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Parental Support Content and Quality: Supporting Girls' and Women's Interest and Persistence in STEM

Elizabeth Dorrance Hall[1]*, Olivia Watson[1], Yue Zhang[1], Brooke H. Wolfe[1], Xiaoran Cui[1], America L. Edwards[2], Ran Liu[1], & Debra Lawlor[3]

[1]Department of Communication, Michigan State University
[2]School of Information Science, University of Kentucky
[3]Mechanical Engineering Department, Michigan State University

Corresponding Author* Contact: edh@msu.edu
ORCID: Hall, Watson, Zhang, Wolfe, Cui, Edwards, Liu, & Lawlor

ABSTRACT

Parental support is a robust facilitator of girls' and women's interest and persistence in STEM fields. This study deepens our understanding of parental support in girls' and women's interest and persistence in STEM by exploring the (a) content and (b) quality of parental support. We interviewed 54 Black, Latina, and non-Hispanic White college women majoring in STEM in the United States to learn about their college experiences and the support their parents provided. Through an iterative coding approach using Xu and Burleson's (2001) support types framework, we explored five types of support messages: informational (e.g. advice), tangible (e.g. resources), emotional (e.g. comfort and empathy), esteem (e.g. encouragement and affirmations), and network (e.g. social connections). We define and provide exemplars of these five types of support to illustrate the complexity of supportive communication. The results reveal variety in both content and perceptions of quality of each type of support. These findings extend our understanding of how diverse supportive messages can help women combat gender-related social disadvantages in high-barrier, male-dominated majors and careers. Best practices

for support providers are discussed, as are suggestions for future researchers interested in parental support of girls' and women's interest and persistence in STEM.

KEYWORDS: social support, communication, parents, support quality, women in STEM

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INTRODUCTION

Women are significantly underrepresented in science, technology, engineering, and math (STEM) fields in the United States (Martinez & Christnacht, 2021), even though girls perform just as well as boys in math and science related subjects (Simpkins et al., 2015a). Among the G20 countries, women make up only 35% of STEM graduates (Gary, 2025) and once in STEM careers, women are twice as likely as their male counterparts to leave (Ceci et al., 2009), with women of color facing even greater disparities (Alfred, 2017). STEM fields are not equally gendered. Women are well represented in the life sciences but remain severely underrepresented in computer science, engineering, and physics, where masculine cultures, gendered stereotypes about brilliance, work-life balance concerns, and limited early exposure create barriers that reduce women's persistence relative to men (Cheryan et al., 2017; Wang & Degol, 2017). In the past year, structural efforts to support the participation and advancement of women in science and engineering careers in the United States have been terminated (American Association of University Presidents, 2025). In light of these changes, individual-level support, particularly from parents, is more critical than ever for encouraging girls and women to pursue and persist in STEM fields.

Children are more likely to develop STEM interests (i.e., a willingness or desire to engage with [or do] STEM in school and during their free time; Archer et al., 2010) and to persist (i.e., continue pursuing and deepening that interest over time), when parents actively encourage engagement with these subjects from an early age (Halim et al., 2023; Starr et al., 2022). While prior research consistently identifies parental support as a key factor in STEM career choice and persistence, less is known about the nature of these supportive interactions— namely, what parents say (message content) and how they say it (communication quality). We argue that the content and quality of support messages shape which messages are perceived as helpful and, ultimately, which support types, content, and quality are likely to have potential downstream effects on women's interest and persistence in STEM. To better understand variations in parental support of STEM interests and persistence, this study examines the types of supportive communication women majoring in STEM fields recall receiving from their parents that they felt helped them remain committed to their educational and career goals. We use an existing typology of supportive communication (Xu & Burleson, 2001) to provide structure and understanding to the ways parents support (and do not support) their daughters' interests and persistence in STEM. This approach has at least three benefits including that it can be replicated and scaled up to larger samples, it can be quantitatively assessed to link types of support to outcomes such as interest and persistence, and it can be used in practical ways to help parents consider the variety of options for supporting children. Interest and persistence in STEM guide the types of parent-child interactions of focus but were not measured as outcomes in this study.

Role of Parental Support in STEM Interest and Persistence

Decades of research confirm that parental support is critical for persistence in STEM (e.g., Cian et al., 2022; Dorrance-Hall et al., 2025; Starr et al., 2022). Family support may be especially critical for girls and women, as other persistence-promoting factors available to boys, such as media depictions and school-based support systems, are often less accessible for girls (Archer et al., 2013; Steinke et al., 2024). Existing literature provides several avenues for understanding parent support of STEM interests and persistence including (a) models of STEM interest development that include parental involvement, (b) empirical studies of behavioral parental support, and (c) research on parent-child STEM-related interactions. Each of these areas are discussed below.

Models of Interest Development

Several models attempt to explain parental involvement in STEM interest development and persistence. Pattison et al.'s (2016) model of early childhood interest development highlights how the process is phased, multifaceted, and driven by ongoing interactions between family members in different settings. According to the model, parents' role in interest development includes the support they provide along with what they say in front of their children, their participation in science activities alongside their children, and demographic factors like their level of education and job. Parents can scaffold STEM interests by doing activities with their children that nurture curiosity and enthusiasm for STEM, matching their level of interest at different developmental stages. As such, parents should tailor their support (of all kinds) to meet children where they are. Models that include parental involvement in STEM interest development are important for understanding the context in which parental support occurs; however, these models are necessarily too broad to capture the variety of messages that communicate parent support (see Dorrance-Hall et al., 2025). This study aims to fill this gap by examining parental support messages reported by women pursuing STEM to better understand support content and quality in this context.

Behavioral Parental Support

Research finds that family support, encouragement, and involvement, particularly when provided early and consistently, are positively associated with interest and self-efficacy in STEM (Dotterer, 2022; Šimunović & Babarović, 2020), career exploration (Liu et al., 2025), and career decision-making self-efficacy (Li et al., 2022). Although research consistently affirms the critical role of parental support in fostering children's interest in STEM, scholars across disciplines measure and conceptualize parental support in varied ways. For instance, researchers have utilized observation of parental behavior and measures of child perceptions of parental support. Conceptualizations of parental support have included parental involvement (e.g., co-activity, school-based activities; Simpkins et al., 2015b), words of encouragement (e.g., giving advice and expressing hope; Starr et al., 2022), and leveraging resources (e.g., monetary support, using kin and community for support; Sánchez et al., 2006). Simpkins et al., (2015b) highlighted three types of parental involvement support behaviors: positivity (e.g., praise you for your schoolwork in science), co-activity (e.g., spend time with children together), and school-based activities. Parents provided words of encouragement by motivating their children to engage or participate in various activities and expressed hope

towards expected behaviors (e.g., Eccles et al., 1993; Soto-Lara & Simpkins, 2022).

Parent-child STEM-related Interactions

Recent research has explored STEM interactions within families including how conversations convey family science capital, everyday science talk experienced by marginalized youth, and science interest-triggering events. Families that are best able to foster science interests are likely high in family science capital, that is, the total of all science-related knowledge, experiences, attitudes, and resources in a family (see Gu et al., 2025). Leveraging family science capital has been linked to early childhood science learning (e.g., children's scientific knowledge, skills, and attitudes). Family science cultural capital (knowledge, attitudes, experiences), practical capital (science-related behaviors), and social capital (parents' science credentials and access to science-related social networks) are key components of family science capital. Parent-child interactions can convey all three types of capital. Studies on practical capital identify parent-child interactions as a place of interactivity, that is, sharing knowledge through dialogue (Gu et al., 2025).

Cian et al. (2022), drawing on Dou et al.'s (2019) work, examined "everyday science talk" that is, the STEM-related conversations individuals have with their parents during childhood. Cian et al. (2022) examined how college STEM majors at a Hispanic Serving Institution (HSI) recalled everyday science talk with their parents and how those conversations were related to their STEM identity. Because they share cultural backgrounds, norms, and values, parents and other caregivers are able to infuse everyday talk about STEM with family and cultural values that support the value of STEM degrees in ways that other mentors or role models can/do not. Parents were also able to support their children's STEM identities when their children were not given that kind of support at school. In another study, Vivante and Vedder-Weiss (2025) recorded science-related interactions between parents and children to identify science interest-triggering events such as asking about the ingredients in a bottle of shampoo or parents providing experiment kits. These events illustrate the content of and context for communication that may (or may not) illicit parental support of STEM interests depending on how the parents respond.

Summary

The above reviewed body of work provides information about what, where, and how families communicate about science. Other work has focused on the amount and the frequency of enacted supportive behaviors. However, existing work does not provide or apply an overarching framework for understanding the variety of support parents can provide, nor does it connect with theories that explain how, when, and why the content of certain types of support are more effective than others. A framework of supportive communication can provide this. Understanding specific content and quality of support messages is important because it shows not just the presence of support, but how it is conveyed. Understanding the content is an initial step in discovering what support content effectively meets the needs of individuals thereby facilitating interest and persistence, particularly in challenging fields like STEM. Better understanding the content of supportive message also provides useful information to parents and caregivers about what they might do or say to facilitate STEM interest.

Below, we draw on a pre-existing categorization system that explores five different types of supportive communication (Xu & Burleson, 2001), and in this study, we focus on the child's perspective of support provided, that is, parental actions that communicated support to them. We aim to deepen understanding of parental support in developing children's interest in STEM by exploring the content and quality of various support types shared via parent-child communication and recalled by undergraduate women majoring in STEM.

Supportive Communication

Supportive communication includes any verbal or nonverbal communication that has an explicit or implicit intent to help others (MacGeorge et al., 2011). The supportive communication literature builds upon traditionally researched tangible support (e.g., parental engagement), to include informational support (e.g., advice), emotional support (e.g., active listening), esteem support (e.g., encouragement), and network support (e.g., providing a sense of belonging by connecting with those with similar interests; Xu & Burleson, 2001). We argue that this pre-existing typology is useful for understanding women's experiences with parental support for their interest and persistence in STEM.

Informational support includes advice, factual input, and feedback on actions. Advice that is appropriate, helpful, sensitive, and comes from sources with expertise is better received and more likely to be implemented (Goldsmith, 2004; MacGeorge et al., 2008). In addition, advice that comes after emotional support and problem analysis is perceived as higher quality compared to advice without this sequence (Feng, 2009). Research on informational support highlights that perceptions of advice are not only about what is said, but also when and how it is delivered.

Tangible support includes offers to provide needed goods (e.g., money, books) and services (e.g., transportation, housework). This form of support can reduce the material burdens associated with navigating stressors, especially in high-demand contexts such as STEM education. Tangible social support is linked to positive psychological outcomes (Åslund et al., 2014; Friedman & King, 1994). Individuals who have access to help and resources often experience improved emotional health, including greater positive affect, reduced stress, and reduced negative mood (Moeini et al., 2018; Yalcin, 2015). These outcomes suggest that practical support can have both immediate and long-term effects on well-being. For women majoring in STEM, tangible support may make the difference between persisting and leaving, especially when balancing academic, financial, and familial demands.

Emotional support consists of expressions of caring, concern, empathy, and sympathy. This type of support has been identified by researchers as among the most valuable because it can provide both physiological and emotional health benefits (Goldsmith, 2004). Emotional support that adapts to the needs of the receiver, the nature of the relationship, and the specific stressor is typically viewed as highest in quality (Feeney & Collins, 2017). Emotional support often lays the groundwork for other forms of support to be effectively received. For example, emotional validation may make recipients more receptive to advice or esteem-boosting messages that follow.

Esteem support refers to support that enhances "how others feel about themselves and their attributes, abilities, and accomplishments" (Holmstrom, 2012, p. 77). This form of support affirms a person's worth and can help buffer against moments of self-doubt, particularly in competitive or male-dominated environments like STEM. Esteem support has been found to improve state self-esteem (Holmstrom & Burleson, 2011), enhance the psychological and physical well-being of adults facing esteem threats (Swift & Wright, 2000), and strengthen interpersonal relationships (Carels & Baucom, 1999). These effects underscore the importance of affirming messages, especially for individuals who may question their abilities or belonging. Within families, esteem support might take the form of reminders of past successes or encouragement to persist through academic challenges.

Network support entails messages that make someone feel like they belong with others who share their interests and concerns and includes connecting the support recipient with others in the provider's network who may offer additional guidance or community (Xu & Burleson, 2001). This type of support can help individuals feel less alone in their experiences and create a broader system of support beyond the immediate family. Network support can be especially meaningful for women pursuing in STEM, where representation and access to mentorship may be limited.

Although research has examined the content that constitutes each type of support message in other contexts, little has been done to explore the content of STEM-support messages from parents. Similarly, little to no work has considered how women interpret the quality of these various types of support messages. Next, we review what research has revealed about parental messages that prepare children for careers and what is known about the factors that influence perceptions of support quality.

Parental Support Content

An area of research that provides information about the content of parental support is that of career-related messages from parents, which can shape children's early thinking about STEM and other careers (Myers et al., 2011). Research on vocational anticipatory socialization (VAS), the process of gathering information about work to develop expectations about one's future career (Jablin, 1985), demonstrates that parents are a central source of career preparation messages (Aley & Levine, 2020; Jablin, 1985). Similar to the parent-child STEM-related interaction studies described above (see Vivante and Vedder-Weiss, 2025), VAS messages are not inherently supportive, but they provide insight into the kinds of content children are exposed to as they form ideas about potential career paths. Myers et al. (2011) found that children often recall messages from parents about the nature of work, the importance of financial security, and whether particular jobs are good or bad.

Parental messages about careers frequently center on practical factors such as job security, financial stability, and societal value, all of which shape how children evaluate STEM options (Myers et al., 2011). Parents may emphasize the benefits of STEM fields by highlighting their perceived stability or prestige casting these careers as smart or strategic choices. Additionally, parents may share detailed information about day-to-day responsibilities within particular fields, helping children envision what a future in STEM could look like. When parents express dissatisfaction with their own jobs, their messages can discourage children from

pursuing similar careers. Even subtle expressions of frustration or boredom can leave lasting impressions about what work in a given field entails. Myers et al. emphasize that these messages operate alongside personal experience and contextual factors, jointly influencing academic decisions and occupational aspirations.

The content of parents' messages can be descriptive, prescriptive, or evaluative—each shaping a child's career beliefs in distinct ways. Parents may *describe* specific careers in STEM, outlining responsibilities and required skills. They may also *prescribe* particular fields based on perceived job prospects or societal value. Lastly, parents can *evaluate* careers using emotional tone or past experiences. For instance, a parent might encourage their child to pursue medicine because it is stable and lucrative (prescriptive), explain what a medical researcher does each day (descriptive), or share regret about not following a similar path themselves (evaluative). Myers et al. (2011) found that such content, regardless of intention, affects how children perceive their own fit with STEM careers.

Vedder-Weiss (2018) examined the content of communication in "science families," that is, families where science is a desirable part of everyday life. Family science interactions can occur almost anywhere including over dinner, on walks, and while driving in the car. These include asking questions (what, why, how, when), modeling, constructing explanations, engaging in arguments from evidence, and engaging with information. This work reports largely on positive interactions, though it is unclear whether children perceived these interactions as supportive. Vedder-Weiss' work illustrates how parents can communicate support, such as by recognizing a child for their creative thinking "Cool!...awesome! How did you think of that?" (p. 1229).

Taken together, these studies underscore that the content of parents' messages can shape children's STEM interests and career beliefs. The content of parental messages is likely interpreted differently depending on the quality of the message. Next, we turn to factors that increase and decrease support message quality.

Parental Support Quality

Research on supportive communication provides clues about the message and contextual features of support that women majoring in STEM will perceive as high and low in quality. High quality *emotional support* messages, for example, are tailored to the recipient including their level of distress, their personality, their past experiences, and the relational context (e.g., messages high in person-centeredness; Burleson, 1982). These messages help the recipient explore their feelings while acknowledging and elaborating on their experience. For example, a parent might validate how their child is feeling while helping them gain perspective on how a challenge fits into the bigger picture. Low quality emotional support messages deny the support seeker's feelings, question their actions, and/or ignore their emotions.

A quality message of *instrumental support* is one where the recipient perceives the message and/or advice as "more efficacious, feasible, and not having too many limitations," (MacGeorge et al., 2016, p. 212). People are more inclined to seek advice and information from people who are perceived as "experts" in the subject matter being discussed (MacGeorge et al., 2016). It is also important to note that

the social identities of the recipient (such as gender and race) will influence how the message is perceived, and that not all messages of support will have a positive impact on the recipient (MacGeorge et al., 2016).

Low-quality advice and messages can lead to resistance and dissatisfaction from the recipient of the advice (MacGeorge et al., 2016), which can hinder the effectiveness of parental support efforts. For instance, advice may inadvertently threaten a child's social identity, be perceived as irrelevant or ineffective, or come from parents who may not be viewed as credible sources of guidance due to their lack of experience or knowledge (MacGeorge et al., 2016). Furthermore, threatening autonomy or undermining competence, along with negative impressions of parents' expertise and trustworthiness, may hinder a child's ability to cope effectively with challenges in STEM fields and reduce their willingness to implement suggested actions (MacGeorge et al., 2016).

Models of STEM interest development and empirical evidence indicate the importance of parent-child STEM interactions and parental support behaviors for girls' and women's interest development and persistence in STEM. As such, this study aims to explore the types, content, and quality of support messages women majoring in STEM receive from their parents during conversations about STEM interests and persistence. We pose the following research question:

> **RQ:** What support messages do women majoring in STEM recall receiving from their parents and how do those messages vary in content and quality?

METHODS

Participants & Procedures

Women aged 18 and older who self-identified as Black, Latina, or White and who were enrolled at any four-year undergraduate program in the United States were recruited for the study following approval from the Institutional Review Board. Recruitment started at a large Midwestern university in the United States through flyers, listserv announcements, and in large lecture courses. The study was also advertised on social media platforms to reach students at multiple universities. Interested individuals contacted a designated study email and were sent a link to the consent form and an initial demographic survey (see Table 1 for details relevant to the present manuscript). Those who met the eligibility criteria, provided consent, and completed the survey were scheduled for an online interview.

Semi-structured interviews were conducted between March and April 2024. Interviews were held via secure video conferencing platform for participant privacy and comfort. The average length of the interviews was approximately 49 minutes (range 12 – 79 minutes). One shorter interview was retained because it provided meaningful responses that addressed the core research question. Interview questions explored when and how participants became interested in STEM and how their families contributed to their persistence in STEM.

The final sample consisted of 54 women majoring in STEM at colleges and universities in the United States, with an average age of 20.41 years (SD = 1.79; range = 18–25). Participants were Black (n = 18), Latina (n = 17), and non-Latina White (n = 19). Participants were in their first year (n = 6), second year (n = 18),

third year (*n* = 9), fourth year (*n* = 13), and fifth year or greater (*n* = 8) of study. Most had at least one parent who had graduated from a four-year university (72.22%, *n* = 39). Others (*n* = 15) reported that neither of their parents had graduated from a four-year university. See Table 1 for participants' race/ethnicity, major, and parent industry.

Table 1. *Participant Demographics*

Pseudonym	Ethnicity/ Race	Major	Mother's Industry	Father's Industry
Maggie	White	Human Biology	Healthcare	Construction
Sloane	White	Civil & Environmental Engineering	Government	Government
Gianna	Latina	Computer Science	Language Services	Entrepreneur
Sara	White	Mechanical Engineering	Project Management	Education
Maddy	White	Geological Engineering	Education	Finance
Erica	White	Biomedical Engineering	Education	Higher Education
Katherine	Latina	Computer Information Systems	Education	Transportation
Courtney	White	Environmental Science	Unemployed	Manufacturing
Deborah	Black	Applied Engineering Sciences		
Kasey	Latina	Biology		
Belen	Latina	Data Science	Real Estate	Healthcare
Anna	White	Mathematics, Economics	Real Estate	Legal Services
Savannah	Black	Biosystems Engineering	Social Services	Real Estate
Jade	Latina	Computer Science	Real Estate	Real Estate
Alexandra	Latina	Biosystems Engineering	Retail	Legal Services
Delilah	Black	Information Systems	Finance	Transportation
Adaline	White	Human Nutrition/ Dietetics	Education	Entrepreneur

Ryder	Black	Biology		Construction
Mia	Latina	Mechanical Engineering	Administrative Services	Government
Carolina	Latina	Financial Math & Statistics		
Emily	White	Biology	Insurance	Healthcare
Maria	Latina	Biomedical Sciences	Education	Information Technology
Linda	White	Actuarial Math	Education	Higher Education
Amanda	White	Chemical Engineering	Administrative Services	Construction
Jordan	Black	Chemical Engineering	Healthcare	
Laura	Black	Food Science & Technology	Healthcare	Transportation
Ashley	Black	Information Science	Healthcare	Information Technology
Tessa	Black	Environmental Engineer		
Veronica	Latina	Mechanical Engineering		
Julia	Latina	Computer Science	Stay-at-home Parent	Landscaping
Jane	Latina	Materials Science & Engineering	Higher Education	Professional Services
Olympia	Black	Microbiology	Healthcare	Information Technology
Leah	Black	Environmental Engineering	Education	Engineering
Alaina	White	Health & Rehabilitation Sciences	Higher Education	Stay-at-home Parent
Rihanna	Black	Civil Engineering	Education	Real Estate
Avery	Black	Materials Science & Engineering	Administrative Services	Healthcare
Ember	Black	Cell & Molecular Biology	Healthcare	Real Estate
Georgia	Black	Biochemistry	Stay-at-home Parent	Supply Chain

Ella	Black	Applied Engineering Science	No occupation	Information Technology
Monica	Latina	Computer Science	Healthcare	Professional Services
Corrine	White	Electrical Engineering & Mathematics	Education	Finance
Raya	Black	Computer Engineering	Information Technology	Unemployed
Christine	Latina	Chemical Engineering	Education	Construction
Edith	White	Mechanical Engineering	Automotive	Environmental Services
Kora	Black	Chemical Engineering		
Kennedy	White	Civil Engineering	Finance	Finance
Brooklyn	White	Chemical Engineering	Education	Finance
Alyse	White	Chemical Engineering	Education	Education
Alice	White	Computational Data Science	Finance	Engineering
D'asia	Black	Physics	Unemployed	Healthcare
Meredith	Latina	Nursing	Stay-at-home Parent	Construction
Izzy	White	Computer Science Engineering	Education	Real Estate
Kendall	Latina	Physics	Stay-at-home Parent	Administrative Services
Aurora	Black	Kinesiology	Marketing	Automotive

Note. Participants with no parent industry listed did not disclose their occupation during the interview.

Data Analysis

Data were analyzed using Tracy's (2020) iterative coding approach where coding was guided by pre-existing literature on parental support and emergent qualitative findings. The authors first read through three transcripts with consideration of pre-existing definitions of support types and identified evocative examples of support. All authors met, discussed, and agreed that participants were discussing various types of support in their interviews. We then created a codebook with definitions of each type of support from Xu and Burleson's (2001; codebook available upon request from the first author) which included definitions of each type of support along with examples from primary-cycle coding. Transcripts were divided among research team members, who coded instances of parental support according to the codebook in the research software Dedoose. Multiple coders independently coded overlapping transcripts, and the team met for peer debriefing sessions to ensure consistent interpretations and coding of the support types. The primary-cycle coding concluded once all transcripts were coded for support type.

The authors then began secondary-cycle coding focused on comparing messages across participants to identify patterns and variations in both content and perceived quality in each type of support. This comparison allowed us to capture the commonalities of content and quality of support messages across participants. Together the authors summarized the shared patterns in content and quality of each support type. The authors then selected exemplars and wrote the results section to reflect these commonalities in participants' perceptions of support messages.

RESULTS

Women majoring in STEM recalled messages of support from their parents, which aligned with five categories of support: informational, tangible, emotional, esteem, and network support. Informational support included advice and feedback about choices during their STEM education journey. Tangible support included the provision of resources (e.g., money, books) and services (e.g., transportation, cooking meals). Emotional support included expressions of validation and care during difficult times. Esteem support referenced messages that boosted women's confidence or reminded them of their unique strengths. Finally, network support entailed parents facilitating connections between their daughters and other social contacts for assistance in meeting STEM goals. Support messages differed in their content and in the perceived quality. Below, we detail how the content of the support messages differed within each support category. We also identify markers of support quality for each support category. Quality encompassed participants' perceptions of how useful, supportive, or actionable a message was in promoting their interest or persistence in STEM. Low quality messages were perceived as less helpful, irrelevant, or even discouraging.

Informational Support

The most prominent type of support participants discussed was informational support. Parents provided informational support messages to help their daughters navigate decisions related to college majors, career decisions, and professional development. Parents used myriad types of informational support, such as offering career-related advice, sharing resources such as job postings and articles, and suggesting educational pathways. However, the quality and effectiveness of

informational support varied as women considered whether the informational support was relevant and aligned with their specific support needs. Women perceived clear and tailored advice from their parents as supportive and high quality. Dana described this occurrence when she was navigating the path to dental school, sharing:

> *[My parents] were the ones that introduced how to appropriately study the DAT (Dental Admission Test). What types of books should I study, that I should purchase or, you know, utilize to study for the DAT. They told me about networking, professionalism, my application, and the grades that I should be getting and then what makes me a well-rounded applicant. So, they were the ones that kind of gave me the real meat of the chunk that I needed.*

Dana's parents provided clear directions that outlined the process and expectations of applying for the graduate STEM degree she was interested in. The support from her parents included concrete resources and strategies rather than general information. This tailoring made the information relevant and aligned with the goals of their child.

Although many parents invested time in offering informational support, the content of their support was not always relevant to the education or career interests of their child. These messages were instances of lower quality informational support despite parents trying their best to be helpful. Illustrative of this, Leah shared:

> *...after I talk about, "Oh, like, I want to find a job that does this." Like, she'll send me articles or like, she'll like, look up jobs, like, send them to me and like, I mean … I'm probably not going to apply to them, but it's like, (laughs) it's the thought that counts.*

Leah remarked that the particular job postings were not useful, but she still appreciated her mother's effort as an attempt at informational support. Some informational support messages included incorrect content and others encompassed parental attempts to influence educational pursuits. Laura remembered a conversation with her mom, who said, "'You should just go to [university] and you'll have better teachers and switch your major.' But, like, they don't have food science there at all...And I'm like, 'Well, that's not gonna get me there.'" This informational support message included advice about switching institutions and majors. In this instance, the parent's advice disregards the child's interests and emphasizes their own values instead. This resulted in the daughter directly disagreeing with the proposal, resulting in lower quality support.

In sum, parents offered informational support related to STEM through various messages that provided context, perspective, and advice about their daughter's educational and career journeys. Informational support messages that were relevant, accurate, and specific to the daughter's desires, interests, and proposed trajectory were described as most useful (and highest quality).

Tangible Support

Women recalled receiving tangible support from their parents that encompassed educational resources (e.g., money, tuition, books) and services (e.g., transportation, grocery shopping, cooking meals) that promoted their persistence in

STEM. Women noted that the level of sacrifice they perceived their parents were making in providing the support was important and relevant to the perceived quality of the tangible support. For example, some commented on how paying for their tuition was harder for their parents compared to the experiences of their classmates. Tangible support was especially powerful when it alleviated stress at a time of great need.

Participants highlighted how their parents supported their STEM interests by providing STEM-related materials and encouraging participation in STEM activities while growing up. D'asia shared:

> *...from elementary [school] I read so many books from the library and the ones that were from my mom...STEM [books], earth science, environmental science, meteorology, weather, animals, marine biology. So that was the start of it...I did great in those classes.*

Women including D'asia noted the tangible support offered by their parents was foundational to their performance in STEM classes.

Beyond providing STEM-related material, participants also noted that their parents supported their education through investing time in assisting with STEM-related homework. For example, Caroline described:

> *...they would sit down with me and explain things, like explain math to me.... like when I was learning my fractions...They would use the calculator, they're like, "2 divided 9 is point, blah, blah, blah," I thought that was so advanced back then.*

Caroline remembered how her parents scheduled time weekly to discuss mathematics in terms that made sense to her. Caroline remarked that this assistance made her feel capable and set the foundation for her current studies.

Several participants emphasized the significance of financial support in facilitating their development in STEM. For example, Amanda stated:

> *I think financially being supported in college is really huge...a lotta people in my class, like they're having to work jobs at the same time, and I just feel so grateful that I don't have to do that.*

Amanda especially appreciated how her parents' financial support alleviated her need to worry. She says, "a huge thing was that I was lucky enough to have my parents pay for everything, so I never had to worry about finances. So I think that's another reason why I could never say no to anything." Amanda was able to take the perspective of her classmates who did not have the same level of support and see how she benefited differently. As she notes here, however, the support was paired with an expectation that she would follow her parents' requests.

Tangible support was often provided at critical moments, signaling care and active engagement from the support provider. Rhianna recalls, "if I need to take off some work or, like, reduce my hours down, they try to help me out to make sure I don't have that stressor as much." Others articulated the burden their parents were taking on so that they could provide tangible support. Kora noted her scholarship did not cover all of her expenses. As a result, "My mom has to help me, she took

out a student loan.” These participants appreciated and sometimes expressed guilt about the tangible support their parents provided.

Women also articulated the tangible support that supported their daily routines in college especially around food. This support often alleviated stress related to these chores so that they could allocate more time to school-related tasks. For instance, Alyse remembered the helpfulness of “paying for groceries...I think without them I would be struggling, for sure.” Altogether, parents offering various forms of tangible support that assisted women in focusing their time and energy on their performance and persistence in STEM education.

Emotional Support

Women recounted their parents offering them emotional support which included encouragement and validation of challenges. Women recalled memorable instances when their parents' offered perspective about challenges such as receiving a bad grade on a test or feeling overwhelmed at certain points in the semester. These messages were often in response to disclosures about academic pressures in STEM courses. Parents crafted affirmations to remind women about their unique abilities and opportunities for success and/or to reframe the difficulty as a temporary experience in their life. For instance, Kora shared that her parents offered, “words of encouragement like, you can do it, you know, don't let this get you down, it's okay to feel how you are feeling, but you know, get up yeah, keep going.” Kora’s parents offered a general message that included reminders that she was capable of navigating these difficulties and that these experiences should not reduce her confidence to continue her education pursuits.

Emotional support was also modelled by parents actively listening to women’s concerns and frustrations, rather than immediately passing judgment about the challenges. For example, Kendal highlighted the role of parents in mitigating stress related to college. Kendal stated, “...my parents are very good about like [saying] ‘I know you're stressed out. I know you've got like three hours of sleep, and you have a midterm, but it's fine. It's fine. It's fine.’” These support messages validated the specific challenges women were experiencing and noted that despite these experiences, everything would work out. Most emotional support messages included validation of the feelings that women were experiencing although the assurances about the situation getting better included minimal elaboration specifying how this would transpire. Overall, parents offered emotional support that specifically addressed women’s feelings about their challenges in STEM. These instances of validation were often combined with general statements that the situation would be better eventually despite the specific difficulties.

Esteem Support

Women recalled receiving esteem support messages from their parents that encompassed affirmations and reminders of their strengths. These messages boosted their confidence, affirmed their value, and reminded them of their accomplishments amidst highly stressful and competitive STEM environments. Some parents provided esteem messages as a response to hearing about the realities of being a woman in STEM. For instance, after sharing a story about a challenging day at college, Kennedy recalled her parents responding with: "I'm sorry that happened to you, but, like, it's just kind of like, we're still in that era,

where people, like, were raised to think women can't be in STEM." Kennedy went on to share that her parents often affirmed her by saying things like "you're very strong, you're very talented, you're very smart." In these messages, her parents would acknowledge the barriers that surrounded her while also reminding her that she was capable enough to succeed despite the challenges. Others, like Mia, shared that her dad told her, "you're so smart, you have everything together," which helped her to believe in herself. Similarly, Veronica said that her dad encouraged her by frequently saying "you can do it." She expanded by sharing that "he'll send texts, and we'll talk on the phone, he really believes in me, and I think that's what helps too." These messages extend beyond just emotional support as parents reminded their daughters that even though they might be going through challenges, they believe in their ability and competence to navigate them.

Some participants, like Laura, described how their parents offered esteem support through comparison to others. She recounted:

> *[My dad] was proud of me because he's never seen people be that perseverant and stuff 'cause he would've straight quit. Like, my sister would've quit, like, she's had, like, majors and she just dropped it because it was too hard. Or a lotta people would do that and I'm just still sticking through with it.*

When women are in competitive environments such as those cultivated by STEM fields, it is easy to compare themselves to others. Those outside of the context, such as parents, have the opportunity to offer a fresh perspective and boost their confidence.

In some cases, esteem support came through parents supporting their daughters decision-making autonomy. Katherine shared that her mom often told her that it was okay to switch career paths if that's what she felt like she needed to do. Although her mother did encourage her to "keep trying and keep studying," she also told Katherine, "if you wanna give up, it's okay. I wouldn't blame you... but I know how you are, and you're not the type of person that give up easily." This conversation offers both explicit and implicit esteem support. Explicitly, Katherine's mother told her that she was persistent and hardworking, while also implying that she was capable enough to make her own decisions. Overall, parents' esteem support messages validated their daughters' place in STEM and reminded them that they had what it takes to persist and succeed.

Network Support

Network support involved parents leveraging their social connections to gain access to resources or guidance for their children. Edith, for example, shared how her father played a significant role in expanding her academic support system by connecting her to someone who could help her with her specific needs. "My dad [gave] me his friend's contact information who was a professor for the class that I was struggling in, which was a big help," she said. This connection helped her through a difficult course in a way that her parents alone could not.

Similarly, D'asia's mother was proactive in helping her network. "I love how she's not afraid to ask for help," D'asia shared. "She'll reach for many people across a wide scale. She found this one person, like, 'Oh yeah, she should take college

classes at [Ivy League university]. I can show you how she could register.'" Even when D'asia's mother did not know how to support her through her educational journey, she worked to connect her with people who had more experience. Perhaps most importantly, modelling this kind of support can teach women how to help themselves. D'asia noted, "that's another great…thing she's given us is to always ask for help, because if you don't ask for help, you're not gonna get what you want."

In many cases, network support functioned to help women explore career options through connecting them with people who had firsthand experience in different STEM fields. Conversations with parents' connections helped women explore the realities of the day-to-day life of specific professions. Amanda shared that her mother connected her with the daughter of a friend who was a chemical engineer as a way of helping when Amanda was unsure if chemical engineering was the right field for her. She recalled the connection telling her to focus on the stability and financial security the career could bring her, instead of focusing on something she was passionate about, because "realistically who's passionate about, like, staring at numbers all day and stuff like that?" While this conversation might not have romanticized the profession, it provided Amanda with an honest perspective about her career options.

Lower quality network support was not tailored to the needs and goals of the women. In other words, the support was not relevant or appropriate. Maggie provided an example of how her parents aimed to be supportive but ultimately that support was not helpful, "they were always offering this and that…and I was like, 'I don't want to do that to get to my goal.' I was offered lots of opportunities, but I wasn't interested in them." Not all network support was appreciated or utilized. Christine's mother connected her with a therapist when she needed mental healthcare, however, "I wouldn't follow through…cause it's a lot. That's a lot to do." In this case, Christine found the additional obligation overwhelming. This type of network support may need to be accompanied by other types of support that would smooth the road for taking advantage of the network support (e.g., giving Christine a ride to the appointment). Ultimately, network support was a mechanism for parents and their daughters to utilize social connections to gain knowledge and opportunities that would not have otherwise been possible.

DISCUSSION

This study aimed to deepen understanding of parental support of girls and women pursuing STEM degrees by exploring the (a) content and (b) quality of parental support. We found that content and quality varied within each of the five types of support examined: informational, tangible, esteem, emotional, and network.

Across categories, participants' narratives showed that parental support played a central role in helping them navigate the unique barriers faced by women majoring in STEM. Informational support often involved countering stereotypes by clarifying that women belonged in technical fields. Tangible support reduced pressure to take on part-time jobs, allowing participants to fully commit to programs where women already felt they had to "prove" themselves. Emotional and esteem support were recalled most vividly in moments when participants doubted their place in STEM due to gendered climates. Network support often extended beyond academics,

offering women access to mentors and models in fields where few women were visible. Taken together, the types and qualities of parental support highlight not only how parents encouraged persistence, but also how they buffered against gender-specific disadvantages embedded in STEM education and careers. Below, we summarize what the findings of this study reveal about the content and quality of advice in this context. Then, we discuss best practices for support providers, suggest avenues for future researchers interested in parental support of girls' and women's persistence in STEM, and set a foundation for interventions that might facilitate supportive family communication environments.

Content of Support Messages

Our findings reveal that support messages vary widely in content within and across the types of support. Tangible support included parents providing educational resources such as paying for tuition, transporting daughters to STEM related programs, providing meals during high stress times, and time spent with daughters helping with homework. Information support ranged from providing advice and/or guidance in making career decisions, setting expectations, and providing information or commentary about others who were interested in similar jobs. Esteem support included affirmations that boosted women's confidence and reminded them of their strength and that they are capable of making decisions on their own. Emotional support involved encouragement, messages that helped women reframe difficult experiences as temporary and something they can overcome, and validation of the challenges they were struggling with. Network support included parents leveraging their social connections to help their daughters, providing access to resources and guidance, and offering opportunities to their children.

Some of the content of the messages explored here maps onto previous research about how parental messages socialize children before they enter STEM careers. Myers et al. (2011) found that parents' socializing messages help guide children's decision making by setting expectations about success and financial stability. In this study, parental instrumental support acted as a guide for daughters' decisions, but not via expectation setting. Instead, parents offered advice about what college major or career to choose and how to gain experience including sharing job postings. Myers et al.'s study found that parents' messages sometimes prescribed certain careers based on prestige. In this study, parents used esteem support to emphasize that their daughters were able to achieve opportunities available to them, which may have steered them to certain careers. Myers et al.'s descriptive messages (e.g., responsibilities of certain jobs) are similar to the support messages that provided advice about how to succeed in college or emphasized certain jobs women would be especially good at based on their qualities (esteem support).

Myers' et al. (2011) also found that parental messages stress the value of STEM careers including how they are important to society, and how they are often stable career choices. This was not a prominent theme in our data. It is likely that parents still communicated the value of STEM careers, but in messages that fall outside of support. Instead, findings showed that parents emphasized the capabilities of their daughters and helped them reframe difficult situations. Myers et al. note that parents also provide subtle cues like tone of voice when speaking about their own jobs that can influence career decisions. In this study, subtle cues might include the

frequency of the support, for example, if a parent offers advice or sends a job posting repeatedly, or implications about whether the parent trusts their daughter to make their own decisions. Repeated and frequent offers of unwanted support could be interpreted as overparenting (Cui et al., 2022). Research on instrumental support (e.g., advice) reveals that the content of advice is important in predicting how the advice will be received. Other types of support are likely similar. This idea is discussed below, highlighting how women in this study articulated varied levels of support quality.

Quality of Support Messages

A clear takeaway of this study is that the quality of support, especially from parents, is more complex than just the content of what is said. Across many interviews, participants described instances where the advice itself was not necessarily helpful, but the experience of receiving it still mattered. The act of showing up through listening, reaching out, or making a gesture carried weight. For some, knowing that their parents made time or sacrificed something to offer support was meaningful in and of itself.

At the same time, participants often described support that was tailored and relevant as higher in quality. This aligns with Burleson's (1982) criteria for high-quality emotional support (e.g., tailoring) and MacGeorge et al.'s (2016) criteria for high-quality advice, which include helpfulness, appropriateness, sensitivity, supportiveness, and effectiveness. MacGeorge et al.'s criteria were developed to capture high quality informational support, and they did align with how participants talked about advice. Advice that was relevant to the situation, offered in a way that felt supportive, and took the recipient's emotional state into account was generally seen as high quality.

Other types of support seemed to follow a slightly different logic. Participants' preferences varied not just by person but also by type of support. For example, in cases of tangible support like financial help or logistical assistance, quality often had more to do with timing and perceived sacrifice. A last-minute plane ticket home, or a gift card during a hard semester, were perceived as especially meaningful. These qualities, timing and sacrifice, are not emphasized in MacGeorge et al.'s (2016) advice framework but emerged as important indicators of quality for tangible support in this context.

Importantly, participants often evaluated their own experiences in comparison to what they perceived others, especially their classmates, were receiving. Observing how much (or how little) support peers received shaped how they interpreted their own parents' actions. The closeness of the parent-child relationship, past patterns of support, and even family norms around emotional expression all played into whether a particular act of support felt high or low quality.

Finally, the level of distress the participant was experiencing mattered. When someone was really struggling, they needed more than generic advice or surface-level check-ins. In those moments, the quality of support was tied to how well it was tailored to their emotional state, that is, how attuned the parent was to what their child really needed in that moment. This suggests that quality is not just a stable set of characteristics but something that is co-constructed in context.

Ultimately, what counts as high quality varies depending on the relationship, the type of support, and the moment in which it's offered.

Practical Applications for Parents and Women Pursuing STEM

Supportive communication is a relational resource that parents can offer to their children. Support is often thought of as universally helpful. The results of this study complicate this idea by illustrating that support messages differ in content and quality. The quality of support messages encompassed tailoring, the timing and relevance of the message, and the perception of sacrifice. Parents could improve their support messages by working to make advice specific and relevant to their child. This could look like saying, "I remember you telling me that you want to be a chemical engineer, so I recommend looking at this university that is well known for this field of study." This message validates that the parent is listening to the goals of their child and also specifies how the advice might be useful. This type of message would likely be perceived as higher quality compared to an advice message stating, "I think you should go to college in California," without any explanation for how this advice is tailored or beneficial to their child.

Similarly, women should consider reflecting on the support messages they would like to hear, and then explicitly asking their parents to share those types of messages. Parents differ a great deal in their ability to offer tailored advice relevant to challenges women face in STEM depending on their own education background and family science capital (Gu et al., 2025). Although not all families have high levels of family science capital, all families have the potential to provide high quality support of one type or another. Women can practice giving feedback about what a message should include to make parents and others feel more capable, knowledgeable, and/or ready to respond to their daily stressors.

Women have options outside their parents from which they can seek support. Participants reflected on how their siblings, classmates, professors, and academic advisors were helpful for providing information and affirmations about their experience in STEM. Research has also emphasized the power of female role models, women's support networks, and professional mentoring programs for students (Guenaga et al., 2022). Creating a diverse network for support is beneficial in the long run given the differing expertise of support network members.

Limitations and Future Directions

There are limitations to consider alongside these results. Women majoring in STEM recounted various stressors that they discussed with their parents. These stressors ranged from receiving a bad grade on a test to uncertainty about how to pay for their college tuition. The wide variety of stressors illustrates the complexity of challenges women encounter during their STEM education journey and may be linked to the type of STEM degree they were pursuing (e.g., biology or physics). Depending on the major, classroom cultures may be more or less masculine, and women may face varying levels of bias. Future research could differentiate between (a) types of stressors and (b) STEM degree which could impact the content and quality of support messages.

Most of our participants had parents who graduated from a four-year undergraduate university which likely increased their ability to give advice and support about college based on their own experience. A different sample could

better capture the range of messages from parents of different educational backgrounds. Future research could utilize purposeful sampling in data collection efforts to ensure first-generation and continuing-generation college women are equally represented in their samples. Researchers could also consider how a parent's education level and career are associated with the types of support messages parents offer. Parents with science backgrounds are more likely to cultivate and leverage family science capital, that is, emphasize the value of science and have stronger science identities (Suortti et al., 2023). Future research might consider how support is offered in response to "bids for recognition" or times when children express an interest in STEM and parents can recognize, support, or reject their expression of interest (Cian et al., 2022; see also, identity bids, Pattison et al., 2018). Cian et al. (2022) found that parents who worked in and out of STEM were able to engage with bids for recognition, but in different ways. Parents working in STEM were able to answer questions about STEM-related topics and parents outside STEM engaged by asking their children questions that encouraged them to continue to explain and express their interests. Both responses could be interpreted as high quality support.

Third, the support messages analyzed here represent women's recollections of received support. The results do not include other types of support women desired but did not receive. Support needs are complex, and people are not always offered messages that align with what they want. Future research should examine the extent to which women majoring in STEM experience discrepancies in the support they want from their parents. These discrepancies include instances when someone receives a different amount and/or wrong type of social support than they desire (i.e., support gaps; Thomas et al., 2023). Measuring the types of support women want in addition to the types they receive as they navigate high-barrier STEM fields and linking those types to outcome variables such as persistence in STEM are crucial next steps in improving support interactions. Doing so could help reduce instances where women receive support that feels misaligned or unhelpful. Women who do not receive the kind of support they need— particularly from parents— may be more likely to disengage from their STEM degree path. In contrast, those who feel supported in ways that align with their needs may be more likely to persist and see themselves as capable of succeeding in a STEM career.

CONCLUSION

Parental support plays a vital yet often complicated role in shaping women's pathways into STEM education and careers. By examining both the content and perceived quality of five types of supportive communication, this study highlights that support is not a one-size-fits-all endeavour— its effectiveness depends on how well it aligns with the evolving needs of the recipient. Two key takeaways emerge from this work. First, scholars must move beyond simply identifying the presence of parental support to also examine how support messages are interpreted by the women receiving them, particularly in relation to their STEM interests and persistence. Second, to offer support that is truly impactful, parents should engage in ongoing conversations with their daughters, asking what kind of support is needed and when. Similarly, women should feel empowered to communicate their shifting needs to support providers, cultivating mutual understanding and more effective encouragement throughout their STEM journeys.

ENDNOTES

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