Parental Perceptions of Elementary Aged Children Learning to Code

David Daniel

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Peter J. Rich, Chair
Ross Larsen
Jason McDonald

Department of Instructional Psychology and Technology

Brigham Young University

ABSTRACT

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David Daniel
Department of Instructional Psychology and Technology, BYU
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Little research has been conducted to understand the role that parents play in children learning to code even though coding has become a necessary skill for students to successfully study STEM (Science, Technology, Engineering, Math) subjects. After identifying five factors that would influence parental perceptions, we developed a survey and administered it to parents of elementary aged children. We validated the survey using a confirmatory factor analysis and structural equation modeling. To be considered valid, factors needed to meet three of the following four fit statistics: RSMEA < 0.08, SRMR < 0.08, CFI > 0.9, TLI > 0.9. Items needed to have a factor loading > 0.3 with a significance of < 0.05. The results confirmed two factors, Parent & Child Interaction with Technology and Parents' Attitudes Towards Coding and Gender. The parent's coding experience and age, child coding experience, and living in the Western United States are significant in predicting the Parent & Child Interaction with Technology factor. The child's grade level and experience coding and living in a suburban area in the Western United States are significant in predicting the Parents' Attitudes Towards Coding and Gender factor. Although these factors proved significant, difficulties with the data make the model limited and additional revisions to the survey are needed. The revised survey will need to be administered again to validate a more robust model.

Keywords: coding, computation, parent participation, parent attitudes, gender bias, STEM education

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CHAPTER 1

Introduction

Research into STEM (Science, Technology, Engineering, Math) has taught us three things. The first, is that there is a concern that not enough young people are equipped to study, or decide not to study STEM fields (Stevenson, 2014). The second, as Weintrop et al. (2016) points out, is that "nearly every field related to science and mathematics has seen the growth of a computational counterpart" (p. 128). And finally, are the troubling findings about declining rates of participation in STEM fields (Chen, 2013). Looking closely at these findings, we can discern two needs of students in STEM subjects. The first need is that we must equip students to successfully study STEM subjects, specifically by addressing the computation counterpart through coding. The second is the need to encourage participation in STEM subjects by offering proper support to students in STEM subjects and encouraging individuals to enter those fields. In addition to helping with STEM education as Weintrop pointed out, the skill to code is now considered an essential 21st century skill (Nambiar, 2020) and therefore beneficial for everyone to learn. This is likely the reason why coding has become increasingly popular with sources like Code.org and why coding is being taught more in schools worldwide (Mason & Rich, 2020).

Understanding our students' and teachers' attitudes can help us better equip students to succeed, which helps to address the first need we previously mentioned. The push to involve more children in computational activities has likewise resulted in several ways to measure its effects. For example, problem-solving tests have been developed to measure cognitive effects (da Cruz Alves et al., 2019). Measures have been developed to gauge how learning to code affects students' attitudes toward computing (Mason & Rich, 2020), as well as teachers' cognitive and affective development in learning to code and to teach computing (Mason & Rich, 2019).

However, focusing on the student is only part of the picture - there is still a need to address how we can successfully support students to succeed with coding. One solution to this is focusing on the parents.

Statement of the Problem

In addressing the need to support students, we turn to Bronfenbrenner's (2009) framework for human psycho-social development. Bronfenbrenner explains that human development occurs in a setting of different types of systems. The closest ecosystem to the individual, the microsystem, has the most influence on the individual through their development. An important part of this ecosystem is the family. Taking Bronfenbrenner's ideas from an educational perspective, this would mean that parents play one of the most crucial roles in helping children develop and succeed in school. This is supported by a wide range of literature about how important parents' roles are in the success of their children (Castro et al., 2015; Galindo & Sheldon, 2012; Hoover-Dempsey & Sandler, 1995; Hoover-Dempsey et al., 2002; Lee & Bowen, 2006; Williams et al., 2002). Recent research on children's attitudes toward coding supports this family-centered perspective. In fact, elementary students' perceptions of their parents' and peers' attitudes toward coding was found to be the strongest influencer of their own attitudes toward coding (Mason & Rich, 2020). With parents playing such a central role in children's development, understanding their perceptions on coding and how they can support children are critical in successfully equipping students succeed and continue studying STEM subjects.

Statement of the Purpose

We have seen that there is a large amount of literature on how parents can support their children in education on a more general level. Unfortunately, there is a lack of literature on how parents can specifically support their children in learning how to code. In this paper, we identify the ways parents help their students succeed in school. We then translate those findings into items for a survey that will help measure parents' perceptions of elementary children learning to code. We then validate the tool to ensure we truly are measuring parental perceptions of coding in elementary education.

Research Questions

We address following to research questions in this study:

1. In a survey to assess elementary aged students' parents' perceptions toward coding, does the hypothesized model and its factors fit the data as assessed by a confirmatory factor analysis analytical approach?
2. What predictive variables are significant for the factors from RQ1 regarding parents' perceptions towards elementary aged students' learning to code?

CHAPTER 2

Literature Review

As there is little research on parents' attitudes toward their children learning to code, we pulled from a wide array of literature to identify relevant constructs. Our literature ranges from parents' involvement in their children's education at a general level, to parents' attitudes towards technology specifically, and to how parents interact with technology with their children. The five constructs that influence parents' attitudes toward coding are as follows:

- Parents' Current Involvement with their Child's Education
- Parents' Attitudes Towards Technology
- Parent & Child Interaction with Technology
- Access to Technology in the Child's Home & Digital Competency
- Parents' Attitudes Towards Coding and Gender

In the following literature review, we explore each construct individually, emphasizing its importance to helping a child succeed in school and how it may influence a parent's perceptions about their child learning to code. Research also made it clear that socio-economic status (SES) and demographic characteristics influence these constructs. Therefore, we will examine those as well.

Parents' Current Involvement With Their Child's Education

Based on Bronfenbrenner's (2009) framework, it is no surprise that parental involvement would influence a child's education. However, Pomerantz et al. (2007) identified that the quality of parental involvement can make a significant difference in the child's success while Galindo and Sheldon (2012) argued that family involvement at school and parents' educational expectations affect academic achievement. These two findings help explain why parental involvement is so crucial. Based on this, we have defined this construct specifically as how the parent is involved with the child's learning at home and school.

Involvement with school from kindergarten to upper elementary has been linked to increases in literacy by the fifth grade (Galindo & Sheldon, 2012). However, these studies point out what appear to be certain factors that can influence parental involvement such as parents' idea of their role (Hoover-Dempsy & Sandler, 1995) and the amount of outreach by the school to the parents (Galindo & Sheldon, 2012). In addition, parents want to be involved in their children's education. Williams et al. (2002) found that almost one-third of parents feel very involved in their child's school life, about 75% wanted to be more involved, and over half felt they had equal responsibility as the school in their child's education. In short, parents recognize the importance of being involved in their children's education and, on the whole, recognize a need to be more involved.

When approaching the question of parents' involvement at home, we specifically focused on their attitudes and beliefs about their children. Research reveals that higher expectations from parents results in higher academic achievement. For example, a parent's beliefs and views of their child's potential enhances a child's achievement (Pomerantz et al., 2007). This is true across the board, but also of minoritized students (Feuerstein, 2000). What's more, the effect of parental expectations starts at the earliest years of education; higher educational expectations resulted in greater gains in reading and math as early as kindergarten (Galindo & Sheldon, 2012).

From these findings, we might expect parents who are more involved with their school and those with higher expectations for their children to have better perceptions towards their children coding. On the other hand, those who don't have high expectations may have negative attitudes.

Parents' Attitudes Towards Technology

This construct is defined as anything related to parents' personal perceptions and experiences with technology as well as their thoughts about technology regarding their children. This is based on the findings of Kirkpatrick and Cuban (1998), who point out that perceptions towards computers are linked to one's experience with them. Specifically, we find that parents' perceptions towards their children's media intake, and the parents' past experience with coding and computers influence their perceptions.

Perhaps the most clear-cut example of how parents' perceptions towards technology could influence their attitudes towards technology and coding is laid out by Schiano et al. (2016). They found that parents' primary concern regarding technology was addiction. They also found that 81% of parents try to manage their children's digital media use in some way. As Grandjean (2002) points out, there is a digital divide among generations, which may account for parents' concerns. In other words, if parents are already concerned about their child's media intake, it may influence whether they support their child learning to code, and that concern could be linked to parents not having grown up with modern technology.

Exposure to technology seems to play a role, but exposure to computer science (CS) and coding specifically also plays a role. D'Alba and Huett (2017) found that a child's interest in CS was influenced by having someone at home who inspired them to try it. They also found that attitudes about CS in general, whether parent or child, increases with interest and awareness. In some cases, parents just haven't been exposed to coding. For example, Aguilera (2018) found when interviewing one parent that they thought that literacy in reading and writing would greatly influence one's ability to code. Another parent expressed similar thoughts but about math.

In summary, it appears that parents seem to already be wary of the amount of time their children use media and are also influenced by their exposure to coding and computer science. As such, this construct should focus on identifying information regarding parents' experience levels with coding, their attitudes towards technology in general, and attitudes towards coding being taught in school. We would expect parents who have experience with coding and technology to have more positive attitudes towards elementary children learning to code and those who are worried about their children's technology use to have less favorable attitudes.

Parent and Child Interaction With Technology

"The significance of parental and home-based involvement with technology is affirmed with it having the greatest impact on student attainment" (Grandjean, 2002, p. 13). Margolis and Fisher (2002) also emphasized that "parents impart their computer enthusiasm and skills to their children, and through early mastery acquired at home children gain a competence and confidence they carry with them into school" (p. 20). Based on these quotes, we defined this construct as anything involving parent, child, and technology interactions in the home. Mothers and fathers can play different roles in this and either parent becoming involved as a tutor has an impact.

In a review of a summer coding program, Clarke-Midura et al. (2018) found that a mother acting as a co-learner with a child helped motivate the child. They also found that mothers providing administrative and emotional support had a positive effect on their child's experience learning coding. For a father, they found that modeling had a positive effect on their child's experience. They also pointed out that investigating parental support as an umbrella is problematic because each parent has different contributions.

Rideout and Hamel (2006) found that only 35% of children ages 4 to 6 years that use computers on a typical day are doing so with parental help. This is surprising as there is significant evidence that parents assisting with technology is beneficial. For example, Lin and Liu (2012) found that in parent-child collaboration in learning computer programming, children were willing to accept their parents' guidance, children wrote programs that were more systematic, spent more time on analysis and design, and the programs were better structured. This is supported by Magnuson and Schindler (2016) who found that parents trained to act as tutors had a large effect on their student's success and Lauricella et al. (2008), who found that "through parental scaffolds, the child is continually supported in achieving new skills" (p. 5).

Based on this literature, it's clear that a parent's involvement not only with education in general, but specifically engaging with technology is a critical factor in student success. Measures for this construct should gauge a parent's willingness to help or teach their child with technology; furthermore, specific mother/father roles may reveal ways in which parents interact with their children and technology to influence their attitudes toward coding.

Access to Technology in the Child's Home and Digital Competency

In attempting to define this construct, we found that it had broad meaning. Conventional wisdom tells us students need access to a computer at home to succeed, plus access to the internet. In addition, and because of advances in technology, a child may not need a computer, but rather any computing device that allows them to code. There is also the question of how a child is using the access they have. All these factors play into a child's current digital competency, which can influence how successful they might be at coding.

Lauman (2000) laid an excellent foundation for this construct when computers and the internet began to be commonplace. They found that all school-aged children, regardless of gender, used computers for recreation-type activities. Children were also unable to self-initiate activities, and so many used computers for gaming activities; it was hard for them to be motivated to do anything else. They also found that parents often lacked the ability to use computers for academic support, even though "it is important for children to observe parents using the home computer for productive purposes, perhaps those relating to work" (p. 201).

Lauicella et al. (2008) later found that only 43% of children ages 4 to 6 used a computer several times a week and that the cognitive demand of using a mouse may be more challenging for younger children. However, they noted that through parental scaffolds, the child can learn the new skills. This matches Aguilera's findings (2018) that “age was also a variable that influenced middle school students’ digital competence” (p. 12). In regard to children’s access to computers, it is important to note that the advent and increased ubiquity of touch-enabled computing since that time has likely made this number conservative by today’s standards. Research in the past decade has revealed that preschoolers in various developed countries spend over two hours per day with screens and that from 2013 to 2017 alone their device use tripled (Dore & Dynia, 2020).

Based on this literature, we might expect that a parent would have different perceptions toward computing depending on how much a child uses the computer, and whether it is being used for educational or recreational activities. How competent a child already is with a computer will likely influence perceptions as well.

Parents’ Attitudes Towards Coding and Gender

This construct is much more easily defined as historically, there has been a gender gap in the computer science (CS) field (Kirkpatrick & Cuban, 1998), which has only become more pronounced over time. As such, we wanted to make sure we addressed gender issues, as they are likely to influence a parent’s perceptions towards their children learning to code.

The gender gap can be contributed to by several people, not just parents, but all interact with each other. Even before the turn of the century, one study found teachers, parents and guidance counselors were more likely to encourage boys than girls to pursue the CS field (Kirkpatrick & Cuban, 1998). This same study outlined how culturally, computers are viewed as a male pursuit and that females don't get as much experience with them. Fast forward 15 years later, and this problem was still present. A Google Inc. survey (2014) found that only 26% of CS and Mathematical Science professionals were women. Furthermore, their decision to pursue CS or mathematics occurred before they began college, when they still lived with their parents. This further emphasizes the importance of parents' influence on their children, in this case specifically about CS fields.

Even though there has been a gender gap, research has shown how parents and others can help. In the same study, Google Inc. (2014) identified four factors that influence a child's decision making to pursue CS: *social encouragement* (i.e., from a parent), *self-perception*, *academic exposure, and career perception*. Clarke-Midura et al. (2018) confirmed the social encouragement factor as they found that both a father's and a mother's support led to an interest in CS. They stated, "by simply having a conversation about the value of CS and the future opportunities afforded by a CS degree, parents may be able to improve their child's perception of CS utility value" (p. 216). And about the differences in gender specifically, they found "the primary predictor of girls' self-efficacy was their parents' emotional support, while for boys it was their career-related modeling" (p. 216). Thus, for girls more than boys, it may be especially important for parents to express support of interest to study and pursue computer science.

Forssell et al. (2008) pointed out, parents do not need to provide direct technical expertise in order to support their child's acquisition of digital media skills. Their attitude and support alone can influence their child's decisions regarding coding. Therefore, we would predict that how a parent feels towards coding would influence how they felt about the different genders coding as well as children as a whole.

Parents' Socio-Economic Status, Demographics, Education, and Work

SES and demographic information-specifically the parents' educational background, income, race, and ethnicity-are likely to influence a parent's involvement with a child and their perceptions about coding as well. We will explore how each influences their children's education and how it may play a role in a parent's attitudes toward coding.

SES and demographic information, like race and ethnicity, significantly influence a child's education (Feuerstein, 2000). For example, children living in economic difficulties demonstrate lower cognitive development and skills than those in better economic circumstances (Ross, 2018). In addition, Thomsen (2015) and Lee and Bowen (2006) found that parents' SES is significantly associated with academic success. Thomsen specifically points out that low academic performance and low income are linked. He also found that SES and a student's grades are the most important variables associated with parental involvement in a child's education. Building off this idea, involvement in children's education tends to be lower for single parents, African American, and Latinos in the United States (Zellman & Waterman, 1998). Lee and Bowen (2006) had similar findings when they found that European American children had higher academic achievement than Hispanic/Latino and African American children. This may explain why Terriquez (2013) also found that the Latino students, who have the lowest median income of all major ethnicities (Kochhar & Cilluffo, 2018), have a lower-than-average graduation rate and participate less in secondary education than any other racial or ethnic group. We do not intend to imply that these groups are less interested in their children's education. In fact, the reason that many people immigrate to the U.S. or another, more developed country, is to provide a more hopeful future and economic opportunity for their children. Rather, we believe that a parent's socioeconomic status and work conditions may help promote or prevent involvement in their child's education.

A parent's education also plays a large role in a child's education. On a general level, Hoover-Dempsey and Sandler (1995) found that less educated parents are less involved in their children's education than more educated parents. Terriquez (2013) and Abel (2012) also supported this when they found that fathers with high levels of education are more likely to participate in a child's education while those with less education spend less time with their children. The mother's education also plays a role, although with more mixed results. One study found that a mother's work or school may impose barriers to involvement (Weiss et al., 2003) while another found that highly educated mothers spent more time with their children (Thomsen, 2015). Even with these results, the idea that more educated parents tend to be more involved in a child's education may help explain why Ross (2018) found that parental cognitive stimulation is a consistent predictor of children's academic achievement.

Based on these findings, it is reasonable to assume that parents with higher SES, those in certain racial and ethnic groups, and those with more education are likely to have more positive attitudes towards coding. This would likely appear because the parents are more available and able to be involved with their child's education.

CHAPTER 3

Methods

After reviewing the literature and defining our five constructs and SES and demographic predictive variables, we went through two steps to create the instrument: item generation and consideration of the format. After creating the instrument, we followed three steps to collect data and validate it: (a) think aloud, (b) snowball sampling, and an (c) analysis of the results. Originally our research questions focused on all K-12 students. However, as we developed the instrument, it became clear we needed to ask an entirely different set of questions to tease our perceptions in secondary education. Thus, parental perceptions of their children learning to code in secondary education fell outside the scope of this study and will be examined in future research.

Item Generation

As there we are no current surveys that match the identified five constructs regarding parental influence of a child's attitudes toward coding, we consulted and adapted questions from other surveys, such as the Elementary Student Coding Attitudes Survey (ESCAS; Mason & Rich, 2020), the Teacher Beliefs about Coding and Computational Thinking scale (TBaCCT; Rich et al., 2020), and Google Inc. and Gallup (2016), as well as generated original questions that address these constructs. Our goal was to produce approximately 50 questions, with 7-8 questions per construct. This would enable us to gather ample data about each construct. As our goal for the survey was for it to only take approximately 10 minutes to complete, we anticipated that the final version of the survey may be cut down to less than 50 questions depending on how the questions contribute to the different factors. See Table A1 in Appendix A for the first draft of current questions.

Format

There were four primary concerns we focused on in developing the format of the instrument: audience use, reading level, question type, and positive wording. In phrasing the questions, one of our primary concerns was determining the audience, specifically if the single survey would account for multiple children or a single child, and whether it should be written toward both parents or a single parent. Our biggest concern with having multiple parents take it or for parents to fill it out for multiple children was survey fatigue. On the one hand, asking each parent to complete a survey for each of their school-aged children could provide a rich and detailed dataset. However, this was likely to lead to survey fatigue and would result in incomplete answers, especially for households with multiple children. Consequently, we planned on writing the instrument in such a way that a parent fills out a single survey, with question branching based on whether the parent is a mother or father and whether the parent has school aged boys or girls. We planned on leaving it up to those using the instrument to determine if they would like it filled out by multiple parents.

Our question wording was written at a high school level, as this instrument would originally be used for any age group in the K-12 range. The instrument would be a combination of closed-answer questions, as well as Likert scale questions when appropriate. We do not believe a person can have a “neutral” confidence, so we planned on using a 6-point Likert scale (strongly agree, agree, somewhat agree, somewhat disagree, disagree, strongly disagree) as Reeve et al. (2011) point out is just as effective, even though a 100-point scale is recommended (Bandura, 2006). For demographic type questions, we tried to match categories as closely to the United States 2020 Census, other than gender, as the census only provided binary options (United States Census Bureau, 2021). Finally, many of the questions we planned on asking about perceptions of coding and gender, as well as the parents' perception of their child, could lead to a biased response based on the question wording. As such, we maintained neutral to positive wording to avoid causing bias. If we did ask a positive worded question, we attempted to also ask the opposite to allow respondents to answer for that side as well. We anticipated asking demographic type questions at the end and the remaining questions in random order to avoid presentation bias.

Think Alouds and Revision

Because we had several concerns about survey fatigue, the length of the survey, and the target audience of the survey, we felt the best approach for feedback was to perform think alouds with members of the target audience. Calderhead (1981) referred to this as 'stimulated recall,' with our survey acting as the stimulation instrument. Calderhead argued that stimulated recall (think alouds) is valuable in collecting data, though cannot give a full picture due to any number of factors that influence the individuals participating. With this limitation, we knew that the data would be useful, although we could not rely entirely on it to make decisions.

We began performing think alouds with parents completing the survey and quickly realized that we needed a formal procedure in order to ensure consistency. We developed a protocol for our think alouds as well as a centralized location to store and compare the data (see Appendix B for the protocol). We performed six think alouds, three with the protocol and three without. This gave us enough data to recognize trends that individuals saw, a general idea of the length of the survey, questions individuals liked, disliked, and other feedback they wanted to include.

This formative feedback led to three overarching conclusions. One, there was a more direct way to organize the survey that was easier for parents to complete; namely separating the questions into parent-oriented questions or child-oriented questions. Two, asking about a single child at a time was easier for parents—the feedback we consistently got was that parents would answer some questions differently depending on which child they were filling the survey out for. Three, attempting to write the survey for all K-12 students was problematic, as perceptions about learning to code in secondary education differed from elementary. With these conclusions in mind, we made the following changes to the survey. First, we organized the questions into parent specific questions and child specific questions. Second, we limited our target audience to only parents of elementary-aged kids and adjusted language in the questions appropriately such as removing options about secondary schooling. Third, because of the first two changes, we were able to format the survey in a way where parents could fill out the survey for multiple children while only answering for themself once by using branching logic in Qualtrics. See Table 1 for the final draft of questions.

Table 1

Final Draft of Questions for Parent's Attitudes Towards Teaching Children to Code Survey

Construct (ID)	Question	Answer Choices/Format	Parent/Child Section, ID
Parents' Current Involvement with their Child's Education (EI)	I volunteer at my child(ren)'s school(s)...	Never, Once a year, once a month, 1x/week, 2x/week, daily	Parent, EI_1
	I help Child [x] with their homework.	Never, once a month, 1x/week, 2x/week, daily	Child, EI_2
	Compared to other students in your child's class, what kind of student do you expect Child [x] to be?	Above average, average, below average, no expectation	Child, EI_3
	I believe Child [x] would be good at coding.	6 pt Likert	Child, EI_5_1
	I would encourage Child [x] to learn to code.	6 pt Likert	Child, EI_5_2
	How often do you enroll Child [x] in STEM or coding extracurricular activities?	Never, Once a year, Once a semester, my child's school doesn't offer those activities	Child, EI_4
	I would enroll my child in STEM or coding extracurricular activities if they were offered. (if answered that they weren't offered)	6 pt Likert	Child, EI_5_3
Parents' Attitudes Towards Technology (ATT)	Learning to use technology is a priority I have for my child(ren)	6 pt Likert	Parent, ATT_1_1
	How much do you agree: The COVID pandemic has positively affected my view on my child(ren)'s use of technology?	6 pt Likert	Parent, ATT_1_2
	How much do you agree: The COVID pandemic has negatively affected my view on my child(ren)'s use of technology?	6 pt Likert	Parent, ATT_1_3
	How much do you agree: The COVID pandemic has not affected my view on my child(ren)'s use of technology?	6 pt Likert	Parent, ATT_1_4

Construct (ID)	Question	Answer Choices/Format	Parent/Child Section, ID
	My experience level with coding is...	None, beginner, intermediate, advanced, my work requires extensive coding	Parent, Parent Experience Coding
	Coding should be taught in elementary schools	6 pt Likert	Parent, ATT_1_5
	How often should coding be taught in elementary schools?	Never, once a semester, once a month, once a week, multiple times a week, Daily	Parent, ATT_2
	When do you think coding should begin to be taught?	Elementary School, Middle School, High School, College, Never	Parent, ATT_3
	Learning to code will enable my child(ren) to succeed in future careers.	6 pt Likert	Parent, ATT_1_6
Parent & Child Interaction with Technology (PCI)	What level of interest do you think your child has in coding?	No interest, some interest, neutral, somewhat interested, very interested, I don't know	Child, PCI_2
	I help Child [x] troubleshoot technology...	Never, once a month, once a week, 2-3x/week, daily	Child, PCI_1
	I help my child(ren) with technology when they need help.	6 pt Likert	Parent, PCI_3_1
	My child(ren) help me with technology when I need help.	6 pt Likert	Parent, PCI_3_2
	If my knowledge is inadequate, I am willing to learn more to help my child(ren) to code.	6 pt Likert	Parent, PCI_3_3
	I am confident I could help my child(ren) with their coding homework.	6 pt Likert	Parent, PCI_3_4
	I have enough time to help my child(ren) learn to code if they need help.	6 pt Likert	Parent, PCI_3_5

Construct (ID)	Question	Answer Choices/Format	Parent/Child Section, ID
Access to Technology in the Child's Home & Digital Competency (AC)	Which of the following devices do you have at home?	Tablet, smartphone, desktop, laptop	Parent, AC_2
	Do you have daily access to the internet at home, whether through Wifi or a smart device?	Yes/No	Parent, AC_4
	How reliable would you rate your home internet connection?	Very Reliable, Reliable, Somewhat Reliable, Somewhat Unreliable, Unreliable, Very Unreliable	Parent, AC_6
	How much do you agree: Child [x] is productive with their time when using technology?	6 pt Likert	Child, AC_5
	On an average day, how many hours a day does Child [x] use technology for non-educational purposes?	Numerical value	Child, AC_1
	Which of the following does Child [x] use technology for the most during the school year? Rank from most to least?	Homework, games, watching shows, creating media, social media, coding/programming	Child, AC_3
	How many times a week does Child [x] use the computer for homework during the school year?	Never, 1-2x/week, 3-4x/week, Every day	Child, AC_7
Parents' Attitudes Towards Coding and Gender (GA)	Teachers and administrators should encourage all children to learn to code.	6 pt Likert	Parent, GA_1_1
	All children should learn to code	6 pt Likert	Parent, GA_1_2
	Coding can be interesting to any child	6 pt Likert	Parent, GA_1_3
	All children can be successful at coding	6 pt Likert	Parent, GA_1_4
	I am likely to encourage my boys to learn to code	6 pt Likert	Parent, GA_1_5

Construct (ID)	Question	Answer Choices/Format	Parent/Child Section, ID
	I am likely to encourage my girls to learn to code	6 pt Likert	Parent, GA_1_6
	Boys are better at coding than girls	6 pt Likert	Parent, GA_1_7
	Girls are better at coding than boys	6 pt Likert	Parent, GA_1_8
Socio-Economic Status, Demographic tioInforman	What state do you live in?	List of US States plus DC and Puerto Rico	Parent, State
	Which option would best describe the area you live in?	Urban Suburban, Rural	Parent, Area
	What is your household income level (in dollars)?	<10,000, 10,001-20,000. 20,001-40,000, 40,001-75,000, 75,000-150,000, 150,000+	Parent, Income
	What is the highest level of education?	None, Middle School, Some High School, High School Diploma, Some College, Associates Degree, Bachelor's Degree, Some Graduate school, Post-Graduate Degree	Parent, Education Level
	How would you identify your race?	White, Black/African American, American Indian/Alaska Native, Chinese, Vietnamese, Native Hawaiian, Filipino, Korean, Samoan, Asian Indian, Japanese, Chamorro, other Asian, other Pacific Islander, Other	Parent, Race
	Are you of Hispanic, Latino, or Spanish descent?	Yes, No	Parent, Race
	I am the child(ren)'s...	Mother, Father, Grandmother, Grandfather, Other Guardian	Parent, Relationship to Child
	Which of the following best describes your current situation? Mark all that apply.	Full-time Employee, Part-time Employee, Full-time Student, Part-time Student, Stay at home Parent/Guardian	Employment Status

Construct (ID)	Question	Answer Choices/Format	Parent/Child Section, ID
	What is your marital status?	Single, Married, Divorced, other	Parent, Marital Status
	What is your age?	Numerical value entry	Parent, Age
	How many people are in your household?	Numerical value entry	Parent, Number in Household
	What gender is Child [x]?	Male, Female, Non-binary, I choose not to identify	Child, Child’s Gender
	What grade level is Child [x] in?	Kindergarten, 1st Grade, 2nd Grade, 3rd Grade, 4th Grade, 5th Grade, 6th Grade	Child, Child Grade Level
	How much experience does Child [x] have in coding?	None, Beginner, Intermediate, Advanced, Expert, I don’t know	Child, Child Experience Coding
	Does Child [x] have a disability?	Yes, no, I prefer not to answer	Child, Child Disability
	How would you classify Child [x]’s disability?	Mild, moderate, severe	Child, Child Disability

Snowball Sampling

After compiling the final draft of survey questions, we needed to distribute the survey. We followed IRB procedures, which indicated that this is an exempt study, so we could move forward. In an ideal world, we hoped to partner with school districts at the beginning of the traditional school year to have schools send the survey out to parents. However, we were unable to finalize the survey in time, and when we approached the districts, districts were either hesitant to send the survey out due to survey fatigue amongst parents, did not want to appear to endorse a specific viewpoint until the survey was validated, or were too busy to go through the process to get the survey approved with local boards. Because of these concerns and rather than putting the survey on hold until the next academic year when parents and districts might be more receptive, we decided to gather data to validate the survey so it could be used by schools and teachers for the academic year. We decided to implement snowball sampling—a method where we encourage others to refer others for a study—to obtain data (Small, 2009). We wrote a short introduction about the purpose of the survey and posted the survey on social media accounts, asked those we knew to post it on their social media accounts, and approached individual acquaintances.

Because we were targeting a very specific audience, namely parents of elementary aged children, this approach was difficult and did not result in the number of responses we hoped for or the diversity of responses we expected. To solicit more diverse and additional responses, we revised the short introduction message to include a call to repost the survey and reach out to others they knew in the target audience and can be found in Appendix B. In addition, we also translated the survey and introduction into Spanish, hoping to allow the survey to be more accessible to individuals of different ethnicities. The first and second versions of the introduction can be found in Appendix B.

Analytical Strategy

After developing the final draft, a hypothesized model was developed with the intent to run a structural equation model (SEM), which can be seen in Figure 1. The first step in running this model required us to run a confirmatory factor analysis (CFA) to verify each construct was a valid factor for the model.

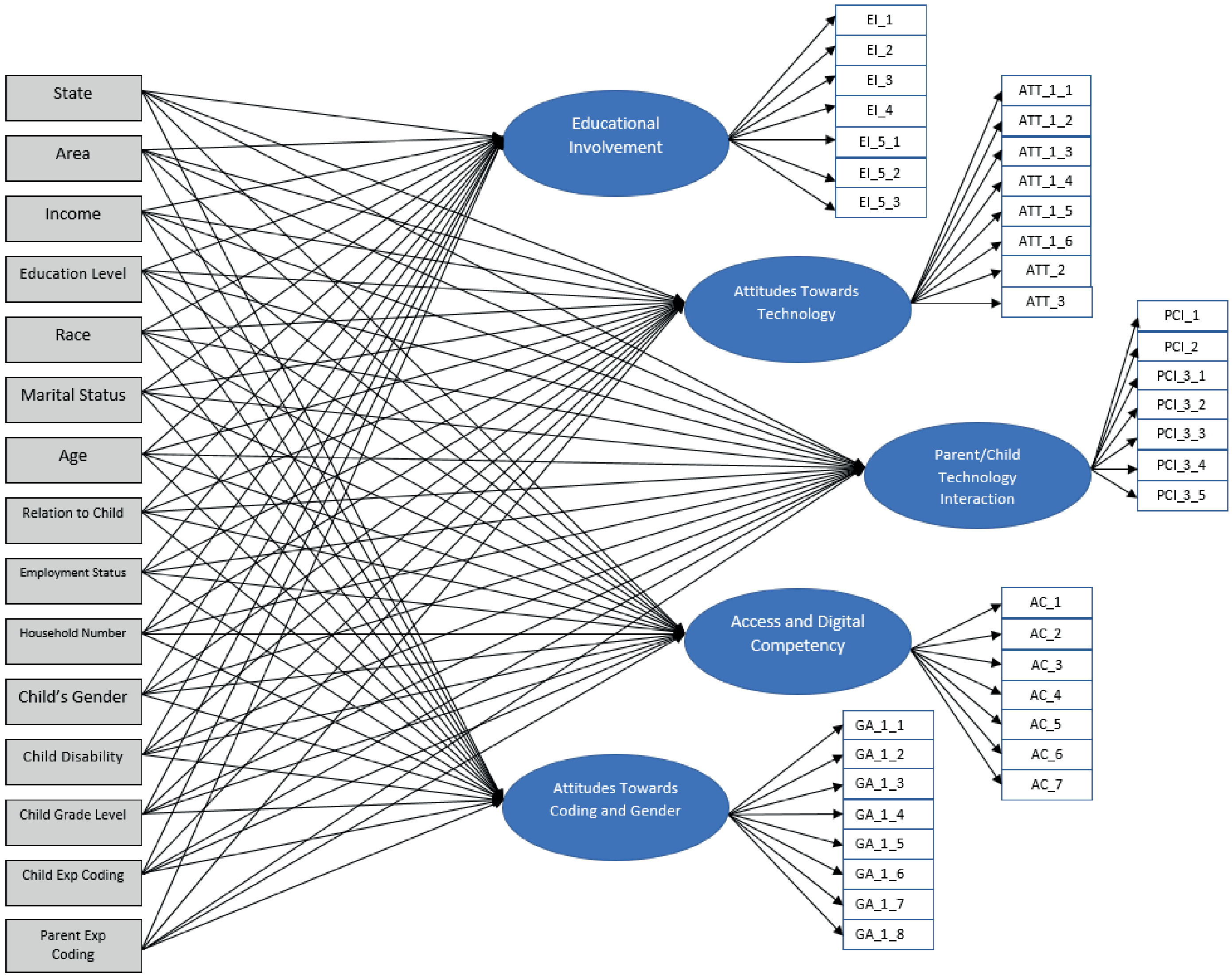
Prior to running the data, it was determined that the root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), Comparative Fit Index (CFI), and Tucker Lewis Index (TLI) would be the measures of determining a good fit for individual factors for the CFA. In order to be considered a good fit, three of the four model fit statistics would need to meet a certain threshold. The RMSEA and SRMR would need to be less than 0.08 and the CFI and TLI would need to be greater than 0.90. Factor loadings would need to be >.3 and be statistically significant. If needed, items with the lowest factor loadings would be removed to improve the model (Wang & Wang, 2012)

Data was run in Mplus version 8 (Muthén & Muthén, 1998-2017). In order to successfully run the data, a number of changes needed to be made to code the data correctly for Mplus to read. For questions that used a 6-point Likert scale, data was coded as 1-6 with 1 representing *strongly disagree* and 6 representing *strongly agree.* Non-Likert scale responses that were still ordinal and represented a progression were coded similarly. This data was treated as continuous data. Categorical data were coded with a number representing each category and accounted for in the Mplus script. A few question responses needed to be split into several variables to appropriately represent responses as numerical data. For example, the question about area was split up into suburban and urban and coded as a 1 if the respondent indicated they lived in this type of area and a 0 if they did not. If the respondent lived in a rural area, both Suburban and Urban would be 0. Finally, several variables had to be removed, either due to a low representation in the data, or trouble with translating the response into something usable. These variables will be addressed later.

SEM has the same conditions as multiple regression: linearity, independence, normality, and equal variance. Using curve estimation in SPSS, linearity was spot checked. No pair scatter plots showed a significant difference between the lines produced by linear and quadratic equations. One major limitation of the data was that independence could not be assumed. In some cases, parents provided answers for multiple children, meaning that some responses had the same data for the parent. This was considered in the model by clustering the data. Because we had 141 usable responses, normality could be assumed using the central limit theorem. Spot checks were done for equal variance and although some residual plots showed outliers, none showed a cone-shaped plot. Although there were a few outliers, we elected to keep them in the data as we were already concerned about having an accurate and complete representation of individuals.

Figure 1

Hypothesized SEM Model



CHAPTER 4

Results

Excluded Data

Several variables were removed from the data due to a lack of representation or the complexity in creating it into a usable variable for Mplus. Race was removed because 94% of respondents identified themselves as 'white'. This result, paired with most respondents answering they had an income $75,000 or greater, was of great concern to begin with. These results mean that we did not get a representative response of SES circumstances, which was something the research clearly showed has an impact on children's success in school.

Marital status was removed for a similar reason because 91% of respondents were married. This too leads to a less than desirable representation in the data. Our hope was to be able to compare both married individuals as well as single parents and others who may have constraints on their time in being involved with their children and children's education.

AC_4, which asked if respondents had access to the internet, was removed because everyone stated they had it. This finding was not entirely surprising as we solicited responses over social media, meaning individuals would have access to the internet. However, it may hint that some of the historical problems surrounding accessibility to the internet may be resolving. However, we recognize this result and the result of the last two questions likely are not realistic as it does not include individuals of lower SES status and will be discussed later.

In addition to these three questions, the results regarding child disability and disability severity were removed because only 10 respondents stated they had a child with a disability. This led to struggles getting accurate data for Mplus and was not crucial to the model or research.

Finally, AC_3, the question asking parents to rank how children used technology led to a lot of missing responses, creating problems with running the data and were therefore removed.

Confirmatory Factor Analysis Results

Initial CFA results were mixed and can be seen in Table 2. The results led us to confirming only one factor, Parent and Child Interaction with Technology (PCI). As a reminder, three of the four model fit statistics would need to meet the previously defined threshold to be considered confirmed. If the factor was not confirmed, an exploratory factor analysis (EFA) was run in an effort to see if there were indicators that could work together to create a factor different from the originally hypothesized one. The results for each factor will be discussed.

Table 2

Standardized Results of CFA by Factor

	RSMEA	CFI	TLI	SRMR
EI	0.086	0.326	0	0.141
ATT	0.16	0.743	0.64	0.11
PCI	0.054	0.912	0.868	0.062
AC*	-	-	-	-
GA	0.225	0.599	0.438	0.156

**Note.* The AC factor did not converge and therefore does not have any results.

Parents' Current Involvement With Their Child's Education (EI)

The EI factor was not confirmed, and all indicators except the RSMEA were dramatically away from the necessary thresholds. The EFA we performed was not much better as it did not converge for two or more factors. Therefore, we were left with the original results from the CFA The CFA's results for factor loadings and p-values can be seen in Table 3. The results indicated that the entire factor was essentially being loaded by a single indicator: EI_5_1. This was the question asking if the parent believed their child would be good at coding. In addition, even though EI_5_1 was the only indicator contributing, it was not statistically significant. All other indicators were below the designated .3 threshold to be considered a good factor loading. Because these results are so inconclusive, it is likely that we were measuring this factor wrong.

Table 3

Standardized EFA Results for the Parents' Current Involvement With Their Child's Education (EI) Factor

Indicator	Factor Loadings	P-value
EI_1	0.071	0.785
EI_2	0.013	0.827
EI_3	-0.071	0.655
EI_4	-0.005	0.946
EI_5_1	-1.624	0.655
EI_5_2	-0.201	0.687
EI_5_3	-0.283	0.686

Parents' Attitudes Towards Technology (ATT)

The ATT factor was not initially confirmed and like the EI factor, the EFA we ran did not converge either for trying two, three, or four factors. Results for the EFA for the ATT factor can be seen in Table 4. The interesting thing in these results is that only one item, ATT_2_4 did not have a good loading and the only one that was not significant. The remaining items had good factor loading and were significant. These results are contradictory to the initial CFA, so we ran a CFA again removing the item that was not significant. Results for this can be seen in Table 5. Removing the item did yield better results for the model fit statistics but continued not to meet the threshold to be considered a good fit. However, with two of the indicators close to the threshold we feel confident that additional and more diverse data would yield a good model.

Table 4

Standardized CFA Results for the Parents' Attitudes Towards Technology (ATT) Factor After Removing ATT_2_4

Indicator	Factor Loadings	P-value
ATT_2_1	0.524	0
ATT_2_2	0.335	0.005
ATT_2_3	-0.301	0.006
ATT_2_5	0.923	0
ATT_2_6	0.755	0
ATT_4	0.805	0
ATT_5	-0.738	0

Note. Final fit statistics - RSMEA: 0.125; CFI: 0.867; TLI: 0.80; SRMR: 0.092.

Parent and Child Interaction With Technology (PCI)

The PCI factor was the only factor initially confirmed. The initial factor loadings are listed in Table 5. Based on the results, we removed the PCI_3_2 item as its loading factor was close to zero and was not significant and reran the CFA. Removing the item improved the indicators across the board and helped every indicator meet the necessary threshold. Results of the CFA were rerun and can be found in Table 5. Two indicators, PCI_1 and PCI_2 did not have a factor loading >.3 and PCI_2 was not significant. We attempted to remove these from the model. However, removing one or both resulted in a poorer model, so we elected to keep them in.

Table 5

Standardized Factor Loadings for Parent & Child Interaction With Technology (PCI) Factor After Removing PCI_3_2

Indicator	Factor Loadings	P-value
PCI_3_1	0.545	0
PCI_3_3	0.688	0
PCI_3_4	0.618	0
PCI_3_5	0.74	0
PCI_2	0.184	0.13
PCI_1	0.238	0.04

Note. Final fit statistics - RSMEA: 0.044; CFI: 0.939; TLI: 0.915; SRMR: 0.062.

Access to Technology in the Child's Home and Digital Competency (AC)

The AC factor was the only factor that did not converge for the initial CFA. We ran an EFA and the EFA did not converge for one or two factors either. These results indicate a major issue with measuring the factor and will be discussed later.

Parents' Attitudes Toward Coding and Gender (GA)

The GA factor proved to be the most interesting. After initially not being confirmed, we identified the items that were not significant and removed GA_7 and GA_8. This did not do much to improve the model, so we ran an EFA on the initial eight items. The results led us to see that GA_7 and GA_8 may be their own factor, but with only two items, the factor could not be identified. The results also indicated that GA_5 may load onto a separate factor all together. With this new piece of information, we ran a CFA excluding those three items. The results confirmed a factor using the remaining 5 items and the model fit statistics results and factor loadings can be found in Table 6.

Table 6

Final Standardized Factor Loadings for GA Factor After Removing GA_5,7,8

Indicator	Loading	P-Value
GA_1	0.947	0
GA_2	0.963	0
GA_3	0.627	0
GA_4	0.391	0.002
GA_6	0.662	0

Note. Final fit statistics- RSMEA: 0.085; CFI: 0.967; TLI: 0.934; SRMR: 0.07.

Structural Equation Model

After being able to identify two usable factors, we ran the remaining items as predictive variables for the two factors to create our final reduced model. Results for each predictive variable are found in Table 7 and the final model can be found in Figure 2. *Only living in the West, Age, Child Coding Experience,* and *Parent's Experience with Coding* were significant for the PCI factor at a .05 level. Only *living in the West, living in a suburban area, Child Coding Experience,* and *Child Grade Level* was significant for the GA factor at a .05 level.

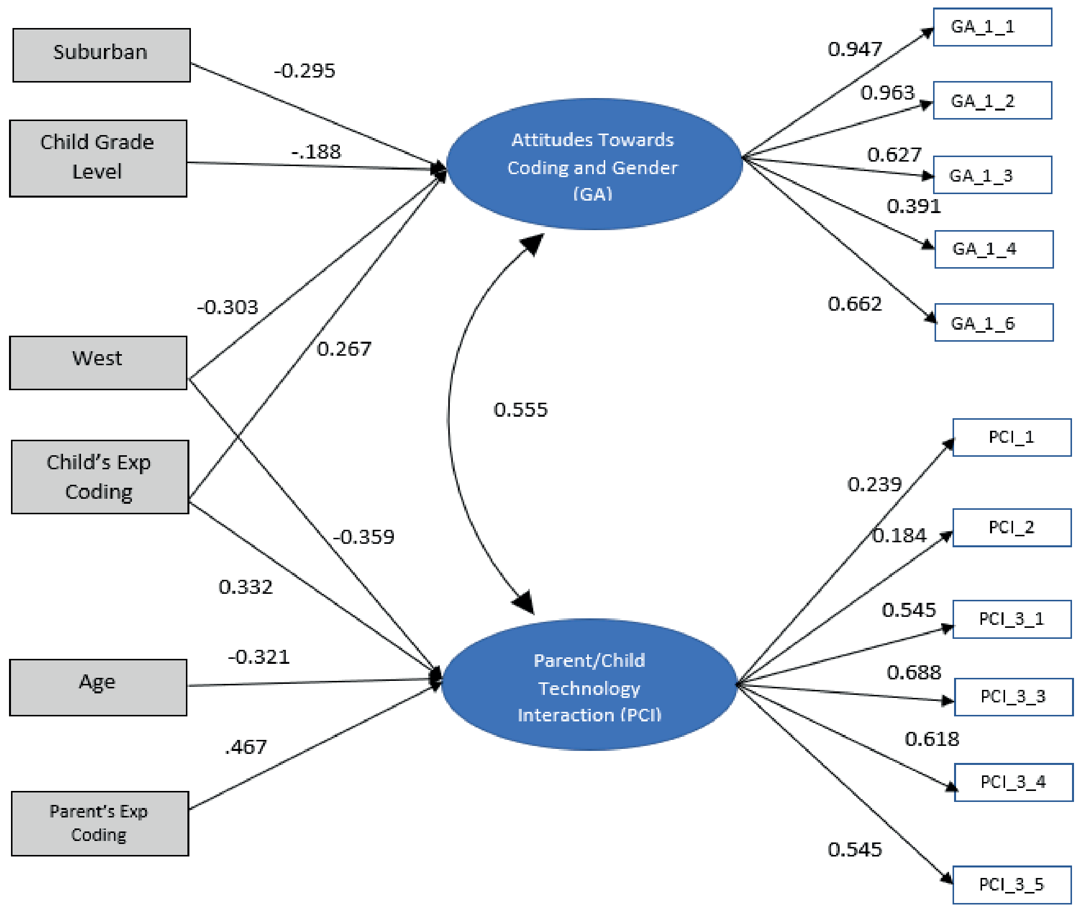
Table 7

Final Standardized SEM Results

	PCI		GA	
	Standardized Betas	Standard Error	Standardized Betas	Standard Error
South	-0.191	0.148	-0.004	0.130
Midwest	-0.491	0.171	-0.184	0.177
West	-0.35*	0.153	-0.296*	0.139
Urban	0.0157	0.115	-0.232	0.126
Suburban	-0.197	0.110	-0.299*	0.122
Income	0.22	0.123	-0.125	0.115
Education	-0.073	0.141	0.162	0.122
Parent Age	-0.377*	0.126	-0.128	0.124
Mother	0.099	0.084	-0.013	0.072
Full Time Employee	-0.136	0.22	-0.231	0.201
Part Time Employee	-0.156	0.134	-0.253	0.157
Full-Time Guardian	-0.013	0.191	0.019	0.186
Boy	-0.067	0.093	-0.119	0.076
Grade Level	-0.128	0.086	-0.191*	0.089
Child Experience	0.335*	0.132	0.269*	0.107
Parent Experience	0.437*	0.147	0.143	0.115
Number in Household	0.115	0.114	0.163	0.108

Figure 2

Final SEM Model



**Note.* N = 141. Model only contains significant predictive variables at .05 level. All estimates are standardized. The correlation of .555 between the two factors indicates that they are distinct factors. R-squared for PCI factor: .542, R-squared for GA factor: .272.

CHAPTER 5

Discussion

Overall Results

Although we were able to answer our research questions, the answers and final model are extremely limited. As a reminder our research questions were:

RQ1: In a survey to assess elementary aged students' parents' perceptions toward coding, does the hypothesized model and its factors fit the data as assessed by a confirmatory factor analysis analytical approach?

RQ2: What predictive variables are significant for the factors from RQ1 regarding parents' perceptions towards elementary aged students' learning to code?

The resulting model gave us two factors that fit the hypothesized model and can be assessed, namely Parent and Child Interaction with Technology as well as Parents' Attitudes Toward Coding and Gender. A third, Parents' Attitudes Towards Technology, showed promise in being able to be used, but likely due to limitations with the data caused by homogeneity, could not be confirmed and usable. In addition, a few of the predictive variables were significant, though most were not even though the research indicated that they should be. Again, this is likely due to the limitations of the data.

The limitations and homogeneity we have discussed stems from the fact that the results gave individuals who were predominately white, well-educated, affluent, and married. Over 50% of respondents were from the state of Utah and 100% had daily access to the internet. These results are not nearly representative of populations we hoped to get responses from. Therefore, this model is likely not predictive of populations outside of those mentioned. Because of the limited usability of this model, the next step would be to refine the model, so it is more usable for those who hope to address issues with parental support for coding.

Each factor as well as the data collected for the factor will be discussed. We discuss these results with a fair amount of caution, knowing that the results could be different if we had a more representative sample. In addition, suggestions, if any, will be proposed for a revised survey in hopes that it will be more representative and usable.

Individual Factors

Parents' Current Involvement With Their Child's Education

Based on the literature, we expected parents who are more involved with their school and those with higher expectations for their children to have better perceptions towards their children coding. Based on the data from the survey, we saw high involvement from parents. On average, parents volunteered at their child's school between once a month and once a year, with many volunteering once a week. Parents also helped their children with homework on average more than once a week. In addition, parents had high expectations for their children as most expected them to be above average compared to other children. Almost all parents stated they would encourage their children to code.

However, based on the results of the CFA, this factor was essentially unusable and showed little hope in ever being usable as is, which is highly surprising. Only one item, EI_5_1, loaded on the factor. This question asked parents if they believed their child would be good at coding. However, no item was statistically significant, including EI_5_1. When examining the questions again, we believe that the issue may lie in the fact that some questions use a Likert Scale while others do not. The questions that do not use a Likert scale may need to be changed because they aim to get at more concrete data.

For example, we asked parents how often they volunteered at a child's school. Initially, we felt that a parent who was involved with their child's education would answer that they volunteer more often at their child's school. We also felt that having an estimate, such as 'Once a week', would be an objective way to measure the factor. However, our thinking was likely backwards. We believe that because the question aims to get a more concrete answer with the way the question is currently phrased, it's likely better used as a predictive variable. Instead, the factor should instead focus on the parent's perception of their involvement in their child's education. For example, we could rephrase the question to use a Likert scale and ask 'How much do you agree with the following statement: I volunteer enough at my children's schools'. Phrasing the question this way will aim specifically at the parent's perceptions about their involvement. This is a common theme throughout the survey and is an approach we will recommend using for other problematic factors.

With this in mind, we still believe that using the question as it was previously phrased would be valuable, but it would need to be used as a predictive variable, rather than for an item to load onto the factor.

Parents' Attitudes Towards Technology

This construct should have focused on identifying information regarding parents' experience levels with coding, their attitudes towards technology in general, and attitudes towards coding being taught in school. We expected parents who have experience with coding and technology to have more positive attitudes towards elementary children learning to code and those who are worried about their children's technology use to have less favorable attitudes.

For the most part, the data confirmed what we were expecting. Parents, on average, agreed that their children's learning technology was a priority to them. In addition, on average, parents agreed that coding should be taught in elementary school and that coding would help in their children's future careers. Each of these questions had strong, positive loadings. 80% of parents also believed that coding should be taught at least once a week. This matched the results where 72% of parents believe coding should begin to be taught in elementary school compared to later in schooling.

Because the results were what we were expecting, and because the factor was close to being confirmed, we anticipate this factor could be usable with minor adjustments. Similar to the last factor, we feel like if every question used a Likert scale, this would help. For example, rather than asking parents how often they feel coding should be taught, we ask how strongly they agree that coding should be taught at least once a week. In addition, we can remove some questions, such as when parents feel coding should begin to be taught since we already ask if they agree it should be taught in elementary school.

After reviewing the questions, we also felt that there were a number of questions that were missing, such as if parents agreed that coding is hard or time consuming. These could replace the questions regarding COVID-19, which although met the criteria to be a good indicator, were the weakest of the items and may not be reliable as we move further away from the pandemic.

Parent and Child Interaction With Technology

Because the factor was confirmed, we primarily need to focus on whether the results confirmed theoretical expectations. Based on the literature, we expected parents who were willing to help their children with technology and to learn to code would have more favorable answers. We also anticipated specific relationships to the child, such as mother or father, might reveal ways in which parents interact with their children and technology to influence their attitudes toward coding.

We asked parents if they help their child with technology when they need help, if they were willing to learn to code if their child needed help, if they were confident that they could help their child learn to code and if they had time to help their child learn to code. Each of these had a positive impact on the factor as expected. The only question in which parents did not answer favorably on average was if they felt confident, they could help. This result just barely resulted in parents somewhat disagreeing with this statement.

Perhaps the most interesting aspect of this factor is that we had two items, PCI_1 and PCI_2, which did not have a significant loading, but weakened the model when removed. These questions focused on how often parents helped their children and the level of interest they thought their child had in coding, respectively. These questions were included in the child specific section of the survey. Although we chose to keep these items in the model, it does beg the question on whether we need to ask parents specifically about a specific child. Up to this point, the only items that loaded successfully onto factors by our initial definition are ones we asked generally about parents' perceptions rather than a specific child. Whether or not to ask about specific children would greatly influence how we revise the EI and AC factor questions as many of those questions are asked specifically about each child.

In addition to these results, the predictive variables were also interesting. The only four variables that played a significant role were the parent’s age, experience with coding, the child’s experience with coding, and living in the Western United States. It is no surprise that the more experience a parent or child had, the more favorable answers they gave for this construct. However, it is interesting that age had a negative influence, meaning that the younger someone is the more favorable the answers. We anticipate that this is likely because the younger the person is, the fewer kids they have, therefore they have more time to dedicate to their child or that this signals a shift where the current generation who has grown up with more technology has more favorable opinions.

Surprisingly, whether the respondent was the mother or father, income level, and education level were not significant. The literature supported that mothers could play a significant role in the parent child interaction with technology as a co-learner or administrator. We also assumed, based on the literature, that those with higher income and education would value and have time to help their children with technology and therefore have more favorable answers. However, neither were significant, and education level had a negative beta, meaning that as education level went up, the answers were less favorable.

Access to Technology in the Child's Home and Digital Competency

Based on this literature, we expected that a parent would have different perceptions toward coding depending on how much a child uses the computer, and whether it is being used for educational or recreational activities. How competent a child already is with a computer was likely to influence perceptions as well. However, because this factor did not converge, a deeper look needs to be taken on what was asked and how it was asked.

Like the EI factor, we assumed that if a parent had positive attitudes about technology and coding, they would allow better access to technology, the internet, etc. This would allow the child to become more digitally competent. However, this logic may be flawed, and these variables are likely predictive of the perceptions a parent has towards how their child uses technology. For example, we asked about specific types of technology the child had access to and the internet availability in the home. These are more likely to act as predictive variables for the factor and may have caused the problems with the factor.

However, this is likely only part of the problem. When asking specifically about the child, we chose to attempt to get more concrete data rather than focus on the parent's perceptions. For example, we asked specifically how many hours a child uses technology for educational purposes. Rather than asking it this way, it would have been better to ask how much they agree with the following statement: *My child uses technology too often to* _____. Similarly, we could have had a question for video games, TV, etc.

Because this factor did not converge, there is a concern to even include it in a revised model. However, we believe that because the research was firm that a parent's perception on coding could be influenced by how their child uses technology, we feel it best to do a major revision of the questions and keep it included.

Parents' Attitudes Toward Coding and Gender

Research showed that parent's attitudes and support alone can influence their child's decisions regarding coding. Therefore, we would predict that how a parent feels towards coding would influence how they felt about the different genders coding as well as children as a whole.

Overall, parents had positive feelings towards children learning to code. On average, parents agreed that teachers and administrators should encourage all children to code, all children should learn to code, coding can be interesting to any child, and any child can be good at coding. The most interesting part of this factor is that we asked parents if they would encourage their boys and girls to code in separate questions. Parents somewhat agreed on average that they would encourage their girls to code. However, the model was better when removing the question about encouraging their boys, even though the results were essentially the same on average. This may confirm that there is still a gender gap as mentioned, but that parents are more cognizant of it and would be more proactive in encouraging their girls to code.

Overall, it is likely that this factor is good as is, with one important caveat. The two questions regarding if girls are better than boys at coding and vice versa, loaded onto their own factor. The only reason it was not included is because the factor was unidentified because there were only two items. Typically, a factor needs at least three items. If another item was identified, it could be added to these questions to create a new factor. However, there is no guarantee that this would be useful. For those two questions, parents strongly disagreed on average with both. This finding may be better looked at on its own rather than have it be part of a new factor.

The only predictive variables that were significant for this factor were the child's grade level, the child's experience coding, whether they live in the western United States, and whether they live in a suburban area. Parents answered more favorably with the more experience a child had coding, which was expected. However, the child's grade level had a negative beta, meaning that parents' answers were less favorable the higher the grade level their child was in. This is somewhat surprising. It leads us to believe that parents believe children, regardless of gender, are on a more even playing field earlier in school. If coding were taught earlier in school, it appears parents believe both girls and boys are equally good at coding and that everyone should learn to code. Most interestingly, though, gender was not significant. As mentioned, there is a gender gap in STEM subjects, so we assumed being a boy would be significant. Because that variable was not significant, it could mean that the gender gap is beginning to shrink, and parents are beginning to see both girls and boys as capable of succeeding in coding.

Limitations of the Model

Even though a model was created, it is extremely limited in its current state. As mentioned previously, we had to remove the Race and Marital Status items. In addition, most of the respondents had a bachelor's degree or higher and an income greater than $40,000. In essence this model is only representative of educated, married, white individuals in the middle class or higher. It does not represent those single, of races other than white, or who are in the lower class. These were all characteristics that were supported by the literature as likely to influence parents' perceptions.

In addition, with over 50 percent of respondents from Utah and 73 percent living in a suburban area, we did not get a representative sample of those around the country and in urban or rural areas. Even though these factors were significant, with additional predictive variables being added, we suggest removing these variables to avoid a longer survey and survey fatigue. Without getting a more representative sample, it cannot be assumed that this model is valid outside of these groups.

To get a more representative sample, different sampling techniques should be employed. For example, rather than using snowball sampling, attempting to partner with school districts would be better. If chosen correctly, a single school district could give a better representation than the data has given so far. Partnering with two or more school districts with differing demographics would be better.

In addition to these suggestions for sampling, there are a number of changes that could be made to the predictive variables. Currently, some demographics like state, area, and full-time employment played no significant role in the model. Because some of the questions for the factors can be changed to be predictive variables, it would be best to remove some of the demographic questions that are not significant to avoid survey fatigue when adding the new items.

Suggested Final Instrument

Below, in Table 8, is the final revised instrument based on the results and suggestions already discussed. As stated previously, most of the suggestions focus around making all questions Likert scales to help focus on perceptions of parents as well as to make some of the existing questions predictive variables instead. In addition, we decided it was best to remove the child-specific questions as this seemed to create more problems than it solved. This change is contrary to the suggestions of the think-aloud participants, which stated they only wanted to focus on a single child at once. However, we have adjusted the wording of the questions to ask parents more generally about their children rather than a specific child. For example, in the first draft used for think alouds, we asked parents “On average, what grade do you expect your child(ren) to earn?” and provided the standard A, B, C, D, F grading scale. In the revised version, the question now reads “I have high expectations for my child(ren) in regard to their education” and uses the six-point Likert scale. This change still addresses the primary concern expressed during the think alouds.

Table 8

Proposed Revised Survey

Construct (ID)	Question	Answer Choices/Format
Parents' Current Involvement with their Child's Education (EI)	*On average, I volunteer at my child(ren)'s school(s)...	Never, Once a year, once a month, 1x/week, 2x/week, daily
	I am actively involved in my child(ren)'s school(s)	6 pt Likert
	I help my child(ren) when they need help with their homework	6pt Likert
	I have high expectations for my child(ren) in regard to their education	6 pt Likert
	I have low expectations for my child(ren) in regard to their education	6 pt Likert
	I believe my child(ren) could successfully learn to code.	6 pt Likert
	I have the time I'd like to help with my chil(ren)'s education	6 pt Likert
	I am actively involved in my child(ren)'s education	6 pt Likert
	I would encourage my child(ren) to learn to code.	6 pt Likert
	I believe STEM/coding extracurricular activities would be important for my child(ren) to enroll in	6 pt Likert

Construct (ID)	Question	Answer Choices/Format
Parents' Attitudes Towards Technology (ATT)	*My experience level with coding is...	None, beginner, intermediate, advanced, my work requires extensive coding
	Learning to use new technology is hard	6 pt Likert
	Learning to code is difficult	6 pt Likert
	Learning to code is easy	6 pt Likert
	Learning to use technology is a priority I have for my child(ren)	6 pt Likert
	Coding should be taught in elementary schools	6 pt Likert
	Coding should be taught at least once a week in elementary schools	6 pt Likert
	Learning to code will enable my child(ren) to succeed in future careers.	6 pt Likert
Parent & Child Interaction with Technology (PCI)	I believe my child(ren) would be interested in coding	6pt Likert
	I help my child(ren) troubleshoot technology when they need help	6 pt Likert
	My child(ren) helps me with technology when I need help .	6 pt Likert
	If my knowledge is inadequate, I am willing to learn more to help my child(ren) to code.	6 pt Likert
	I am confident I could help my child(ren) with their coding homework.	6 pt Likert
	I have enough time to help my child(ren) learn to code if they need help.	6 pt Likert

Construct (ID)	Question	Answer Choices/Format
Access to Technology in the Child's Home & Digital Competency (AC)	My child(ren) has access to the technology they need to be successful now, and in the future	6 pt Likert
	My child(ren) has reliable access to the internet	6 pt Likert
	*On an average day, how many hours a day do(es) your child(ren) use technology for-educational purposes?	Numerical value
	*On an average day, how many hours a day do(es) your child(ren) use technology for non-educational purposes?	Numerical value
	My child(ren) use technology primarily for entertainment	6 pt Likert
	My children use technology primarily for homework	6 pt Likert
Parents' Attitudes Towards Coding and Gender (GA)	Teachers and administrators should encourage all children to learn to code.	6 pt Likert
	All children should learn to code	6 pt Likert
	Coding can be interesting to any child	6 pt Likert
	All children can be successful at coding	6 pt Likert
	I am likely to encourage my boys to learn to code	6 pt Likert
	I am likely to encourage my girls to learn to code	6 pt Likert
	Boys are better at coding than girls**	6 pt Likert
	Girls are better at coding than boys**	6 pt Likert
	Boys and girls are equally good at coding**	6 pt Likert

Construct (ID)	Question	Answer Choices/Format
	What is your household income level (in dollars)?	<10,000, 10,001-20,000. 20,001-40,000, 40,001-75,000, 75,000-150,000, 150,000+
Socio-economic Status, Demographic Information	What is the highest level of education?	None, Middle School, Some High School, High School Diploma, Some College, Associates Degree, Bachelor's Degree, Some Graduate school, Post-Graduate Degree
	How would you identify your race?	White, Black/African American, American Indian/Alaska Native, Chinese, Vietnamese, Native Hawaiian, Filipino, Korean, Samoan, Asian Indian, Japanese, Chamorro, other Asian, other Pacific Islander, Other

Construct (ID)	Question	Answer Choices/Format
	Are you of Hispanic, Latino, or Spanish descent?	Yes, No
	I am the child(ren)'s...	Mother, Father, Grandmother, Grandfather, Other Guardian
	What is your marital status?	Single, Married, Divorced, other
	Which of the following best describes your current situation? Mark all that apply.	Full-time Employee, Part-time Employee, Full-time Student, Part-time Student, Stay at home Parent/Guardian
	What is your age?	Numerical value entry
	How many people are in your household?	Numerical value entry
	What gender are your child(ren). Mark all that apply.	Male, Female, Non-binary, I choose not to identify

Construct (ID)	Question	Answer Choices/Format
	What grade levels are your child(ren) in. Mark all that apply.	Kindergarten, 1st Grade, 2nd Grade, 3rd Grade, 4th Grade, 5th Grade, 6th Grade

Note. Starred (*) items are factor specific predictive variables. Double-starred (**) items questions could be used to identify a new factor based on new data.

Future Research

Because the model that was confirmed was so limited, future research will focus around attempting to confirm a more robust and usable model by administering the revised survey to a more diverse sample. We anticipate that using only Likert scale questions and removing the ability to answer for multiple children will make it easier to obtain a diverse representation in the data because it can now be given in a paper format. Currently, we are in the process of working with the Provo School District in Provo, Utah, to distribute the revised survey to parents of the children in the district. According to NCES statistics (National Center for Education Statistics, n.d.), Provo School District has over 13,500 students across 23 schools. Its racial makeup is 74% white, 17% Hispanic or Latino, 3% Asian, 1% Black, 1% American Indian, 1% Pacific Islander, and 3% mixed race. Seventy-eight percent of parents are married, while 20% are single-parent households. Fifteen percent of families fall below the poverty level with 13.6% qualifying for free and reduced meals. Working with Provo will allow us to probe a more economically and racially diverse sample of parents and specifically include some of the populations the current model missed. It might also be helpful to include one or two districts in other parts of the country so that we can also account for geographic diversity, which our original model indicated was significant. In order to encourage participation, we will offer an incentive for parents to participate in this study. The current plan would be to obtain data from the district, use it to fully validate the instrument and provide the final validated instrument for use at the beginning of the 2022-2023 academic year to schools, teachers, administrators, and any others that may be interested in its use.

Conclusion

With coding now considered a 21st century skill and parental influence having the greatest effect on elementary aged children's perceptions about coding, we took a deeper look at how we could successfully measure parents' perceptions on teaching elementary aged children to code. Research pointed out five factors: *Parents' Current Involvement with their Child's Education, Parents' Attitudes Towards Technology, Parent and Child Interaction with Technology, Access to Technology in the Child's Home and Digital Competency,* and *Parent's Attitudes Towards Coding and Gender*. These factors could help us explore a parent's perception as well as numerous other variables that may influence those perceptions. We generated a survey based on these factors and variables and tested it out.

Initial feedback gave us valuable formative information to refine the survey. Once we felt it would be successful in answering our questions, we sent the survey out in hopes of validating the instrument. Results were mixed with only two of the factors viable, namely the *Parent/Child Interaction with Technology* and *Parent's Attitudes Towards Coding and Gender*. The remaining factors needed some additional adjusting, such as making Likert scale questions, and changing the questions to better target perceptions. In addition, most of the variables we assumed would influence the parents' perceptions proved not to do so with any significance.

Results were mixed but provided a great deal of insight into refining the survey further. Question format was considered, and several items were changed. The structure of the survey was affected and rearranged. The result is a much more refined survey that we feel would more effectively measure these factors and that could be validated in the future. Our hope is that this survey can help teachers, administrators, and policy makers better understand how to support elementary aged children learning to code.

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APPENDIX A

First Draft of Survey

Table A1

First Draft of Survey

Construct	Question	Answer Choices/Format
Parents' Current Involvement with their Child's Education	I volunteer at my child's school.	Never, Once a year, once a month, 1x/week, 2x/week, daily
	I help my child with their homework.	Never, once a month, 1x/week, 2x/week, daily
	On average, what grade do you expect your child(ren) to earn?	A, B, C, D, F, no expectation
	I believe my child would be good at coding.	6 pt Likert
	I would encourage my child to learn to code.	6 pt Likert
	I give time and attention to being involved in my child's education. (Father's only)	6 pt Likert
	I enroll my child in STEM or coding extracurricular activities.	Never, Once a year, Once a semester, my child's school doesn't offer those activities
	I would enroll my child in STEM or coding extracurricular activities if they were offered. (if answered that they weren't offered)	6 pt Likert

Construct	Question	Answer Choices/Format
Parents' Attitudes Towards Technology	Learning to use technology is a priority I have for my child(ren)	6 pt Likert
	My child(ren) is/are productive with their time on the computer.	6 pt Likert
	How much do you agree: COVID has affected my view on my child(ren)'s use of technology?	6 pt Likert
	My previous experience with coding is...	None, beginner, intermediate, advanced, my work requires extensive coding
	Coding should be taught at school...	6 pt Likert
	How often should coding be taught in schools?	Never, once a semester, once a month, once a week, multiple times a week, every day
	At what grade level do you think coding should be taught?	Numerical value entry
	Learning to code will enable my children to succeed in future careers.	6 pt Likert
Parent & Child Interaction with Technology	What level of interest do you think your child has in coding?	No interest, some interest, neutral, somewhat interested, very interested
	I help my child with technology...	Never, once a month, once a week, 2-3x/week, daily
	I help my child with technology when they need help.	6 pt Likert
	I am willing to learn to code alongside my child.	6 pt Likert

Construct	Question	Answer Choices/Format
	I am confident I could help my child with their coding homework.	6 pt Likert
	I have enough time to help my child learn to code if they need help.	6 pt Likert
Access to Technology in the Child's Home & Digital Competency	How many people are in your household?	Numerical value entry
	Which of the following devices does your child have access to on a daily basis?	Tablet, smartphone, desktop, laptop
	Which of the following does your child use technology for the most during the school year? List from most to least?	Homework, games, watching shows, creating media, social media, coding/programming
	Does your child have daily access to the internet at home, whether through Wi-Fi or a smart device?	Yes, No
	How many times a week does your child use the computer for homework during the school year?	Never, 1-2x/week, 3-4x/week, Every day
Parents' Attitudes Towards Coding and Gender	Teachers and administrators should encourage all children to learn to code.	6 pt Likert
	All children should learn to code	6 pt Likert
	All children can be successful at coding	6 pt Likert
	I am likely to encourage my boys to learn to code (if they have boys)	6 pt Likert
	I am likely to encourage my girls to learn to code (if they have girls	6 pt Likert
	Boys are better at coding than girls	6 pt Likert

Construct	Question	Answer Choices/Format
	Girls are better at coding than boys	6 pt Likert
Socio-Economic Status, Demographic Information	What is your household income level (in dollars)?	<10,000, 10,001-20,000. 20,001-40,000, 40,001-75,000, 75,000-150,000, 150,000+
	What is the highest level of education?	None, Middle School, Some High School, High School Diploma, Some College, Associates Degree, Bachelor's Degree, Some Graduate school, Post-Graduate Degree
	How would you identify your race?	White, Black/African American, American Indian/Alaska Native, Chinese, Vietnamese, Native Hawaiian, Filipino, Korean, Samoan, Asian Indian, Japanese, Chamorro, other Asian, other Pacific Islander, Other
	Are you of Hispanic, Latino, or Spanish descent?	Yes, No
	I am the child(ren)'s...	Mother/Father
	I am currently in school or working (mothers only)	Yes, No
	What is your marital status?	Single, Married, Divorced, other
	What is your age?	Numerical value entry
	What gender are your children? Select all that apply.	Male, Female, Non-binary, I choose not to identify

APPENDIX B

Think Aloud Protocol

Thank you for your participation in reviewing our survey. Coding is quickly becoming a necessary 21st century skill. Previous research has shown that parents' attitudes play one of the biggest roles on children's attitudes towards coding (Mason & Rich, 2020). As such, this survey is designed to gauge parents' perceptions about elementary children learning to code

Today you will review the third draft of our survey. We ask that you take the survey and provide feedback. We anticipate this exercise taking approximately 15-20 minutes in total. Specifically, we are asking that you give us your thoughts as you take it. These thoughts can be about anything from word choice to interface problems. Our goal is to ensure the survey is comprehensible prior to sending it out to a larger group. We will record the feedback on a separate Google Doc, as well as the amount of time it takes to finish the survey to use in the future. After you have completed the survey, you will be asked 4 questions about your experience.

We will now begin.

Link: [Link to survey]

QR Code:

Additional Questions After completing the survey:

How did you feel about the length of the survey?

Were there questions that you felt were missing?

Were there questions you felt shouldn't be included? Why?

Do you have any other comments that you would like included in the feedback?

APPENDIX C

Snowball Sampling Message

Coding/Computer programming is quickly becoming a necessary 21st century skill. Previous research has shown that parents' attitudes play one of the biggest roles on children's attitudes towards coding (Mason & Rich, 2020). Yet, little is known about how parents feel about the increasing emphasis on teaching young children to code. To better understand parents' perspectives on coding in elementary education, we invite parents of elementary-aged children to complete the following anonymous survey: [link to English version of survey].

The survey should take about 10-15 minutes to complete. If you have children in elementary school, please complete this survey to provide greater parental representation in this research. After completing the survey, if you know other parents with elementary-aged children, we ask that you please pass the survey along to them to complete it.

Spanish version: [link to Spanish version of survey]

THESIS REFERENCES

Mason, S. L., & Rich, P. J. (2020). Development and analysis of the Elementary Student Coding Attitudes Survey. *Computers & Education, 153*, Article 103898. https://doi.org/10.1016/j.compedu.2020.103898