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RESEARCH ARTICLE

The Impact of In- and Out-of-School Learning Experiences in the Development of Students' STEM Self-Efficacies and Career Intentions

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Abstract

The experiences students have in and out of school can influence the way they think about STEM and the career decisions they make. The purpose of this mixed-methods study was to determine which learning experiences students perceived as meaningful to the development of their STEM self-efficacy and career choices, and how those perceptions differed between STEM and non-STEM students. A survey of 312 undergraduates elicited these perceptions while a follow-up interview with eight participants from the sample expanded on the nuances of their decision-making. Results from the study suggested that students enrolled in a STEM major were more likely to have had career-specific experiences as part of their curriculum, early experiences and family involvement in STEM, participation in STEM extracurriculars, and strong performance in STEM coursework. Interviews revealed how students from both STEM and non-STEM pathways engaged in these experiences and their perceptions of how the experiences influenced their STEM decision-making. Synthesis of quantitative and qualitative results suggested that perceived innate interest may actually be the result of early experiences and family-related activities, and students' experiences with STEM extracurriculars and career-focused activities affected how they viewed their career path. These findings suggest implications for how career-specific curriculum, family support, and access to out-of-school opportunities can benefit students' STEM beliefs and career actions.

Keywords Learning experiences · STEM careers · STEM beliefs · Informal learning · Self-efficacy

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Introduction

Students' early life and school experiences have an impact on the development of their future career interests and choices (Maltese et al., 2014). Understanding the factors that are influential in these experiences can guide educators and policymakers toward the tools necessary to prepare students for society's future needs. The US Bureau of Labor Statistics (2022) predicts a 10.8% growth in STEM jobs between 2021 and 2031 compared to 4.9% growth for non-STEM jobs. As such, there is a demand for the development of graduates who are capable and interested in STEM fields as the workforce continues to become more dependent on critical thinking skills and knowledge of engineering and technology (World Economic Forum, 2017).

To meet these growing demands, educational reform should focus on practices that help students develop confidence in STEM and prepare them for entry into STEM fields. Numerous studies have demonstrated that intent to pursue STEM careers develops from a variety of factors including STEM experiences in the classroom, interactions with family and friends, out-of-school experiences, coursework, and perceived ability in STEM (Dabney et al., 2013; Maltese et al., 2014; Maltese & Tai, 2010, 2011; Sadler et al., 2012; Tai et al., 2006). These studies indicate that the timeline and mechanism for the development of interest can vary depending on the individual, but that learning experiences are important factors that influence future decisions (Dawes et al., 2015; Maltese et al., 2014; Maltese & Tai, 2011).

Understanding the role of these learning experiences can help educators make decisions about how to structure students' school experience and shape curriculum. Reform in educational standards over the last decade such as the *Next Generation Science Standards* (NGSS Lead States, 2013) and *Principles and Standards for School Mathematics* (National Council for Teachers of Mathematics, 2016) have introduced frameworks for instruction in science, engineering, and mathematics that strive to meet the ever-changing needs of students and society. However, the learning opportunities afforded to students still vary widely based on school environment, availability of resources for quality instruction, and qualified teachers (Hampden-Thompson & Bennett, 2013; Steenbergen-Hu & Olszewski-Kubilius, 2017; Thiry, 2019). STEM learning experiences that take place outside of the classroom have also demonstrated promise for developing STEM interest, but are less common among students and often require support from family or other adults (Bonnette et al., 2019; Dabney et al., 2013).

The connection between in- and out-of-school learning experiences and career intentions is complex, and the decision-making process is influenced by many factors. When a student chooses to follow a particular career path, it is likely because the student's beliefs about their ability to pursue that path and the resulting outcomes were influenced by learning experiences (Bandura, 1986; Lent et al., 1986). While research has demonstrated connections between learning experiences and STEM career interest and eventual pathways (Bottia et al., 2015), little has been done to investigate how students who follow STEM and non-STEM career paths perceive the effect of those learning experiences on their own confidence to pursue STEM. This study seeks to examine the experiences that STEM students believe propelled them to be more confident in their pursuit of a STEM career and explore how students from both STEM and non-STEM pathways describe their learning experiences.

Theoretical Framework

This study is situated in the use of self-efficacy theory (Bandura, 1977) as a means of connection between learning experiences and career choice. Self-efficacy and outcome expectations are constructs that originated as part of social learning theory (Bandura & Walters, 1977). They center on a person's beliefs about themselves and influence whether a person chooses to engage in a behavior or not. Outcome expectations are what a person envisions as the results of a particular behavior, while self-efficacy is a person's belief about whether they will be able to successfully perform that behavior (Bandura, 1977). Based on the combination of these constructs, engaging in a behavior is not grounded on what someone can accomplish, but on what they believe they can accomplish (Schunk & Pajares, 2005).

The development of self-efficacy is most pronounced when learners have positive experiences with particular tasks, which then leads them to continue pursuing those tasks in a cycle of positive reinforcement (Bandura & Locke, 2003; Schmid & Bogner, 2017). Several studies have indicated that people choose tasks they feel they will be able to do well and avoid those in which they fear failure (Bandura, 1977, 1997; Guay et al., 2006; Krueger Jr & Dickson, 1993). Those with high self-efficacy toward a task may view difficulties within that realm as a challenge they can overcome and will select those tasks despite their difficulty because they believe in their abilities (Bandura, 1977, 1991). On the other hand, those with low self-efficacy toward a task tend to avoid situations that are uncomfortable or intimidating, focusing on the possibility of negative consequences of the task rather than the task itself (Bandura, 1977; Bandura & Locke, 2003; Pajares & Schunk, 2005). Choices and actions can then happen because of a person's self-efficacy toward a task or subject, and this self-efficacy can be the result of their own experiences, learning through others, discussion and encouragement from others, or their own physical responses to the tasks (Bandura, 1977).

The development of self-efficacy can be affected by various background influences. The World Economic Forum (2017) revealed that males enter the STEM workforce at a higher rate than females, even independent of STEM achievement levels. One possible contributor to this is that females often have lower self-efficacy toward STEM than males (Marshman et al., 2018; Vincent-Ruz & Schunn, 2017). Additionally, MacPhee et al. (2013) and Steenbergen-Hu and Olszewski-Kubilius (2017) found that students in minority groups were more likely to have reduced STEM self-efficacy compared to students in non-minority groups. Some of these students in minority groups may feel like they do not belong in STEM environments because of persistent stereotypes and discrimination in these fields, and many of these students fail to pursue STEM when they do not have a support system in place (Meador, 2018). These factors can affect the development of STEM self-efficacy, how students access opportunities for learning, and how they experience those opportunities.

Learning Experiences

The development of self-efficacy and outcome expectations happens through the confluence of social engagement and the individual experiences that happen throughout a person's life. These occurrences that happen in everyday life, in the school classroom setting, or in purposeful out-of-school environments influence how and what people learn (Allen & Peterman, 2019; Maltese & Tai, 2010), and are defined in this paper as learning experiences. While each learning experience occurs individually, it is the sum of these experiences together with outside influences, beliefs, and values that leads to learning and decision-making (Allen & Peterman, 2019). This learning happens in a variety of settings, and both in- and out-of-school environments provide learning experiences that students see as valuable toward their decisions to pursue STEM (Halim et al., 2018; Kang et al., 2018).

One way these in- and out-of-school learning experiences can affect STEM career choice is through their impact on the development of students' self-efficacy toward STEM. In the K-12 classroom, the use of project-based learning (Beier et al., 2018), lab learning as a method for science skill development (Lee et al., 2020), solving real-world problems (Schukajlow et al., 2019), and curriculum oriented toward subject mastery (Fast et al., 2010) are all associated with increased STEM self-efficacy. Informal STEM contexts such as camps and other summer programs along with support from family or non-family role models have also demonstrated positive impacts on the STEM self-efficacy of K-12 students (Heiselt, 2014; Maiorca et al., 2021). Moreover, Brown et al. (2016) found that students who were not involved in group STEM activities had lower STEM self-efficacy than those who were actively involved in these activities.

While these studies have focused on how STEM self-efficacy develops in students through specific interventions, other researchers have examined this topic by having older students or adults reflect on their own learning experiences. Burt and Johnson (2018) and Maltese and Tai (2010) interviewed graduate students in STEM and found that many of them developed interest in STEM through family or teacher influence, interactive play, home science projects, class content that had relevance to the student, or the sense that they had an intrinsic interest in STEM. A study of STEM undergraduate students by Goff et al. (2019) found that those who had participated in out-of-school STEM experiences before college reported greater interest and proficiency in mathematics and science and higher STEM career aspirations than those who had not. While these studies provide insight into the decision-making process of those who chose a STEM career, they lack information about how learning experiences guide those who chose not to pursue a career in STEM. Each person's story tells about the factors that cause them to take the path they do, and there is a need to understand the experiences that affect how people make decisions about their STEM pathways.

Overall, the literature suggests that a variety of learning experiences in STEM are connected to the development of STEM self-efficacy and career choices and has helped to generate a set of these experiences for study. However, there is still a lack of understanding of how these learning experiences are perceived by students, especially when comparing the perceptions of those who pursue a STEM career with those who do not pursue a STEM career. Sahin et al. (2017) suggest that measuring how students perceive the learning activities would be valuable to understanding whether those experiences were effective in developing STEM self-efficacy and career intention. These limitations indicate the need to better identify how students view these learning experiences as a means to understanding the process by which they make career decisions.

Because the nature of these experiences appears to be a vital part of self-efficacy development, it is important to gain an understanding of what experiences are meaningful to students and whether they have a lasting impact on their STEM goals and actions. This study seeks to understand how student perceptions regarding STEM learning experiences differ between STEM and non-STEM students, and to gain an in-depth look into the process by which students perceive their learning experiences and how they affected the paths students eventually followed. The study sought to answer these research questions:

- How do types of pre-college STEM learning experiences and perceptions of those learning experiences differ between STEM and non-STEM undergraduate students?
- How do undergraduate students in various STEM and non-STEM majors describe their experiences in STEM throughout their lives?

Methods

To examine these research questions, the researchers used an explanatory sequential mixed-methods design (Creswell & Plano Clark, 2017). A mixed-methods design was chosen to provide a more complete picture of the effect of learning experiences than what quantitative or qualitative data could provide on their own. Using both approaches allowed for the examination of the trends from a larger group while also exploring the nuances of those choices as voiced by individuals within the group.

The first phase of the study used survey methodology to gather subjective data from a large pool of participants. We then used a selection matrix based on survey results to select eight participants for interviews to gain a deeper understanding of their perceptions of the STEM learning experiences they had and how those experiences affected them. Because the experiences in question are widely ranging in their context, it should be noted that the term STEM is used in this study to represent the individual subjects that make up STEM as opposed to an integrated model of STEM. This definition allowed participants to recall experiences that were part of any individual discipline or an integration of disciplines to express their experience and perceptions. Prior to data collection, the authors received IRB approval from the institution to complete the study.

Quantitative Phase

Participants

A questionnaire was distributed via email and flyers to first- and second-year undergraduate students at a large midwestern land-grant university. A total of 375 students completed the questionnaire, though some did not answer all questions and were removed from the data. In the end, 312 participants were used for the quantitative analysis. These participants are described in Table 1 for the whole sample and between STEM (n = 206) and non-STEM (n = 106) participants. The breakdown demonstrates that the racial makeup of STEM and non-STEM participants is very similar. The gender representation of the STEM group is similar to that of the whole sample, and there is a slightly higher percentage representation of female students in the non-STEM group. While the questionnaire was sent only to first- and second-year students, 21 students (6%) participated who identified themselves as juniors or seniors, while 59% were freshman and 35% were sophomores.

Procedures

The questionnaire for this study was developed by the researchers to answer the research questions while remaining consistent with the principles of self-efficacy theory. This questionnaire was used as part of a larger study concerning learning experiences and student beliefs about STEM, and the relevant sections for this study are included here. The first section contained demographic information along with the participant's intentions to pursue a career in a STEM field. The next two sections contained the measures for learning experiences and self-efficacy described subsequently. Data was collected for the questionnaire using the Qualtrics (http://www.qualtrics.com) online survey collection platform and is available from the corresponding author on reasonable request. All participants who completed the survey

Table 1 Survey participant demographics

	Full sample *n* (%)	STEM *n* (%)	Non-STEM *n* (%)
All participants	312	206 (66%)	106 (34%)
Gender			
Male	97 (31%)	68 (33%)	29 (27%)
Female	206 (66%)	132 (64%)	74 (70%)
Non-binary	9 (3%)	6 (3%)	3 (3%)
Race			
American Indian or Native Alaskan	23 (7%)	11 (5%)	12 (11%)
Asian	12 (4%)	8 (4%)	4 (4%)
Black	9 (3%)	7 (3%)	2 (2%)
Hispanic/Latino	22 (7%)	12 (6%)	10 (10%)
White	246 (79%)	168 (82%)	78 (74%)

were eligible to be selected for a $50 gift card as compensation for their participation in the research.

Measures

The learning experiences section of the questionnaire comprised two multi-part questions in which the participants designated the learning experiences they had participated in throughout their lives. The first question asked participants to select the experiences in which they participated during a mathematics, science, engineering, or technology-related class in grades K-12. There were 19 experiences in the list, and it included statements such as "speakers from professional STEM fields," "hands-on activities," and included an "other" choice where participants could add to the list. The list of experiences used for this study was developed based on the results of prior research on learning experiences in STEM (Maltese et al., 2014; Maltese & Tai, 2010, 2011). The second question asked participants to select the STEM experiences they had participated in outside of school throughout their lives. This list included 26 experiences and included statements such as "tinkering with electronics" and "reading about STEM or science fiction," along with an "other" choice where participants could add to the list. The list of experiences used for this portion of the study was developed based on the results of prior research on informal learning experiences in STEM (Burt & Johnson, 2018; Dou et al., 2019; Maltese et al., 2014; Maltese & Tai, 2010, 2011). The researchers sought to obtain content validity of both lists through the use of a broad range of prior research on the topics of learning experiences, and the subsequent results were consistent with those from prior studies. After participants selected all the learning experiences in which they had participated, they were directed to a second page that contained only those selected experiences and asked about their perceptions of each. This question asked participants to indicate whether each learning experience increased their confidence in their ability to succeed in STEM, had no effect on their confidence in their ability to succeed in STEM, or decreased their confidence in their ability to succeed in STEM. Both scales were analyzed for reliability using Cronbach's alpha, with the in-school learning experiences α = .86 and out-of-school learning experiences α = .84.

The next section of the questionnaire examined participants' self-efficacies in science, engineering, and mathematics. The self-efficacy scale used in this study is based on the Academic Efficacy subscale in the Patterns of Adapted Learning Scales (PALS) (Midgley et al., 2000). The original intent of the PALS was to examine how patterns of learning affected students' beliefs and attitudes about learning in the classroom, along with mastery or performance goals. The scales in the PALS are written so that they can be used for general schoolwork or adapted to be subject-specific. Lent and Brown (2006) denote that instruments used in social cognitive research should be domain-specific for the variables of interest, so the scales were adapted for the subjects in the study. This adaptation of the PALS for STEM subjects is similar to the modifications done by van Aalderen-Smeets et al. (2019) and Shin et al. (2016). The self-efficacy subscales measure students' perceptions of their ability to complete class work in a particular subject. The measure includes 5 items (e.g., "I'm certain I can figure out how to do the most difficult class work in mathematics") with a 5-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. The items were repeated for mathematics, science, and engineering, providing a self-efficacy score for each domain. The subscales were analyzed for internal consistency using Cronbach's alpha, with math subscale $\alpha = .91$, science subscale $\alpha = .88$, and engineering subscale $\alpha = .91$.

Data Analysis

Quantitative analysis was completed on the learning experiences instrument and demographic data. The in-school and out-of-school groupings of learning experiences from the questionnaire were retained for logical analysis and presentation of results. The researcher first examined each learning experience on its own to determine the frequency of reported participation, then calculated and graphed the percentage of participants that selected each. In the next stage, the researcher examined the participants' perceptions of the learning experiences. For each learning experience, the percentage of participants who indicated the experiences had a positive effect, no effect, or a negative effect on their STEM interests and confidence was calculated.

The researcher then compared the selection and perceptions of learning experiences between participants majoring in STEM and non-STEM subjects. To determine whether students were enrolled in a STEM major or not, the researcher compiled a list of the university's offered majors and sorted them into STEM and non-STEM categories based on the list presented by Maltese and Tai (2011). If a major offered at this university differed from the list, it was associated with the most similar major and grouped accordingly. Table 2 lists the university's offered majors in the groups as described.

The comparison between STEM and non-STEM majors began with an examination of the actual experiences selected by each group. The percentage of participants in each category was determined for each learning experience and compared graphically. Statistical analysis was completed for this comparison using a chi-square test of independence. The researchers then compared the perceptions of learning experiences between groups. The perceptions were assigned values as ordinal variables on a 0–3 scale. A value of 0 on this scale indicated the participant did not participate in that learning experience, a value of 1 indicated the participant did participate in the experience but had a negative perception of its value toward their STEM confidence, a value of 2 indicated the participant felt the experience did not affect their STEM confidence, and a 3 indicated the participant felt the experience had a positive effect on their STEM confidence. Statistical comparison between the STEM and non-STEM groups was completed using an independent sample *t*-test.

Qualitative Phase

Selection Process

The selection of candidates to be interviewed in this study was based on the explanatory sequential design so individual members of the quantitative sample could voice how learning experiences influenced their STEM self-efficacy and career intentions

Table 2 Classification of university's majors into STEM and non-STEM categories

STEM	Non-STEM
Aerospace Engineering	Accounting
Architectural Engineering	American Studies
Chemical Engineering	Apparel Design
Civil Engineering	Architecture
Computer Engineering	Art
Construction Engineering Technology	Art History
Electrical Engineering	Child and Family Services
Industrial Engineering	Communications
Mechanical Engineering	Early Child Care
Mechanical Engineering Technology	Education (all fields not designated in a STEM category)
Chemistry	
Geology	Economics
Medicinal and Biophysical Chemistry	English
Physics	Entrepreneurship
Biochemistry	Fire Protection
Molecular Biology	Finance
Biology	Foreign Language
Entomology	Business
Microbiology and Molecular Genetics	Geography
Physiology	Geospatial Information Science
Plant Biology	Graphic Design
Zoology	History
Mathematics	Hospitality
Statistics	Interior Design
Aerospace Administration and Operations	Landscape Architecture
Computer Sciences	Management
Communication Sciences and Disorders	Management Information Systems
Exercise Science	Marketing
Health Education and Promotion	Merchandising
Nursing	Multidisciplinary Studies
Nutritional Sciences	Journalism
Recreational Therapy	Music
Agribusiness	Philosophy
Agricultural Education	Political Science
Agricultural Leadership	Psychology
Animal Science	Recreation Management
Biosystems Engineering	Sociology
Environmental Science	Sports Media
Food Science	Theatre
Horticulture	
Natural Resource Ecology and Management	
Plant and Soil Sciences	

(Creswell & Plano Clark, 2017). To better understand how learning experiences affected different groups of students, the researchers used a purposive sample of interview candidates with a range of beliefs about their STEM abilities. A selection matrix developed by the researchers used the science, engineering, and mathematics self-efficacy scores as calculated from the self-efficacy instrument in the quantitative phase. These score values were plotted onto a 3-dimensional graph using QTI Plot software (Version 5.9.7), with mathematics self-efficacy on the x-axis, science self-efficacy on the y-axis, and engineering self-efficacy on the z-axis. Figure 1 shows the complete plot with data points from all participants, as well as circles around the eight participants who were selected and agreed to be interview participants. The two blue circles in the top right represent interviewees who had high self-efficacy scores in all three subjects, the two red circles in the bottom left represent interviewees who had low self-efficacy scores in all three subjects, and a single yellow circle directly in the middle represents the interviewee whose self-efficacy scores were near the median for all three subject areas. The three green circles along the edges represent interviewees who had mixed self-efficacy, meaning they had low self-efficacy in one or more subjects, but high self-efficacy in the others. The mixed self-efficacy interviewees were selected so that each subject had a representative with a low self-efficacy score. The eight participants involved in the interviews for the study are described in Table 3.

Interview Protocol

The interview protocol was developed for this study and based on self-efficacy theory (Bandura, 1977). The questions and prompts were designed to elicit responses that revealed the participants' learning experiences and beliefs about STEM learning experiences and self-efficacy. The questions for the interview are included in

Fig. 1 Scatterplot of self-efficacy scores for interview selection

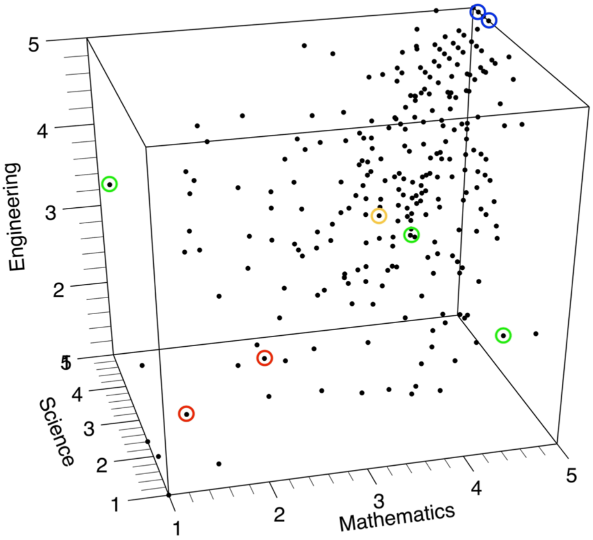

Table 3 Interview participant demographics

Name	Classification	Gender	Race	Major	Intends to pursue a STEM career	STEM self-efficacy category	Math self-efficacy	Science self-efficacy	Engineering self-efficacy
Regina	Freshman	Female	American Indian	Global Studies	No	Low	1.4	3.0	1.0
Noah	Sophomore	Male	White	Secondary Education/ History	No	Low	2.2	2.6	2.0
Evan	Freshman	Male	American Indian	Animal Science	Yes	Mixed: Low math	1.0	5.0	3.2
Annabelle	Freshman	Female	White	Interior Design	No	Mixed: Low science	4.4	1.2	2.4
Neely	Freshman	Female	White	Zoology	Yes	Mixed: Low engineering	4.4	5.0	2.2
Ashley	Junior	Female	White	English/ Creative Writing	Unsure	Median	3.6	3.6	4.0
Blake	Freshman	Male	White	Mechanical Engineering	Yes	High	5.0	4.4	5.0
Nolan	Freshman	Male	White	Computer/ Electrical Engineering	Yes	High	5.0	4.8	5.0

Table 4. While the general structure of the interview was based on self-efficacy, the interviews followed a phenomenological approach, emphasizing the lived experiences of the interviewees and how these experiences molded their views and beliefs about STEM (Marshall & Rossman, 2014). By approaching the interview in this way, the interviewer was able to ask appropriate follow-up questions and allow the participants to openly talk about their experiences and how the experiences shaped them.

Procedures

The first author conducted the semi-structured interviews with the eight participants via the online communication platform Zoom (http://www.zoom.us). Students who were interviewed were given a $10 gift card as compensation for participation in the research. The researcher used the interview protocol detailed above, taking notes during the interview over key points. After each interview was completed, a summary was written that incorporated general impressions of the interviewee, nonverbal or emotional cues that would not come across in the transcripts, and major ideas generated during the interview.

Data Analysis

The process for analysis was similar to that described by Marshall and Rossman (2014): organization of the data, immersion in the data, generation of themes, coding the data, interpretation of meanings, consideration of alternative meanings, and writing results. A transcript was made for each interview and rechecked for accuracy before entering into the Provalis Research QDA Miner (Version 6.0.3) software. Each transcript was read multiple times for immersion, and the researchers wrote a summary for each, incorporating the field notes with the transcript. The goal of the interviews was to expand on the learning experiences that led to student self-efficacy and career intentions, so the researchers began the coding process with the use of provisional coding (Saldaña, 2015) based on the literature on self-efficacy and learning experiences. The data was then coded by types of learning experiences and

Table 4 Interview protocol

Interview question
1. When did you first become interested in (your current major)?
2. Why are you still interested in (your current major)?
3. Tell me about a time where you felt successful in STEM.
4. Tell me about a time where you did not feel successful in STEM?
5. What activities did you do prior to college that affected your interests and/or confidence in your abilities in STEM?
6. Tell me about your family and their influence on your interests and/or confidence in your abilities in STEM.
7. Have you experienced any obstacles to your STEM plans?

several themes emerged regarding the types of experiences the interviewees found valuable and how STEM and non-STEM participants compared (Creswell, 2007). Interpretation of the data used a process described by Patton (2014) in which the findings were evaluated for meaning, explanations, conclusions, and inferences were developed, and significance was ascribed to the data. At the end of this process, the findings were analyzed to ensure they were reasonable, consistent, and connected to the literature.

Validity and Reliability

Determining validity in qualitative research involves the establishment of trustworthiness. Hays and Singh (2012) provide criteria for trustworthiness, including credibility, confirmability, and authenticity. The researchers sought to establish trustworthiness with these criteria using a variety of strategies. Throughout the research process, the researchers kept notes and wrote analytic memos keeping track of key ideas interviewees were conveying and the researchers' evolving thoughts concerning the topics of the study. While writing, the researchers used vivid and descriptive explanations of the interviewees' comments in a process called thick description (Hays & Singh, 2012).

The researchers also implemented member checking (Hays & Singh, 2012) to confirm that the analysis was being done in a way that truly reflected the thoughts of the interviewees. Transcripts of the interview and brief preliminary interpretations were sent to each interviewee requesting confirmation of the analysis or changes to be made. Of the eight interviewees who were sent this email, four responded and confirmed that the transcript and analysis appropriately reflected the conversation. The researchers also analyzed the data throughout the collection process. By taking notes during and after each interview, the researchers were able to determine whether appropriate information was gathered. This allowed for flexibility in the semi-structured interviews, and the protocol changed slightly as the interviews progressed. Based on this, the researcher was better able to anticipate responses and react with suitable follow-up questions that met the purpose of the study.

Results

Quantitative Phase

The first research question inquired about how participation and perception of STEM learning experiences differ between students who intend to pursue a STEM career and those who do not intend to pursue a STEM career. The learning experiences that participants reported and the comparison between STEM and non-STEM students are given in the first section below. The second section includes the reported perceptions of those learning experiences and the comparison between STEM and non-STEM students.

Learning Experience Selections

Figure 2 displays the in-school experiences selected by STEM students (n = 206) and non-STEM (n = 106) students, and comparisons between the two groups were made using a chi-square test of independence. The in-school experiences that were selected significantly more by STEM students than non-STEM students include cooperative learning, $\chi^2(1, N = 311) = 8.09$, $p = .004$, speakers from professional STEM fields, $\chi^2(1, N = 311) = 17.83$, $p < .001$, discussion of STEM careers in classes, $\chi^2(1, N = 311) = 16.95$, $p < .001$, taking classes with content that is relevant to the student, $\chi^2(1, N = 311) = 8.43$, $p = .004$, taking classes with an emphasis on further study in STEM, $\chi^2(1, N = 311) = 36.53$, $p < .001$, taking a class with an emphasis on problem solving, $\chi^2(1, N = 311) = 16.63$, $p < .001$, and performing well in a STEM course, $\chi^2(1, N = 311) = 26.55$, $p < .001$.

Figure 3 displays the out-of-school experiences for STEM students and non-STEM students, and comparisons were made using a chi-square test of independence. The out-of-school experiences that were selected significantly more by STEM students than non-STEM students include reading about STEM or science fiction, $\chi^2(1, N = 311) = 8.79$, $p = .003$, having STEM as a part of regular family activities,

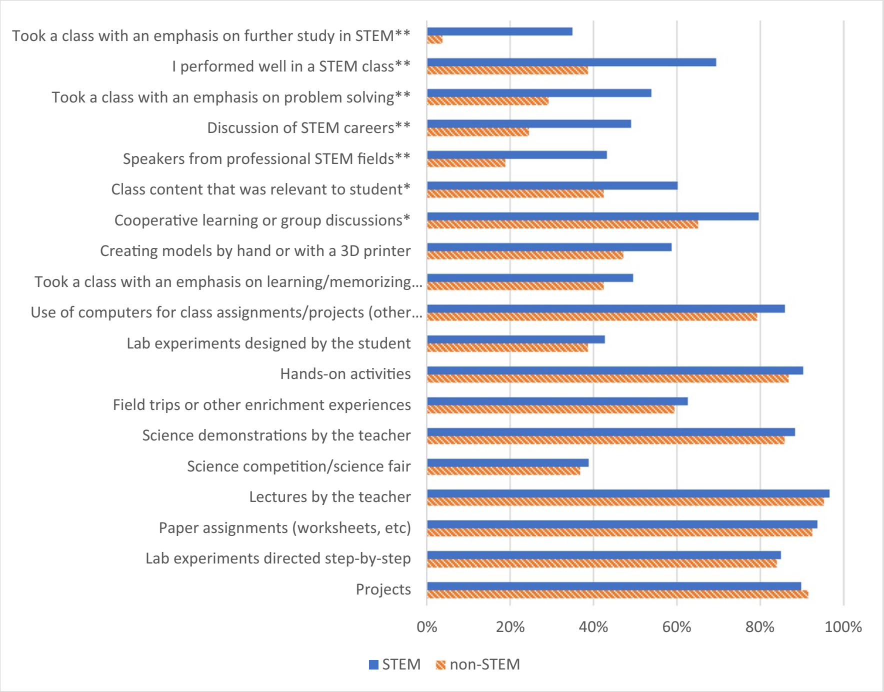

Fig. 2 Percentage of STEM (n = 206) and non-STEM (n = 106) students who selected each in-school learning experience in the survey. Note: Categories are ordered by difference between STEM and non-STEM majors. Comparison between groups made with chi-square test of independence. *p<.05, **p<.001

$\chi^2(1, N = 311) = 4.29$, $p = .038$, pressure from family or peers to pursue STEM, $\chi^2(1, N = 311) = 4.83$, $p = .028$, participation in STEM clubs or groups, $\chi^2(1, N = 311) = 9.07$, $p = .003$, having an interest in mathematical problems or logic games, $\chi^2(1, N = 311) = 15.32$, $p < .001$, and always having an interest in science, mathematics, and/or engineering, $\chi^2(1, N = 311) = 55.68$, $p < .001$. The single activity that was selected significantly more by non-STEM majors than STEM majors was playing video games, $\chi^2(1, N = 311) = 5.38$, $p = .020$.

Perceptions of Learning Experiences

For each learning experiences selected, the researcher compared the perceptions of those experiences between students majoring in STEM and students not majoring in STEM. The results of the independent sample *t*-test are displayed in Table 5. These results indicate that there were multiple learning experiences with a more positive perception from STEM majors than from non-STEM majors, particularly in categories that relate to STEM-specific opportunities in schools, interactions with STEM professionals, class performance, STEM extracurricular activities, and family influences. Six experiences had effect sizes that are considered medium according to

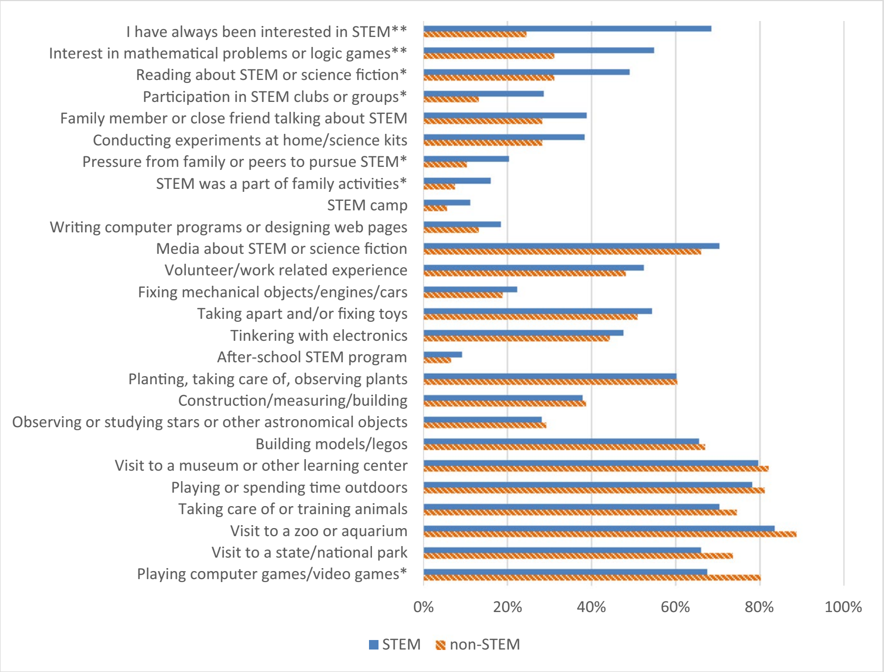

Fig. 3 Percentage of STEM (n = 206) and non-STEM (n = 106) Students who Selected Each Out-of-School Learning Experience in the Survey. Note: Categories are ordered by difference between STEM and non-STEM majors. Comparison between groups made with chi-square test of independence. *p<.05, **p<.001

Table 5 Comparison between STEM and non-STEM students' perceptions of learning experiences in the survey

Experience	STEM			Non-STEM			*t*	*p*	*d*
	N	Mean	SD	*N*	Mean	SD			
In-school experiences									
Lectures	206	2.47	.769	105	2.08	0.840	3.980**	<.001	.490
Science demonstrations	206	2.50	.996	105	2.35	1.074	1.213	.227	.149
Computers	206	2.07	1.017	105	1.86	1.096	1.681	.094	.207
Creating models	206	1.64	1.424	105	1.26	1.387	2.286	.023	.271
Projects	206	2.43	.989	105	2.28	0.946	1.311	.191	.155
Paper assignments	206	1.87	.857	105	1.53	0.748	3.610**	<.001	.413
Lab exp by students	206	1.11	1.362	105	0.92	1.261	1.209	.228	.141
Lab exp step by step	206	2.28	1.111	105	2.16	1.119	0.857	.392	.103
Hands-on activities	206	2.63	.922	105	2.50	1.030	1.098	.273	.136
Cooperative learning	206	2.03	1.181	105	1.58	1.292	2.977*	.003	.367
Field trips	206	1.80	1.419	105	1.68	1.438	0.727	.468	.087
Professional speakers	206	1.19	1.407	105	0.43	0.949	5.641**	<.001	.597
STEM careers	206	1.30	1.385	105	0.50	0.982	5.855**	<.001	.628
Science fair	206	0.97	1.295	105	0.90	1.247	0.499	.618	.059
Relevant content	206	1.72	1.427	105	1.22	1.434	2.908*	.004	.348
Further study	206	1.00	1.386	105	0.09	0.462	8.576**	<.001	.786
Memorization	206	1.01	1.152	105	0.72	0.976	2.296*	.023	.260
Problem solving	206	1.48	1.424	105	0.73	1.179	4.919**	<.001	.554
Performance	206	2.02	1.365	105	1.09	1.388	5.643**	<.001	.684
Out-of-school experiences									
Tinkering	206	1.35	1.443	105	1.21	1.405	0.823	.411	.098
Fixing	206	1.49	1.403	105	1.35	1.387	0.797	.426	.095
Models/legos	206	1.75	1.327	105	1.67	1.276	0.522	.602	.062
Construction/build	206	1.03	1.356	105	0.95	1.259	0.527	.599	.061
Engines	206	0.64	1.201	105	0.50	1.048	1.065	.288	.122
Video games	206	1.67	1.236	105	1.95	1.078	-2.042*	.042	.234
Computers/Web	206	0.50	1.072	105	0.36	0.942	1.166	.245	.134
Home science kits	206	1.05	1.366	105	0.70	1.176	2.338*	.020	.266
Animals	206	1.90	1.293	105	1.90	1.205	-0.045	.964	.005
Plants	206	1.62	1.369	105	1.56	1.315	0.372	.710	.044
Stars	206	0.78	1.264	105	0.80	1.266	0.154	.878	.018
Outdoors	206	2.01	1.152	105	2.01	1.079	0.001	.999	.000
STEM media	206	1.94	1.311	105	1.70	1.272	1.568	.118	.186
STEM books	206	1.37	1.428	105	0.81	1.233	3.582**	<.001	.409
Family talk	206	1.08	1.386	105	0.74	1.209	2.228*	.027	.255
Family activities	206	0.46	1.067	105	0.20	0.713	2.566*	.011	.271
Family pressure	206	0.58	1.157	105	0.30	0.876	2.404*	.017	.264
STEM club	206	0.82	1.311	105	0.34	0.897	3.775**	<.001	.402
STEM camp	206	0.31	.889	105	0.16	0.667	2.092*	.038	.054

Table 5 (continued)

Experience	STEM			Non-STEM			*t*	*p*	*d*
	N	Mean	SD	*N*	Mean	SD			
Afterschool	206	0.28	.870	105	0.18	0.690	2.053*	.010	.117
Zoo/aquarium	206	2.18	1.069	105	2.28	0.946	-0.814	.416	.094
Museum	206	2.10	1.148	105	2.19	1.119	-0.690	.491	.082
National park	206	1.69	1.284	105	1.86	1.204	-1.103	.271	.129
Volunteer/work	206	1.45	1.416	105	1.20	1.311	1.526	.128	.178
Math/logic	206	1.57	1.449	105	0.81	1.233	4.828**	<.001	.548
Always interested	206	2.00	1.381	105	0.65	1.185	9.023**	<.001	1.274

*p<.05, **p<.001

Cohen (1988): speakers from professional STEM fields (d = .597), discussion of STEM careers in classes (d = .628), classes with an emphasis on problem solving (d = .554) and further STEM study (d = .786), performing well in a STEM course (d = .684), and interest in math or logic games (d = .548). Always being interested in STEM (d = 1.274) had a large effect size, and all other significant learning experiences had small effect sizes.

Qualitative Phase

The second research question asks how select participants describe their learning experiences with STEM. The intent of this research question and resulting interviews was to provide support for the responses in the quantitative data and help describe the multifaceted process that people go through when making choices related to STEM. Career decisions in particular are complex, and the interview data below provides nuance to support that learning experiences can influence student beliefs and decision-making. The quantitative findings revealed that there were differences in the perceptions of many learning experiences between students pursuing a STEM career and those that were not. We wanted to examine whether there were particular reasons why students differed in their perceptions and if they pointed to the reason students began pursuing STEM. The responses to the interview questions revealed differing pathways and perceptions of experiences for both groups with commonalities in the experiences from those within each group.

The four interviewees currently pursuing a STEM career all indicated that their interest in STEM came at a young age. Three of these indicated a strong family tie to STEM pursuits or careers, while the fourth, Neely, said she “has always loved animals” and “wanted to be a vet as long as I can remember.” Blake and Nolan both exhibited high self-efficacy scores in science, mathematics, and engineering, and their perceptions of their STEM experiences were often so positive that both responded to a question about challenges they had experienced with stories about how they overcame difficulties to ultimately find success in STEM. Evan and Neely also demonstrated a commitment to their choices that were long-held and a desire to continue despite challenges, with Evan even saying “this is what I’m doing, no matter what.”

The four interviewees not pursuing a STEM career are more varied in their paths, but they also demonstrated specific experiences or sets of experiences that took them away from STEM. Ashley and Noah both had STEM interest early, but poor performance in mathematics and science courses derailed them from those goals and sent them in pursuit of other career paths. Regina had much success early in her STEM career, even developing award-winning science fair projects. However, when she moved schools midway through high school, they did not offer a science fair and she had several bad experiences with teachers so she started exploring other subjects. Annabelle has a strong family connection to STEM—her father is a mathematics teacher and her brothers are engineers—but said that the lack of good science instruction and opportunities in her school decreased her interest in science dramatically, saying “I’m very, very drawn back from the idea of science.”

In addition to exploring the individual stories of the interviewees, we reviewed their common experiences to examine how students’ perceptions of experiences might guide their intentions and actions. We found several categories of experiences consistent with those categories in the quantitative data. The following section details what interviewees said about their learning experiences and how they influenced STEM self-efficacies and career intentions.

Career Discussion, STEM Professionals, and STEM-Specific Programs

The interviewees pursuing a STEM career all talked about STEM-specific opportunities embedded into their middle and high school experiences. Nolan was part of an engineering program at a technical school, and one aspect of the program was a senior design project meant to prepare students for similar projects they would encounter in college and their future careers. This project incorporated knowledge from many of the courses and topics that Nolan had encountered up to this point. His perception of this experience was that it was substantially more complex than the types of activities he had done previously and presented an exciting challenge:

> Not everything is straightforward like it had been up to then. Because everything else was like, worksheets, physics, math. And so, you’re just taught it instead of doing it yourself. It was kind of like a hit in the face, like, oh, this is a lot harder than I thought it was.

Blake went to a high school that offered tracks in a variety of career paths, including the engineering track in which he participated. He spoke of his considerable number of engineering courses in high school as something that “just made my decision stronger.” When asked about things he might change about his high school experience, Blake stated, “I don’t think there’s things other than what I’ve had in high school that would prepare me better.”

Neely shadowed her family’s veterinarian in the eighth grade as part of a school-led career internship program because she had always loved animals, and that helped spark her desire to follow that career path in earnest. She detailed that the veterinarian “was helping me learn things a lot more hands on,” and that she was able to do a lot of the things that would be done on the job. She said that "starting to be able to do that was really cool." Evan shared that he had a teacher at a technical school who was a licensed nurse and described her impact:

> Just the real-life experience she brought to it. She actually had been there and done everything that she was teaching us. She was able to speak from a place of positivity because she loved the field that she was in and so it really rubbed off on you and her enthusiasm and everything about science.

Evan also pursued his interest in veterinary medicine by job-shadowing two different local veterinarians, indicating that these experiences helped entrench his desire to follow this career path.

Two interviewees that are not pursuing a STEM career indicated that they felt their high schools had not done enough to support students in having career options. Ashley said that her high school should have worked to help students become interested in STEM, and that would help increase the number of people who follow STEM career paths. Annabelle suggested that schools should work to raise career awareness, and even indicated that STEM career introduction should be a part of the curriculum to help teachers accurately represent the careers:

> I think one major thing for science specifically would just be showing different careers in science…because it really does negatively affect, and I know I'm not the only one in my school who experienced that. There's a lack of doctors, any science related fields coming out of my high school because the teachers just aren't positively reflecting what those careers can be. So I would for sure say showing real-world applications to those classes, rather than just the class.

The two interviewees with the lowest self-efficacy did not indicate any participation or involvement with STEM careers or professionals during their K-12 experience.

Class Performance

The two interviewees who are engineering majors, Nolan and Blake, indicated throughout their interviews that they had substantial success in their STEM courses. They each described multiple experiences where they performed well and enjoyed accomplishment in STEM. Evan also talked about an experience in freshman biology, where he "absolutely crushed the course" and "was able to help all my peers… in the class, help them succeed." This class helped him to realize his potential in science, specifically biology, and bolstered his desire to pursue a career centered on biology.

Several students had negative experiences in their courses that caused them to reevaluate their involvement with STEM moving forward. Regina stated that she's "terrible at math. I don't understand it," and then pointed toward her low score on the ACT math section as further proof of her ability. She also talked about flunking a chemistry course, saying that it "kicked my butt and I ended up dropping it at the semester because I knew that I couldn't survive if I didn't understand." Noah described high school experiences in mathematics that led to his decreased belief in his math ability. Early on, he indicated positive attitudes toward math, stating "when I was a kid, I thought, math was definitely my subject," but when he reached high school, that confidence in his ability began to fade. He said of this decline:

> And, so, then your skills taper off where you just bomb something, so you start to have that negative aspect… eventually, you come to the point where it was, well, why don't I just switch to something that comes more naturally, I mean that you are more passionate about. Because the more you fail at a subject I feel like the less actually you become more, dreading to go to it and maybe that leads to you failing even more.

Ashley also describes poor course performance as a cause for reevaluation, though it came in college. Ashley started college as an engineering major, but when asked why she switched to creative writing, she said, "physics and calculus two told me engineering was not for me." She went on to talk about struggles with chemistry pre-college, but it was clear that being unsuccessful in those two college courses caused her to deviate from the engineering field to one that does not involve mathematics or physics.

STEM Extracurriculars

The two interviewees currently majoring in engineering and pursuing a STEM career discussed participation in robotics clubs as influential in the development of their STEM career aspirations, though in different ways. Blake was proud of his and his team's accomplishment with a robotics competition, saying "I was the team leader and we took it home, we won that competition." Nolan also participated in a successful robotics team, but while he had a good experience he did not desire to continue. He stated, "It was something that I'm like, okay I can do this. It's just not what I want to be for the rest of my life." Even though both were already interested in engineering, each indicated that the club helped them see types of engineering did and did not interest them.

Ashley also participated in a robotics club and enjoyed it thoroughly. In fact, it was one of the factors that motivated her to initially pursue engineering when she got to college. She said "our team was actually really successful and I was sort of the big, like I pretty much did all the hard building tasks. And so that was probably my most successful moment in STEM." The four interviewees not pursuing a STEM career stated that they did not participate in any STEM extracurricular activities even though they were aware of their availability.

Family Influence

Family participation in STEM careers and family STEM activities and discussions were prominent influences of those pursuing STEM. Blake was the most pointed about his family's influence in his choice to pursue an engineering career, saying "it's almost family tradition at this point to become an engineer" and that all but one of his cousins have studied to become engineers. While Nolan did not have any particular family influences in a STEM career, he said his mother “wanted me to have a good foundation for whatever I want to do, and kept throwing math books at me.” He stated that she was supportive of whatever he did but prepared him and helped guide him to his current career path.

Evan’s uncle is a veterinarian and he stated “he’s definitely been a huge part of my interest in STEM just seeing how successful he was how much he loved it.” Additionally, he recalled, “growing up, my grandma, she always had the Nat Geo little magazines weekly subscription.” He said that these magazines helped him see more of the animals he was interested in and that they “super piqued my interest,” and when he got to read them he “was always excited about that.” Furthermore, he grew up on a farm and indicated that his experiences there manifested in his desire to be a veterinarian:

> As far as where it originally rooted from, I’ve always been super interested in wildlife. Going out to creeks and stuff by the house and flipping over rocks and seeing what I could find…just growing up and really being able to explore the world around me really ignited that passion. And I mean so it’s given me confidence to kind of push myself further and further and seeing how high I can take it and how successful I can be. It really has driven me to go that extra mile, that some other people haven’t been able to do.

Each of the other interviewees was asked about family influence in STEM, and while most of them had some small influences from family, none of them indicated that their family made a difference in their beliefs or career interest. Noah posited that parent involvement would probably make a difference, stating “if your parents were like a scientist or something, maybe you would be naturally pursuing down that line more.”

Discussion and Implications

This study uses the lens of self-efficacy theory to focus on the STEM learning experiences students have both in and out of school and how students perceive those experiences to influence their STEM self-efficacy and career intentions. Prior studies have established that particular in-school experiences (Thiry, 2019), out-of-school experiences (Allen & Peterman, 2019), or a combination of the two (Halim et al., 2018; Maltese et al., 2014) are significant in the development of students’ STEM beliefs and goals. This study supports many of these findings while finding areas of learning experiences that are particularly meaningful for those students who end up in STEM career pathways. We examined how STEM and non-STEM students perceived the learning experiences to have affected their self-efficacy, followed by purposeful interviews to look deeper into the process by which these experiences guided students from various backgrounds. This explanatory model brought nuance to the experiences of a small group of students and provides rationale for many of the findings in the quantitative data. The following section details some of the main categories of learning experiences that were experienced differently by

STEM and non-STEM students based on quantitative results. Then the qualitative section describes the experiences of individual students and how STEM learning experiences throughout their lives affected their beliefs about STEM and the career paths they chose to follow. Finally, the authors synthesized the results from both parts of the study following the explanatory design. The methods used in this study build on prior research through expansion of learning experience instruments, delineation between STEM and non-STEM majors' perceptions of these experiences, and exploration of specific learning experiences that affected individual students in their career development path.

Quantitative Section

In-School

There are a number of classroom experiences that STEM students in the study perceived as beneficial to the development of their self-efficacy. The first set of experiences is consistent with research regarding curriculum that focuses on relevant content, problem-solving, and creating models (Beier et al., 2018; Burt & Johnson, 2018; Schukajlow et al., 2019). Many resources for student learning call for emphasis on critical thinking and relevant content to aid in learning (National Council for Teachers of Mathematics, 2016; National Research Council, 2012), and our findings suggest that those skills are also perceived by students as beneficial for the development of STEM self-efficacy and could be useful in training the future STEM workforce. While those active learning strategies were important for STEM students, the findings also indicate that students pursuing a STEM career were significantly more likely than those not pursuing STEM to perceive lectures by the teacher, classes involving memorization of facts, and paper assignments in a positive light. While we cannot provide direct reasoning for these results, it is possible that high-performing students appreciate traditional methods in which they excel. Results from this study indicated that participants pursuing STEM were 30% more likely to report high performance in a STEM course, and Dawes et al. (2015) found that high-performing STEM students are likely to succeed in traditional school settings. More information is needed to understand these results, and we suggest that future studies examine the differences in learning styles preferred by STEM and non-STEM students in these courses.

Another key curricular component that was significantly different between STEM students and non-STEM students was involvement with coursework that was focused on STEM careers, future study in STEM, and interaction with STEM professionals. There are findings in the current literature that suggest student collaboration and involvement with STEM professionals (Mohd Shahali et al., 2019; Struyf et al., 2019; Thiry, 2019), authentic critical-thinking projects (Beier et al., 2018; Guzey et al., 2016), and explicit discussion of the real-world nature of STEM coursework (Jahn & Myers, 2015) can influence STEM career interest. This study adds that focused in-school learning experiences centered on STEM careers and professionals also have high value to STEM students toward their own confidence to pursue a STEM career. Moreover, our survey found that these were among the least-selected experiences in the whole sample, indicating that few students were presented with these opportunities. The findings suggest STEM career-focused activities could be important additions to school curricula for increasing students' STEM self-efficacy and likelihood of choosing a STEM career. We also suggest that future studies examine whether broader implementation of these experiences results in improved STEM self-efficacy among more students.

Out-of-School

STEM experiences that occur outside of the school setting also had a perceived beneficial effect on the development of STEM students' self-efficacies compared to that of non-STEM students. Some of these experiences are activities done at home with family support or by the students' own initiative. Certain experiences that STEM students indicated were helpful were direct actions conducted by the family including guided STEM activities and talking about STEM. Other experiences were likely supported by family such as conducting home science experiments, enjoying mathematical problems or logic games, and reading STEM books. Individual pieces of these findings are supported by studies that suggest people are more likely to develop an interest in STEM careers when children participate in STEM-related activities at home (Morris et al., 2019) or families talk about or model STEM careers (Dou et al., 2019; Steenbergen-Hu & Olszewski-Kubilius, 2017; VanMeter-Adams et al., 2014). Our findings show that a variety of supports from the home are valuable to students who end up pursuing a STEM career compared to their non-STEM counterparts. These can include direct and indirect activities and reinforcements and suggest that a supportive STEM environment can be impactful for the development of students' intent to pursue a STEM career.

Out-of-school learning experiences that are more explicit include STEM extracurriculars such as summer camps, after school programs, and clubs. Participation in clubs was selected significantly more by STEM students than non-STEM students, and all three categories were perceived significantly more by STEM students as beneficial to the development of their self-efficacy. There are multiple studies that tie participation in STEM extracurriculars such as clubs (Campbell et al., 2012; Mohd Shahali et al., 2019) and camps (Bonnette et al., 2019; Gossen et al., 2021) to increased STEM career interest. The sample for this study selected these extracurricular activities in low numbers, limiting the overall impact we can claim for them. However, those STEM students who did take part in them had more positive perceptions of the extracurriculars and their effect on the students' self-efficacies. These results suggest there is a need for more research into how these experiences affect students' self-efficacy and whether increasing participation would affect the experiences' role in STEM career intention.

Qualitative Section

The development of early interest seems to have value toward pursuit of a STEM career and is supported by prior research (Maltese & Tai, 2010; Tai et al., 2006), and these interviews provide insight into how students' reported innate interest may actually be the result of family influences and exploration of the natural world. Each of the interviewees who are currently pursuing a STEM career reported a high volume of connections to STEM through family and friends at an early age. These connections included having family members who had careers in STEM that served as role models, and also providing experiences such as exposure to media or targeted learning specific to STEM. One of the interviewees also discussed the ability to explore in nature as being foundational to his interest in science. Interviewees' descriptions of these experiences help provide insight to how students may develop this early innate interest in STEM.

As students proceed through school, the maintenance of their interest and self-efficacy in STEM can be affected by further experiences. The interviewees continuing to pursue STEM described experiences involving career-specific curriculum and course performance that bolstered their confidence in STEM. There were two interviewees, one with median and one with mixed self-efficacy, who indicated high involvement with STEM from family early in life and had considered STEM careers, but negative experiences later on derailed them from a STEM path. The contrast between how positive experiences with career-specific curriculum or course performance helped some students and negative experiences with these experiences impeded others reveals how learning experiences can affect self-efficacy and career decision-making.

Annabelle developed early STEM interest based on the connections she had with her family in STEM careers. However, she believes her high school teachers represented science careers so poorly that she and her peers drew away from science. The four interviewees pursuing STEM all indicated connections to career-specific focus in their middle or high school curriculum and that these experiences helped build on their early interest through the development of their self-efficacy in STEM. This supports research connecting real-world STEM focus and STEM professionals in schools to career interest (Beier et al., 2018; Mohd Shahali et al., 2019), while also demonstrating that lack of this support can lead to weakening of interest in STEM careers. Some of the schools described by interviewees provided substantial STEM career programs that were highly effective in helping these students maintain STEM self-efficacy, while other schools were lacking. Stories like Annabelle's demonstrate the need to emphasize career-specific curriculum and positive representation of STEM careers for the development and maintenance of self-efficacy in STEM.

Interviews also revealed that STEM students talked often about how well they performed in a course, while each of the non-STEM majors spoke of times in which their poor classroom performance caused them to feel less confident in STEM. Whether this is from actual issues with performance or perceived performance relative to other subjects (Witteveen & Attewell, 2020) is more difficult to assess, but some interviewees did claim to make decisions based on their perceptions. In the cases of Regina, Noah, and Ashley, poor performance was a major contributor to their change from a STEM career path to a non-STEM path. Successes and failures in STEM can cause students to increase or decrease their self-efficacy in those subjects (Bandura, 1977, 1997). Studies by Byars-Winston et al. (2017) and Zientek et al. (2019) suggest that these mastery experiences are more important to the development of self-efficacy than any other factor. This study supports those findings while also taking into account how individuals' experiences drive their decision-making. Some students, such as Evan and Nolan, used strong performances in coursework to drive them toward a STEM career. Others saw poor performance in a course as an indicator that they do not belong in STEM. This poor performance manifested differently for each person, and focus on their stories may illuminate reasons for how these learning experiences affect self-efficacy. For Regina, it was a difficult chemistry course with a teacher who taught using direct memorization methods she did not understand. Noah thought he was successful in mathematics into middle school, but when it started to become difficult, he had feelings of low self-efficacy which put him in a cycle of failure in mathematics courses. Ashley felt strongly about her aptitude in STEM until advanced college courses dashed her confidence in her ability to succeed in STEM. Attention to individual stories of how experiences shaped different students' paths can be beneficial to understanding how to better address these issues and should continue to be the focus of future research.

Synthesis

This study was built on an explanatory sequential design, and this method allowed us to examine some of the results from the initial quantitative phase through purposeful and planned interviews. Through the synthesis of these results and discussions, we found three main areas where personal explanations provided rationale for why students might make the decisions indicated in the larger survey. The first piece of this discussion is the development of an early interest in STEM that participants responded as "always having an interest in STEM." The development of early interest seems to be very important based on prior research (Burt & Johnson, 2018; Maltese et al., 2014; Maltese & Tai, 2011) along with the results from this study. Students' description of having this innate interest may well come from the environments that students are a part of early in life. The results indicate that STEM students in the survey are more likely to participate in family STEM-focused activities including home science kits and STEM books, as well as always being interested in STEM. Interviewees who were pursuing STEM all gave stories about how their early life and family impacted their confidence in pursuing STEM as a career path. Each person's story was unique, but contained aspects of family and environment that were common for all.

STEM extracurriculars were activities that were rarely selected by the survey sample, but seen as valuable to those who did them. These results were consistent even among interview candidates, as the only ones who had participated in those activities were those that already had prior interest in STEM. Also similar to the survey results, these interviewees described these experiences as very beneficial to the development of their STEM self-efficacy. Those who participated said that these experiences were useful to them because they helped them find success through competition and camaraderie. These experiences boosted the self-efficacy of those who described them because they felt their success in these experiences was indicative of their ability.

The point most relevant to schools and teachers are experiences related to careers. Several categories associated with careers were listed in the quantitative results, and the qualitative results accentuated the stories behind many of these. Those students who had access to career-driven programs or STEM professionals in the schools saw them as major benefits to the development of their skills over time and made them more prepared and able to succeed in STEM. Other students talked about how the poor representation of STEM careers in schools had negative impacts on them. These results suggest the need to emphasize these types of programs and make them accessible to more students in schools.

Limitations and Future Research

There are some known limitations to this study. First, the questionnaire was designed based off previous research on learning experiences in STEM, and care was taken to avoid bias whenever possible. However, the questions were all specific to learning experiences in STEM. Because of this, STEM students were more likely to complete the questionnaire and the participants' responses may have been skewed based on their initial views about STEM. Second, the results are dependent on the participants recalling experiences accurately and responding to questions truthfully. Third, goals and actions change as peoples' experiences and beliefs change. Therefore, participants' current beliefs do not necessarily represent the beliefs they had while going through these experiences.

Understanding these limitations supports the need for future research to track the changes in beliefs of students over time while they are having these experiences. Studies should also examine how learning experiences in and out of school affect students' interests, specifically in whether those experiences are encouraging the pursuit of STEM or turning them away. These experiences also may differ among students who are pursuing separate STEM disciplines, and it may be valuable to look at these experiences through the lenses of different STEM subjects and pathways. Finally, access to learning experiences in STEM may be different for students who come from various backgrounds, and attention should be paid to how factors such as gender, race, and socio-economic status affect how students engage with these experiences. Understanding how learning experiences affect students' beliefs and choices can be a powerful tool for educators and researchers in the development of curriculum, course offerings and design, and research influencing the STEM career pipeline.

Declarations

Competing Interests The authors declare no competing interests.

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