and** Hutchinson **et al. (2019) both**

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implemented the 11-item science subscale, and Jackson et al. (2019) implemented the 11- item engineering subscale, while Vaino et al. (2015) adapted and used the technology subscale of the STEM-CIS to develop a 10-item instrument. Evidence that supports the use of each STEM- CIS subscale separately, as well as an adapted subscale, is relevant to this project because the newly developed computer science subscale was the sole survey distributed to the participants of this study. Table 1 STEM-CIS Item and Aligning SCCT Aspect Item SCCT Aspect STEM-CIS Item Number CS1 Self-efficacy CS2 Self-efficacy CS3 Personal goal

I am able to do well in activities that involve computer science. I am able to complete activities that involve computer science. I plan to use computer science in my future career2

. CS4 CS5 CS6 CS7 CS8 CS9 CS10 CS11 Personal goal Outcome expectation Outcome expectation Interest in computer science Interest in computer science Contextual support Personal input Contextual support

I will work hard on activities at school that involve computer science. If I learn a lot about computer science, I will be able to do lots of different types of careers. My parents would like it if I2

chose a computer science

career. I am interested in careers that involve computer science. I like activities that involve2

computer science.

I have a role model in a computer science career. I would feel comfortable talking to people who work in computer science careers. I know of someone in my family who uses computer science in their career2

. Validity and Reliability. Validity is defined as an instrument's ability to accurately measure what it is intended to (Cohen et al., 2007). The items on the STEM-CIS were developed using

previous instruments (Fouad et al., 1997; Tyler-Wood et al., 20102

)—and SCCT (

. After the researchers developed initial items, they were reviewed by experts in STEM education and career counseling. The initial instrument was pilot tested, and the researchers conducted structural data analysis. Items that had low item-total correlations (0.05 – 0.16) were eliminated. The remaining 44 items, 11 items per subscale, were further pilot tested to assess the instrument's reliability. Reliability is defined as an instrument's ability to produce consistent and replicable data (Cohen et al., 2007). The STEM-CIS was administered to more than 1000 sixth to eighth-grade students in six stages to assess the instruments' reliability, including the internal consistency and confirmatory factor analyses of each subscale. The confirmatory factor analysis results indicate that the model fit was strong for the four subscales. Each subscale requires a root mean square error (RMSEA) <0.08, normed fit index (CFI) ≥0.90, and comparative fit index ≥0.95 to be considered an adequate model fit. During pilot testing, each subscale was able to meet these established criteria. These results suggest that the STEM-CIS is a strong instrument not only when used in totality, but each subscale may also be administered individually as a helpful evaluative tool.

Focus Group Protocol In qualitative research, validity refers to the integrity of method implementation and the accuracy with which the findings reflect the data (Nobel & Smith, 2015). The researcher implemented several methodological strategies to improve the trustworthiness of the qualitative conclusions. The researcher created a positionality statement before developing focus group material to account for personal biases. Triangulating the quantitative and qualitative data can also increase the trustworthiness of the findings. The researcher implemented an interview guide approach, outlining topics ahead of focus groups. In an interview guide approach, data collection is systematic, and more comprehensive data can be collected (Patton, 1980, p.206; Cohen et al., 2007). The interview questions were developed using the items from the STEM-CIS, which has been psychometrically evaluated. For the focus groups, the researcher turned STEM-CIS items into open-ended questions rather than items that elicit a Likert scale response.

Data Collection Procedures The researcher observed human subjects in this study. IRB approval (See Appendix F) was received before any data collection. After the researcher selected the research site, they visited the school to explain the project to the students and pass out assent and parental permission forms. The script to explain the project to the students, assent forms, and parental permission forms were approved by the IRB before being implemented at the research site (See Appendix C, D, and E). The treatment took place over three weeks in January and February of 2023. The researcher implemented instruction every Monday, Wednesday, and Friday in the participants' science classrooms. The researcher collected all data in the participants' science classrooms during their science block. The researcher collected all the participants' assent and parental permission forms on the first day of the treatment. To begin the first day, every student completed the pre-survey STEM-CIS before receiving any computer science instruction. After everyone completed the survey, the researcher transferred the data to a google sheet. The post-survey STEM-CIS was administered on the ninth day after the treatment. After everyone completed the post-survey, the researcher transferred the data to a google sheet. The survey data from students who did not return an assent and parental consent form, or opted out of the research, were immediately deleted from the google sheet. Students were asked to include their names on the instrument so that individual pre-survey and post-survey could be matched to observe changes in individual participants' data. After the researcher

matched the surveys, participants were randomly assigned numbers, and personal identifiers were removed from the data set. The researcher analyzed the survey data and used it to select focus group participants. The researcher pulled select students

from their science class to participate in focus group **interviews. The**

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focus groups occurred in a storage room adjacent to the students’ science classroom. Participants sat around a circular table with an audio recording device. To start the focus groups, the researcher explained the purpose of conducting the focus group and encouraged participants to speak openly and answer questions honestly. The students introduced themselves; then, the researcher began asking questions using a list of pre-determined questions to guide the interview (See Appendix B). When participants gave closed-ended answers, the researcher asked probing questions to understand student responses better. After the researcher asked every question on the list and the participants stopped sharing their thoughts, the researcher thanked them and ended the audio recording. The audio-recorded data was uploaded to REV, transcribed, and analyzed. The researcher redacted all identifying information from the transcriptions, and participants were assigned a random number. STEM-CIS As a part of this research, 33 fifth-grade students participated. The participants engaged in two 45-minute and seven 1-hour computer science lessons. To observe the impact of the computer science experience, the STEM-CIS was administered using a pre-survey/post-survey design. The STEM-CIS was initially administered on day one of the computer science treatment before students participated in any computer science learning activities. On day nine of the intervention, the STEM-CIS was administered again immediately following the final lesson

of the treatment. The survey was administered to participants **using** google forms. **The**

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researcher read each item and the corresponding responses out loud to the participants. Students followed along and selected a response using their Chromebooks. Students were given approximately 15 minutes to complete the 11-item survey. When the developers of the STEM-CIS pilot tested the engineering and technology subscales individually, the average administration time for each subscale was 10 minutes. Because the participants in this research project are slightly younger than the students in the pilot test, fifth grade rather than sixth through eighth grade, the researcher provided an additional 5 minutes for students to complete the 11-item survey. After students responded to each item, they submitted the google form. Through the STEM-CIS, quantitative data was collected; additional data collection tools were needed to gather qualitative data. Focus Groups To gather qualitative data, select students participated in semi-structured focus group interviews. The lead researcher used stratified sampling to select focus group participants based on the degree of change in the STEM-CIS. The researcher found the mean for each participant’s pre-survey and post-survey to identify strata. The researcher calculated the difference between the post-survey and pre-survey mean. One group represented the participants with the greatest positive change, 0.82 to 1.45. One group represented the students with the greatest negative change, -0.73 to -0.55. Two groups represented students with zero change or a minor change, +/- 0.09. By selecting participants with the

greatest increase post-treatment, participant responses reveal the strengths of the treatment. The negative change group provides a better understanding of the weaknesses of the treatment and methodology. The zero to slight change group offers further insight into why the treatment had little to no effect on some participants. This way, the researcher may collect data more efficiently by stratifying focus groups. The qualitative data gathered from focus groups will help explain quantitative findings and further understand participants' perceptions towards the treatment and computer science in general. Participants completed the post-survey on a Friday, and focus groups took place the following Tuesday. The researcher pulled focus group participants during their scheduled science block. No additional consent forms were given, as the initial consent and assent forms specified that select students may participate in audio-recorded focus group interviews. The focus groups occurred in a storage room adjacent to the students' science classroom. The researcher led the focus groups and initiated the conversation by explaining the purpose of the interview and encouraging participants to answer

questions honestly and to the best of their ability

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. Four researcher-led focus groups were conducted, with 3-6 students in each group. Each interview was approximately 10 to 15 minutes. The researcher used a list of pre-determined questions to start a dialog and guide the discussion. Still, ultimately the direction of the conversation was led by student responses and appropriate probing of those responses. The focus groups were audio-recorded, transcribed, and later analyzed to identify common themes among student responses. Data Analysis Procedures The researcher implemented an explanatory multi-method approach to analyze the data accumulated. In this approach, quantitative data is collected and examined before qualitative. Qualitative data is then collected and analyzed to further explain any findings from quantitative data analysis (Creswell, 2012). This method uses multiple data sources to justify any conclusions further and helps address the limitations of a strictly quantitative study. The quantitative findings

provide a general picture of the research problem, and the qualitative

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results can be used to explain that general picture further. Quantitative Data The surveys completed by participants used a

Likert Scale with the response options: Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree

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. Student responses were converted into numerical data to begin data analyses, with one representing Strongly Disagree and five representing Strongly Agree. All participants' survey data was uploaded to a google sheet, with all personal identifiers

removed. Instead of pseudonyms, all participants were randomly assigned numbers. A total of 29 students responded to every item on the pre-test and post-test.

Descriptive statistics, mean , variance, and standard deviation, were calculated using the 40

entire sample of

29 participants’ data. Using the statistical software R, the researcher ran a two-tailed paired

sample t-test with a 95% confidence interval to determine any change between the 61

entire samples' pre-survey and post-survey responses. The decision to perform

a paired sample t-test was to observe any change in the 20

STEM-CIS following the treatment. These results can be used to answer the research question: How does a design-based computer science treatment impact 5th-grade students’ interest in computer science careers? The findings are statistically significant if the paired sample t-test produces a p-value less than

0.05 . If the p-value is less than 0.05 , this suggests that the 60

treatment positively impacted participants' interest in computer science careers. The paired sample t-test results may also be used to provide evidence that the treatment had no impact or even a negative impact on the samples’ computer science career interests. The results of this t-test will provide evidence of the overall effect of the treatment on 5th-grade students' career interests. Additionally, the researcher analyzed data by each item on the STEM-CIS and by SCCT aspect. The sample for each item was 31 participants, except for CS2 and C3, which had 30 respondents. The pre-and post-survey mean for each item and SCCT aspect is reported, and the researcher calculated the difference between the post- and pre-survey mean. The researcher also ran a two-tailed, paired sample t-test for each survey item and SCCT aspect. Finding the difference between the post- and pre-survey mean for each item and each SCCT aspect provides data to understand better the treatment's impact on each survey item and their corresponding SCCT aspects. The survey means, and difference was also calculated for each individual participant. The difference between everyone’s survey means was used to stratify focus groups by degree of change. In an educational setting, many external variables can influence a student's change in attitude. While these extraneous variables cannot be eliminated, research design choices can reduce the impact of these outside variables. For instance, the researcher administered the surveys directly before and after students received the treatment,

thus reducing the timeframe for students to receive any other experiences outside the treatment that may influence their survey responses. Qualitative Data The data from the focus groups may be used to explain the quantitative findings further and provide more insight to answer the research question: How does a design-based computer science treatment impact 5th-grade students' interest in computer science careers? Analysis of the survey data can be used to determine a positive, negative, or no impact. Still, the researcher may use data from the focus groups to evaluate how the project changed participants' interest in computer science careers. More effective treatments for increasing 5th-grade students' interest in computer science careers may be developed using these findings. The researcher conducted a content analysis to analyze the qualitative data. In content analysis, quantitative methods are applied to qualitative data analysis (Berelson, 1952). In their educational research, Bradbury et al. (2019) and Kalelioglu and Gülbahar (2014) developed a frequency chart to display the number of student responses related to identified themes, thus quantifying qualitative findings. The researcher used REV to transcribe the focus group audio; then, the transcription was revised as needed. After, the transcription was coded for common themes amongst participant responses. For each question, the researcher created a chart to display the themes and the number of responses about the theme. One can assume that the themes with many responses had a more significant impact on participants than seldom mentioned themes. Conclusion The methods used in this study were explicitly selected to answer the research question: How does a design-based computer science treatment impact 5th-grade students' interest in computer science careers? The researcher implemented an adapted version of the SCCT-aligned STEM-CIS to gather specific data about participants' interest in computer science careers. Analysis of the survey data determined whether the treatment had a positive, negative, or no impact on participants' interest in computer science careers. The addition of focus groups provided more in-depth data on what treatment components impacted participants' interests in computer science careers. Collecting and analyzing data this way may be used to design curricula that increase elementary students' interest in computer science careers.

CHAPTER FOUR: RESULTS This chapter will present the results of the

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analyzed STEM-CIS and focus group data. The STEM-CIS was administered on the first day of the treatment, before students received any instruction, and again on the last day. Thirty-three participants completed the pre-survey, while the post-survey had 31 respondents. Of those, 29 participants responded to all 11 pre- and post- survey items. The instrument included 11 items, to which participants responded using a Likert scale (1 – 5). The lowest possible individual score on the instrument is an 11, while the highest is 55. The first section of this chapter presents the results from the entire sample's data. The researcher found descriptive statistics using the statistical software R, and a paired sample t-test was performed with the whole sample's (29) pre-survey and post-survey data. In the second section, the results are presented per SCCT aspect. The survey means were calculated, the difference was found, and a paired sample t-test was run for each SCCT aspect. The second section also presents descriptive statistics for each instrument item. The averages were calculated for each instrument item, and

the difference between pre-survey and post-survey means are presented. The

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percentage of participants that selected each response will also be presented. In the third section, descriptive statistics for each participant are presented, including pre-and post- mean and the difference between the two. After analyzing individual participants'

pre-survey and post-survey data, the difference between means was found and used to

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form stratified focus groups. Finally, the content analysis of the qualitative data is presented. Entire Sample Descriptive statistics, presented in Table 2, were derived from the quantitative data sets, including mean, standard deviation, and variance. Using the data from the 29 participants that responded to all 11 items, the mean of the pre-survey was 37.17 (SD = 7.66). The mean of the post-survey was 39.62 (SD = 8.07). The difference between the post-survey and pre-survey mean was 2.45. Using the data from 29 participants that responded to all 11 items on

the pre -survey and post-survey, a two-tailed paired sample t-test was conducted. The

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two-tailed paired sample t-test produced the results $t(28) = -2.04$, $p = .051$. For this research, the statistical significance (α) level is .05. Table 3 presents these results. Table 2 Descriptive Statistics of STEM-CIS for the Entire Sample Adapted STEM-CIS Mean Std. Dev. Variance Pre-Survey (n = 37.17 7.66 58.65 29) Post-Survey (n = 39.62 8.07 65.17 29) Table 3 Paired T-test of STEM-CIS for the Entire Sample Adapted STEM- t df p CIS Pre/post-survey -2.04 28 .051 (n = 29) Note. *Significant at $\alpha = .05$ SCCT Aspects and Survey Items The pre-survey and post-survey mean, and standard deviation per SCCT aspect are presented in Table 4. The table also includes the difference between survey means and a two- tailed paired sample t-test comparing the surveys per SCCT aspect. The self-efficacy aligning items, CS1 and CS2, increased 0.53 from

the pre-survey (M=7 .7, SD=1 .62) to the post-survey (M=8 .23, SD=1 .63); t (29)=
-1.94, p

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= .062. Personal goal items, CS3 and CS4 had no change

pre-survey (M=7 .37, SD=1 .5) to post survey (M =7.37, SD=1 .52); t (29)= 0, p

21

= 1. Outcome expectation items, CS5 and CS6, had a 0.16 decrease from

pre-survey (M=7.06, SD=1.18) to post-survey (M=6.90, SD=1.64); t (30)= 0.54, p	46
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= .592. The interest aligning items, CS7 and CS8, increased 0.71 from

pre-survey (M=6.65, SD=2.11) to post-survey (M=7.35, SD=1.89); t(30)= -2.30, p=.028. Contextual support items, CS9 and CS11, increased 0.87	51
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from pre-survey (M=4.65, SD=2.46) to post-survey (M=5.52, SD=2.29); t (30)= -2.25, p=.032. The only personal input aligning item, CS10, increase 0.16	22
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from pre-survey (M=3.71, SD=3.87) to post-survey	73
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t(30)= -1, p=.325. Table 4 STEM-CIS Paired Sample t-test per SCCT Aspect

Pre- Survey Mean (SD) Post- Survey Mean (SD) Diff. in Means t df p	69
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Self-efficacy CS1 CS2 30 7.7 (1.62) 8.23 (1.63) +0.53 -1.94 29 .062 Personal goal CS3 CS4 30 7.37 (1.50) 7.37 (1.52) 0 0 29
1 Outcome expectation CS5 CS6 31 7.06 (1.18) 6.90 (1.64) -0.16 0.54 30 .592 Interest in computer science CS7 CS8 31 6.65 (2.11) 7.35 (1.89) +0.71 -2.30 30 .028* Contextual support CS9 CS11 31 4.65 (2.46) 5.52 (2.29) +0.87 -2.25 30 .032*
Personal input CS10 31 3.71 (1.13) 3.87 (1.06) +0.16 -1 30 .325 *Significant at $\alpha = .05$ The researcher analyzed each item on the survey separately to identify any change following the treatment. A total of 31 participants completed the pre-survey and post-survey (n=31), apart from CS2 and CS3, in which only 30 completed the pre-survey. The researcher found

the mean and standard deviation for each item on the pre-survey and	6
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post-survey. The difference between the means was calculated. These results are presented in Table 5. The mean of item CS1:

I am able to do well in activities that involve2

computer science, was 3.90 for the pre-survey, while the post-survey mean was 4.16, denoting an increase of 0.26. One participant left item CS2: I am able to complete activities that involve computer science, blank on the pre-survey (n=30).

The pre-survey mean for CS2 was 3.8, and the post-survey mean was 4.1 for an4

increase of 0.3. One participant left item CS3:

I plan to use computer science in my future career2

, blank on the pre-survey (n=30).

The pre-survey mean of item CS3 was 2.93, and the post-survey mean was 24

.9, for a decrease of 0.03. The item with the highest comparative pre-survey mean, and the post-survey mean was CS4:

I will work hard on activities at school that involve2

computer science, with respective means of 4.32 and 4.45, and an increase of 0.13. Item CS5:

If I learn a lot about computer science, I will be able to do lots of different types of careers2

, had the greatest negative change.

The pre-survey mean for item CS5 was 3.94, while the post-survey mean was 34

.81, signifying a decrease of 0.13. Item CS6:

My parents would like it if I chose a computer science career

2

, which had a small decrease from pre-survey to post-survey.

The pre-survey mean for CS6 was 3 .13, while the post-survey was 3

4

.10, demonstrating a decrease of 0.03. The pre-survey and post-survey mean for item CS7: I am interested in careers that involve computer science, was 2.84 and 3.16, respectively, for an increase of 0.32. For item CS8: I like activities that involve computer science,

the pre-survey mean was 3 .81, and the post-survey was 4.19, denoting an

4

increase of 0.39. The item with the lowest comparative pre- and post-survey mean and the greatest change was CS9:

I have a role model in a computer science career. The pre-survey and post-survey

30

mean for CS9 were 2.13 and 2.58, respectively, for an increase of 0.52. Item CS

10: I would feel comfortable talking to people who work in computer science careers

30

, had a

pre-survey mean of 3 .71 and a post-survey mean of 3 .87, for an

4

increase of 0.16. Item CS11:

I know of someone in my family who uses computer science in their career , had a

2

2.52 pre-survey mean, and a 2.94 post-survey mean, for an increase of 0.42. Table 5 STEM-CIS Pre-Survey and Post-Survey Difference Between Means Item Number (N) SCCT Aspect Pre- Survey Mean (SD) Post- Survey Mean (SD) Diff. in STEM-CIS Item Means CS1 (31) CS2 (30) CS3 (30) CS4 (31) CS5 (31) CS6 (31) CS7 (31) Self- efficacy Self- efficacy Personal goal Personal goal Outcome expectation Outcome expectation Interest in computer science 3.90 4.16 (0.98) (0.82) 3.8 4.1 (0.89) (1.02) 2.93 2.9 (1.31) (1.08) 4.32 4.45 (0.91) (0.77) 3.94 3.81 (0.89) (1.08) 3.13 3.10 (0.92) (1.04) 2.84 3.16 (1.07) (1.10) +0.26 +0.3 -0.03 +0.13 -0.13 -0.03 +0.32

I am able to do well in activities that involve computer science. I am able to complete activities that involve computer science. I plan to use computer science in my future career. I will work hard on activities at school that involve computer science. If I learn a lot about computer science, I will be able to do lots of different types of careers. My parents would like it if I

2

chose

a computer science career. I am interested in careers that involve computer science

2

. CS8 (31) CS9 (31) CS10 (31) CS11 (31) Interest in computer science Contextual support Personal input Contextual support 3.81 4.19 (1.22) (1.05) 2.13 2.58 (1.31) (1.29) 3.71 3.87 (1.13) (1.06) 2.52 2.94 (1.43) (1.50) +0.39 +0.45 +0.16 +0.42 I like activities that involve computer science.

I have a role model in a computer science career. I would feel comfortable talking to people who work in computer science careers. I know of someone in my family who uses computer science in their career

2

. Note. Item responses used

a Likert scale with Strongly Disagree, Disagree, Neither Agree Nor Disagree, Agree , and Strongly Agree

2

, correlating with 1 – 5, respectively. Tables 6 and 7 present the total number of each response per item and its corresponding percentage for the pre-survey and post-survey, respectively. The standard deviation for each item is also presented. Notably, on item CS2: I am able to complete activities that involve computer science, the choice: strongly agree,

was selected by 6 participants (19.35%) on the pre-survey and increased to 13 participants (41.94%) on the post-survey. The number of participants who selected Strongly Agree for item CS6:

My parents would like it if I choose a computer science career

2

, decreased from pre-survey to post-survey, from 3 (9.09%) to 2 (6.45%). Although increasing from pre-survey to post-survey, items CS9:

I have a role model in a computer science career, and CS11: I know of someone in my family who uses computer science in their career

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, had more participants select 1 – Strongly Disagree, with 8 (25.81%) and 9 (29.03%) respectively, than any other item on the post-survey. Table 6 STEM-CIS Pre-Survey Response Frequencies and Standard Deviation Item

1 - Strongly Disagree 2 - Disagree 3 - Neither Agree Nor Disagree 4 - Agree 5 - Strongly Agree SD n

23

%	n	%	n	%	n	%	n
CS1	1	3.03	1	3.03	7	CS2	0
0	3	9.68	6	CS3	7	21.88	5
15.63	10	CS4	2	6.06	0	0	3
CS5	1	3.03	1	3.03	10	CS6	1
3.03	8	24.24	15	CS7	7	21.21	4
12.12	14	CS8	3	9.09	1	3.03	9
CS9	14	42.42	12	36.36	1	CS10	3
9.09	1	3.03	11	CS11	13	39.39	4
12.12	4	21.21	14	19.35	16	31.25	6
9.09	11	30.3	11	45.45	6	42.42	7
27.27	9	3.03	3	33.33	9	12.12	9
42.42	10	51.61	6	18.75	4	33.33	17
33.33	10	18.18	3	21.21	1	27.27	11
9.09	3	27.27	9	27.27	3	30.30	19.35
12.5	51.52	30.3	9.09	3.03	33.33	9.09	27.27
9.09	.97	.87	1.32	1.06	1	.97	1.13
1.23	1.3	1.2	1.48	Note.	N = 33	(n = 31	for CS2
and n = 32	for CS3).	Table 7 STEM-CIS					

Post-Survey Response Frequencies and Standard Deviation Item

1 - Strongly Disagree 2 - Disagree 3 - Neither Agree Nor Disagree 4 - Agree 5 - Strongly Agree SD n

23

% n % n % n % n % CS1 0 0 1 CS2 1 3.23 2 CS3 4 12.90 5 CS4 0 0 0 CS5 1 3.23 3 CS6 4 12.90 1 CS7 3 9.68 5 CS8 0 0 2 CS9 8 25.81 7 CS10 0 0 4 CS11 9 29.03 2 3.23 5 16.13 13 41.94 12 38.71 .82 6.45 2 6.45 13 41.94 13 41.94 1.02 16.13 14 45.16 6 19.35 2 6.45 1.08 0 5 16.13 7 22.58 19 61.29 0.77 9.68 6 19.35 12 38.71 9 29.03 1.08 3.23 16 51.61 8 25.81 2 6.45 1.04 16.13 9 29.03 12 38.71 2 6.45 1.10 6.45 8 25.81 8 25.81 18 58.06 1.05 22.58 9 29.03 4 12.90 3 9.68 1.29 12.90 7 22.58 9 29.03 11 35.48 1.06 6.45 8 25.81 6 19.35 6 19.35 1.50 Note. N = 31. Individual Respondents

A total of 33 participants completed the pre-survey , and the

80

post-survey had 31 respondents. The mean of individual participants'

pre-survey and post-survey responses was calculated , along with the difference

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between these two means, displayed in Table 8. The difference between means was calculated to identify any change from individuals'

pre-survey to post-survey responses . The difference between individuals' post- survey and pre- survey

4

means was then used to determine focus groups. Four focus groups were developed: one group with the most significant positive change, one with the greatest negative change, and two with 0 change or very little change (± 0.09). Group one had the most significant positive difference between post-survey and pre- survey. This group included five participants, with differences ranging from 0.82 to 1.45. One of the participants in this group was absent during focus group interviews, so only four participants were interviewed. The group with a negative change, group three, included four participants, with differences ranging from -0.73 to -0.55. Focus groups two and four had little to no change (± 0.09) and included six and three participants, respectively. Table 8 Individual Respondents' STEM-CIS Difference Between Means Mean Participant Pre-survey (n=33) Post-survey (n=31) Difference 1 3.09 2 4 3 4.27 4 4.27 5 4.73 6 3.64 7 3.91 8 3.18 9 3.82 10 3.55 11 3.82 12 3.27 2.73 -0.36 4.82 0.82 4.91 0.64 3.45 -0.82 4.64 -0.09 3.64 0 3.18 -0.73 3.64 0.45 4.36 0.55 3.91 0.36 3.91 0.09 2.73 -0.55 13 1.9 14 2.82 15 4.09 4 -0.09 16 2.73 4 1.27 17 3.60 3.91 0.31 18 4.09 4.36 0.27 19 2.64 4 1.36 20 1.82 3.27 1.45 21 3.27 3 -0.27 22 3 3.91 0.91 23 2.36 2.27 -0.09 24 3.55 4.09 0.55 25 3.27 2.73 -0.55 26 3.27 3.36 0.09 27 2.70 2.36 -0.34 28 3.73 3.64 -0.09 29 3 3 0 30 2 2 0 31 3.82 4.27 0.45 32 3.36 3.73 0.36 33 2.45 2.91 0.45 Note. Numbers were randomly assigned to participants. Two participants (13 and 14) did not respond to the post-survey. Focus Groups Four semi-structured focus groups were conducted. The data was transcribed using REV. The REV transcriptions were verified and then analyzed by the lead researcher. The focus group structure, including the range of participants' difference between means, length of focus group interviews and the number of participants is displayed in Table 9. Focus group one, which consisted of participants with the most significant positive change, included four students and lasted approximately 12 minutes. Group two lasted about 10 minutes and included six participants with little to no difference between their survey means. Group three, the negative change group, had four participants and lasted 11 minutes. Group four consisted of three students with little to no change, and the interview lasted around 10 minutes. Table 10 displays the questions used to guide the focus group interviews and the SCCT aspects that align with those questions. Table 9 Focus Group Structure Focus Group Time Number

of Students 1 (0.82 to 1.45) 12 minutes 4 2 (-0.09 to 0.09) 10 minutes 6 3 (-0.73 to -0.55) 11 minutes 4 4 (-0.09 to 0.09) 10 minutes 3 Note. The difference between survey means is presented in parentheses. Table 10 Focus Group Questions and Aligning SCCT Aspect Focus Group Question SCCT Aspect - What did you learn from the experience? - Do you feel that you can do well in a CS activity? Why or why not? - Could you see yourself using computer science in your future career? Why or why not? - Could you see yourself using computer science outside of school? How? - What did you like about the CS experience? - What did you dislike about the CS experience? - - - - Self-Efficacy Personal Goal Interest in Computer Science What careers could you do if you learned a lot about computer Outcome Expectations science? What would your parents think if you pursued a career in computer science? What did you know about computer science before this experience? What can be done to improve this experience? Personal inputs Do you know anyone that uses computer science at work? Contextual supports and barriers In every focus group, students were asked: What did you learn from this experience? In Table 11, themes from the analysis of the focus groups are presented, along with the number of comments participants made relating to that theme. Several participants made comments about programming or coding in general. A few participants mentioned programming-specific terms, such as loops, variables, and events, and a few mentioned Scratch-specific content, such as backdrops and characters. A participant in group four said, "But we learned a lot about the programming. Like how to use variables in the thing and how to ask questions". How to make an application and learning about science content were also mentioned. Table 11 Responses to: What did you learn from the experience? (Self-efficacy) Theme Number of Comments Scratch specific concepts (backdrops and 5 characters) Coding 4 Computer programming concepts (loops, 4 variables, events) Programming 3 Science content (atoms) 1 Application development 1 Table 12 displays common themes and a corresponding number of comments focus group participants made when asked: Do you feel you can do well in computer science activities? Many students shared that they felt they could do well in computer science activities and gave reasons related to gaining knowledge, computer science became easy and being good at computer science. Several participants also shared that they do not think they could do well in computer science activities. A participant in group three stated, "It's like a 50/50, I don't know. Usually, I just don't pay attention. I just like being on electronics. I'm gonna be honest." Another participant in group three shared, "Sometimes it gets a little complicated. Like, with uh, with all these commands, it gets complicated." A student in group four said, "Well, we did learn a lot about it in the past few weeks. But we're not very g... Or I'm not very good at it. But I- I could." Table 12 Responses to: Do you feel you can do well in computer science activities? (self-efficacy) Theme Gained knowledge Got easier Complicated Good at it Not good at it Number of Comments 5 3 1 1 1 When asked if they could see themselves using computer science in a future career, a participant in group three shared, "Yes. It's in a car. I- I'm a police officer, so they have to have the- the computer right next to them." After stating no, another member of group three said, "Uh. Because I don't see me, like, really using it that much, uh, I like it, but it's not useful to me." Every participant in group four said no. After stating no, one participant in this group said, "Because I really want to be a police officer." While another participant said, "I want to be a lawyer," and a third participant shared, "Uh, I want to be a singer." Across the groups, several participants commented that most future jobs would require computer science knowledge. After stating that most jobs will require computer science knowledge in the future, participants of focus group two discussed whether or not they believed everyone should learn computer science. One participant said, "Yeah, not everybody has to, but I- I feel like it would be a cool side thing to know." Another participant said, "You can if you want, but not everybody has to do it."

wanted to be computer scientists, across focus groups, the word proud was shared by six different participants. One participant in group three said, "Um, a little bit mad because my parents don't like me on electronics that much. My dad doesn't have a problem with it. It's just the stuff that we have to do. We have a lot of work. Especially with the talk about it in our hands." Across the focus groups, various responses followed the question - what did you like about the computer science experience? The themes identified and the corresponding number of comments are presented in Table 13. Five students described the experience as fun. Four students stated that they enjoyed the coding aspect of the experience. A member of group four said, "Well, it helped us learn a lot of stuff about programming and how to make an app. Well, we learned a lot of stuff along the way to make the app." Two participants expressed that they liked using the Scratch platform, with one saying, "It was fun, and I liked how we did it on Scratch." One student shared that they liked making a clicker game. A participant in group two liked being creative, saying, "It was fun, and I liked how we could kind of create anything we wanted with it." One student in group three shared that they liked "showing other people" their program. Two students said they liked the teaching method used to learn the computer science content, with one of the students in group three saying, "Um, I liked how you taught it to us like not just tell us." One student in group three shared that they liked completing their app and said, "It makes me feel good whenever it's all done and everything- it works well. There's nothing that needs to be fixed or anything. And that the app works correctly." Another member of group three said, "Getting to kind of experiment with it and figure out how to do it." Table 13 Responses to: What did you like about the computer science experience? (Interest in CS) Theme It was fun Number of Comments 5 Coding 4 Creating a program (clicker game, application) 4 Learning about programming 3 Making it Better (adding designs) 2 Scratch platform 2 Teaching method 2 Creativity 1 Showing other people 1 Across the focus groups, there were several reoccurring themes about what students disliked about the experience, displayed in Table 14. Three students expressed that they disliked the magnitude of coding. One student mentioned they disliked having to duplicate code. Two students expressed that the experience was confusing sometimes. Three participants shared that they wanted the experience to go on longer. One participant expressed problems with the scratch application not saving their project. A participant in group four said, "Well, sometimes you use the wrong programs, and then you have to start over with doing that and have to figure out the right program to use." Table 14 Responses to: What did you dislike about the computer science experience? (Interest in CS) Theme Number of Comments Lots of Coding 3 Not enough time (I wish it went on longer) 3 Confusing 2 Duplicating everything 1 Scratch platform (did not save) 1 A few participants stated they knew someone who uses computer science at work. A person in group one shared that their uncle makes video games. A participant in group two said, "My- my brother didn't do it as a job, but he built his own PC, and he had to code some stuff to it." Two members of group two said their parents did, with one saying, "My dad used to. Uh, he drove big semis." And the other said, "My mom does- she does taxes." Two members of group four also said they knew someone, one saying, "My brother... he works at a school. As a teacher." And the other saying, "Well, I think my uncle's an engineer. So, I'm pretty sure he's..." Two participants in group four expressed disinterest when asked if they could see themselves using computer science outside of school. One participant said, "Because usually I just want to relax. And the other stated, "It's kind of hard to find information about it. Kind of- ish." Table 15 displays how students could see themselves using computer

science outside of school. Across the focus groups, participants shared that they could see themselves using computer science outside of school to create video games, applications, and movies. One student expressed interest in using a different platform called Roblox.

Table 15 Responses to: Could you see yourself using computer science outside of school?

(Personal goal) Theme Number of Comments Making video games 4 Make a movie 1 Make an app 1 Roblox 1 Groups three and four were asked: what can be done to improve this experience? A participant in group four suggested providing an opportunity for students to create other applications, "Um, probably helping us to make a thing, for like, social studies? Well, help us do other kinds of stuff. Like, different apps because there can be a lot of different kinds and stuff." A participant in group three suggested a similar improvement saying, Like, try to like, interest them. Like, interest them. Uh, by like telling them what you could do and the things. Another participant in group three simply suggested, "Maybe continue to do it," regarding the computer science treatment. Outside of this study, some students had prior computer science experience.

Table 16 displays themes from participant responses about their prior computer science knowledge. Three 94 comments were made about knowing how to use technology. Four comments were made about knowing computer was used to create video games and applications, with one participant in group four saying, "I knew we could make apps, but it was a lot more hard. Because we didn't know as much". Two participants mentioned they had used the Scratch platform before, and two others mentioned they used computer science in Lego League. Two participants also mentioned using other learning platforms, learning.com and code.org.

Table 16 Responses to: What did you know about computer science before this?

(Personal inputs) Theme Number of Comments I knew it was used to make video games and apps Knew how to use technology (turn on, get apps, and change settings) Experience with other platforms (code.org and learning.com) 4 3 2 Participated in Lego League 2 Used Scratch before 2 When asked - Do you see yourself using your apps later to study? – one participant in group four said, "Yeah. Because for the SOL test, it has one that fits together." Participants were also asked if they could see themselves using another student's app, and one participant said, "Because there's a lot of different ones that you could use." In focus group four, participants were asked to define computer science. One participant said, "Um, program something?" while another said, "From what we did is where you use a lot of stuff and you put it together to make one big thing. And then you use that, and then you get to have fun on it when you make it." Every focus group was asked - if you learn a lot about computer science, what kind of jobs can you do? Across the focus groups, participants gave a wide variety of responses. Themes identified from student responses are displayed in Table 17. Many participants mentioned application and video game development. One participant in group three responded, "Creating better things." A participant in group two said, "Uh, can help the people who have like medical stuff. You could have like a fake arm."

Table 17 Responses to: What jobs can you do if you learn computer science? (Outcome expectations)

Theme Number of Comments Video game developer App Developer Amazon Robotics Tesla Apple Building Creating better things Creating phones Develop new technology Engineering Gmail Medical device developer NASA Scientist Social media creator Underwater explorer Verizon Youtuber 4 3 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1

CHAPTER FIVE: DISCUSSION

This chapter will be a summary and interpretation of findings, in which the findings of this study will be compared to prior research on the topic of career interests. The researcher will share the implications of these findings. The researcher will also convey the study's limitations, recommendations for future research, and conclusions in this chapter.

Findings Summary

This study was performed to answer the research question: How does a design-based computer science treatment impact 5th-grade students' interest in computer science careers? The STEM-CIS was implemented using a pre-survey and post-survey design, and the difference

between these two means was found to identify any change following the treatment. A paired t-test was also calculated to determine if the change was statistically significant. The two-tailed paired sample t-test, calculated using the entire sample's ($n = 29$) pre-survey and post-survey data, yielded the result $p = .051$. This figure is slightly more than the significance level $\alpha = .05$, so the null hypothesis: the sample pre-survey and post-survey means are not significantly different, cannot be rejected. These results indicate that the difference between the means is not statistically significant. There was an increase in participants' responses on the post-survey ($M = 37.17$, $SD = 7.66$), following the computer science treatment, compared to the pre-survey ($M = 39.62$, $SD = 8.07$), $t(28) = -2.04$, $p = .051$. A paired t-test was conducted for each SCCT aspect on the STEM-CIS, to observe any changes related to these aspects following the treatment. Of all the SCCT aspects, contextual support demonstrated the greatest increase (+0.87) from pre-survey ($M = 4.65$, $SD = 2.11$) to post-survey ($M = 5.52$, $SD = 2.29$). The paired t-test comparing the contextual support items on the pre-survey to the post-survey produced statically significant results; $t(30) = -2.25$, $p = .032$. While all SCCT aspects are interrelated and affect one another, the interest aspect is the focus of this research. The SCCT aspect: Interest in Computer Science, increased 0.71 from pre-survey ($M = 6.65$, $SD = 2.11$) to post-survey ($M = 7.35$, $SD = 1.89$). The paired t-test, comparing the pre- and post-interest items, was statistically significant, $t(30) = -2.30$, $p = .028$. The mean of each item on the surveys was determined. Analysis of both surveys revealed an increase in eight out of eleven items on the instrument. The items with the greatest change were items CS7, CS8, CS9, and CS11 with increases of 0.32, 0.39, 0.45, and 0.42 respectively. Items CS7: I am interested in careers that involve computer science, and CS8: I like activities that involve computer science, align with interest, while CS9: I have a role model in a computer science career, and CS11: I know of someone in my family who uses computer science in their career are both aligned with the SCCT aspect, contextual support. Analysis of the qualitative data provided further insight into the quantitative findings. Regarding what participants liked about the experience, they commented about developing their applications, improving their creations, and sharing them with others. Although several participants expressed that they enjoyed coding, some students disliked the immense amount of coding necessary to develop their programs. Students also made comments about getting confused during the process. Following the intervention, several participants commented on how they gained knowledge from the treatment, stating that programming became easy and depicting confidence in their ability to program. While most focus group participants shared many positive sentiments, the opposite was true from select participants. Analyzing responses from group three, the participants with the most significant negative change, there were a few responses that provide further insight as to why their STEM-CIS responses decreased following the treatment. A participant in the negative change group also said, "Uh. Because I don't see me, like really using it that much. Uh, I like it, but it's not useful to me." when asked about using computer science outside of school. Having already established career aspirations was an unexpected response from focus group participants. During the focus group interview, all three participants in group four had expressed career goals, none of which were in computer science. These findings contradict popular career theories, which suggest career aspirations develop between 11 and 14 years of age (Gottfredson, 1981; Lent et al, 2002; Super, 1953). Although students in 5th grade are customarily 10 – 11 years old, several participants in this study had expressed apparent career interests in mind. Implications This study provides evidence contributing to a further understanding of computer science education. Following the intervention, participants overall responses on the STEM-CIS increased, specifically the items aligning with interest in computer science. These results suggest that career-related learning experiences, such as the treatment implemented in this study, positively correlate with increased student interests. Beyond early learning

experiences, the findings of this study also support the use of design-based learning as an instructional method to foster students' interests in the field of computer science.

Necessity of Early Career Experiences

A fundamental tenet of Lent et al.'s (1994) SCCT is the importance of educational experiences to promote interests that lead to career aspirations. The findings of this study support that tenet: following the treatment, 10 out of 11 items increased, and the items related to interest in computer science were among the items with the most significant increase. These results align with those of Tran (2018), who observed the impact of ten 60-minute hybrid computer sciences lessons on elementary-aged participants' career aspirations. Tran found that the experience increased participants' perceptions of STEM and computer science and their career aspirations in STEM careers. Hutchinson et al.'s (2019) also implemented a career-related experience. The researchers administered the science subscale of the STEM-CIS before and after a lesson in which sixth-grade students mimicked a genetic counseling visit. The researchers found a statistically significant increase ($p=0.0488$) for item 9: I have a role model in a science career, which aligns with the SCCT aspect of contextual support. Similarly, to the findings of Hutchinson, item 9: I have a role model in a computer science career, had the greatest increase following the treatment implemented in this study. The findings of Hutchinson et al. (2019) support this research project, suggesting that career-related learning experiences can help students find career-specific role models. According to SCCT (Lent et al., 2000), contextual supports, such as career role models, directly influence an individual's choice goals and choice actions. Choice goals and choice actions are one's intentions to pursue a particular career and the actions taken to obtain that career. Unlike this study, the participants in Hutchison et al.'s (2019) study did not demonstrate an increase in item 7: I am interested in careers that use science, but rather a decrease from pre-survey ($M=4.00$, $SD=1.26$) to post-survey ($M=3.67$, $SD=1.21$, $p=0.9703$). There was also a slight decrease for item 8: I like my science class, from pre-survey ($M=4.83$, $SD=0.41$) to post-survey ($M=4.80$, $SD=0.45$, $p=0.6813$). These items align with the SCCT aspect, interest. The researchers reference the small sample size ($n=6$) and short intervention as limitations of their study. These limitations may explain the difference between the findings of this study and Hutchinson et al.'s (2019) study. While Hutchinson et al.'s (2019) treatment was a single, 40-minute class session, the treatment in this study spanned over nine days, for eight and a half contact hours. Continued activity is another principle of SCCT: "Through continued activity exposure, practice, and feedback, people refine their skills, develop personal performance standards, form a sense of their efficacy in particular tasks, and acquire certain expectations about the outcomes of activity engagement" (Lent et al., 2002, p. 751). The treatment in this study provided continual exposure and practice with computer programming, resulting in increased computer science self-efficacy and outcome expectations. The results of this study support this principle of SCCT and contribute to a clearer understanding of the necessity of continual career-related experiences to develop career-related interests.

Value of Design-Based Learning

The findings of this study provide evidence that supports the use of design-based computer science instruction to increase 5th-grade students' interest in the field of computer science. This study used DBL to aid students in developing their applications. Participants were presented with a problem that they needed to create an application to solve. Participants had a significant degree of autonomy with their applications as long as their programs met a short list of specifications. Some participants favored an increased level of autonomy, with one participant saying, "It was fun, and I liked how we could kind of create anything we wanted with it." Emphasizing autonomy over learning is a principle of DBL (Jones, 2009; Wells, 2016). The results of this study provide further data that supports learning approaches with a high level of student autonomy to increase student interest in a content area. Another principle of DBL is providing opportunities for students to

experience success, increasing self-efficacy, and influencing interests (Lent et al., 1994; Wang & Degol, 2013; Wigfield & Eccles, 2000; Wigfield et al., 2015). The DBL treatment in this project allowed participants to design a working application, thus experiencing success. Following the treatment, both items aligned with self-efficacy increased, CS1: I am able to do well in activities that involve computer science (+ 0.26) and CS2: I am able to complete activities that involve computer science (+0.3). Although they also implemented a design-based treatment to observe a change in students' career interests, the findings in Jackson et al.'s (2018) study differed from the findings of this study. Jackson et al. (2018) administered the engineering subscale of the STEM-CIS before and after implementing a 10-session, design-based robotics unit to measure a change in interest. The participants did not demonstrate a statistically significant increase from the pre- lesson survey ($M=3.23$, $SD=0.85$) to the post-lesson survey ($M=3.17$, $SD=0.89$), but rather a slight decrease (-0.06). Out of 279 participants, only 9 (3.23%) had increased interest following the lessons. The researchers speculate that challenges with the curriculum may have impacted participants' perceptions of their success during the design experience. To address this, the researchers revised the curriculum, emphasizing iterations, to help participants become more accepting of failure through the design process. Jackson et al. (2018) also emphasized the societal benefits of students' design solutions. The findings of this study may differ from those of Jackson et al.'s (2018) because the treatment emphasizes iterations and societal benefits. The Scratch platform is inherently iterative, as programs will not function properly until a working code is entered. Participants were also frequently encouraged to test and debug their programs, provide feedback to one another, and enhance their programs beyond meeting the established design criteria. As a part of the design challenge, participants were made aware of the difficulties fifth-grade students have passing state-mandated tests. The participants were then challenged to develop applications to help students prepare for these state-mandated tests. Designing applications to help other students highlights the societal benefits of learning to program. The treatment in this study was purposely created using DBL methods. The increase in participant responses on the STEM-CIS, specifically the self-efficacy and interest aligning items, implies that DBL is a practical approach for fostering students' interest in computer science. Limitations In educational research, many confounding variables can impact the validity and reliability of findings. These variables, such as participant absence and experiences independent of the study, can be challenging to control. Although steps were taken to increase internal validity, such as having participants complete the STEM-CIS immediately before and after the treatment, other external factors could have influenced student responses. The generalizability of the results is limited because participants in this study were from two different classes within the same school. The sample size in this study was also relatively small and did not achieve the recommended sample size from a prior analysis. When performing a two-tailed paired t-test, to achieve a statistical power ≥ 80 with a large effect size and 95% confidence interval, the sample should include at least 34 participants. A post hoc analysis, with the same parameters, and a sample of 29, the power achieved was 0.74. Additionally, the original STEM-CIS was designed for 6th to 8th-grade participants. Further making the STEM-CIS a challenging instrument for 5th-graders to understand. The instrument was read aloud, and students were encouraged to ask clarifying questions. As a part of the study, students completed the first implementation of the STEM-CIS without a definition of computer science. Although not defining computer science may yield more accurate pre- survey responses, some students may have yet to understand the term computer science fully. A limitation of the methodology used in this research project was the organization of focus groups. Students were reluctant to share their thoughts, even when probing questions were asked. Students often answered with closed-ended responses and responded with "I don't know" when

probed for an explanation." The focus group was semi-structured, allowing students to guide the conversation and share ideas. The interviews went much quicker than anticipated. Interviews were scheduled for 30-to-45-minute blocks but concluded within 10 to 12 minutes. Although the focus groups did not go as anticipated, there were a few notable responses from students, and common themes could be identified. Recommendations Future studies should consider the previously stated limitations. Further research that addresses these limitations can be done to provide increasingly reliable and generalizable data, furthering our understanding of computer science education and how to design curricula that foster and sustain interest in the field of computer science. A study with a larger sample size, can provide data with greater statistical power. A study that is spread across multiple research sites can provide more generalizable results that can be applied to a larger population. In a similar study, implementing teacher-led focus groups may produce higher-quality responses from participants because students feel more comfortable sharing ideas with someone, they have developed a strong rapport. Further

research is needed to understand the unanticipated findings of this study

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better. Unexpectedly, many participants in this study had established career goals. In popular career theories, career goals do not develop until after 5th grade (Gottfredson, 1981; Lent et al., 2002; Super, 1953). These theories agree that interest development, the precursor to career goals, solidify during late adolescents; although SCCT posits interests can change in post-adolescents from learning experiences that alter ones'

self-efficacy beliefs and outcome expectation (Lent et al., 2002). The timeline for

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career goal development, proposed in these theories does not align with the qualitative findings of this study. Krumboltz (2009) suggests it is simple for children to state occupational goals, but choice action, which succeeds choice goals in SCCT (Lent et al., 1994), is a much more demanding task. To better understand when and how career choice goals form, a similar study with younger participants would provide valuable data. A longitudinal study, starting in early childhood, would also provide compelling evidence on the impact of a design-based computer science treatment on individuals' career-related development over time. Another surprising result was the outcome expectation aligning items, CS5 and CS6, decreasing

from pre-survey (M =7.06, SD=1 .18) to post-survey (M =6.09, SD=1

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.64). Avenues for further research include observing the impact of career-related experiences on students' outcome expectations. For a more compressive understanding of career-related interests and goals development, additional research

can be done on each of the SCCT aspects that influence interest and career choice. This study focused on the SCCT aspect of interest, which is influenced by other aspects, including

self-efficacy and outcome expectations (Lent et al., 1994). Future research

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should measure any change to participants perceived self-efficacy and outcome expectations following a career-related experience to better understand how these aspects influence one another. Conclusion The findings of this study help answer the research question: How does a design-based computer science treatment impact 5th-grade students' interest in computer science careers? Participants demonstrated an increase in their career-interest survey following the DBL treatment. Focus group participants also shared many positive sentiments about the teaching methods and increased interest in computer science. These findings suggest that design-based learning is effective for fostering 5th-grade students' interest in computer science. To prepare students to be successful in the growing field of STEM and computer science, providing practical career-related learning experiences is critical. These findings can be used to develop more effective computer science education. Design-based learning is a practical approach to fostering student interest in the field, leading to career goals and actions. 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 49 50 52 53 54 55 56 57 58 60 61 62 63 64 65 66 67 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 95 96 97 98 99 100 101 102 103 104 105 106

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