Examining the Role of Parental Support on Youth's Interest in and Self-Efficacy of Computer Programming

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Objectives. The increasing demand for computing skills has led to a rapid rise in the development of new computer science (CS) curricula, many with the goal of equitably broadening participation of underrepresented students in CS. While such initiatives are vital, factors outside of the school environment also play a role in influencing students' interests. In this paper, we examined the effects of students' perceived parental support on their interest in computer programming and explored the mechanisms through which this effect may have been established as students participated in an introductory CS instructional unit.
Participants. This instructional unit was implemented with upper primary (grade 5) school students and was designed to broaden trajectories for participation in CS. The participants in the current study (N=170) came from six classrooms in two rural schools in the western United States.
Study Method. The seven-week instructional unit began with students playing a commercial CS tabletop board game that highlighted fundamental programming concepts, and transitioned to having students create their own board game levels in the block-based programming language, Scratch. Further, because the board game could be taken home, the instructional unit offered opportunities to involve the family in school-based CS activities. To investigate the effect of students' perception of parental (specifically father and mother) support on their interest in and self-efficacy to pursue CS, we surveyed students before and after the unit's implementations and explored the structural relationship of the data using structural equation modeling (SEM).
Results. We present three findings. First, the combined effect of students' perceived mother's and father's support measured prior to the implementation (pre-survey) predicted students' self-efficacy (Std B = 0.37, SE = 0.010, $p < .001$) and interest in computer programming (Std B = 0.328, SE = 0.134, $p < .003$) measured after the implementation (post-survey). Secondly, the combined effect of perceived mother and father support (Std B = 0.132, 95% CI [0.039, 0.399], 99% CI [0.017, 0.542]) on students' interest was mediated by whether or not they took the CS board game home.
Conclusions. Our findings indicate that perceived parental support has the potential to play an important role in students' self-efficacy and interest in computer programming and that providing opportunities for students to bring CS artifacts home has the potential to further affect students' interest in computer programming.

CCS Concepts: • **Social and professional topics → K-12 education**.

Additional Key Words and Phrases: Introductory Programming, Primary School CS, Parental Support, Structural Equation Modeling

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1 INTRODUCTION

Research has shown that when parents value something their children tend to value it too [85]. Accordingly, research has explored the role that parental support plays [54] in influencing students' interest, belief in their own abilities to perform a task (i.e., self-efficacy), and subsequent career choices [42, 59, 60, 78]. While the existing research in this area helps establish a correlation between students' perceived parental support, self-efficacy, and interest, there is a need for research that explores how perceived parental support is related to youths' self-efficacy and interest in computer programming. A more comprehensive understanding of the interdependencies between these concepts has the potential to inform the design of CS interventions intended to broaden the participation of underrepresented and underserved group in CS.

In this paper, we use a socio-cognitive lens to explore grade 5 students' affect prior to and after participating in an instructional unit for introductory CS designed to broaden the participation of upper primary school students (ages 10-11) at two rural primary schools in the western United States. Underlying the design of the unit was the conjecture that playing board games has the potential to support learning and reasoning [13], including developing foundational knowledge for programming. The instructional sequence started with students playing an unplugged computer science-themed tabletop board game called //CODE: On the Brink, which included fundamental programming concepts in its game mechanics [61]. The board game featured levels, or challenges, where players navigated an agent (a robot token) along a grid-based path from the 'Start' to the 'Finish' by programming its movements. After playing the game, students designed their own board game levels using the block-based programming language Scratch. The instructional unit consisted of seven weekly lessons that spanned the classroom and school library and consisted of both unplugged (board game play) and plugged activities (programming in Scratch [61]. An important component in the design of the unit was that students were able to sign out a copy of the board game to take home as they would a book in the school library.

In the following sections, we first review key socio-cognitive constructs that are thought to play important roles in attracting and retaining upper primary students in CS instruction (self-efficacy, interest, and parental support). We present our research design, results, followed by our discussion and implications for future research.

1.1 Self-efficacy in CS Education

Self-efficacy is an individual's belief in their ability to perform a task and plays a critical role in human agency [8]. In particular, self-efficacy is a major determinant of whether an individual chooses to engage in or avoid an activity, how much effort that person invests in the activity, and how long they persist in the face of difficulties [9]. Self-efficacy has been shown to predict student achievement [81] as well as career interest [50].

In studies involving primary and secondary students, researchers have examined the relationship between self-efficacy in computer programming and career orientation. Studies have found that higher self-efficacy correlated with intentions to pursue programming in the future. Conversely, low self-efficacy played a role in students' decisions not to pursue programming. For example, in one study, students' initial self-efficacy in computing affected their career identification after participating in a summer camp on programming [5]. In another study of a summer programming camp, girls who saw themselves as computer scientists and were more confident in their computing abilities were also more open to a computing career [33]. In a study in Spain [76], the self-concept of ability, which is a construct that closely relates to self-efficacy, was found to be positively associated with the intention to pursue a career in CS. Similarly, in another study with secondary-aged girls participating in a summer camp, confidence in CS and AI was found to be correlated with their interest in pursuing a career in AI [82]. In a formal learning context, Aivaloglou & Hermans [1] found self-efficacy to be correlated to career orientation only for female students. In another study conducted in a school that focused on English language learners [28], students increased in their self-efficacy to program as well as their perception about the value of STEM careers.

Numerous studies have focused on the relationship between students' self-efficacy and career pathways, and their influences on broadening participation in CS in higher education [2, 14, 15, 25, 27, 36, 47, 53, 66, 72, 75]. In a study where students were interviewed about their reasons for choosing to study CS [2], students identified self-efficacy (i.e., the ability to do well) as one of the reasons for choosing a CS major. Another study found that students' self-efficacy at the start of a CS1 course predicted their interest at the end of the course [52]. Self-efficacy has also been found to be highly correlated with intention to pursue the study of CS [25] and having an orientation towards a CS career [66] in undergraduate students.

Self-efficacy has also been linked to issues of inequitable participation in CS according to a subset of this literature. One study reported that women in college who did not take a computer-related course reported low computer self-efficacy as a reason [14]. For first-generation women in university, self-efficacy in computing after an introductory computing course strongly predicted their sense of belonging in the field [15]. Another study identified the differences in self-efficacy as the main reason for the disparity in participation among different groups [53]. Hence, the disparity in the initial levels of self-efficacy is an important factor contributing to inequitable participation in CS [72].

As discussed, a large portion of the research on the relationship between CS education and self-efficacy focuses on higher education [22], in particular in entry-level CS courses. Much of the research on self-efficacy in primary and secondary aged-students has occurred in informal learning contexts which are flexible, in that they allow learners to engage at their own pace and time frame. In contrast, formal education follows a more predetermined structure [69] allowing students fewer opportunities to pursue their interests and shape their learning experiences. As such, there remains a need to explore the determinants of self-efficacy and its relationship to interest in CS in formal contexts at the primary level.

1.2 Interest in CS Education

Self-efficacy plays a critical role in interest development. Research suggests it is a precursor to interest in that people will develop interest in an activity in which they feel efficacious [50]. In their model of interest development, Hidi and Renninger [40] propose that interest progresses in four sequential and distinct stages: triggered situational interest, maintained situational interest, emerging individual interest, and well-developed individual interest. Situational interest refers to the psychological state and affective reaction to an external (e.g., an object or an environmental condition) stimulus in the moment, while individual interest is an enduring predisposition to seek repetitive engagement in an activity over time. In addition, situational interest is the precursor to individual interest, and it takes time for the former to turn into a well-developed individual interest.

The research on interest and CS education has reported mixed results in that many intervention studies have not found significant changes in interest [22, 68, 73, 86]. The studies that did show a change in interest did not explain what factors affected interest in programming other than the ones that are specific to those studies. For example, AlSulaiman & Horn [3] reported differences in what activities were considered interesting by boys and girls based on the gendered cultural forms used in the activity. In contrast, Chen et al. [20] reported no improvement in students' interest in programming and attributed this to a ceiling effect. These inconsistent results are also likely due to how interest is measured. Renninger and Hidi [62] state that when measuring interest, researchers should be clear about how they conceptualize interest; otherwise, the empirical findings may not be helpful in instructional interventions designed to generate interest in learners.

1.3 Parental Support and CS

According to Social Cognitive Career Theory (SCCT), a positive change in one's social support predicts a positive change in that person's attitudes toward a field or a career [50]. Research on self-efficacy suggests it is influenced by support from teachers, peers, and parents [51, 85]. Turner and Lapan [78] suggested that parental support can have a moderating effect on students' career self-efficacy. In a subsequent study, Turner et al. [79] developed a career-related parental support scale, defining categories of parental support. A meta-analysis by Youn et al. [87] found that all categories of parental support were significantly correlated to students' career self-efficacy. The meta-analysis also found that two of these categories, namely, verbal encouragement and emotional support had the largest effect sizes of all categories. Vekiri and Chronaki [84] developed a survey of parental support for the computing education context, which includes the dimensions of emotional support and verbal encouragement. Clarke-Midura et al. [23] adapted this survey further to include items related to perceived parental support while learning computer programming. They found that children's perception of parents' support while learning programming affected children's beliefs about its usefulness, and these beliefs affected to what extent they were interested in programming.

1.4 Linking Self-efficacy, Interest, and Parental Support

Exploring the relationship between students' perceived parental support, self-efficacy, and interest offers insights into fostering positive attitudes and effective teaching approaches for computer programming.

As described above, prior research found that self-efficacy is a predictor of one's interest in a field or a career [50, 51], and self-efficacy in learning to program is correlated with interest in programming [48]. Parental support is a form of social support that strongly predicts career interest and aspiration [42, 59, 60, 78], and perceived parental support in CS is correlated to an increase in CS interest [21, 26]. Students' perceived support is also linked to increases in self-efficacy [10]. A parent's interest in their child's education has also shown to significantly impact their attitude and in turn their persistence [71].

Research underscores a positive correlation between parental involvement and students' achievement motivation and attitudes [35]. Lent et al. [50] suggested that both parental resources and support influence their child's learning experiences, subsequently shaping self-efficacy and outcome expectations. However, the diverse factors associated with a child's parents can have distinct effects on student affect, with some exerting a pronounced influence [30]. The existing literature suggests a connection between parental support and self-efficacy but does not definitively establish a direct relationship between these two constructs. This study contributes to the field by examining the direct relationship between parental support, self-efficacy, and interest within a single model.

In this study, we specifically focus on parental encouragement to pursue programming, and the expression of confidence in a child's abilities. Fisher [32] found that parental encouragement plays a significant role in students' career decision-making. Additionally, children's intrinsic motivation improves when parents are consistently informed about their progress and are provided guidance on how to support their children at home [4, 30]. Such motivation is further heightened when parents react positively to their children's academic achievements [30]. Furthermore, when parents project confidence in their children's potential, it paves the way for a smoother and less stressful transition to college life [24]. Lent and Brown [49] suggest that individuals are more likely to translate their career interests into actionable goals when they experience supportive environments, such as receiving encouraging feedback at home.

However, many of these studies at the primary school level have been done outside the formal CS education context, leaving the relationship between the constructs of students' perceived parental support, students' interest in computer programming, and self-efficacy in computer programming an understudied area. For example, a previous study in an informal learning context [21], analyzed the effect of parental support on students' interest in and perceived value of CS, but the analysis did not include self-efficacy measures in the model. In a different study [23], the changes in students' interest, self-efficacy, and perceived parental support were reported but the relationships between the three constructs were not explored.

Bresnihan et al. (2021) found that parents who engage in creative programming tasks with their children gain computing confidence, develop a positive attitude towards computing, and show increased involvement in their children's CS learning. On the other hand, understanding the impact that parental support can have on students' affect towards computer programming has implications for the design of CS curricula. Specifically, it underlines the importance of including elements aimed at influencing students' perceived parental support into instructional designs. For example, Harackiewicz et al. [37] sent home educational brochures about the science and mathematics activities carried out in a 15-month-long unit. Children whose parents were sent the brochures were more likely to subsequently take advanced STEM courses. In the context of CS education, two studies describe students taking projects home so that they could show them to their parents [23, 68] to encourage conversations about CS and careers in CS between students and their parents.

Student interview data in one of the studies revealed that some students were praised by their parents for their skills in CS, some engaged with their parents in conversations about CS skills and careers, and some reported spending quality time together while playing with programming projects [23]. The other study [68] also reported positive effects of sending students' final projects home. Others have tested the effect of parental involvement on academic achievement [34, 43, 56] and on student absenteeism and drop-outs [7, 64].

The above findings show how students' perceived parental support can influence their self-efficacy and interest in programming. However, to our knowledge, none of these studies looked at the interdependence between self-efficacy, interest, and parent support. Furthermore, a recent literature review [70] found no conclusive findings on what instructional design features were effective in improving self-efficacy and interest in programming.

1.5 Research Questions, Aims, and Objectives

To investigate mechanisms through which students' interest in programming, self-efficacy, and parental support are related, we address the following two research questions:

(1) *Does students' perceived mother and father support predict students' self-efficacy to pursue computer programming and their interest in computer programming?*
(2) *Does students' perceived mother and father support affect students' interest in computer programming indirectly through their action of taking the board game home?*

While the first research question explored the interplay between students' perceptions of parental support, their self-efficacy, and their interest, the second question examined whether a key design feature of the instructional unit (enabling students to take the board game used in CS activities home) affected students' interest in computer programming (see Figure 1). The term "predict" in this paper is used in a statistical sense and does not necessarily imply causality. While statistical prediction often involves identifying relationships between variables, it doesn't automatically establish that one variable directly causes changes in the other.

First, we explored whether students' perceived parental support as self-reported on a pre-survey predicted students' self-reported self-efficacy and interest in programming. Subsequently, we examined whether the effect of parental support (as self-reported in the pre-survey) on students' interest was mediated by the action of taking the CS board game home and (possibly) talking about it with their parents. Overall, the present study addressed the importance of out-of-school factors by examining the predictive relationship between parental support, students' self-efficacy, and interest in computer programming. The present study also explored whether involving families by sending a CS artifact (in this case, a board game) home with students predicted an increase in students' interest in programming.

2 METHOD

2.1 Participants

This study was conducted in a rural region of the Western United States. Fifth grade students (N=170) in two schools that assented to participate and returned the parental consent form participated in the research. In total, 96 fifth grade students (46 girls and 50 boys) across three classrooms from one primary school and 74 fifth graders

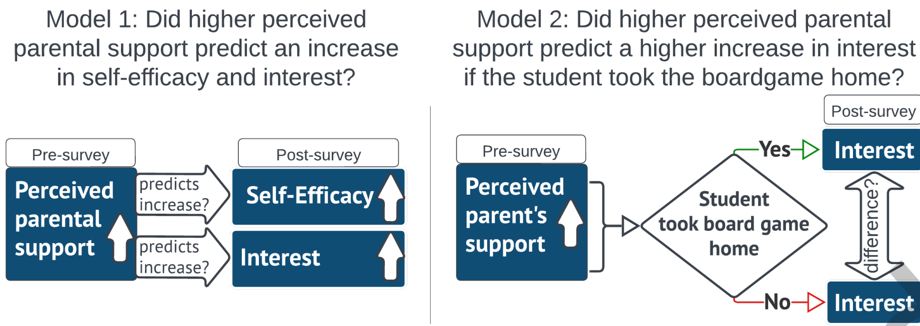

Fig. 1. Model 1 examines whether higher parental support (pre-survey) is associated with a higher self-efficacy and interest (post-survey). Model 2 examines whether interest is mediated by the action of taking the board game home.

(35 girls and 39 boys) across three classrooms from another primary school participated in the study. 44% of the students in school 1 and 45% in school 2 qualify for free or reduced-price lunches as per data provided by the school district.

The instructional unit was taught to all the students in the schools, regardless of whether they participated in the research. The study was reviewed and approved by the university's institutional review board (IRB).

2.2 Research Context

The study integrated a commercial paper-based board game in the design of its instructional unit. Board games have been identified as computationally rich environments, capable of instantiating various computational concepts through game play, regardless of the players' awareness of their computational nature [13]. Commercial board games vary in their designs, but can represent computer science (CS) through actions presented as written code, algorithmic sequences manifested as player moves, and solutions derived through the application of conditionals and Boolean logic.

After evaluating multiple options, we developed our instructional unit to use the commercial board game, //Code: On the Brink published by ThinkFun, as the initial entry point. The game consisted of various levels or puzzles for players to solve. Each level included a grid where players must program an agent (represented by a robot token) to move from a 'Start' square to a 'Finish' square. Players created procedures, allowing the robot token to execute commands and navigate from the starting space, as well as any subsequent grid spaces, until it eventually reached the 'Finish' square . To form these procedures, players used move cards (e.g., 'Move Forward', 'Turn Right', 'Do Nothing') placed on a control panel (see Figure 2). For instance, placing a 'Turn Right' in the first spot and a 'Move Forward' in the second spot of the control panel for blue would cause the robot to turn right and move forward one square each time it landed on a blue space.

The instructional unit was comprised of seven weekly lessons that encompassed both the classroom and the school library. The reason for this was that the partnering schools were exploring the possibility of utilizing the school library as a setting for implementing CS instruction. The design of our unit was an attempt to provide support to both the classroom teachers and school librarians in delivering CS instruction.

The typical lesson structure involved a classroom component led by the teacher, lasting up to 20 minutes, after which students proceeded to their scheduled weekly library time for 30 minutes of CS instruction. In the library, the school librarian introduced and assisted students working in pairs to: play the physical board game; play a

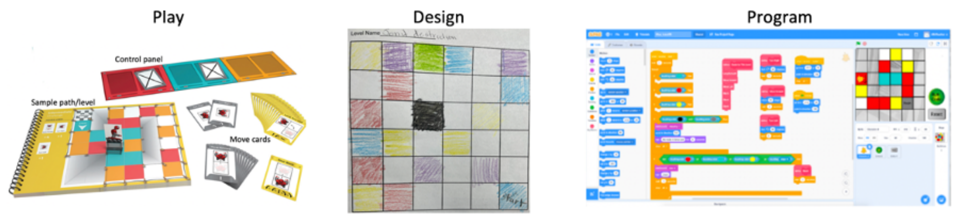

Fig. 2. Instructional unit sequence

Scratch version of the same game; design their own game level on paper using colored paper pieces and pencils; and program their level in Scratch for their peers to attempt (see Figure 2).

2.3 Data Collection

The study was designed as a one-group pre-post survey. The research team collected survey data at both the outset and completion of the instructional unit. All items were measured on a Likert scale ranging from 1 to 6, with "1" denoting "strongly disagree" and "6" indicating "strongly agree.

2.4 Measures and Covariates

The survey items were taken from a validated survey developed in another study [23], which had adapted the survey for use in CS education from established and validated surveys for STEM, e.g., [19, 31, 84]. Based on our model described above, four constructs were included: 1) mother support (MS) and 2) father support (FS), which measured students' perception of the encouragement, confidence, and importance shown by their mothers and fathers in the students' ability to program; 3) self-efficacy (SE) or students' belief in their ability to learn to program and become a proficient coder; 4) interest in programming (IP), which measured students' interest in computer programming (see Table 1). We also identified students who voluntarily took the board games home and reported it on the post-survey. Coded as a binary yes/no item, the TakeHome variable served to measure whether taking the board game home acted as a mediator between students' perceived parental support and their interest.

Building on the premise that self-efficacy is an important factor in students' interest in programming, the SE items in our survey were framed as inquiries about how students saw themselves in relation to computer programming (see Table 1). For the variable of interest, Hidi and Renninger's four-stage model of interest [40] was adapted in the study that developed the survey [23]. In discussing the different types of interest (e.g., situational interest vs. individual interest; see [22]), Clarke-Midura et al. [23] underlined the difficulty in differentiating these different types in practice as no precise measurements have been developed [62]. Therefore, they adapted measures widely used in the motivation literature to measure students' interest in and enjoyment of computer programming [23]. While we agree that interest takes time to develop [40] and that a seven-week instructional unit may not be able to change students' individual interest, we hoped that by increasing their self-efficacy in programming we would trigger their interest, and thus students would develop further interest in programming that would grow over time.

As described earlier, the present study included multiple survey items for measuring students' perceived mother's support and father's support (see Table 1). We also gave students the option to take the CS-themed tabletop board game home with them. The idea was that students would show the board game to and perhaps play with their parents, leading to conversations about CS and programming skills and careers. Students were thus asked on the post-survey if they took the board game home.

Table 1. Survey items, their labels and constructs

Construct	Question	Label
Interest in Programming	Computer programming sounds fun.	IP_fun
	I think computer programming is interesting.	IP_interest
	I think computer programming is boring.	IP_bore
Mother's Support	My mother has encouraged me to learn computer programming.	MS_Encourage
	My mother thinks I could be a good computer programmer.	MS_Confidence
	My mother thinks I'll need to learn computer programming for the future.	MS_Need
	My mother has shown no interest in whether I learn computer programming.	MS_Interest
Father's Support	My father has encouraged me to learn computer programming.	FS_Encourage
	My father thinks I could be a good computer programmer.	FS_Confidence
	My father thinks I'll need to learn computer programming for the future.	FS_Need
	My father has shown no interest in whether I learn computer programming.	FS_Interest
Self-Efficacy	If I took a class on computer programming, I could do well.	SE_Future
	If I wanted to, I could be a computer programmer in the future.	SE_Career
	I think I could do more challenging computer programming.	SE_Challenge
	I can learn to do computer programming.	SE_Learn
	I am a good computer programmer.	SE_Now
	I am confident in my ability to program.	SE_Confidence
	I can program computers well.	SE_Ability

2.5 Psychometrics

In the present study, we used a survey instrument developed and validated by [23]. We performed two separate explanatory factor analyses (EFA) [46] with varimax rotation [44] to explore the underlying structures of the measured constructs. For each EFA, Parallel analyses [41] were performed to calculate the optimum number of factors that represented the underlying constructs.

2.5.1 EFA 1: Parental Support. We performed an EFA that included mother's support and father's support variables. The EFA revealed that survey items underlying the two constructs loaded strongly onto one factor see Table 4. As can be seen, items related to mother's and father's interest did not load strongly onto factor 1, whereas other items did, thus the mother's and father's interest items were dropped from the analyses. Since all mother's and father's support items loaded strongly onto factor 1, they were combined into one construct of parental support. The Cronbach's alpha value for the parental support construct was calculated to be 0.89, an improvement over the Cronbach's alpha of 0.76 reported by [23] for either mother's support and father's support,

Table 2. Descriptive statistics of survey items at two time points. All items were measured on a Likert scale, ranging from 1-6 with "1" denoting "strongly disagree" and "6" denoting "strongly agree."

	Pre-survey			Post-survey		
	N	Mean	SD	N	Mean	SD
IP_Fun	156	4.70	1.58	164	4.30	1.71
IP_Interest	156	4.40	1.71	164	4.15	1.85
IP_Bore	156	4.70	1.57	164	4.40	1.66
MS_Encourage	151	3.15	1.69	164	2.60	1.55
MS_Confidence	151	3.88	1.65	164	3.44	1.68
MS_Need	151	3.22	1.68	164	2.93	1.73
FS_Encourage	151	3.23	1.63	164	2.94	1.62
FS_Confidence	151	2.95	1.67	164	2.72	1.71
FS_Need	152	3.70	1.65	163	3.29	1.70
SE_Future	156	4.45	1.38	164	4.21	1.36
SE_Career	154	4.12	1.59	164	4.02	1.68
SE_Challenge	156	3.71	1.68	164	3.66	1.77
SE_Learn	156	4.66	1.44	164	4.41	1.68
SE_Ability	156	3.95	1.62	164	3.85	1.60
SE_Confidence	156	4.19	1.57	164	3.93	1.68
SE_Now	156	3.53	1.56	164	3.57	1.67

suggesting strong construct validity. However, combining the mother's support and father's support variables into a single construct removed our ability to examine the independent effects of mother's support and father's support on students' interest [6, 21, 58] within the structural equation modeling (SEM) framework.

2.5.2 EFA 2: Self-efficacy and interest. We also performed an EFA on items of self-efficacy and interest (see Table 5). As the items for the two constructs loaded onto two separate factors, interest and self-efficacy were treated as separate latent constructs in subsequent analyses. The Cronbach's alpha values for self-efficacy (0.92) and interest (0.87) showed strong reliability.

A total of 17 survey items were used in the final analyses, including the single item that asked students if they took the board game home with them.

2.6 Data Diagnostics

Data collected from the surveys were modeled using structural equation modeling. Statistical models were built in R [77] using the sem( ) function in the Lavaan package [65]. Since all of the variables in the model are measured on a Likert scale, frequency distributions were created to check normality assumptions [63]. In cases where assumptions were violated, they were treated as ordered pairs. To address the asymptotic non-normality of the relatively small dataset, robust maximum likelihood (MLR) estimates were used for the model that used continuous items, and weighted least squares estimators with mean and variance adjustment (WLSMV) were used for the mediator model as it used the dichotomous TakeHome variable.

2.7 Analytic Strategy

We used confirmatory structural equation modeling (SEM), which allowed us to test a set of directional relationships between multiple variables [80] and thus, an appropriate method for addressing our research questions.

Table 3. Descriptive statistics of survey items divided by boys and girls. All items were measured on a Likert scale, ranging from 1-6 with "1" denoting "strongly disagree" and "6" denoting "strongly agree."

	Boys				Girls			
	Pre-survey		Post-survey		Pre-survey		Post-survey	
	N	Mean	N	Mean	N	Mean	N	Mean
IP_Fun	78	4.95	78	4.54	78	4.45	77	4.06
IP_Interest	78	4.63	78	4.4	78	4.18	77	3.96
IP_Bore	78	4.81	78	4.6	78	4.59	77	4.14
MS_Encourage	76	3.21	78	2.68	75	3.08	77	2.55
MS_Confidence	76	4.08	78	3.56	75	3.68	77	3.29
MS_Need	76	3.17	78	3.01	75	3.27	77	2.87
FS_Encourage	76	2.93	78	2.79	75	2.96	77	2.62
FS_Confidence	77	3.91	78	3.37	75	3.48	76	3.2
FS_Need	76	3.21	78	2.97	75	3.24	77	2.9
SE_Future	78	4.53	78	4.4	78	4.37	77	4.08
SE_Career	78	4.29	78	4.26	76	3.95	77	3.9
SE_Challenge	78	3.82	78	3.99	78	3.6	77	3.42
SE_Learn	78	4.92	78	4.64	78	4.4	77	4.21
SE_Ability	78	4.05	78	3.95	78	3.85	77	3.9
SE_Confidence	78	4.44	78	4.1	78	3.94	77	3.81
SE_Now	78	3.59	78	3.76	78	3.47	77	3.45

Table 4. EFA performed on mother's and father's support survey items

	Factor1	Factor2
FS_need_pre	0.75	
MS_Need_pre	0.71	
FS_Encourage_pre	0.79	
MS_Encourage_pre	0.80	
FS_Confidence_pre	0.74	
MS_Confidence_pre	0.70	
FS_Interest_pre		0.76
MS_Interest_pre		0.88

Note: Factor values smaller than 0.4 are not shown in the table.

2.7.1 Examining the effect of parental support on self-efficacy and programming interest. The first research question examined the effect of students' perceived parental support on students' self-efficacy and interest in computer programming. We posit that students' perception of parental support can predict the change in self-efficacy as well as their interest in computer programming. In a confirmatory factor analysis (see 3), we tested whether the perceived mother's support and perceived father's support combined (PS_1) as measured on the pre-survey had an effect on the students' self-efficacy (SE_2) as well as students' interest (I_2) on the post-survey while controlling for pre-survey measures (SE_1 and I_1).

Table 5. EFA performed on Self-efficacy and Interest items

	Factor1	Factor2
SE_Future_pre	0.60	
SE_Career_pre	0.54	0.51
SE_Challenge_pre	0.77	
SE_Learn_pre	0.47	0.56
SE_Ability_pre	0.85	
SE_Confidence_pre	0.66	0.44
SE_Now_pre	0.82	
IP_interest_pre		0.78
IP_fun_pre	0.40	0.80
IP_bore_pre		0.75

Note: Factor values smaller than 0.4 are not shown in the table.

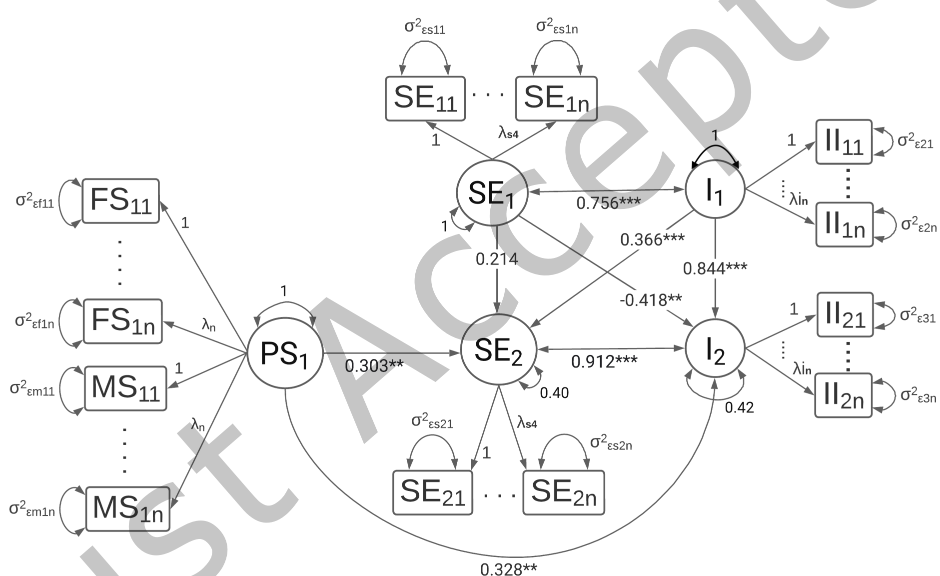

Fig. 3. Perceived parental support (PS_1) on pre-survey significantly predicted self-efficacy (SE_2) and interest (I_2) on post-survey while controlling for self-efficacy and interest on pre-survey (where ** p< .01; *** p<.001) (SE=Self-Efficacy ; I=interest in Programming; PS=Parental support)

Note that mother's support and father's support variables were combined in the SEM approach to avoid the problem of multicollinearity.

2.7.2 Single mediation models to test the effects of taking the board game home. For the second research question, we tested the mediation effect [55] of taking the board game home (see Figure 4) between students' perceived parental support in the pre-survey (PS_1) and students' interest in programming (post-survey) (I_2) controlling for

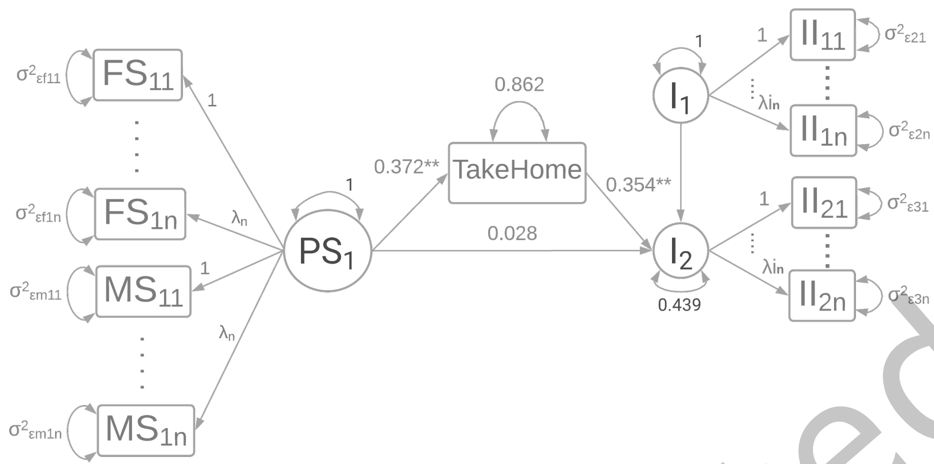

Fig. 4. Perceived parent's support (PS_1) on the pre-survey significantly predicted student's interest (I_2) on post-survey. This effect was mediated by students' action of taking the board game home.

pre-survey (I_1). The outcome of this model provides insights for creating instructional designs that can affect students' interest in computer programming.

The mediator variable (TakeHome) was treated as dichotomous in the models. Furthermore, estimates of indirect effects were calculated via bootstrapping method [38] for 5000 samples with replacement for the calculation of 95% and 99% confidence intervals in R. Just like in the previous model, mother's support and father's support variables were combined in the SEM approach.

3 RESULTS

3.1 Statistics and Data Analysis

Nine students from the first school and seven students from the second school had missing data for the pre and post surveys (see Table 2) characterized as missing at random (MAR) [67]. Full Information Maximum Likelihood (FIML) strategy was used to address missing patterns [29, 39] .

Since structural equation modeling assumes asymptotic normality, the distribution of the items was plotted and skewness and kurtosis measures were calculated. All of the skewness values fell between -3 and +3 and all of the kurtosis values fell between the values of -10 and +10, considered acceptable for structural equation modeling [17].

The chi-square test, Tucker-Lewis index (TLI) [12], root mean square error of approximation (RMSEA) [18, 74], and comparative fit index (CFI) [11], were calculated as model fit measures. For the first model in Figure 3 ($PS_1 \rightarrow SE_2$ & $PS_1 \rightarrow I_2$), the model fit statistics were calculated as: χ^2 (289, N = 170) = 537.7, p < .001; CFI = 0.935; TLI = 0.927; RMSEA = 0.062, SRMR = 0.058). For the mediation model in Figure 4 ($PS_1 \rightarrow TakeHome \rightarrow I_2$), the model fit statistics were calculated as: χ^2 (66, N = 170) = 85.84, p = .051; CFI = 0.914; TLI = 0.90; RMSEA = 0.042, SRMR = 0.055). Although TLI and CFI values of 0.95 or higher are generally considered acceptable, Kline [45] suggests that these values can be too strict when the model is too complex or uses a small sample size. For such models, they suggest the threshold values of TLI> 0.90; CFI > 0.90; RMSEA <.08, SRMR < .08, which both of our models meet.

3.2 How parental support influences self-efficacy and interest

The regression results from the first model ($PS_1 \rightarrow SE_2 \rightarrow I_2$; see 3) revealed that the students' perceived parental support measured at the start of the unit (PS_1) predicted students' self-efficacy (SE_2 controlling for SE_1) (B = 0.366, SE = 0.10, p <. 001). This means that for a one standard deviation increase in the latent variable PS_1, the SE_2 increased by 0.366 standard deviations while controlling for pre-survey measures of SE_1 and I_1. The model also showed that parental support (PS_1) also predicted students' interest (I_2) (B = 0.328, SE = 0.134, p < .003) while controlling for pre-survey measures of SE_1 and I_1. Stated differently, for one standard deviation increase in the latent variable PS_1, the I_2 increased by 0.394 standard deviations. This means that students' perceived parental support predicted a change in students' self-efficacy and their interest in programming. See Table 6) for factor loadings.

Table 6. Factor loadings (standardized) of survey items on their respective latent variables for model in Figure 3

	Pre-survey measures			Post-survey measures		
Construct	Indicator	Std. B	Std. Err	Indicator	Std. B	Std. Err
Interest	IP_Fun	0.93	0.00	IP_Fun	0.87	0.00
	IP_Interest	0.84	0.07	IP_Interest	0.94	0.07
	IP_Bore	0.73	0.09	IP_Bore	0.76	0.08
Self-efficacy	SE_Future	0.71	0.08	SE_Future	0.78	0.06
	SE_Career	0.73	0.07	SE_Career	0.80	0.06
	SE_Challenge	0.81	0.06	SE_Challenge	0.82	0.05
	SE_Learn	0.70	0.08	SE_Learn	0.74	0.09
	SE_Ability	0.87	0.00	SE_Ability	0.85	0.00
	SE_Confidence	0.80	0.09	SE_Confidence	0.88	0.06
	SE_Now	0.85	0.04	SE_Now	0.83	0.06
Parental Support	MS_Encourage	0.81	0.08			
	MS_Confidence	0.71	0.10			
	MS_Need	0.74	0.00			
	FS_Encourage	0.79	0.10			
	FS_Confidence	0.73	0.10			
	FS_Need	0.75	0.08			

To better visualize this, data is plotted in Figure 6 which shows that composite means for mother's support and father's support were both similarly correlated to the composite means of self-efficacy and interest, as our model suggests.

3.3 The effect of taking the board game home

As shown in Figure 4, we tested if the effect of students' perceived parental support before the unit (PS_1) on students' interest in programming after the unit (I_2) was mediated by the action of taking the board game home (TakeHome variable). Using the indirect effects approach [38] with the percentile bootstrap method with 5000 iterations, we found that 95% CI and 99% CI did not include a 0, which indicated a significant indirect effect through the TakeHome variable (Std B = 0.132, 95% CI [0.039, 0.399], 99% CI [0.017, 0.542]), confirming that perceived parental support indirectly affected students' interest through the effect of taking the board game home.

Students who reported voluntarily taking the board games home also reported an increase in interest in computer programming, and this increase was significantly different from students that did not take the board

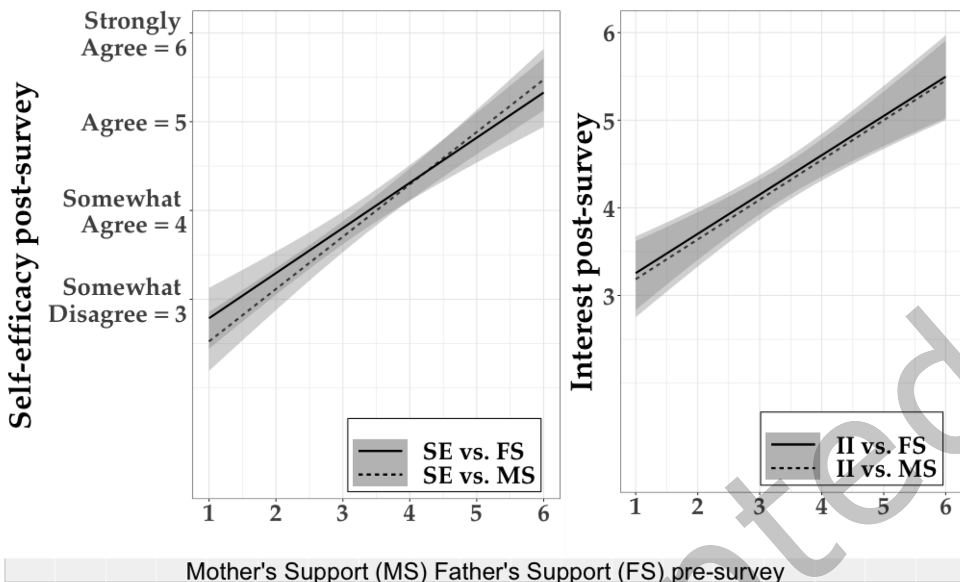

Fig. 5. Higher mother's and father's support (MS and FS) scores on pre-survey are correlated with higher self-efficacy and interest on post-survey, 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = somewhat agree, 5 = agree, 6 = strongly agree

game home. This suggests that the instructional design feature of allowing students to take a CS artifact home (here, a board game) is related to an increase in interest in programming (see Figure 6).

Table 7. Factor loadings of survey items on their respective latent variables for mediation model in Figure 4

Construct	Indicator	Std. B	SE	Construct	Indicator2	Std B	SE
Interest_pre	IP_Fun	0.91	0.00	Parental Support pre	MS_Encourage	0.78	0.15
	IP_Interest	0.90	0.10		MS_Confidence	0.72	0.14
	IP_Bore	0.71	0.09		MS Need	0.75	0.00
Interest_post	IP_Fun	0.91	0.00		FS Encourage	0.78	0.17
	IP_Interest	0.92	0.10		FS Confidence	0.71	0.17
	IP_Bore	0.75	0.09		FS Need	0.75	0.15

The composite means of mother's and father's supports are plotted against composite means of programming interest in Figure 4. Based on our mediation analysis (see Table 7), we conclude that the combined effect of mother's support and father's support on students' interest is mediated by students' action of taking the board game home and that mother's support and father's support variables both have a similar influence on the mediation.

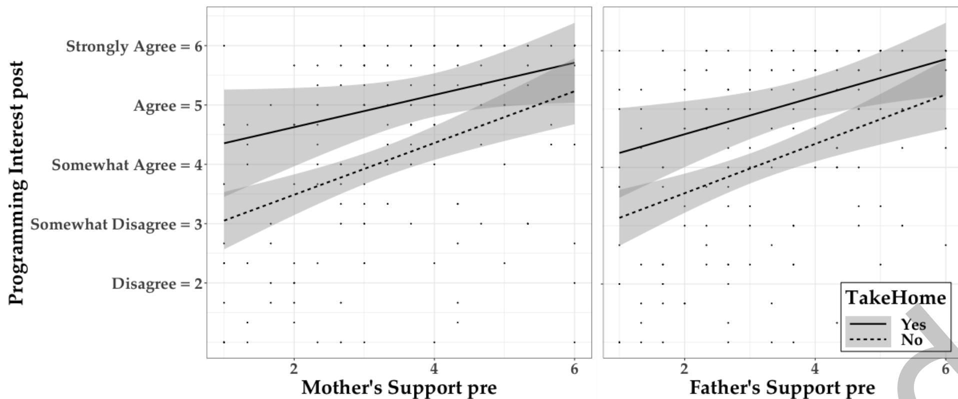

Fig. 6. Students who took the board game home have a higher interest on post-survey compared to their peers who didn't but had similar mother's and father's support (MS and FS) scores on the pre-survey

4 DISCUSSION AND LIMITATIONS

4.1 Addressing Research Questions

The present study set out to explore the relationship between perceived parental support, self-efficacy, and interest in computer programming. Our findings suggest that perceived parental support played a role in students' belief about their ability to program as well as their interest in programming.

4.1.1 Parental Support, Self-Efficacy, and Interest. Our results show that perceived parental support (PS_1) predicted self-efficacy (SE_2) and student interest in programming (I_2). The present research builds on our current understanding by relating the two constructs (perceived parental support and self-efficacy) to the construct of interest in programming. We also found that perceived parental support measured in the pre-survey (PS_1) influenced interest in programming (I_2) mediated by students' action of taking the board game home.

The present study is unique in its use of structural equation modeling in a formal K-12 school setting for the examination of affective constructs. Although it is difficult to relate students' self-efficacy in programming in primary education directly to the choice of a computing career later in their lives, the self-efficacy survey items in our study included questions about the students' beliefs in their ability to learn to program and become proficient coders in the future. We hoped that framing self-efficacy items in this way would help us draw connections between our findings and the existing literature on students' orientation towards a computing career. In the present study, we discovered that perceived parental support significantly predicted students' self-efficacy in computer programming.

Interest can lead to persistence [51] thus, interest in programming can be an important indicator of positive orientation towards a computing career. Despite its importance, there are many examples in the CS education literature where interest was measured but no significant change in interest was found [22, 68, 73, 86]. Some studies that showed a change in interest did not adequately explain what factors affected it [3, 20]. In the present study, we used interest in programming (I_2) as an outcome variable (see Figures 3 and 4). In the first of these models, the change in self-efficacy was highly correlated with interest at both timepoints. This is in line with the previous research which suggests that self-efficacy and interest have a reciprocal relationship [50, 57]. Perceived parental support also predicted interest, which is similar to one of our previous findings in which we found that parents' support in their children's pursuit of CS affects children's beliefs about the usefulness of CS, and these beliefs affect to what extent they are interested in CS [21]. We found that mother's support and father's support have a combined effect that is significant. We hope that the present study will help fill gaps in the understanding of the relationship between perceived parental support, self-efficacy, and interest in programming.

Another aspect to consider is that students' initial self-efficacy (SE_1) did not predict either self-efficacy (SE_2) or interest (I_2) on the post-survey. This indicates that, after accounting for the effect of initial parental support (PS_1), students' initial self-efficacy in programming was not a significant predictor of their interest or confidence towards programming after the unit.

Another noteworthy observation is that, after accounting for the effect of initial parental support (PS_1), students' initial interest in programming (I_1) did predict both self-efficacy (SE_2) and interest (I_2) on the post-survey. In other words, while students' initial confidence in programming tasks did not influence their subsequent confidence and interest towards programming, their initial interest in programming had a positive impact. This suggests that efforts to increase students' interest in computer programming should be prioritized, regardless of students self-perceived proficiency in programming. Additionally, the positive correlation between initial parental support (PS_1) and both self-efficacy (SE_2) and interest (I_2) on the post-survey implies that parents could be provided with strategies that help portray computer programming in a favorable light. In the second model, we discovered that the influence of parental support on students' interest in computer programming can be positively mediated by providing CS education materials at home (such as a CS-themed board game). This implies that schools could provide strategies that encourage parents to engage in positive conversations about computer science with their children.

4.1.2 Sharing Artifacts from School at Home. Our findings based on the single mediator model (see Figure 4) have implications for how we design classroom instruction for computer science. In particular, it showed the importance of finding ways to make connections between students' home and school lives. There is a dearth of research that explores how sharing computer programming related materials with parents affect students' interest in programming. In a previous literature review [70], no conclusive findings were found on what instructional design features are effective in improving self-efficacy and interest in programming.

In the present study, we studied the effects of enabling students to take the board game used in CS classroom activities home to their parents. The idea behind enabling students to take the board games home was that students may show board games to their parents, leading to conversations about computer programming and careers in CS. Such conversations may in turn influence students' perception of support from their parents and or their interest in computer programming. Our results indeed showed that taking the board game home had a significant mediation effect between perceived parental support reported in the pre-survey and in students' interest in programming in the post-survey and the action of taking the board game home mediated this effect. We hope that this finding will encourage other research that will further examine ways to make connections between youth's school and home lives by sharing computing materials. Such research should explore methods of influencing parents' involvement in student learning and its effects on students' subsequent interest in and career aspirations toward computing.

In addition to the statistical significance of the results, it is crucial to consider the effect sizes, as it provides a better measure of the meaningfulness of the findings. In our first model, a one standard deviation increase in parental support predicted approximately one-third of a standard deviation increase in both self-efficacy and interest, which can be considered a moderate effect size. In the second model, the mediation effect size of 0.132 for taking the board game home can be considered moderate. This suggests that the TakeHome variable explained 13% of the variance in the effect of parental support on interest. However, since the TakeHome variable is dichotomous, it represents only 13% of the total effect of initial parental support on the students' interest (post), which is a small proportion of the overall interest.

While student gender data was collected, it was not used in analyses. As a group-level variable, disaggregating by gender would reduce the group sample size, resulting in models lacking sufficient power. As gender inequality has consistently been found in computer science participation [14], future research should consider incorporating demographic variables to explore potential differences across different populations.

Another point to note is that, although positive associations were found between parental support (pre) and self-efficacy (post) and interest (post), the overall means decreased for almost all measures (see Tables 2 & 3). This is likely due to a ceiling effect, where students' initial responses (pre-survey) were very high, leaving little room for improvement. Thus, students reported a positive attitude toward programming before our implementation, limiting the potential for further growth.

4.2 LIMITATIONS

The present study has several limitations that should be acknowledged:

(1) Lack of qualitative data: Qualitative data, such as interviews or observations, could have provided richer insights into the experiences of students and their parents, and helped to contextualize the findings.
(2) Unavailability of demographic data: As the schools were located in a mostly white rural district, the study did not collect information on students' race or other demographic characteristics, which limits our understanding of how these factors might influence the relationships among perceived parental support, self-efficacy, and interest in programming. Student gender data was collected but were not used in the analyses. Future research should consider incorporating demographic variables to explore potential differences across different populations.
(3) Household arrangements: The study used variables for mother's and father's support. This may not reflect the experiences of students from other household types like single parents, same-gender parents, or other guardians. We chose these variables based on their strong theoretical foundation. Including more family arrangements would lead to smaller sample sizes for those categories, potentially affecting statistical validity. Future research should use a larger, diverse sample to better represent different family structures and provide a more comprehensive measure of parental support.
(4) Self-reported take-home variable: The TakeHome variable measured whether students took the board game home and was self-reported on the post-survey as a yes/no response. This measure did not provide information about the duration for which the board game was taken home or whether students played the game with their parents or engaged in conversations about programming, as intended. The reliance on self-report data could have introduced biases and limited the accuracy of this measure. It is also possible that spending more time with the board game resulted in an increase in their interest. Perhaps adding a question like 'How many times did you play the board game with your parents?' could better enable us to examine how engagement with the board game by both the students and their parents affected the students' interest, while also overcoming the statistical limitations associated with a dichotomous variable. Future research should consider using other methods to assess students' engagement with programming-related materials at home and the extent of parental involvement in these activities.

In addition, there are limitations related to the statistical models used in the study. The first limitation is related to our parent support model. In the SEM framework, we could not examine the differences in how perceived mother and father support influence interest and self-efficacy in the same model owing to a high degree of correlation between the two variables. While an alternative approach to SEM, such as multiple linear regression (MLR) analysis, to test significance for mother's support and father's support separately could be used, SEM is considered a more robust and accurate approach for several reasons [16, 45]. SEM allows for the simultaneous estimation of multiple relationships in a single model, providing a more comprehensive understanding of the inter-dependencies among variables. MLR, conversely, is limited to examining a single dependent variable at a time (e.g., either self-efficacy or interest), which may lead to a fragmented understanding of the relationships in the data.

A limitation of the SEM model (see Figure 3) is that the self-efficacy (SE_1&SE_2) and interest (I_1&I_2) were measured at the same times (on pre-survey and post-survey respectively). Thus, the relationship between SE_1, I_1 and SE_2, I_2 is reciprocal and not predictive.

Finally, we note that circumstances where the independent variables cannot be manipulated, are not ideal for a mediation analysis [83]. This posed a threat to the validity of the mediation results since students' perceived mother's support and father's support variables were not manipulated, instead, they were simply observed. Despite this threat, we think that demonstrating the effect of taking the board game home can provide useful implications for instructional design practices.

5 CONCLUSIONS

The growing demand for computer programming skills brings along with it a critical need to broaden participation of underrepresented and under-served students in computer science education. In this study, we found that students' perceived mother support and students' perceived father support affected students' interest in programming and students' self-efficacy to program (see Figures 3 & 4).

Studying the predictive effects of parental support on students' attitude in programming and examining the mediation effect of sending CS artifacts home is an important contribution to the field, as it reveals implications about out-of-school factors that should be considered in the design and implementation of any primary-level computing unit. These results have implications for research on broadening participation in CS education as well as in the design of CS instruction. For the former, studying the influence of out-of-school factors such as parental support can provide ways to understand and mitigate the effects of inequities that persist in computing education. Likewise, our findings inform the design of CS instructional activities. Interest-driven CS learning often fails to take these external factors into account as the instructional design is mostly aimed at improving in-activity interest. In the present study, we gave students the option to take a CS artifact home to see if it affected students' interest. Designers and researchers should examine other ways of building connections between school and home activities as means of influencing social supports that impact important constructs such as interest and self-efficacy.

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REFERENCES

[1] Efthimia Aivaloglou and Felienne Hermans. 2019. Early Programming Education and Career Orientation: The Effects of Gender, Self-Efficacy, Motivation and Stereotypes. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*. ACM, Minneapolis MN USA, 679–685. https://doi.org/10.1145/3287324.3287358

[2] Amnah Alshahrani, Isla Ross, and Murray I. Wood. 2018. Using Social Cognitive Career Theory to Understand Why Students Choose to Study Computer Science. In *Proceedings of the 2018 ACM Conference on International Computing Education Research*. ACM, Espoo Finland, 205–214. https://doi.org/10.1145/3230977.3230994

[3] Sarah AlSulaiman and Michael S. Horn. 2015. Peter the Fashionista?: Computer Programming Games and Gender Oriented Cultural Forms. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. ACM, London United Kingdom, 185–195. https://doi.org/10.1145/2793107.2793127

[4] Carole Ames, Lizanne de Stefano, Thomas Watkins, and Steven Sheldon. 1995. The Role of Parent Perceptions and Beliefs. *Center on Families, Communities, Schools, and Children's Learning, Michigan State University* (1995).

[5] Chulakorn Aritajati, Mary Beth Rosson, Joslenne Pena, Dana Cinque, and Ana Segura. 2015. A Socio-Cognitive Analysis of Summer Camp Outcomes and Experiences. In *In Proceedings of the 46th ACM Technical Symposium on Computer Science Education*. ACM, 581–586.

[6] Abdulkadir Bahar and Tufan Adiguzel. 2016. Analysis of Factors Influencing Interest in STEM Career: Comparison between American and Turkish High School Students with High Ability. *Journal of STEM Education* 10 (Sept. 2016), 64–69.

[7] Jayson Troy Bajar and Mary Ann Bajar. 2019. *Teachnology: Drop-out Prevention by Increasing Parent Involvement through Text Messaging.* SSRN Scholarly Paper ID 3729711. Social Science Research Network, Rochester, NY. https://papers.ssrn.com/abstract=3729711

[8] Albert Bandura. 1977. Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review* 84, 2 (1977), 191–215. https://doi.org/10.1037/0033-295X.84.2.191 Place: US Publisher: American Psychological Association.

[9] Albert Bandura. 1986. *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall, Inc, Englewood Cliffs, NJ, US. Pages: xiii, 617.

[10] Albert Bandura. 1997. *Self-efficacy: The exercise of control.* W H Freeman/Times Books/ Henry Holt & Co, New York, NY, US. Pages: ix, 604.

[11] P. M. Bentler. 1990. Comparative fit indexes in structural models. *Psychological Bulletin* 107, 2 (1990), 238–246. https://doi.org/10.1037/0033-2909.107.2.238 Place: US Publisher: American Psychological Association.

[12] P. M. Bentler and Douglas G. Bonett. 1980. Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin* 88, 3 (1980), 588–606. https://doi.org/10.1037/0033-2909.88.3.588 Place: US Publisher: American Psychological Association.

[13] Matthew Berland and Victor R. Lee. 2011. Collaborative Strategic Board Games as a Site for Distributed Computational Thinking. *International Journal of Game-Based Learning (IJGBL)* 1, 2 (2011), 65–81. https://doi.org/10.4018/ijgbl.2011040105 Publisher: IGI Global.

[14] Sylvia Beyer. 2014. Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. *Computer Science Education* 24, 2-3 (July 2014), 153–192. https://doi.org/10.1080/08993408.2014.963363 Publisher: Routledge _eprint: https://doi.org/10.1080/08993408.2014.963363.

[15] Jennifer M Blaney and Jane G Stout. 2017. Examining the Relationship Between Introductory Computing Course Experiences, Self-Efficacy, and Belonging Among First-Generation College Women. In *In Proceedings of the ACM SIGCSE Technical Symposium on Computer Science Education.* New York, NY, 69–74.

[16] Kenneth A. Bollen. 1989. *Structural Equations with Latent Variables: Bollen/Structural Equations with Latent Variables.* John Wiley & Sons, Inc., Hoboken, NJ, USA. https://doi.org/10.1002/9781118619179

[17] Timothy A. Brown. 2015. Confirmatory Factor Analysis for Applied Research. https://books.google.com/books?hl=en&lr=&id=tTL2BQAAQBAJ&oi=fnd&pg=PP1&dq=Confirmatory+factor+analysis+for+applied+research+brown&ots=alRztIZMbF&sig=vOge0A-TVWzeLsQSs9dFJK2sbOY#v=onepage&q=Confirmatory%20factor%20analysis%20for%20applied%20research%20brown&f=false

[18] Michael W. Browne and Robert Cudeck. 1992. Alternative Ways of Assessing Model Fit. *Sociological Methods & Research* 21, 2 (Nov. 1992), 230–258. https://doi.org/10.1177/0049124192021002005 Publisher: SAGE Publications Inc.

[19] Cheryl Carrico and Chosang Tendhar. 2012. The Use of the Social Cognitive Career Theory to Predict Engineering Students' Motivation in the PRODUCED Program. In *2012 ASEE Annual Conference & Exposition Proceedings.* ASEE Conferences, San Antonio, Texas, 25.1354.1–25.1354.13. https://doi.org/10.18260/1-2--22111

[20] Yesheng Chen, Zhen Chen, Shyamala Gumidyala, Annabella Koures, Seoyeon Lee, James Msekela, Halle Remash, Nolan Schoenle, Sarah Dahlby Albright, and Samuel A. Rebelsky. 2019. A Middle-School Code Camp Emphasizing Digital Humanities. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education.* ACM, Minneapolis MN USA, 351–357. https://doi.org/10.1145/3287324.3287509

[21] Jody Clarke-Midura, Frederick J. Poole, Katarina Pantic, Chongning Sun, and Vicki Allan. 2018. How Mother and Father Support Affect Youths' Interest in Computer Science. In *Proceedings of the 2018 ACM Conference on International Computing Education Research.* ACM, Espoo Finland, 215–222. https://doi.org/10.1145/3230977.3231003

[22] Jody Clarke-Midura, Chongning Sun, and Katarina Pantic. 2020. Making Apps: An Approach to Recruiting Youth to Computer Science. *ACM Transactions on Computing Education* 20, 4 (Dec. 2020), 1–23. https://doi.org/10.1145/3425710

[23] Jody Clarke-Midura, Chongning Sun, Katarina Pantic, Frederick Poole, and Vicki Allan. 2019. Using Informed Design in Informal Computer Science Programs to Increase Youths' Interest, Self-efficacy, and Perceptions of Parental Support. *ACM Transactions on Computing Education* 19, 4 (Dec. 2019), 1–24. https://doi.org/10.1145/3319445

[24] Carolyn E. Cutrona, Valerie Cole, Nicholas Colangelo, Susan G. Assouline, and Daniel W. Russell. 1994. Perceived parental social support and academic achievement: An attachment theory perspective. *Journal of Personality and Social Psychology* 66, 2 (1994), 369–378. https://doi.org/10.1037/0022-3514.66.2.369 Place: US Publisher: American Psychological Association.

[25] Jennifer Dempsey, Richard T. Snodgrass, Isabel Kishi, and Allison Titcomb. 2015. The Emerging Role of Self-Perception in Student Intentions. In *Proceedings of the 46th ACM Technical Symposium on Computer Science Education.* ACM, Kansas City Missouri USA, 108–113. https://doi.org/10.1145/2676723.2677305

[26] Jill Denner. 2011. What Predicts Middle School Girls' Interest in Computing? *Science and Technology* 3, 1 (2011), 17.

[27] Jill Denner, Linda Werner, Lisa O'Connor, and Jill Glassman. 2014. Community College Men and Women: A Test of Three Widely Held Beliefs About Who Pursues Computer Science. *Community College Review* 42, 4 (Oct. 2014), 342–362. https://doi.org/10.1177/0091552114535624

[28] J. Elizabeth Casey, Puneet Gill, Lisa Pennington, and Selina V. Mireles. 2018. Lines, roamers, and squares: Oh my! using floor robots to enhance Hispanic students' understanding of programming. *Education and Information Technologies* 23, 4 (July 2018), 1531–1546. https://doi.org/10.1007/s10639-017-9677-z

[29] Craig K. Enders. 2001. A Primer on Maximum Likelihood Algorithms Available for Use With Missing Data. *Structural Equation Modeling: A Multidisciplinary Journal* 8, 1 (Jan. 2001), 128–141. https://doi.org/10.1207/S15328007SEM0801_7

[30] Weihua Fan and Cathy M. Williams. 2010. The effects of parental involvement on students' academic self-efficacy, engagement and intrinsic motivation. *Educational Psychology* 30, 1 (Jan. 2010), 53–74. https://doi.org/10.1080/01443410903353302

[31] Elizabeth Fennema and Julia A. Sherman. 1976. Fennema-Sherman Mathematics Attitudes Scales: Instruments Designed to Measure Attitudes toward the Learning of Mathematics by Females and Males. *Journal for Research in Mathematics Education* 7, 5 (1976), 324–326. https://doi.org/10.2307/748467 Publisher: National Council of Teachers of Mathematics.

[32] Teresa A. Fisher and Inna Padmawidjaja. 1999. Parental Influences on Career Development Perceived by African American and Mexican American College Students. *Journal of Multicultural Counseling and Development* 27, 3 (1999), 136–152. https://doi.org/10.1002/j.2161-1912.1999.tb00220.x _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/j.2161-1912.1999.tb00220.x.

[33] Michelle Friend. 2015. Middle school girls' envisioned future in computing. *Computer Science Education* (2015), 152–173. https://doi.org/10.1080/08993408.2015.1033128

[34] Eleftheria N. Gonida and Kai S. Cortina. 2014. Parental involvement in homework: Relations with parent and student achievement-related motivational beliefs and achievement. *British Journal of Educational Psychology* 84, 3 (2014), 376–396. https://doi.org/10.1111/bjep.12039 _eprint: https://bpspsychub.onlinelibrary.wiley.com/doi/pdf/10.1111/bjep.12039.

[35] Alyssa R. Gonzalez-DeHass, Patricia P. Willems, and Marie F. Doan Holbein. 2005. Examining the Relationship Between Parental Involvement and Student Motivation. *Educational Psychology Review* 17, 2 (June 2005), 99–123. https://doi.org/10.1007/s10648-005-3949-7

[36] Jamie Gorson and Eleanor O'Rourke. 2020. Why do CS1 Students Think They're Bad at Programming? Investigating Self-Efficacy and Self-Assessments at Three Universities. In *Proceedings of the 2020 ACM Conference on International Computing Education Research*. New Zealand, 170–181. https://doi.org/10.1145/3372782.3406273

[37] Judith M. Harackiewicz, Christopher S. Rozek, Chris S. Hulleman, and Janet S. Hyde. 2012. Helping Parents to Motivate Adolescents in Mathematics and Science: An Experimental Test of a Utility-Value Intervention. *Psychological Science* 23, 8 (Aug. 2012), 899–906. https://doi.org/10.1177/0956797611435530 Publisher: SAGE Publications Inc.

[38] Andrew F. Hayes. 2009. Beyond Baron and Kenny: Statistical Mediation Analysis in the New Millennium. *Communication Monographs* 76, 4 (Dec. 2009), 408–420. https://doi.org/10.1080/03637750903310360

[39] Corinne M. Henk and Laura Castro-Schilo. 2016. Preliminary Detection of Relations Among Dynamic Processes With Two-Occasion Data. *Structural Equation Modeling: A Multidisciplinary Journal* 23, 2 (March 2016), 180–193. https://doi.org/10.1080/10705511.2015.1030022 Publisher: Routledge _eprint: https://doi.org/10.1080/10705511.2015.1030022.

[40] Suzanne Hidi and K. Ann Renninger. 2006. The Four-Phase Model of Interest Development. *Educational Psychologist* 41, 2 (June 2006), 111–127. https://doi.org/10.1207/s15326985ep4102_4 Publisher: Routledge _eprint: https://doi.org/10.1207/s15326985ep4102_4.

[41] Lloyd G Humphreys and Richard G Montanelli Jr. 1975. An investigation of the parallel analysis criterion for determining the number of common factors. *Multivariate Behavioral Research* 10, 2 (1975), 193–205. Publisher: Taylor & Francis.

[42] Kathleen M. Jodl, Alice Michael, Oksana Malanchuk, Jacquelynne S. Eccles, and Arnold Sameroff. 2001. Parents' Roles in Shaping Early Adolescents' Occupational Aspirations. *Child Development* 72, 4 (Aug. 2001), 1247–1266. https://doi.org/10.1111/1467-8624.00345

[43] Ursula Y. Johnson and Darrell M. Hull. 2014. Parent Involvement and Science Achievement: A Cross-Classified Multilevel Latent Growth Curve Analysis. *The Journal of Educational Research* 107, 5 (Sept. 2014), 399–409. https://doi.org/10.1080/00220671.2013.807488 Publisher: Routledge _eprint: https://doi.org/10.1080/00220671.2013.807488.

[44] Henry F Kaiser. 1958. The varimax criterion for analytic rotation in factor analysis. *Psychometrika* 23, 3 (1958), 187–200. Publisher: Springer.

[45] Rex B. Kline. 2016. *Principles and practice of structural equation modeling, 4th ed.* Guilford Press, New York, NY, US. Pages: xvii, 534.

[46] Derrick Norman Lawley and Albert Ernest Maxwell. 1971. Factor analysis as a statistical method. (1971). Publisher: Butterworths.

[47] Kathleen J Lehman. 2016. Women planning to major in computer science: Who are they and what makes them unique? *Computer Science Education* 26, 4 (2016), 277–298. https://doi.org/10.1080/08993408.2016.1271536

[48] Luzia Leifheit, Katerina Tsarava, Korbinian Moeller, Klaus Ostermann, Jessika Golle, Ulrich Trautwein, and Manuel Ninaus. 2019. Development of a Questionnaire on Self-concept, Motivational Beliefs, and Attitude Towards Programming. In *Proceedings of the 14th Workshop in Primary and Secondary Computing Education*. ACM, Glasgow, Scotland, 9. https://doi.org/10.1145/3361721.3361730

[49] Robert W Lent and Steven D Brown. 1996. Social Cognitive Approach to Career Development: An Overview. 44 (1996).

[50] Robert W. Lent, Steven D. Brown, and Gail Hackett. 1994. Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance. *Journal of Vocational Behavior* 45, 1 (Aug. 1994), 79–122. https://doi.org/10.1006/jvbe.1994.1027

[51] Robert W. Lent, Antonio M. Lopez, Frederick G. Lopez, and Hung-Bin Sheu. 2008. Social cognitive career theory and the prediction of interests and choice goals in the computing disciplines. *Journal of Vocational Behavior* 73, 1 (Aug. 2008), 52–62. https://doi.org/10.1016/j.jvb.2008.01.002

[52] Alex Lishinski and Joshua Rosenberg. 2020. Accruing Interest: What Experiences Contribute to Students Developing a Sustained Interest in Computer Science Over Time? In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*. Association for Computing Machinery, New York, NY, USA, 1414. http://doi.org/10.1145/3328778.3372568

[53] Alex Lishinski and Joshua Rosenberg. 2021. All the Pieces Matter: The Relationship of Momentary Self-efficacy and Affective Experiences with CS1 Achievement and Interest in Computing. In *Proceedings of the 17th ACM Conference on International Computing Education Research (ICER 2021)*. Association for Computing Machinery, New York, NY, USA, 252–265. https://doi.org/10.1145/3446871.3469740

[54] Xin Ma, Jianping Shen, Huilan Y. Krenn, Shanshan Hu, and Jing Yuan. 2016. A Meta-Analysis of the Relationship Between Learning Outcomes and Parental Involvement During Early Childhood Education and Early Elementary Education. *Educational Psychology Review* 28, 4 (Dec. 2016), 771–801. https://doi.org/10.1007/s10648-015-9351-1

[55] David P. MacKinnon, Amanda J. Fairchild, and Matthew S. Fritz. 2007. Mediation Analysis. *Annual Review of Psychology* 58, 1 (Jan. 2007), 593–614. https://doi.org/10.1146/annurev.psych.58.110405.085542

[56] Sandra Moroni, Hanna Dumont, Ulrich Trautwein, Alois Niggli, and Franz Baeriswyl. 2015. The Need to Distinguish Between Quantity and Quality in Research on Parental Involvement: The Example of Parental Help With Homework. *The Journal of Educational Research* 108, 5 (Sept. 2015), 417–431. https://doi.org/10.1080/00220671.2014.901283 Publisher: Routledge _eprint: https://doi.org/10.1080/00220671.2014.901283.

[57] Margaret M. Nauta, Jeffrey H. Kahn, James W. Angell, and Erika A. Cantarelli. 2002. Identifying the antecedent in the relation between career interests and self-efficacy: Is it one, the other, or both? *Journal of Counseling Psychology* 49, 3 (2002), 290. https://doi.org/10.1037/0022-0167.49.3.290 Publisher: US: American Psychological Association.

[58] Luther B. Otto. 2000. Youth Perspectives on Parental Career Influence. *Journal of Career Development* 27, 2 (Dec. 2000), 111–118. https://doi.org/10.1177/089484530002700205 Publisher: SAGE Publications Inc.

[59] Sylvia Palmer and Larry Cochran. 1988. Parents as agents of career development. *Journal of Counseling Psychology* 35, 1 (1988), 71–76. https://doi.org/10.1037/0022-0167.35.1.71 Place: US Publisher: American Psychological Association.

[60] Ramona Paloş and Loredana Drobot. 2010. The impact of family influence on the career choice of adolescents. *Procedia - Social and Behavioral Sciences* 2, 2 (2010), 3407–3411. https://doi.org/10.1016/j.sbspro.2010.03.524

[61] Frederick J. Poole, Jody Clarke-Midura, Melissa Rasmussen, Umar Shehzad, and Victor R. Lee. 2021. Tabletop games designed to promote computational thinking. *Computer Science Education* 0, 0 (July 2021), 1–28. https://doi.org/10.1080/08993408.2021.1947642 Publisher: Routledge _eprint: https://doi.org/10.1080/08993408.2021.1947642.

[62] K Ann Renninger and Suzanne Hidi. 2011. Revisiting the Conceptualization, Measurement, and Generation of Interest. *Educational Psychologist* 46, 3 (2011), 168–184. https://doi.org/10.1080/00461520.2011.587723

[63] Mijke Rhemtulla, Patricia É. Brosseau-Liard, and Victoria Savalei. 2012. When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychological Methods* 17, 3 (Sept. 2012), 354–373. https://doi.org/10.1037/a0029315

[64] Carly D. Robinson, Monica G. Lee, Eric Dearing, and Todd Rogers. 2018. Reducing Student Absenteeism in the Early Grades by Targeting Parental Beliefs. *American Educational Research Journal* 55, 6 (Dec. 2018), 1163–1192. https://doi.org/10.3102/0002831218772274 Publisher: American Educational Research Association.

[65] Yves Rosseel. 2012. **lavaan** : An *R* Package for Structural Equation Modeling. *Journal of Statistical Software* 48, 2 (2012). https://doi.org/10.18637/jss.v048.i02

[66] Mary Beth Rosson, John M. Carroll, and Hansa Sinha. 2011. Orientation of Undergraduates Toward Careers in the Computer and Information Sciences: Gender, Self-Efficacy and Social Support. *ACM Transactions on Computing Education* 11, 3 (Oct. 2011), 1–23. https://doi.org/10.1145/2037276.2037278

[67] DONALD B. RUBIN. 1976. Inference and missing data. *Biometrika* 63, 3 (Dec. 1976), 581–592. https://doi.org/10.1093/biomet/63.3.581

[68] Mihaela Sabin, Rosabel Deloge, Adrienne Smith, and Applethorn Drive. 2017. SUMMER LEARNING EXPERIENCE FOR GIRLS IN GRADES 7-9 BOOSTS CONFIDENCE AND INTEREST IN COMPUTING CAREERS. *Applied Engineering and Sciences Scholarship* (2017), 8.

[69] R. Keith Sawyer. 2006. *The Cambridge handbook of the learning sciences.* Cambridge University Press.

[70] Umar Shehzad, Mimi Recker, and Jody Clarke-Midura. 2023. A Literature Review Examining Broadening Participation in Upper Elementary CS Education. In *Proceedings of the 54th ACM Technical Symposium on Computing Science Education (SIGCSE 2023)*. Association for Computing Machinery, Toronto, ON, Canada. https://doi.org/10.1145/3545945.3569873

[71] Jacqueline C. Simpson. 2003. Mom Matters: Maternal Influence on the Choice of Academic Major. *Sex Roles* 48, 9 (May 2003), 447–460. https://doi.org/10.1023/A:1023530612699

[72] Kusum Singh, Katherine R. Allen, Rebecca Scheckler, and Lisa Darlington. 2007. Women in Computer-Related Majors: A Critical Synthesis of Research and Theory From 1994 to 2005. *Review of Educational Research* 77, 4 (Dec. 2007), 500–533. https://doi.org/10.3102/0034654307309919 Publisher: American Educational Research Association.

[73] Courtney Starrett, Marguerite Doman, and Chlotia Garrison. 2015. Computational Bead Design: A Pilot Summer Camp in Computer Aided Design and 3D Printing for Middle School Girls. In *Proceedings of the 46th ACM Technical Symposium on Computer Science Education.* ACM, Kansas City, MO, USA, 4. https://doi.org/10.1145/2676723.2677303

[74] J. H. Steiger and Lind. 1980. Statistically based tests for the number of common factors. *the annual meeting of the Psychometric Society. Iowa City, IA. 1980* (1980). https://ci.nii.ac.jp/naid/10012870999/

[75] Phil Steinhorst, Andrew Petersen, and Jan Vahrenhold. 2020. Revisiting Self-Efficacy in Introductory Programming. In *In 2020 International Computing Education Research Conference (ICER '20)*. ACM, Virtual Event, New Zealand. ACM, New York, NY, USA, 12. https://doi.org/10.1145/3372782.3406281

[76] Milagros Sáinz and Jacquelynne Eccles. 2012. Self-concept of computer and math ability: Gender implications across time and within ICT studies. *Journal of Vocational Behavior* 80, 2 (April 2012), 486–499. https://doi.org/10.1016/j.jvb.2011.08.005

[77] R Core Team. 2023. R: A language and environment for statistical ## computing. https://www.R-project.org/

[78] Sherri Turner and Richard T. Lapan. 2002. Career Self-Efficacy and Perceptions of Parent Support in Adolescent Career Development. *The Career Development Quarterly* 51, 1 (2002), 44–55. https://doi.org/10.1002/j.2161-0045.2002.tb00591.x _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/j.2161-0045.2002.tb00591.x.

[79] Sherri L. Turner, Annette Alliman-Brissett, Richard T. Lapan, Sharanya Udipi, and Damla Ergun. 2003. The Career-Related Parent Support Scale. *Measurement and Evaluation in Counseling and Development* 36, 2 (July 2003), 83–94. https://doi.org/10.1080/07481756.2003.12069084

[80] Jodie B Ullman and Peter M Bentler. 2012. Structural Equation Modeling. (Sept. 2012), 30.

[81] Ellen L. Usher and Frank Pajares. 2008. Sources of Self-Efficacy in School: Critical Review of the Literature and Future Directions. *Review of Educational Research* 78, 4 (Dec. 2008), 751–796. https://doi.org/10.3102/0034654308321456 Publisher: American Educational Research Association.

[82] Marie Vachovsky, Grace Wu, Sorathan Chaturapruek, Olga Russakovsky, Richard Sommer, and Li Fei Fei. 2016. Toward more gender diversity in CS through an artificial intelligence summer program for high school girls.. In *In Proceedings of the 47th ACM Technical Symposium on Computing Science Education*. ACM, 303–308.

[83] Tyler J. Vanderweele and Stijn Vansteelandt. 2009. Conceptual issues concerning mediation, interventions and composition. *Statistics and Its Interface* 2, 4 (2009), 457–468. https://doi.org/10.4310/SII.2009.v2.n4.a7 Publisher: International Press of Boston.

[84] Ioanna Vekiri and Anna Chronaki. 2008. Gender issues in technology use: Perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. *Computers & Education* 51, 3 (Nov. 2008), 1392–1404. https://doi.org/10.1016/j.compedu.2008.01.003

[85] Ming-Te Wang and Jacquelynne S. Eccles. 2012. Social Support Matters: Longitudinal Effects of Social Support on Three Dimensions of School Engagement From Middle to High School: Social Support. *Child Development* 83, 3 (May 2012), 877–895. https://doi.org/10.1111/j.1467-8624.2012.01745.x

[86] Heidi C Webb and Mary Beth Rosson. 2011. Exploring careers while learning Alice 3D: a summer camp for middle school girls. (2011), 6.

[87] Jisoo Youn, Christopher M. Napolitano, Dasom Han, Wooje Lee, and James Rounds. 2023. A meta-analysis of the relations between parental support and children's career self-efficacy in South Korea and the US. *Journal of Vocational Behavior* 141 (March 2023), 103839. https://doi.org/10.1016/j.jvb.2022.103839

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