Title
Investigating Children’s Science Motivation Beliefs as Participants in a Science Fair: The Role of Parents, Child Gender, and Science Domain

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INVESTIGATING CHILDREN'S SCIENCE MOTIVATION BELIEFS AS PARTICIPANTS IN A SCIENCE FAIR: THE ROLE OF PARENTS, CHILD GENDER, AND SCIENCE DOMAIN

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in

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by

Tess Avril Shirefley

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Investigating Children's Science Motivation Beliefs as Participants in a Science Fair: The Role of Parents, Child Gender, and Science Domain

Abstract

Tess A. Shirefley

The situated expectancy-value theory (SEVT) of motivation posits that children's ability beliefs and task value about science can influence their later science-related choices and achievements. Additionally, SEVT posits that parents can affect the development of children's motivational beliefs through gender-stereotyped attitudes and support provided to their children. In the present research, I investigated students' participation in science fairs as a site for understanding if and how parents' gender-differentiated attitudes and support may predict gender variations in science motivation. Although science fair participation may help to foster science motivation, these may be spaces where parents privilege boys more than girls. Additionally, the domain of the science project—either engineering/physical science or life/behavioral science—was tested as a potential moderator given gender gaps are greater in the former than the latter. The sample included 65 children (n_{girls}=38) ranging in age from 4th – 11th grade, and 57 parents. Findings indicated that parents perceived their sons as more capable in science than daughters, and offered more science encouragement to boys than girls who were participating in the life science domain. Otherwise, there were no gender or science domain differences in children's science motivational beliefs or parents' support. Significant associations were discovered primarily between parents' attitudes, support, and children's science ability beliefs

(with only one significant link to science task value beliefs). Parents' beliefs about their children's science interest predicted children's beliefs about their science abilities. Additionally, children's science ability beliefs were positively associated with parents' science encouragement and negatively associated with parents' help with science fair projects. These results suggest that parental encouragement to participate in the science fair may foster children's science ability beliefs, whereas high amounts of instrumental support may undermine their ability beliefs. Alternatively, parents in the science fair context may be especially attuned to children's abilities, and respond with more help when children hold lower abilities. I propose that future research should investigate how student grade-level, race/ethnicity, and family background may moderate gender-differentiated socialization of science motivation. I also suggest how my research may inform programmatic choices by science fairs to improve the experiences of participants from diverse backgrounds.

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Investigating Children's Science Motivation Beliefs as Participants in a Science Fair: The Role of Parents, Child Gender, and Science Domain

There were two main goals of this dissertation project which sought to further understand children's science motivational beliefs as participants in a science fair. The first goal was to examine if there were differences in children's science motivational beliefs, parents' science-related attitudes, and parents' science-related behaviors (e.g., support) by child gender or the science domain of a child's project (e.g., life vs physical science). The second goal was to investigate links between parents' perceptions of their children's abilities and interests in science (i.e., parents' science attitudes), science support, and children's science-related motivational beliefs.

In the following sections I will review research which has documented developmental trends of gender gaps in science achievement, noting why existing gaps are of particular concern in the context of a science fair. I will then review factors that may contribute to gender gaps in children's science motivation using situated expectancy-value theory (SEVT) as a theoretical framework (Eccles-Parsons et al., 1982; Eccles & Wigfield, 2000, 2020). Next, I will discuss the role of parents in the development of children's science-related motivation beliefs. Closing the introduction, I will present my dissertation project with a model and hypotheses.

Underrepresentation of Women and Girls in STEM

Gender gaps in many science, technology, engineering, and math (STEM) occupations have narrowed over the years—especially in the life sciences; However, there remain large gender gaps in the physical sciences and engineering domains (Cheryan et al., 2017; National Science Foundation, 2017). For example, women make up approximately 58% of the workforce in the biosciences, whereas women constitute fewer than 20% of the workforce in the physical sciences (National Science Foundation, 2021) Continued gender gaps in women's participation in some STEM workforces are of ongoing concern to researchers, educators, and policymakers alike (see Cheryan et al., 2017 for a review). When women are excluded from certain fields, these areas miss out on the benefits of greater diversity in thoughts and ideas. Additionally, STEM jobs are of high social status and earn relatively high salaries. Thus, limiting women's participation in STEM may limit the economic and social independence women can achieve. As a result it is important to consider how young girls can be supported in early science-related contexts to counter existing barriers that limit their participation in the later workforce.

Science fairs are an early learning context where children are able to engage with science in both informal and formal settings outside of school. Children often work on the project informally at home with their families or other adults who can support them. Then they present their work more formally to judges at the fair. Science fairs and other school-based extra-curricular programs have become topics of debate in recent years as researchers have highlighted that these programs may be unfairly benefiting the science learning of children from already privileged backgrounds (e.g., white boys) more so than children from underrepresented backgrounds (e.g., girls and students of Color) (Meier et al., 2018; Schmidt et al., 2020).

The current study collected data from a science fair in Santa Cruz County, CA. Examining participant data from the 2021 and 2022 Santa Cruz County Science and Engineering Fairs point to concerning imbalances in student participation (McRae, 2021; Wygant, 2022). In both years, approximately equal numbers of boys and girls participated in the science fair; however, further investigation by science domain reveals large gaps in participation within some fields. For example, across years girls represented nearly 61% of the participants in the behavioral sciences, 76% of participants in the animal sciences, and 86% in the plant sciences categories. In contrast, girls represented only 25% of participants in the physics and astronomy category and 22% in the engineering category.

The aforementioned gender gaps in participation rates in the Santa Cruz County Science and Engineering Fair (SCSEF) mirror existing gender gaps within the STEM workforce. As a result, these gaps in participation must be further investigated to understand how the local science fair can improve opportunities for girls to participate in all science domains. Accordingly, this study examined children's attitudes and support as participants in the science fair and how this might differ for boys and girls participating in life/behavioral vs physical science domains.

Children's Science-Related Motivational Beliefs

Within this section, I will first focus on reviewing research on children's motivational beliefs using situated expectancy-value theory (SEVT) as a theoretical framework (see Eccles & Wigfield, 2020). I will next review research documenting existing gender gaps in children's science-related motivational beliefs. Lastly, I will focus on how children's motivational beliefs may be shaped by their parents.

Situated Expectancy-Value Theoretical Framework

There is strong evidence that motivational beliefs, in particular one's expectations of success and views about the value of science are significant predictors of science achievement across development (Eccles & Wigfield, 2002, 2020; Simpkins et al., 2005; Simpkins et al., 2015a). Situated expectancy-value theory (SEVT) posits that motivational beliefs are comprised of *expectations for success* (e.g., "Can I do the task?") and *task value* (e.g., "Do I want to do the task?"), which each drive an individual's performance, choices, and achievement in a given domain (Eccles-Parsons et al., 1982; Eccles & Wigfield, 2002, 2020).

The expectancy component of SEVT reflects individuals' expectations for success in a given achievement domain. Expectations for success reflect an individual's ability beliefs and confidence in a subject or task. Some researchers have also referred to these constructs as competence beliefs, ability self-concepts, or self-efficacy (see Wigfield et al., 2015 for a review). The task value component of SEVT is composed of an individual's intrinsic interest (i.e., enjoyment), perceived utility value (i.e., perceived importance) and attainment value (i.e., personal importance of doing well on a task). Negative task value is reflected through considerations of costs, such as anxiety or perceived barriers associated with the subject. Other costs may include time spent participating in a task that is of less interest than other tasks.

From the large body of SEVT research, evidence indicates that when children and adolescents have high situated expectancy-value beliefs related to a task, they tend to be more motivated in the task and achieve greater outcomes in the task (see Eccles & Wigfield, 2002, 2020; Denissen et al., 2007; Wigfield et al., 2015). Research has further documented that children's situated expectancy-value beliefs matter not only for short-term motivations and outcomes but also for longer-term motivational beliefs and outcomes (Durik et al., 2006; Simpkins et al., 2006; Wigfield et al., 2015). For example, Simpkins et al. (2006) found evidence that fifth-grade children's expectancy-value beliefs about science were predictors of their 10th grade science expectancy-value beliefs as well as their enrollment in physical science courses during high school. As a result, children's expectancy-value beliefs may be a strong indicator of children's current and future motivation and achievement in science domains.

Gender Gaps in Children's Science-Related Motivational Beliefs

Because research has documented that science motivation is an important factor in youth's later science-related choices and achievements, it is important to examine if and when gaps in motivational beliefs begin, and what drives these differences (see Leaper, 2015 for a review). By middle childhood, girls on average have been found to hold lower science-related motivational beliefs than boys including differences in task-value of science (Alexander et al., 2012; Andre et al., 1999), and view of abilities in science (Kurtz-Costes et al., 2008; Lerdpornkulrat et al., 2012)—despite girls generally obtaining similar or slightly higher grades in math and science relative to boys (Voyer & Voyer, 2014). These gaps in motivational beliefs continue into adolescence and emerging adulthood, where in many cases gaps continue to widen (Simpkins et al., 2015a). Some evidence suggests that gaps in girls' and boys' science-related motivational beliefs may differ by science domain. Sikora and Pokropek (2012) found through a meta-analysis of over fifty countries, that adolescent girls reported a stronger interest than boys for behavioral and health science careers, whereas boys reported a stronger interest in computer, engineering, and math careers.

Investigating the motivational beliefs of children as they prepare projects for a science fair offers insight into the ways children's motivational beliefs may be impacted in an out-of-school science learning context. A key feature of examining children's science-related motivational beliefs includes considering possible ways these beliefs are shaped. Within the science fair context in particular it is important to evaluate if and how parents' attitudes and behaviors are linked to children's science-related motivational beliefs as this is an extra-curricular activity often completed at home.

The Role of Parents in Children's Science-Related Motivational Beliefs

According to SEVT, motivational beliefs are shaped by a number of cultural and social influences (Eccles-Parsons et al., 1982; Eccles & Wigfield, 2020; Wigfield & Eccles., 2002; Wigfield et al., 2015). These influences include cultural stereotypes, family demographics, and the attitudes/beliefs of key socializers such as parents. The SEVT model proposes that youths' individual characteristics, such as gender, can influence parents' specific beliefs and perceptions (e.g., men are better at science than women) and additionally shape parents' attitudes and behaviors (e.g., praising boys more than girls during a science activity), which in turn may influence children's situated expectancy-value beliefs (Eccles, 2015).

Prior work has found evidence to support the SEVT proposed role of parents in the socialization of children's motivations in domains outside of science. For example, Simpkins et al. (2015a) examined the longitudinal links between parents' attitudes, parents' behaviors, and children's motivations from kindergarten through high school within the domains of sports, music, reading, and math. In support of SEVT, the researchers found that parents' socialization practices in childhood had an impact on adolescents' later motivations. Parents' attitudes predicted their behaviors with their children, which subsequently predicted their children's motivational beliefs (e.g., Simpkins et al., 2015a). Similarly, work with high school age students found that parents' science-related behaviors positively predicted their children's beliefs about their general abilities in science as well as their children's task-value assessments of science (Simpkins et al., 2015b).

In the context of a science fair, for many students, parents are sources of contact which may be particularly important and salient to a child as they participate in the science fair. Parents may vary in their behaviors with their children. Specifically, parents may differ in providing support that aides their children's engagement with their science project. This might include instrumental support focusing on the design of their project, access to project materials, and/or practice presenting their project. It also may include socioemotional support whereby parents validate and encourage their children's efforts as participants in the science fair.

As SEVT theorizes, parents' support may be driven by parental attitudes such as perceptions of their children's abilities and interests in science. Parent attitudes and behaviors may differ by key features of their child including their gender. These gender-differentiated attitudes and subsequent behaviors may in turn influence the process of children's science fair participation and science-related motivational beliefs. The following sections will review research documenting the role of parents' attitudes and behavioral support on children's science-related motivational beliefs.

Parental Attitudes

Three prior studies suggest that parents may hold gender-differentiated attitudes about their children's science abilities and goals. For example, Andre et al. (1999) conducted a study examining parents and their kindergarten through sixth grade children's expectancy-value beliefs. Across grade-levels, parents on average evaluated their sons higher than daughters in perceived science competence. Parents also reported higher science-performance expectations for boys than girls. Work by Bhanot and Jovanovic (2009) found similar gender differences where parents of middle-school-aged sons reported higher perceptions of their child's science ability than parents of daughters. Researchers also documented gender differences in parents' task-value beliefs, such that parents believed science was more important for sons than daughters.

Tenenbaum and Leaper (2003) noted similar patterns. Despite little to no gender differences in middle-school children's science interests or reported science grades, parents were more likely to report boys as more interested and more likely to be successful in science tasks than girls. The researchers also found that parents' attitudes were linked to their children's expectancy-value beliefs such that children were more likely to report low expectancy-value beliefs in science when parents viewed science as difficult for them.

As prior work highlights, parents may hold gender-differentiated attitudes and beliefs about their children's abilities in science beginning as early as kindergarten and continuing into adolescence. When parents hold different expectations for boys and girls to be successful in science, these attitudes may intentionally or unintentionally lead parents to support boys' and girls' science opportunities and learning differently. In the science fair context, this may shape the domain of science that parents encourage their children to participate in and may also influence children's beliefs about their own abilities within the science fair. As prior work has documented, parent-child interactions in science contexts may differ by science domain. Parents may be more likely to engage in physical science topics with boys than girls (Short-Myerson et al., 2016); conversely, they may be more likely to engage in life science topics with girls compared to boys (Shirefley & Leaper, 2021).

Parental Socioemotional and Instrumental Support

Some studies focusing on science domains have documented average gender differences in parents' science-related behaviors, in particular their support of boys' and girls' science learning and engagement. Parental support can include both instrumental support (e.g., provision of science materials and opportunities) and socioemotional support (e.g., encouragement).

Regarding gender differences in instrumental support, some work has documented that by the age of 10 girls and boys had significant differences in their science-related experiences. Boys reported more extracurricular experiences with science tools like batteries, microscopes, and pulleys while girls reported more experiences with bread-making, knitting, sewing, and planting seeds (Jones et al., 2000). Regarding socioemotional-focused support, one study found that for middle-school children, parent-child conversations about school course selection followed stereotypical patterns where parents of girls encouraged fewer science courses than parents of boys (Tenenbaum, 2009). Another study found that parents of middle-school-aged children encouraged science interest more with sons than daughters (Bhanot & Jovanovic, 2009).

Other work by Simpkins et al. (2005) investigated parents' socializing behaviors related to their second to fifth-grade children's participation in out-of-school math, science, and computer activities. This included measures of both parents' instrumental support (opportunities to participate in activities) and socioemotional support (encouragement). For math, science, and technology (e.g., computer science), researchers found that mothers encouraged and provided more opportunities to engage with these activities for boys than girls. Additionally, parental behaviors encouraging math and science were significant predictors of children's math and science activity participation across the age ranges.

Some prior work has compared the role of parental support reported by parents to children's perceptions of their parents' support. Recent work with adolescents found that parental reports of their math support at home was positively linked with their children's perceptions of parents' math support (Rubach & Bonanati, 2021). Additionally, these researchers found that both parental reports of math support and children's perceptions of parents' math support were linked to children's motivational beliefs in math.

Work examining the math and science motivational beliefs of high school girls found similar patterns where perceptions of mothers' science and math support was linked to daughters motivations in science and math (Leaper et al., 2012). In another study, Simpkins et al. (2015b) investigated adolescents' perceptions of parental science support. Results suggested that adolescents' perceptions of parental support differed by the gender and ethnicity of the youth with girls, in particular Latinx girls, reporting lower perceptions of science support than boys. Despite gender differences in perceived science support, researchers found that for both genders, perceived support positively predicted students' science motivational beliefs.

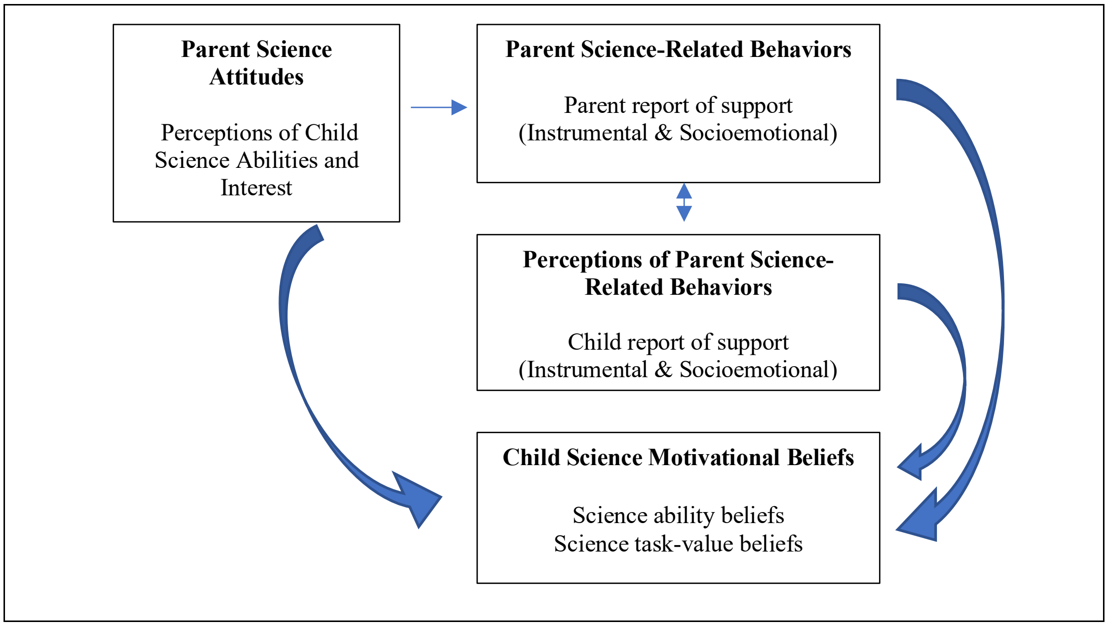
The studies described above provide evidence that parents may in some cases offer more science-related opportunities and encouragement to boys than girls; in turn, children may likely perceive this differential support. For example, there is evidence that the subtle messages parents convey to their children about science may be more impactful on children's beliefs about science than parents' direct messages (Šimunović et al., 2018). Thus, by providing different opportunities and encouragement, girls may have less time and space to learn about science and to develop an interest in science than boys. Furthermore, girls may interpret the lack of opportunities and social support as a signal that science is not a domain that girls should pursue and this may lead to girls separating themselves from science-related activities and interests.

In the science fair context, gender-differentiated treatment could present through differential opportunities and encouragement to engage with science based on domain. Given the overrepresentation of girls in the behavioral science and life sciences divisions, and the underrepresentation of girls in physical sciences divisions at the Santa Cruz County Science and Engineering Fair, it is possible that this divide is partially due to differences in opportunities afforded and encouraged by parents.

Proposed Model and Research Hypotheses

The proposed model for this research study is noted in Figure 1 below.

Figure 1. Proposed model of children's science motivational beliefs through participation in a science fair.



In the figure above, children's science motivational beliefs are measured before presenting their projects in the fair. This study considered how parents' science attitudes about children's science motivations (abilities and interest), and the support parents provided were linked to children's science motivational beliefs. While the current model proposes links between parent science attitudes and science-related behaviors, this study only examined predictors of children's science motivational beliefs (bolded arrows).

To close my introduction, I present an outline of my hypotheses below. First, I will state hypotheses that focus on overall differences in constructs based on child gender and science domain. When examining science domain, I contrasted those participating in life or behavioral sciences with those in engineering or physical sciences. Next, I advance my hypotheses that predict links between children's motivational beliefs and parental attitudes and support.

Average Differences in Constructs Based on Child Gender and Science Domain

1a. Children's science motivational beliefs were predicted to be greater for boys than girls participating in physical science and engineering domains.

1b. Children's science motivational beliefs were predicted to be greater for girls than boys participating in life and behavioral science domains.

2a. Parents' perceptions of child science motivations were hypothesized to differ by child gender and science domain, with parents reporting higher science motivations for sons completing physical science and engineering projects than daughters completing physical science and engineering projects.

2b. Parents' perceptions of child science motivations were hypothesized to differ by child gender and science domain, reporting higher science motivations for daughters completing life and behavioral science projects than sons completing life and behavioral science projects.

3a. Among those participating in physical science and engineering domains, boys were hypothesized to be more likely than girls to perceive greater instrumental and socioemotional support from parents.

3b. Among those participating in life and behavioral science domains, girls were hypothesized to be more likely than boys to perceive greater instrumental and socioemotional support from parents.

4a. Parents' instrumental and socioemotional support were hypothesized to be greater for boys than girls participating in physical science and engineering domains.

4b. Parents' instrumental and socioemotional support were hypothesized to be greater for girls than boys participating in life and behavioral science domains.

Links between parental support and children's science motivational beliefs

5. Parents' perceptions of child science ability and interest were expected to predict children's science motivational beliefs.

6. Children's perception of parental support were expected to predict children's science motivational beliefs.

7. Parents' self-reported support were expected to predict children's science motivational beliefs.

Whereas I expected both instrumental and socioemotional support to positively predict children's science motivational beliefs, I explored if they differed in relative strength. Also, I expected that parents' attitudes and support would predict children's science ability beliefs and task-value beliefs, but I did not hypothesize if one of there would be differences for these two outcome measures.

Method

This study consisted of a series of surveys administered to participants of the Santa Cruz County Science and Engineering Fair, and their parents. The fair includes Kindergarten to 12th grade students; However, for this study only children between 4th and 12th grade were assessed. Children's attitudes and experiences related to their participation were measured before and after the science fair; However, for this dissertation only pre-fair data was examined. Parents were invited to participate by completing a separate survey which was collected at the same time as children's pre-fair survey. Data collection took place over two years of science fairs in 2022 and 2023.

Participants

The sample included 65 children (n_{girls} = 38) between 4^{th} to 11^{th} grade. 42 children were in 4^{th}-5^{th} grade, 18 children were between 6^{th}-8^{th} grade, and 5 children were in 10^{th}-11^{th} grade. The average grade level of girls and boys did not significantly differ, $t(1,62) = .089$, $p = .938$. Of the total sample, 55 children also had their parents complete a survey, 8 children completed the survey on their own without their parent also completing a survey, and 2 parents completed the survey on their own without their child completing the survey. Participants in the current study were not asked to report their race/ethnicity. However, participants of the entire SCSEF were comprised of the following backgrounds averaged across years 2022 and 2023: approximately 81% of participants identified as European-American, 11% identified as Latinx, 6% identified as Asian American/Pacific Islander, and 2% identified as Native American.

Procedure

Children and their parents/guardian were invited to each complete a survey during the process of registering as a participant for their respective science fair. The surveys were administered through Qualtrics online survey platform. During the registration process for their respective science fairs, children and parents were given the opportunity to opt-out of completing the survey if they did not wish to participate. Children who participated in the study received monetary compensation. Children who completed only the pre-survey received a $5 gift card code to Amazon.com; and children who complete both the pre- and post-surveys received a $15 gift card code to Amazon.com. There were several measures included in the parent and child surveys that were separate from the goals of this dissertation. These measures will not be summarized in detail within the survey measures subsections below.

Children's Survey Measures

Children's Ability Beliefs

Children's ability beliefs were measured using Jacobs et al.'s (2002) short version of the expectancy-value scale, which was adapted to be more appropriate for children ranging in age from elementary school to high school. This scale included four questions about children's *ability beliefs* about science (e.g., "How good at science are you?", "Compared to other subjects, how good are you at science", "If you were to list all the students from best to worst in science where are you?", "How good would you be at learning something new in science", $\alpha = .827$). All questions were on a 1- to 6-point likert scale specific to the question. The full questions and likert scale information can be found in Appendix A.

Children's Task-Value Beliefs

Children's task-value beliefs were measured also using Jacobs et al.'s (2002) adapted scale. The task-value sub-scale included three questions regarding children's *beliefs about the importance of science* (e.g., "Compared to other activities, how useful is learning science?"), and two questions regarding *children's interest in science* (e.g., "How much do you like science?". Factor analysis and scale reliability indicated that questions about children's interest, and children's views about the importance of science could be combined into one factor of overall task-value (α = .734). All questions were on a 1- to 6-point likert scale specific to the question. The full questions and likert scale information can be found in Appendix A.

Perceived Instrumental Support

To assess children's perceptions of instrumental support for their science fair projects, children were asked a series of questions created for the present study. Children were asked about the general support they had received on their projects so far ("How much help have you received on your project so far from adult family members/guardians?"), in addition to the support they received on specific components of their project ("how much did your older family member help you [decide your topic for the science fair/design your project for the science fair]."). These questions were answered on a 4-point likert (1 = *No help*, 2= *Just a little help*, 3= *Some help*, 4= *A lot of help*). Factor analysis and scale reliability indicated the items loaded sufficiently into one combined item of perceived instrumental support (α = .816).

Perceived Socioemotional Support

To assess children's perceptions of their parents' socioemotional support, children were asked four questions about their perceived science encouragement. The first question was from Desy et al. (2011) and asked children to report "How frequently do adult family member/guardians encourage your interest in science?" on a 4-point likert (1 = *Never*, 2 = *Rarely*, 3 = *Occasionally*, 4 = *Quite often*). Children were also asked two questions edited from Simpkins et al. (2005) to be specific about parental encouragement in the home and science fair contexts ("To what extent did your adult family members/guardians encourage your participation in the [science fair, home]?" on a 6-point likert (anchors 1 = *Strongly discourage*, 6 = *Strongly encourage*). After rescaling items to be on the same likert scale, factor analysis and scale reliability indicated the three items loaded sufficiently into one combined item of perceived socioemotional support (α = .674).

Parents' Survey Measures

Parental Beliefs About Child Science Abilities

To assess the perceptions that parents have about their children's' abilities in science, a three-item scale previously devised by Simpkins, Fredricks, and Eccles (2012) was used. The wording of items was modified to include "science" (opposed to the original term of "math"). Items included "How good is this child at science", "Compared with other children, how much innate ability or talent does this child have in science", and "How well do you think this child will do in science next year?", α = .839. All questions were on a 1- to 6-point likert scale specific to the question, and can be viewed in Appendix B.

Parental Beliefs About Child Science Interest

To assess the perceptions that parents have about their children's' interests in science a two-item scale edited from Jacobs et al. (2002) expectancy-value questions about child interest was used. A similar edit to items was used in Tenenbaum & Leaper (2003), but this contained only one item. The first item asked parents "My child finds science…" with a 6-point likert (anchors 1 = *Very boring*, 6 = *Very interesting*). The second item asked parents, "My child likes science … " with a 6-point likert (anchors 1 = *A little*, 6 = *A lot*). Factor analysis and scale reliability indicated the two items loaded sufficiently into one combined item of parent perception of children's science interest (α = .928).

Parental Evaluation of Instrumental Support

To assess instrumental support, parents reported their support for their child's completion of their science fair project generally and in regard to specific science fair components ("How much did you help, or how much do you plan to help, your child on their science fair project?", "How much did you help, or how much do you plan to help, your child [decide their topic for the science fair/design their project for the science fair/complete their project/create their poster board and presentation for their project]?" These questions were answered on a 4-point likert (1 = *No help*, 2= *Just a little help*, 3= *Some help*, 4= *A lot of help*). Factor analysis and scale reliability indicated the five items loaded sufficiently into one combined item of parent reported instrumental science support (α = .806).

Parental Evaluation of Socioemotional Support

To measure reported socioemotional support, parents were asked about their encouragement using three items previously used in Simpkins et al. (2005). However, only the science-related items were used (opposed to the additional computer-related and math-related items used in the original study). Parents were asked, "How much have you encouraged your child to participate in science-related activities at home?", "How much have you encouraged your child to participate in science-related activities at school?", and "How much have you encouraged your child to participate in the science fair?" Responses were based on a 6-point likert (anchors 1= *Strongly discourage*, 6= *Strongly encourage*). Factor analysis and scale reliability indicated the three items loaded sufficiently into one combined item of parent reported socioemotional science support (α = .724).

Results

To address project hypotheses, analyses were conducted in two groupings. The first set of analyses (addressing hypotheses 1-4) examined average differences by gender and science fair project domain in the four main constructs of this study: children's science motivational beliefs (ability, task-value), parents' science attitudes (beliefs about their children's science ability and science interest), children's perceptions of parents' science behaviors (instrumental and socioemotional support), and parents' self-reported science behaviors (instrumental and socioemotional support). The second set of analyses (addressing hypotheses 5-7) examined if and how parents' science attitudes and parents' science behaviors predicted children's science motivational beliefs. For the science domain variable, I distinguished between participating in life or behavioral sciences and those in engineering or physical sciences.

As mentioned previously, situated expectancy-value theory posits that motivational beliefs are comprised of two distinct factors: beliefs about abilities in a specific domain, and evaluations of the importance, value, or interest in a specific domain (often referred to as task-value) (Eccles & Wigfield, 2020). Some work has examined motivational beliefs as a combined item of ability-beliefs and task-value beliefs, while others have evaluated each separately. Factor analysis of the current sample suggested that motivational beliefs reported by children should be examined as two separate factors: science ability beliefs, and science task-value beliefs. Chronbach's Alpha for each scale can be found in the methods section. As a result, each analysis that includes children's motivational beliefs considers children's science ability beliefs and science task-value beliefs separately. Additionally, factor analyses indicated that parents' perceptions of their children's science motivations loaded into two distinct factors: science abilities, and science interest. It is important to note that within the SEVT model task-value beliefs include both evaluations of importance and interest in a domain; however, parents in this study were only asked about their children's interest. As a result, I will refer to parents evaluations of their children's task-value beliefs as evaluations of interest to reflect the measurement tool accurately.

Factor analyses additionally suggested that parents' behaviors including instrumental and socioemotional support were distinct constructs. As a result, analyses which considered parental support, both support perceived by children and support reported by parents, examined instrumental and socioemotional support as two separate constructs. Because the measurement of socioemotional supports asked children and parents about science encouragement, throughout the results and discussion I will use the terms socioemotional support and encouragement interchangeably. Lastly, it is important to note that limited work has examined children's perceptions of support and parents reported support in one study. Within the current sample, I found that for both socioemotional and instrumental support, children's perceptions and parents reports of support were correlated (see Table 2).

Average Differences in Constructs based on Child Gender and Science Domain

To examine average differences among constructs by gender and science fair project domain, six 2 (gender: girls vs boys) x 2 (domain: life science vs physical science) ANOVAs with the following outcome measures were conducted: children's science ability beliefs, children's science task-value beliefs, parents' beliefs of their children's science abilities, parents' beliefs of their children's science interest, children's perceived instrumental support, children's perceived socioemotional support, parents' reported instrumental support, and parents' reported socioemotional support. Missing scores for any participants were replaced with the sample means. Findings for each overarching construct are explained further below. Means and standard deviations for each construct are shared in Table 1.

Children's Science Motivational Beliefs (Abilities and Task-Value). I hypothesized that children's science motivational beliefs would differ by child gender and science domain. I predicted that boys completing physical science and engineering projects would report on average higher motivational beliefs than girls completing physical science and engineering projects (H1a), and that conversely girls completing life or behavioral science projects would report on average higher motivational beliefs than boys completing life or behavioral science projects (H1b).

My hypotheses were not supported as ANOVA analyses revealed no significant main effects or interactions by gender or science domain when examining children's science ability beliefs or children's science task-value beliefs.

Parents' Beliefs About Their Children's Science Motivations (Abilities and Interest). Analogous to children's science motivational beliefs, I hypothesized that parents' beliefs about their children's science motivations (ability beliefs and interest) would differ by child gender and science domain. I predicted that parents on average would report higher evaluations of children's science abilities and science interest for boys than girls among those completing physical science and engineering projects (H2a). Conversely, I predicted that parents on average would report higher evaluations of children's science abilities and science interest for girls than boys among those completing life or behavioral science projects (H2b).

When examining parents' beliefs about their children's science abilities, a main effect of child gender revealed that parents on average reported higher science abilities for sons ($M = 6.3$, $SD = .69$) than for daughters ($M = 5.6$, $SD = .81$), $F(1,53) = 8.53$, $p < .01$, partial $\eta^2 = .15$. There was not a significant main effect of science domain, $F(1,53) = .212$, $p = .648$, or a significant science domain by gender interaction, $F(1,53) = .212$, $p = .648$. There were no significant gender or science domain main effects, or interactions when examining parents' beliefs about their children's science interest. Hence, my predictions for H2a and H2b were partially supported as there was a significant difference by child gender, but not science domain.

Children's Perceived Science Support (Instrumental and Socioemotional). I predicted that children's perceived instrumental and socioemotional science support would each differ by child gender and science domain. Specifically, among those completing physical science and engineering projects, I expected that boys would be more likely than girls to report perceived support (H3a). I also predicted among those completing life or behavioral projects that girls would be more likely than boys to report perceived support from their parents (H3b). My hypotheses were unsupported as ANOVA analyses revealed no significant main effects or interactions by gender or science domain when examining children's perceived instrumental science support or children's perceived socioemotional support.

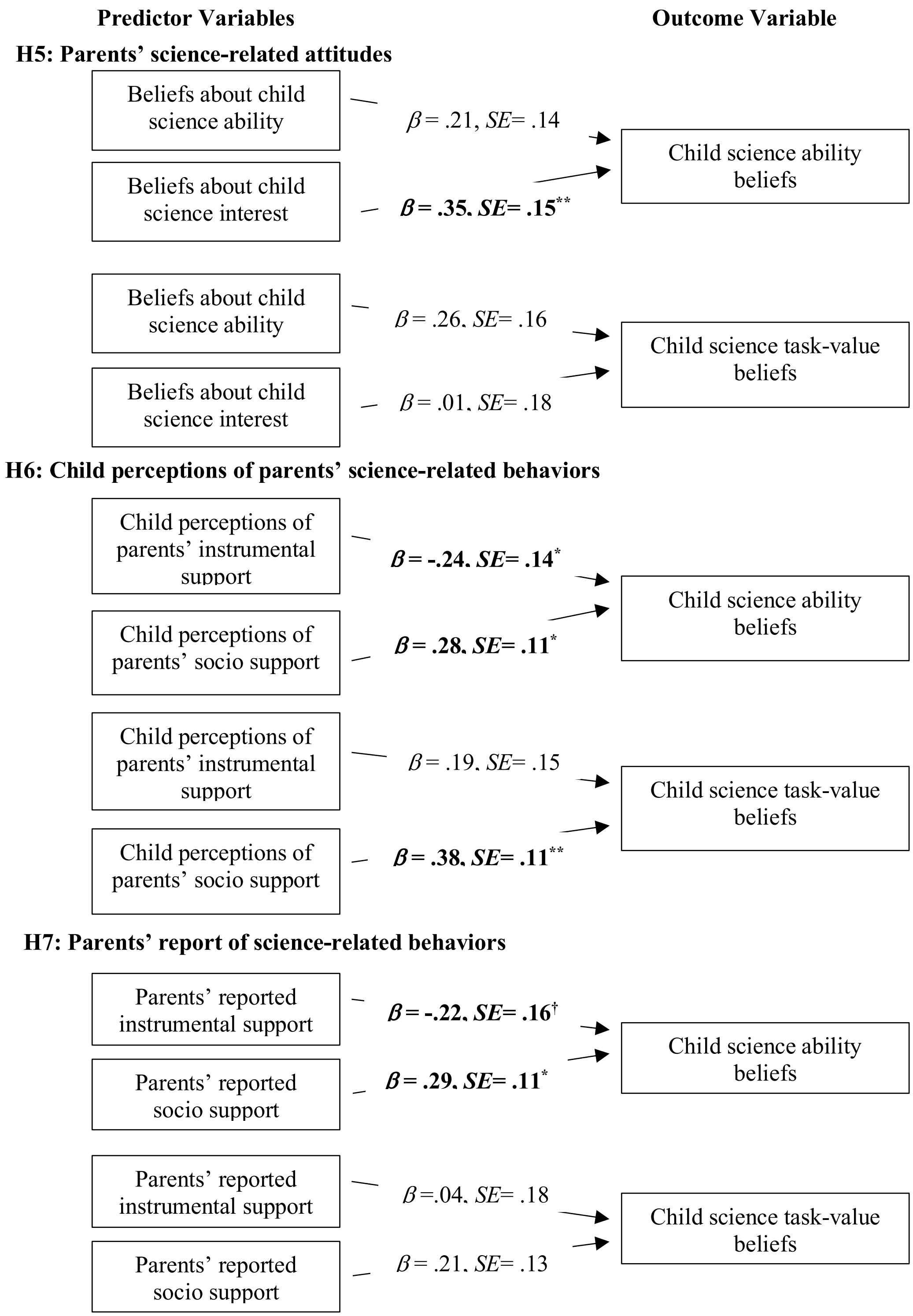
Parents' Reported Science Support (Instrumental and Socioemotional). My predictions for parents' self-reported evaluations of the science support they provided to their children mirrored those of children's perceived support. I predicted that parents' reported instrumental and socioemotional support would each differ by child gender and science domain. Specifically, among students completing physical science and engineering projects, I expected that parents would more likely provide support to boys than to girls (H4a). Conversely, among students completing life or behavioral projects, I predicted that parents would more likely provide support to girls than to boys (H4b).

When examining parents' reported instrumental science support, ANOVA analyses revealed no significant main effects, or interactions by gender or science domain. However, when examining parents' reported socioemotional science support, a significant gender by science domain interaction revealed that parents were more likely to offer science encouragement to sons (*M* = 5.3, *SD* = .76) than daughters (*M* = 4.59, *SD* = .92) completing a life or behavioral science project, $F(1,53) = 4.196$, $p = .046$, partial $\eta^2 = .08$. There were no significant main effects of gender, $F(1,53) = .250$, $p = .619$, or science domain, $F(1,54) = 1.94$, $p = .170$. These findings are counter to what my hypotheses (H4a and H4b) predicted.

Links Between Parental Science Attitudes, Parental Science Behaviors, and Children's Science Motivational Beliefs

I hypothesized that parental attitudes about their children's science motivations (ability beliefs and interest), children's perceptions of their parents' instrumental and socioemotional support, and parents' reported instrumental and socioemotional support would predict children's science ability and task-value beliefs (H5, H6, H7). To examine these links three linear regressions were conducted with the outcome variable of children's science ability beliefs and three linear regressions were conducted with the outcome variable of children's science task-value beliefs. All variables were first centered by subtracting the mean from each score before being included within the models. Regression analyses only included child participants who also had their parents participate. Missing scores for any participants were replaced with the sample means. Bivariate correlations across all variables are presented in Table 2. Linear regression findings are represented in Tables 3-5, and Figure 2.

Figure 2. Linear Regression Models



$^{*}p<.05$. $^{**}p<.01$. $^{***}p<.001$.

Parents' Beliefs About Their Children's Science Motivations (Abilities and Interest). The results of the two regressions testing links between parents' science attitudes and children's science motivational beliefs (Hypothesis 5) are presented in Figure 2 and Table 3. The first regression investigated links between parents' perceptions of children's science abilities and science interest (predictor variables) and children's science ability beliefs (outcome variable). The regression model was significant, $R^2 = .251$, $F(1, 64) = 10.8$, $p < .01$. I found parents' perceptions of their children's science interest predicted children's beliefs about their science abilities, $\beta = .349$, $t(64) = 2.68$, $p < .01$. However, parents' perceptions of their children's science abilities was not a significant predictor of their children's science ability beliefs, $\beta = .214$, $t(64) = 1.64$, $p = .104$. The second regression examined links between parents' perceptions of children's science abilities and interest (predictor variables) and children's science task-value beliefs (outcome variable). The regression model was not significant, $R^2 = .071$, $F(1, 64) = 2.44$, $p = .095$. As a result, my hypothesis (H5) was supported for ability beliefs, but not task-value beliefs.

Children's Perceptions of Parents' Science Support (Instrumental and Socioemotional). The results of the two regressions testing links between children's perceptions of science support and children's science motivational beliefs (Hypothesis 6) are presented in Figure 2 and Table 4. The regression investigating links between children's perceptions of the instrumental and socioemotional science-related support they received (predictor variables) and children's science ability beliefs (outcome variable) was significant, $R^2 = .133$, $F(1, 60) = 4.61$, $p < .05$. Results indicated that children's perceptions of the instrumental science support they received from their parents was negatively associated with children's science ability beliefs, $\beta = -.284$, $t(62) = -2.48$, $p < .05$. However, children's perceptions of parents' socioemotional science support was positively related to children's science ability beliefs, $\beta = .235$, $t(62) = 2.36$, $p < .05$.

The regression which examined links between children's perceptions of the instrumental and socioemotional science-related support they received (predictor variables) and children's science task-value beliefs (outcome variable) was also significant, $R^2 = .190$, $F(1, 60) = 7.05$, $p < .01$. However, in this case children's perceived socioemotional science support was the only significant predictor of children's science task-value beliefs, $\beta = .339$, $t(60) = 3.29$, $p < .01$. Children's perceived instrumental support was not a significant predictor, $\beta = .227$, $t(60) = 1.59$, $p = .116$.

As a result, my predictions (H6) were somewhat supported. Children's perceptions of their parents' science support was linked to children's science motivational beliefs. However, results indicated that the relationship between perceived support and motivational beliefs differed by the type of support (instrumental vs socioemotional) and the specific motivational belief (ability belief vs task-value).

Parents' Reported Science Support (Instrumental and Socioemotional). The results of the final two regressions testing links between parents' reported science support and children's science motivational beliefs (Hypothesis 7) are presented in Figure 2 and Table 5. The first regression model examining children's science ability beliefs was significant, $R^2 = .133$, $F(1, 64) = 4.9$, $p < .05$. Results indicated that parents' reported science socioemotional support was positively associated with children's science ability beliefs, $\beta = .292$, $t(64) = 2.51$, $p < .05$. Parents' instrumental science support was trending toward a significant negative link to children's ability beliefs; $\beta = -.308$, $t(64) = -1.9$, $p = .06$. The final regression which examined links between parents' reported instrumental and socioemotional science support (predictor variables) and children's science task-value beliefs (outcome variable) was not significant, $R^2 = .045$, $F(1, 64) = 1.51$, $p < .229$.

As a result, my predictions (H7) were partially supported. Parents' reported socioemotional science support-- but not instrumental support-- was linked to children's science ability beliefs. Neither parents' reported instrumental nor socioemotional support were linked to children's science task-value beliefs.

Discussion

This study expanded prior work in three ways. First, this work considered how children's science motivational beliefs are shaped as participants in an informal science learning setting: the Santa Cruz Science and Engineering Fair (SCSEF). Second, this work built upon prior research by further examining links among parental science attitudes, science behaviors, and children's science motivational beliefs. Lastly, this study considered how children's beliefs and experiences as participants in a science fair may differ by the child's gender, and the domain of science in which a child is completing a project (e.g., animal sciences vs physics).

Below I will first review if and how my findings supported my hypotheses. I will consider why some results were significant while other findings were nonsignificant. I will then acknowledge some limitations of the current study and offer recommendations for future directions. I will conclude with suggestions for how these findings can be used to inform programmatic choices that better support children's science learning experiences within science fair contexts.

Children's Science Motivations

Contrary to my first hypothesis (H1a, H1b), boys and girls did not significantly differ in science ability beliefs or science task-value. This somewhat differs from prior work which found from middle childhood into adolescence that boys were more likely than girls to positively evaluate their science abilities (Kurtz-Costes et al., 2008; Lerdpornkulrat et al., 2012). Additionally, in some studies, boys were more likely than girls to express interest in science (Baram-Tsabari et al., 2006) while girls were more likely than boys to perceive costs associated with science (Britner, 2008).

One possible explanation for why this study did not reveal significant gender (or gender by domain) differences in children's science ability and task-value beliefs could be due to the context. Prior work has primarily examined science beliefs within the context of school performance, as opposed to extra-curricular spaces such as science fairs (Andre et al., 1999; Lerdpornkulrat et al., 2012; Simpkins et al., 2015b). Participation in the SCSEF often requires a time investment outside of regular school hours. Thus, it would be reasonable to expect that children who participate in the science fair may hold high science motivational beliefs, and may have low variability in their beliefs compared to a general school population. Additionally, students in the science fair context may differ from a general school population in other beliefs, such as gender-stereotype endorsement which prior work has found to be a significant moderator of motivational beliefs (Lerdpornkulrat et al., 2012). Future work might further investigate how motivational beliefs differ by science-learning context, and may consider additional moderators of beliefs such as gender-stereotype endorsement.

Parents' Beliefs About Their Children's Science Motivations

While this study did not reveal average gender differences in children's evaluations of their own science motivational beliefs, there were significant differences in parents' perceptions of their daughters' versus sons' science motivational beliefs. Partly consistent with my hypotheses (H2a, H2b), I found that parents of sons were more likely than parents of daughters to perceive their child as high in science abilities. This finding mirrors prior work with elementary-school-aged children where parents evaluated their sons higher than daughters in science competence and science-performance expectations (Andre et al., 1999). Similarly, other researchers found that parents of middle-school-aged children reported sons as more likely to be successful in science tasks than girls (Bhanot & Jovanovic, 2009; Tenenbaum & Leaper, 2003). Counter to prior work, the current study found no significant differences by child gender in parents' perceptions of children's science interest. Some studies have found that parents were more likely to evaluate their sons than daughters as interested in science (Tenenbaum & Leaper, 2003); and parents were more likely to view science as important for sons than daughters (Bhanot & Jovanovic, 2009).

In the present research, I identified a significant child gender difference in parents' evaluations of science ability but not in science interest. 3

While prior work found an average gender difference in parents' evaluations of their children's science motivational beliefs, it was somewhat surprising to find a gender difference within the science fair context. In the SCSEF, boys and girls participated equally overall, although there were some differences in participation by domain (e.g., more boys in engineering, more girls in behavioral sciences). As a result, a gender by domain interaction was more expected than a main effect of gender. The lack of a significant gender by domain interaction could be due to the small sample, and perhaps would be indicated with larger group analyses in the future.

Parents' Science Socioemotional and Instrumental Support

When examining children's perceptions of support and parents' reported support, I predicted in hypotheses 3a and 4a that boys would be more likely than girls to receive parental support as documented in prior work (e.g., Simpkins et al., 2005; Tenenbaum, 2009). However, I expected this pattern of gender-differentiated support to be observed within the context of children completing a physical science or engineering project. I expected opposite results in hypotheses 3b and 4b, whereby I predicted girls would be more likely than boys to receive parental support in the context of completing a life or behavioral science project. I expected gender by domain interactions to mirror current gender gaps in the STEM workforce, whereby boys would receive more support than girls in the physical sciences opposed to the life sciences. The rationale was that the gender gaps in science favoring men are especially indicated in physical sciences and engineering, whereas gaps favoring women are more common in the life and behavioral sciences. As discussed below, the support for these hypotheses was mixed.

I found partial support for hypothesis 4a, such that parents reported providing more socioemotional support to boys than girls. Unexpectedly, however, the greater average socioemotional support for sons than daughters occurred specifically among children completing life/behavioral science projects. I did not find differences by gender or science domain in parents' instrumental support. My counter-stereotypical finding regarding the science domain moderation for socioemotional support is somewhat analogous to a recent study looking at parents' book reading of life science and physical science books with younger children (Shirefley & Leaper, 2022). In this study, girls heard more science-talk than boys from their parents--but only when reading a science book about a physical science topic. The researchers posited that the counter-stereotypical pattern might have been due to encouraging children to excel in a domain in which they are more underrepresented. In a similar manner, this might be the case in the science fair where most life/behavioral science projects are completed by girls. It should be noted that the current sample is still relatively small especially when the interactions of child gender and science domain were examined. Although this finding should be interpreted with caution, it highlights the potential complexities of gender inequities in science domains dependent on differing contexts (e.g., workforce, home, science fair).

In addition to looking at parents' reports of support, I assessed children's perceptions of their parents' support. Contrary to my predictions in hypotheses 3a and 3b, I did not find any significant differences in children's perceptions of their parents' socioemotional or instrumental support. These null results were also indicated when I took science domain into account. In sum, there were no child gender differences in parents' reported instrumental support. Nor were there any child gender differences in children's perceptions of parents' socioemotional or instrumental support.

These findings are counter to prior work which found average gender differences in either children's perceptions or parents' reports of support. In one study, parents reported providing more instrumental support to boys than girls through the provision of STEM-related materials outside of school (Simpkins et al., 2005). Another study indicated that by sixth grade boys and girls had experienced gender-differentiated opportunities to engage with extra-curricular science activities (Jones et al., 2000). Researchers found this gender difference was also specific to domain, with boys reporting more experiences with physical science activities, and girls reporting more experiences with life science activities (Jones et al., 2000). Regarding children's perceptions of instrumental and socioemotional support, one study found that girls reported lower perceptions of parental academic science support, and science positivity (i.e., encouragement) than did boys (Simpkins et al., 2015b). However, this research examined support within the school classroom context rather than an extra-curricular setting such as the science fair.

One potential explanation for the differences within the current study could be attributed to the type of instrumental support assessed. Prior work assessed the materials that parents provided their children such as science-related books and the frequency of access to science-related experiences. In contrast, in the current study, my measure of instrumental support reflected the help that parents offered children on specific components of their projects (e.g., choosing a topic, designing the method). Perhaps within the science fair context, where boys and girls participate broadly in equal numbers, parents are offering similar levels of support in order for their child to participate. With a larger sample size, perhaps gender differences in parents' instrumental support would be observed within the context of specific domains (e.g., physical vs life sciences). In addition to mirroring prior work, this would also be consistent with current findings where parents' reported socioemotional support did differ by gender and science domain.

Predictors of Children's Science Motivations

As was proposed in my theoretical model, I investigated the links between parental science attitudes, parental science behaviors, and children's science motivational beliefs. When examining parental attitudes as predictors, my hypothesis H5 was partially supported. I found that when parents perceived their children as highly interested in science this was associated with children holding high beliefs about their science abilities, but not beliefs about science task-value. Interestingly, parents' perceptions of their children's science abilities were not predictive of children's science ability or science task-value beliefs.

My findings are partially supported by prior longitudinal work which found that parents' perceptions of their children's task-value were predictive of children's ability beliefs within the domains of math, reading, sports, and music (Simpkins et al., 2015a). However, Simpkins et al. (2015a) and another study by Fredericks and Eccles (2002) found evidence that parents' perceptions of their children's math ability beliefs were also predictive of children's own math ability and task-value beliefs. This difference in findings could be due to domain differences between math and science, or potentially differences in learning contexts of the sample populations. The prior studies evaluated children's attitudes as members of a school population, while this study considers children's attitudes within a unique extracurricular setting. Perhaps in this setting, children are already highly interested in science, thus their parents' attitudes had a stronger link to children's beliefs about their abilities than to children's task-value of science.

When examining links between parents' behaviors and children's science motivational beliefs, I found partial support for my hypotheses H6 and H7. Specifically, I found that socioemotional encouragement, both children's perception of encouragement (H6) and parents' self-reports of encouragement (H7), positively predicted both children's ability and science task-value beliefs. This finding is consistent with other studies finding students' perceptions of their parents' science positivity were predictive of high-school students' ability and task-value science beliefs (Simpkins et al., 2015b). However, the current study expands existing literature by revealing that parents' reported encouragement is also a positive predictor.

Interestingly, when examining parents' instrumental support, I found an unexpected pattern whereby higher perceived instrumental support predicted *lower* ability beliefs among children. Additionally, while only marginally significant, parents' reported instrumental support was trending toward a similar negative pattern of predicting children's ability beliefs. This finding is counter to prior work which found strong positive links between parents' instrumental support through science coactivity (e.g., doing science-related tasks together) and children's science motivational beliefs (Simpkins et al., 2015b). As discussed above, one potential explanation for this difference is the measurement of parental instrumental support. In the current study, instrumental support assessed how much help parents offered their children on their science fair projects as opposed to assessing whether parents and children did science-related tasks together. Thus, it could be that the specific help parents offer on designing, creating, and completing their child's science fair project is distinct from more general engagement with science.

The negative association between parents' instrumental support and children's science ability beliefs could be interpreted in two ways. First this pattern could suggest there may be a diminishing return on targeted parental support. Consistent with this interpretation, Bhanot and Jovanovic (2005) found that in some cases parents' instrumental support of their fifth-grade children's math homework bordered on intrusive. Intrusive support consisted of increased monitoring, continual reminding, and offering unsolicited help. In cases when support was intrusive children's math-related ability beliefs declined, especially for girls. The researchers posited that for some groups, too much help could be perceived by a child as a lack of belief in their abilities and competencies and thus could have more negative consequences.

Perhaps a similar pattern is occurring within the current study. If parents offer too much help on their child's project, children may subsequently feel less expert or confident in their own science abilities. Future analyses might consider exploring the point at which instrumental support becomes negatively associated with children's science abilities. For example, perhaps help on all parts of the science project is too much support, but help during one or two stages is beneficial.

Another potential interpretation of the findings could be that parents are aware of their children's science abilities and are adjusting to offer more help to children with lower abilities. Future analyses may consider structural equation modeling to examine links between parents' perceptions of children's abilities, the instrumental support they offer, and children's motivational beliefs. This kind of analysis could offer insight into the underlying mechanisms of parental support. The inclusion of behavioral or open-ended survey data could also help illuminate the bidirectional nature between parental science support and children's science motivational beliefs.

Lastly, it could be enlightening to explore links between instrumental support and socioemotional support. Instrumental support on its own may have negative links to children's motivational beliefs; however, when paired with high levels of science encouragement, instrumental support might be more helpful.

Study Limitations and Future Directions

While the current study has contributed some notable findings to existing literature, there are limitations to acknowledge. As mentioned previously, the current sample is relatively small for some analyses—particularly those considering interactions by gender and domain. A recent meta-analysis found that average gender differences in STEM-related ability and task-value beliefs had small to medium effect sizes (Parker et al., 2019). As a result, a larger sample is likely needed to better understand average differences in constructs by child gender, science domain, and the interaction between the two variables.

Simpkins et al. (2015a) found that academic domain (math, reading, sports, or music) and child gender moderated links among parental attitudes, behaviors, and children's motivations. Other work within STEM domains has also noted important links among these constructs (see Šimunović & Babarović, 2020 for a review). As a result, a larger sample will also allow for structural equation modeling methods to examine how gender and science domain moderate these links within the science fair context.

Another future factor to consider with this work is the grade-level of the child. The current study has a large grade-level range of participants including children from 4th to 11th grade, with the majority of participants between 4th - 8th grade. Prior work has indicated that this wide of a range likely contains high variability in children's science-related attitudes and parental support. When considering changes to children's science-related attitudes, some work has suggested that children's evaluations of science task-value change over time (Andre et al., 1999). Interestingly, this pattern of change was moderated by child gender with boys increasing in science interest, and girls decreasing in science interest. Other work has noted that STEM-related motivations declined over time, especially during academic transitions like the shift from middle-school to high-school (Wigfield et al., 2015). When examining changes over time in parental attitudes, Simpkins et al. (2015a) found that parents' estimates of their children's abilities in the domains of sports, reading, math, and music increased over time. With increases in estimates of children's abilities it might stand to reason that over time parents' support also changes; however, to my knowledge prior work has not examined how parental support, either instrumental or socioemotional, changes over time within science or STEM-related domains. As a result, it will be particularly interesting in future analyses with a larger sample to include grade-level as a covariate to better understand how current patterns differ across development. This kind of analysis would also be particularly informative for programming choices in the science fair as currently guidelines and expectations are the same for children across 4th to 8th grade.

In addition to grade-level, there may also be important factors to consider such as the race/ethnicity of participants as well as family background (e.g., parents' years of schooling, or occupational background). Prior work has noted that these can be important moderators of children's motivational beliefs (Simpkins et al., 2015b). Historically, the SCSEF has consisted of predominantly European-American families, and parents with high-levels of education. As a result, the fair will likely need to make structural changes to increase the participation of students from diverse backgrounds in order to examine these factors.

Lastly, the current study assessed children's motivational beliefs prior to participation in the formal science fair where they present their projects to judges. Future analyses should consider how the formal component of fair participation is linked to changes in beliefs. Some research has indicated that children's motivational beliefs, can be influenced by involvement in extracurricular STEM-related activities such as summer programs (Weinberg et al., 2011). Other work has found that children's task-value beliefs of science and math can be improved through targeted parent-child conversations about the importance of science and math courses in high school (Harackiewicz et al., 2012).

In the context of the science fair, it is possible that children's motivational beliefs would increase through further exposure to science and through positive parent-child conversations about science. However, the component of evaluating student work and scientific process as part of the judging could have negative consequences, especially for groups that already face negative gender-stereotypes in science (see Cheryan et al., 2017 for a review). If children's beliefs improve after formally presenting their projects, this could suggest that the presentation portion of the science fair may be an important experience that offers a boost to children's beliefs about their abilities and task-value of science. Alternatively, if children's motivations decline after presenting their projects, this could suggest that current practices including the method of judging and interviewing children may negatively impact children's science ability and task-value beliefs. As a result, programmatic improvements, such as judge training, could be put in place to better ensure children have a positive experience when presenting their final science fair projects.

Conclusions

In conclusion, this study examined children's science beliefs and experiences as participants in the Santa Cruz County Science Fair. In particular, this study considered how children's science motivational beliefs are linked to the attitudes and behaviors of their parents, and if there are average differences by child gender or science domain in these constructs.

Some of my findings suggested that parents may hold gender-differentiated attitudes about their children's science abilities, and offer more encouragement to boys than girls in some science domains. However, most of my findings suggested that within the context of a science fair, there were no differences by gender or domain in children's science motivational beliefs, the support children perceived, or the instrumental support parents offered. This study also found important links among parents' science attitudes, behaviors, and children's motivational beliefs.

Historically, participants of the SCSEF tend to be students from already privileged backgrounds (e.g., attend charter/private school, European-American backgrounds), thus equity and access to science fair participation is an ongoing dilemma. Findings from this study can be used to inform future programmatic choices by the SCSEF to improve the experiences of current science fair participants as well as future participants of various backgrounds.

Specifically, this study highlights that children may not need high amounts of instrumental support to benefit from science fair participation, and in fact too much support may be damaging. Rather, children may benefit most from parental encouragement to participate in the fair. As a result, the SCSEF might consider constructing materials that guide families through the process of creating a science fair project. This may better support parents in providing appropriate instrumental support, and further encourage parents to offer equal support to boys and girls across project domains. Future analyses examining predictors, and potential moderators, of children's science motivations over time may also offer more insight into the ways researchers and educators can better support children and families in their extra-curricular science learning.

Table 1
Means (and Standard Deviations) for Study Variables by Gender and Science Domain

	Boys	Girls	Boys with physical science projects	Girls with physical science projects	Boys with life science projects	Girls with life science projects
Child science ability beliefs	(4.9, .93)	(5.1, .75)	(4.7, .84)	(5.3, .51)	(5.0, 1.1)	(5.1, .81)
Child science task-value beliefs	(4.9, .98)	(5, .83)	(4.8, 1.1)	(5.1, .76)	(5.1, .85)	(4.9, .86)
Parent attitude child science ability	(6.3, .69)**	(5.5, .81)**	(6.3, .53)	(5.7, .39)	(6.3, .81)	(5.5, .87)
Parent attitude child science task-value	(6.2, .91)	.(5.9, 1.1)	(6.1, .91)	(6.4, .49)	(6.3, .93)	(5.9, 1.1)
Child perception of parent instrumental support	(2.4, .75)	(2.2, .71)	(2.6, .89)	(2.2, .85)	(2.2, .54)	(2.2, .67)
Child perception of parent socioemotional support	(4.1, .91)	(3.8, 1.1)	(3.9, .89)	(4.1, .63)	(4.1, .96)	(3.6, 1.1)
Parent report of instrumental support	(2.2, .59)	(2.1, .65)	(2.3, .82)	(1.9, .56)	(2.1, .44)	(2.1, .67)
Parent report of socioemotional support	(5.2, .86)	(4.8, .94)	(5.1, 1.1)	(5.6, .58)	(5.3, .76)*	(4.6, .92)*

$^{*}p<.05$. $^{**}p<.01$. $^{***}p<.001$.

Table 2
Bivariate Correlations of Study Variables

	Child science task value	Parent child science ability	Parent child science interest	Child perception instrumental support	Child perception socio support	Parent report instrumental support	Parent report socio support
Child science ability	.515**	.459**	.511**	-0.23	.268*	-0.25	.334*
Child science task value		.313*	0.227	0.21	.395**	0.053	0.25
Parent child science ability			.636**	-0.006	0.055	-0.093	.351**
Parent child science interest				-0.129	0.033	-0.158	.281*
Child perception instrumental support					0.064	.660**	0.001
Child perception socio support						-0.108	.328*
Parent report instrumental support							0.014

*p<.05. **p <.01. ***p <.001.

Table 3
Linear Regression for Students' Science Motivational Beliefs with Parents' Science-Related Attitudes (Hypothesis 5).

Predictor	***B* (*SE*)**	**ß**
Child's Science Ability Beliefs		
Parent beliefs of child science ability	.22 (.14)	.21
Parent beliefs of child science interest	.41 (.15)	.35**
Child's Science Task Value		
Parent beliefs of child science ability	.29 (.16)	.26
Parent beliefs of child science interest	.02 (.18)	.01

Note. For model with child's ability beliefs, $F(1, 64) = 10.80$, $R^2 = .251$, $p < .01$. For model with child's task-value beliefs, $F(1, 64) = 2.44$, $R^2 = .071$, $p = .095$.

$^{*}p < .05$. $^{**}p < .01$.

Table 4
Linear Regression for Students' Science Motivational Beliefs with Children's Perceptions of Science Support (Hypothesis 6).

Predictor	*B* (*SE*)	ß
Child's Science Ability Beliefs		
Child perception socioemotional support	.24 (.10)	.28*
Child perception instrumental support	-.28 (.14)	-.25 *
Child's Science Task Value		
Child perception socioemotional support	.34 (.10)	.38**
Child Perception instrumental support	.23 (.14)	.18

Note. For model with child's ability beliefs, $F(1, 60) = 4.61$, $R^2 = .133$, $p < .05$. For model with child's task-value beliefs, $F(1, 60) = 7.05$, $R^2 = .19$, $p < .01$.

$^{*}p < .05$. $^{**}p < .01$.

Table 5
Linear Regression for Students' Science Motivational Beliefs with Parent Report of Science Support (Hypothesis 7).

Predictor	***B* (*SE*)**	**ß**
Child's Science Ability Beliefs		
Parents' report socioemotional support	.28 (.11)	.29*
Parents' report instrumental support	-.31 (.16)	-.22
Child's Science Task Value		
Parents' report socioemotional support	.21 (.13)	.21
Parents' report instrumental support	.06 (.18)	.04

Note. For model with child's ability beliefs, $F(1, 64) = 4.91$, $R^2 = .133$, $p < .05$. For model with child's task-value beliefs, $F(1, 64) = 1.51$, $R^2 = .045$, $p = .229$.

$^{*}p < .05$. $^{**}p < .01$.

Appendix A

Child Survey Measures

Time = time of measurement.

Construct	**Measure**	**Likert**	**Source**
Details of prior participation	"Have you participated in the Santa Cruz County Science Fair, before?"	2-point-likert 1 = Yes 2= No	Created
	"What division of science was your project in?"	Drop-down menu with all science fair divisions	Created
Children's choice in science fair participation	"Whose idea was it to participate in the science fair?"	3-point-likert 1 = I chose entirely on my own 2 = I chose but somebody also chose with me 3 = the choice was made entirely by someone else and I had no choice	Beymer et al. (2018) edited to be about science fair opposed to STEM program
	"Did you complete this science fair project for your school before completing it for the county science fair?"	3-point-likert 1 = yes my school required I complete a science fair project 2 = yes, I completed this project for school first but it was not required 3 = no, I did not complete this project before for my school	Created
Progress with project	"How much of your project is done so far?"	6-point-likert 0 = I haven't started 1 = I have my project idea but have not started the project 2 = I have worked on my project a little 3 = my project is about half way done 4 = my project is almost done 5 = my project is done	Created
Affect	"How happy are you feeling about your science fair project?"	4-point-likert 1 = not at all happy 2 = a little happy 3 = somewhat happy 4 = very happy	Beymer et al. (2018) edited to be about science fair opposed to STEM program

	“How excited are you feeling about your science fair project?”	4-point-likert 1 = not at all excited 2 = a little excited 3 = somewhat excited 4 = very excited	
	“How frustrated are you feeling about your science fair project?”	4-point-likert 1 = not at all frustrated 2 = a little frustrated 3 = somewhat frustrated 4 = very frustrated	
	“How stressed are you feeling about your science fair project?”	4-point-likert 1 = not at all stressed 2 = a little stressed 3 = somewhat stressed 4 = very stressed	
Frequency of science learning in school	"During a regular week in school, how often do you learn about science?"	5-point-likert 1 = Never 2 = One day a week 3 = Two-three days a week 4 = Almost every day 5 = Everyday of the week	Created
Grades in Science and other subjects	"What grade do you usually earn in ________?" [English, Math, Science]	6-point-likert 1 = I don't receive a grade in this at my school 2 = the lowest grade (F) 3 = a pretty low grade (D) 4 = in the middle grade (C) 5 = not the highest grade, but still pretty high (B) 6 = the highest grade (A)	Created
Science Activities	"How frequently have you done the following things: [collect things like rocks, insects, leaves and shells; experiments at home or at school; read science books, go to science museums, work with science kits, watch science TV shows, be part of science clubs.	6-point-likert 1 = Almost never 2 = 3 = 4 = 5 = 6= Almost every day for a long while	Simpkins et al. (2005) edited to include more science activities

Instrumental Support (general)	"How much help did you receive on your project from each of the following _________?" [adult family member/guardians, teachers or other adult helper, classmates or friends, older siblings/cousins]	4-point-likert 1 = No help 2 = just a little help on some parts of my project 3 = help on almost every part of my project 4 = help on all of the parts of my project	Created
Socioemotional Support (general)	"How frequently do the following people encourage your interest in science?" [adult family member/guardians, teachers or other adult mentor, classmates or friends, older siblings/cousins]	4-point-likert 1 = Never 2 = Rarely 3 = Occasionally 4 = Quite Often	Desy et al 2011. (part of 8 measure survey)
	"To what extent did the following people encourage your participation in the science fair?" [adult family member/guardians, teachers or other adult mentor, classmates or friends, older siblings/cousins]	6-point-likert 1 = Strongly discourage 2 = 3 = 4 = 5= 6 = Strongly encourage	Simpkins et al. (2005) edited to be about science fair
Support [filter question]	Which of the following older family members have been the most involved with your science fair project?	select one from the list [mother, father, older adult family member other than a parent, older sibling]	Created
Instrumental Support from Parents or other adult family members [instruction: when answering the following questions, please think about the family member you reported above who provided/ you expect will provide the most help with your science fair project]	"How much did your older family member help you decide your topic for the science fair?"	4-point-likert 1 = No help 2 = Just a little help 3 = Some help 4 = A lot of help	Created
	"How much did your older family member help you design your project for the science fair?"	4-point-likert 1 = No help 2 = Just a little help 3 = Some help 4 = A lot of help	Created
	"How much did your older family member help you complete your project?"	4-point-likert 1 = No help 2 = Just a little help 3 = Some help 4 = A lot of help	Created
	"How much did your older family member help you create your poster board and presentation for your project?"	4-point-likert 1 = No help 2 = Just a little help 3 = Some help 4 = A lot of help	Created

Socioemotional Support from Parents [instruction: when answering the following questions, please think about the family member you reported above who provided/ you expect will provide the most help with your science fair project]	"How much has your older adult family member encouraged you to participate in science-related activities at home".	6-point-likert 1 = Strongly discourage 2 = 3 = 4 = 5= 6 = Strongly encourage	Simpkins et al. (2005)
	"How much has your older adult family member encouraged you to participate in science-related activities at school?	6-point-likert 1 = Strongly discourage 2 = 3 = 4 = 5= 6 = Strongly encourage	
Expectancy/ Ability Beliefs	"How good at _______ are you?" [reading, math, science]	6-point-likert 1 = Not very good 2 = 3 = 4 = 5= 6 = Very good	Eccles et al. 1993, Jacobs et al. 2002. .
	"Compared to other subjects, how good are you at ___________? [reading, math, science]	6-point-likert 1 = A lot worse 2 = 3 = 4 = 5= 6 = A lot better	
	"If you were to list all the students from best to worst in _______ where are you?" [reading, math, science]	6-point-likert 1 = One of the worst 2 = 3 = 4 = 5= 6 = One of the best	
	"How good would you be at learning something new in ___________?" [reading, math, science]	6-point-likert 1 = Not very good 2 = 3 = 4 = 5 = 6 = Very good	

Task Value	"For me, being good in ______ is…" [reading, math, science]	6-point-likert 1 = Unimportant 2 = 3 = 4 = 5 = 6 = Very important	Eccles et al. 1993, Jacobs et al. 2002.
	"Compared with other activities, how useful is learning _____?" [reading, math, science]	6-point-likert 1 = Not as useful 2 = 3 = 4 = 5 = 6 = a lot more useful	
	"Compared with other activities, how important is it to be good at _________" [reading, math, science]	6-point-likert 1 = not as important as being good in other activities 2 = 3 = 4 = 5 = 6 = a lot more important than being good in other activities	
Interest	"I find _________ .." [reading, math, science]	6-point-likert 1 = Very boring 2 = 3 = 4 = 5 = 6 = Very Interesting	Eccles et al. 1993, Jacobs et al. 2002.
	"How much do you like _____?" [reading, math, science]	6-point-likert 1 = a little 2 = 3 = 4 = 5 = 6= A lot	

Future interest in STEM Occupations *Not used for dissertation*	"How interested would you be in having the following jobs when you are older?" [**Physical science** (people who study non-living things like rocks, space, and physics. These people include physicists, chemists, astronomers, and geologists) ; **Life science** (people who study living things like animals, plants, and bacteria. These people include biologists, animal scientists, and botanists) : **Behavioral Science** (people who study the way humans act and think. These people include psychologists, sociologists, and anthropologists); **Technology & Engineering** (people who study the way things work to create technology and build the world around us. These people include computer scientists, and engineers)]	6-point-likert 1 = Very unlikely 2 = 3 = 4 = 5= 6 = Very likely	Wang et al (2017), edited occupations
Judge Fairness *Not used for dissertation*	"How fair did you feel the judges were in judging your project?	4-point-likert 1 = Not fair at all 2 = Kind of fair 3 = Mostly fair 4 = Very fair	Created
Judge Encouragement *Not used for dissertation*	"How encouraging were the judges about your project?"	4-point-likert 1 = Not encouraging at all 2 = Kind of encouraging 3 = Mostly encouraging 4 = Very encouraging	Created
Judge Interest	"Did the judges make you feel more or less interested in science?"	6-point-likert 1 = A great deal less interested 2 = Less interested 3 = A little less interested 4 = A little more interested 5= More interested 6 = A great deal more interested	Created

Influence of science fair	"Did doing a science fair project make you more or less interested in science?"	6-point-likert 1 = A great deal less interested 2 = Less interested 3 = A little less interested 4 = A little more interested 5= More interested 6 = A great deal more interested	Created
Future science fair participation	"Do you think you will participate in the science fair again?"	5-point-likert 1 = Not sure 2 = I definitely will not 3 = I probably will not 4 = I maybe will 5 = I definitely will	Created
Potential to participate in a follow-up interview in the future	"Would you be interested in sharing more about your experiences with the Santa Cruz County/ Monterey County/Westlake Science Fair through a brief interview sometime in the future? Note: answering yes does not sign you up for participating in an interview in the future, answering yes will indicate to researchers you may be interested and someone from the research team may follow-up with you about future participation"	1 = yes 2 = no	Created
Open Response	"In as many or as few words as you would like, please tell me about your experience with the science fair?"		
Open response	"In as many or as few words as you would like, please tell me about the support you received to complete your science fair project"		

Appendix B

Parent Survey Measures

Construct	**Measure**	**Likert**	**Source**
Expectancy/ Ability Beliefs	"How good at ______ are you?" [reading, math, science]	6-point-likert 1 = Not very good 2 = 3 = 4 = 5= 6 = Very good	Eccles et al. 1993, Jacobs et al. 2002.
	"Compared to other subjects, how good are you at ___________? [reading, math, science]	6-point-likert 1 = A lot worse 2 = 3 = 4 = 5= 6 = A lot better	
	"If you were to list most of the people you know from best to worst in _______ where are you?" [reading, math, science]	6-point-likert 1 = One of the worst 2 = 3 = 4 = 5= 6 = One of the best	
	"How good would you be at learning something new in ___________?" [reading, math, science]	6-point-likert 1 = Not very good 2 = 3 = 4 = 5 = 6 = Very good	
Task Value	"For me, being good in ______ is…" [reading, math, science]	6-point-likert 1 = Unimportant 2 = 3 = 4 = 5 = 6 = Very important	Eccles et al. 1993, Jacobs et al. 2002.
	"Compared with other activities, how useful is learning _____?" [reading, math, science]	6-point-likert 1 = Not as useful 2 = 3 = 4 = 5 = 6 = a lot more useful	

	"Compared with other activities, how important is it to be good at _________" [reading, math, science]	6-point-likert 1 = not as important as being good in other activities 2 = 3 = 4 = 5 = 6 = a lot more important than being good in other activities	
Interest	"I find _________ .." [reading, math, science]	6-point-likert 1 = Very boring 2 = 3 = 4 = 5 = 6 = Very Interesting	Eccles et al. 1993, Jacobs et al. 2002.
	"How much do you like _____?" [reading, math, science]	6-point-likert 1 = a little 2 = 3 = 4 = 5 = 6= A lot	
Perceptions of children's abilities in science	"How good is this child at __________?" [reading, math, science broadly, physical sciences, life sciences, engineering, behavioral/social sciences]	7-point-likert 0 = Not good at all 1 = 2 = 3 = 4 = 5= 6 = Very good	Simpkins et al. (2012)
	"Compared to other children, how much innate ability or talent does this child have in ________?" [reading, math, science broadly, physical sciences, life sciences, engineering, behavioral/social sciences]	7-point-likert 0 = Much less than 1 = 2 = 3 = 4 = 5= 6 = Much more than	
	"How well do you think this child will do in _________ next year?" [reading, math, science broadly, physical sciences, life sciences, engineering, behavioral/social sciences]	7-point-likert 0 = Not at all well 1 = 2 = 3 = 4 = 5= 6 = Very well	

Perceptions of children's interest in science	"My child finds ______" [reading, math, science broadly, physical sciences, life sciences, engineering, behavioral/social sciences]	6-point-likert 1 = Very boring 2 = 3 = 4 = 5 = 6 = Very Interesting	Edited from EVT measures of Jacobs et al. 2002; Eccles-1993
	"My child likes _____?" [reading, math, science broadly, physical sciences, life sciences, engineering, behavioral/social sciences]	6-point-likert 1 = a little 2 = 3 = 4 = 5 = 6= A lot	
Instrumental Support Overall	"How much did you help, or how much do you plan to help, your child on their science fair project?	4-point-likert 1 = No help 2 = just a little help on some parts of my project 3 = help on almost every part of my project 4 = help on all of the parts of my project	Created
Instrumental support on specific parts of the science fair project	"How much did you help, or how much do you plan to help your child decide their topic for the science fair?"	4-point-likert 1 = No help 2 = A little help 3 = Some help 4 = A lot of help	Created
	"How much did you help, or do you plan to help, your child design your project for the science fair?"	4-point-likert 1 = No help 2 = A little help 3 = Some help 4 = A lot of help	Created
	"How much did you help, or do you plan to help, your child complete their project?"	4-point-likert 1 = No help 2 = A little help 3 = Some help 4 = A lot of help	Created
	"How much did you help, or do you plan to help, your child create their poster board and presentation for your project?"	4-point-likert 1 = No help 2 = A little help 3 = Some help 4 = A lot of help	Created
Provision of science materials	"How often anyone in the family bought or rented ______ materials for their child in the past year?" [science books, science games or toys, television shows or movies about science.	2-point-likert 0 = Yes 1= No	Simpkins et al. (2005) edited to include some more science-specific materials

Science Coactivity	"How often do you do the following activities with your child?" [go to science museums together, read science books together, watch science TV shows or movies]	6-point-likert 1 = Never 2 = 3 = 4 = 5 = 6 = Almost every single day for a long while	Simpkins et al. (2005) edited to include some more science-specific materials
Socioemotional Support	"How much have you encouraged your child to participate in science-related activities at home".	6-point-likert 1 = Strongly discourage 2 = 3 = 4 = 5= 6 = Strongly encourage	Simpkins et al. (2005)
	"How much have you encouraged your child to participate in science-related activities at school?	6-point-likert 1 = Strongly discourage 2 = 3 = 4 = 5= 6 = Strongly encourage	Simpkins et al. (2005) edited to be about science at school specifically
	"How much have you encouraged your child to participate in the science fair?"	6-point-likert 1 = Strongly discourage 2 = 3 = 4 = 5= 6 = Strongly encourage	Simpkins et al. (2005) edited to be about science fair specifically
Open response	"in as many or as few words as you would like, please tell us about why your child is participating in the science fair this year"		

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