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Potential Factors to Enhance Students' STEM College Learning and Career Orientation

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In this study, we highlight the importance of high school students having a college-attending and career-ready mindset in STEM fields. With this purpose, we adopted a stepwise multiple regression analysis to determine which variables are significant predictors of students' STEM college learning and career orientation. The participants were 1,105 high school students from nine randomly selected high schools across greater Houston Texas. Forty-two percent of the variance on STEM college learning and career orientation as an outcome variable can be explained by six predictor variables: (a) parental involvement; (b) STEM related activities engagement; (c) academic experience; (d) teacher effective pedagogy; (e) technology/facilities; and (f) self-esteem. The results indicate that when students received support from teachers and parents, they could develop more positive attitudes toward future post-secondary education and career pathways in STEM fields.

Keywords: high school, STEM—science technology engineering mathematics, college readiness, career decision, parent involvement

INTRODUCTION

In 1986, the idea of Science, Technology, Engineering, and Math (STEM) education was first brought up to the public in a report named "Neal Report: Undergraduate Education Statement" by the National Science Board (Prados, 1998). The National Science Foundation further suggested STEM education policy reform within K-12 education (Fortenberry, 2005). In 2009, former President Barack Obama re-emphasized the importance of STEM education and invested more money in STEM teachers' professional development (Johnson, 2012). In 2015, STEM education was incorporated into Every Student Succeeds Act (ESSA) signed by former President Obama (Every Student Succeeds Act, 2015). The ESSA is the latest reauthorization of the Elementary and Secondary Education Act (Every Student Succeeds Act, 2015). This reauthorization aims to enhance students' performance and interests in STEM education, to discover students' potential to be scientists, computer programmers, engineers, and mathematicians, as well as to enhance STEM teachers' teaching skills. For this reason, high school education emphasizes STEM curriculum and teacher professional development in STEM education, which will hopefully help enhance high school students' academic and career interests in STEM fields.

In this study, we highlighted the importance of high school students having a college-attending and career-ready mindset in STEM fields (Conley, 2010; Radcliffe and Bos, 2013). According to the Center on Education Policy (2011) and the College Board (2011), they suggested that developing the college-attending and career-ready mindset can enhance high school students' knowledge about their future-to-be (occupations) and their willingness to pursue a college degree. In addition, according to the Center on Education the Workforce (2013), between 2013 and 2020 there will be 55 million job openings; 76% of these jobs will require the applicants to have post-secondary education attainment and achievement (e.g., vocational certificate, associate's degree, or bachelor's degree).

To enhance high school students' STEM college learning and career orientation, we have to think from their perspective so as to better understand what they need. Then we can address what their schools can do for these students. With this purpose, we wanted to discover what factors influence high school students' STEM college learning and career orientation.

LITERATURE REVIEW

Career decision is the biggest challenge for high school students in the process of college and career readiness. This decision will force students to choose what they will study in college and what practical trainings they want to take. However, career decision is an ongoing process, and this decision is influenced by individuals' ecologies such as school and home according to Lent et al.'s social cognitive career theory (1994). Social cognitive career theory emphasizes that individuals' self-efficacy influences their formation of educational and vocational interests, decision making in education and career, persistence in academic and occupational endeavors, as well as performance attainment (Lent et al., 1994). Individuals' learning experiences influence their self-efficacy while individuals' learning experiences are influenced by person factors (e.g., gender and ethnicity) and background contextual factors (e.g., support system from school, home, or community). Social cognitive career theory was developed based on Bandura's social learning theory. Social learning theory emphasizes that an individual's beliefs, emotions, and thoughts are influencers of their behaviors (Bandura, 1977). These behaviors in turn help predict patterns of an individual's beliefs, emotions, and thoughts. Environment influences an individual's beliefs and behaviors, while those beliefs and behaviors help predict in what environment an individual may choose to stay.

For high school students, they need to make their first career decision regarding educational and career plans before they graduate. Therefore, helping high school students to understand what their academic and vocational interests are and enhancing their interests are important aspects. The research literature indicates that positive awareness and aspiration toward education and career among high school students can be fostered and developed through improvements in the multiple learning environments in which students reside (e.g., home and school), as well as through the development of protective factors within those environments (e.g., parents in the home environment and

teachers or mentors in the school environment) (Wang and Staver, 2001; Gushue and Whitson, 2006; Kirdök, 2018).

The Role of Parents

Parents play a critical role in their children's educational and career paths and socialization (Ginevra et al., 2015; Heddy and Sinatra, 2017; Niles and Harris-Bowlsbey, 2017). According to Sharf (2006), children's relationship with their parents will influence what educational and career paths the children will take. When children make their educational and career decisions, they respect their parents' feedback as well as rely on emotional and financial support from their parents. Research indicates that parents' positive support such as encouragement and guidance would enhance children's self-determination on achieving educational goals (Urdan et al., 2007; Ramsdal et al., 2015; Zhang et al., 2019) and career goals (Urdan et al., 2007; Zhang et al., 2019). In addition, research indicates that if parents maintain positive attitudes about their children's educational and career endeavors, then children are more likely to actively continue their educational and career paths (Zhang et al., 2019).

Regarding increasing students' STEM learning interests and career orientation, parents' constant involvement in their children's learning has been shown to be an effective factor (Gottfried et al., 2016). According to Heddy and Sinatra (2017), students' learning interest in science can be better maintained when their parents get more involved in the learning process. Furthermore, research corroborated that parental involvement is associated with students' learning performance in math (Sheldon and Epstein, 2005).

The Role of Schools and Teachers

Students' academic and career paths can be affected or enhanced by schools and teachers. When high school students consider which academic or career path they would like to take, they rely on resources the school provides such as learning facilities (Xie and Reider, 2014), college and career guidance (Schwartz et al., 2016), as well as counseling service (Schwartz et al., 2016). In addition, students get to know their academic and/or vocational interests better when schools provide educational activities such as college and career day, and learning exposition (Zeng et al., 2018). Nugent et al. (2015) discovered that when students participate in STEM-related activities in informal learning environments, such as STEM summer camps, their STEM learning interests and career orientation are enhanced. These out-of-school STEM learning experiences could support and enhance students' STEM learning in classroom (Nugent et al., 2015).

Research indicates that students develop more positive awareness and aspiration toward education and career when they receive teachers' support in the classroom learning environment (Hurtado et al., 1996; Kao and Thompson, 2003; Lazarides and Watt, 2015) and parental involvement in their learning (Chavira et al., 2016; Holmes et al., 2018). Dalgety and Coll (2006) investigated first-year college students' learning attitudes and self-efficacy regarding chemistry learning; they found that these students' previous learning experience and achievement in high school may be critical to their self-efficacy in college-level

chemistry learning. Lee et al. (2008) further argued that teachers play an important role in the process by which students make educational or career decisions, as students' positive learning attitudes and achievements are affected by teachers' instructional contents, tools, and skills.

With the aforementioned purpose of this study and review of literature focusing contextual factors on high school students' educational and career paths, one research question is addressed in this study: from high school students' perspectives, what factors (e.g., parental engagement, academic experience, and teachers' effective pedagogy) will influence their STEM college learning and career orientation.

METHODS

Our study adopted a mixed-method design. We collected quantitative data through a survey and qualitative data was collected through two focus group interviews. In this study, we primarily focused on the quantitative results; the qualitative results were used for supporting evidence through data triangulation.

Participants

The study was carried out in nine high schools across greater Houston, Texas. These nine schools were randomly selected to participate in the study (e.g., survey and focus group interviews) based on a list of high schools provided by one school district. The total of student participants was 1,540. Students who did not answer the survey completely were removed from the analysis. As a result, there were only 1,105 student participants in our study. Participants' distribution by grade level was 413 ninth grade, 324 tenth grade, 206 eleventh grade, and 162 twelfth grade students. There were 529 male students and 576 female students. The age range for participants was 14 years old to 17 years old (mean = 15.2). Regarding the focus group interviews, three students from each grade were randomly chosen for a total of 12 students (two focus group interviews).

Survey Instrument

A bilingual survey (Spanish/English) was developed for students. The survey was mainly designed to gather (a) basic background information, (b) systematic information on classroom/home teaching/learning environments, (c) systematic information on resources in the home learning environment, and (d) beliefs and attitudes toward STEM education and STEM careers and degrees. The survey contained nine constructs. These constructs were: (a) STEM related activity engagement; (b) STEM college learning and career orientation; (c) teacher support; (d) school support; (e) self-esteem; (f) parental involvement; (g) teachers' effective pedagogy; (h) safety and behavior at school; and (i) technology-assisted learning. There were 47 closed items with a six-point Likert scale. Each survey item offered one of two types of answer choices for the students. The first type of choice was the disagree-agree type (strongly disagree = 1; disagree = 2; slightly disagree = 3; slightly agree = 4; agree = 5; and strongly agree = 6). The second type of choice was the frequency type (never = 1; seldom = 2; sometimes = 3; frequently = 4; usually = 5; always = 6).

Examples of survey items and the Cronbach's Alpha values for each construct are provided below:

a. *STEM Related Activity Engagement* (Cronbach Alpha =0.7/5 items):
   In my STEM classes, I work with other students on projects during class and after school (disagree-agree choice).
b. *STEM College Learning and Career Orientation* (Cronbach Alpha =0.75/5 items):
   If I perform well in the STEM subjects, it will lead me to a great college or a great job in STEM fields (disagree-agree choice).
c. *Teacher Support* (Cronbach Alpha =0.86/5 items):
   My STEM teachers mentor me effectively in preparation for my STEM projects (frequency choice).
d. *School Support* (Cronbach Alpha =0.75/5 items):
   A guidance counselor at school has given me advice on how to get into a college or career in STEM fields after graduation (disagree-agree choice).
e. *Self-efficacy* (Cronbach Alpha =0.82/5 items):
   I am confident I can produce high quality work in my STEM classes (disagree-agree choice).
f. *Parental Involvement* (Cronbach Alpha =0.73/5 items):
   My parents support my attending STEM related activities at school (frequency choice).
g. *Teachers' Effective Pedagogy* (Cronbach Alpha =0.9/7 items):
   My STEM teacher uses open-ended or guided questions to help us deeply understand the idea behind the STEM curriculum (frequency choice).
h. *Safety and Behavior at School* (Cronbach Alpha =0.81/5 items):
   Discipline is fairly enforced at school (disagree-agree choice).
i. *Technology-Assisted Learning* (Cronbach Alpha =0.88/5 items):
   The computers and equipment available to students for STEM projects and labs are up to date (disagree-agree choice).

Survey Implementation

The procedure for survey implementation involved three steps including (1) survey development, (2) survey piloting, and (3) survey implementation.

Step 1: For the development of the survey, we examined literature on: (a) home learning environment research (e.g., Peterson et al., 2005; Urdan et al., 2007; Sad and Gurbuzturk, 2013; Ramsdal et al., 2015); (b) parental involvement (e.g., Chavira et al., 2016; Holmes et al., 2018); (c) effective teaching practices in STEM programs (e.g., National Research Council., 2011; Bruce-Davis et al., 2014); and (d) STEM classroom learning environment research (e.g., Smith et al., 2009; Denson et al., 2015). Examining these studies helped us better understand areas of focus for the survey. In addition, we examined literature on College and Career Readiness Standards (e.g., American Institutes for Research, 2014; Neri et al., 2016), as well as literature on STEM Program Development (Lara-Alecio et al.,

2012; Kim, 2016; Mupira and Ramnarain, 2018). By further examining these studies, we could develop items addressing educational experiences in home and classroom environments as viewed and experienced by the students during home and/or classroom activities.

Step 2: This step involved the piloting of the survey with two focus groups, one in Spanish and one in English, in an effort to do the final calibration of the instrument with high school students from ninth through twelfth grades. These focus groups assisted us by addressing any language ambiguity and/or revising poorly written items across all surveys.

Step 3: Upon obtaining all signed consent forms from the students and permission forms from their parents, the online survey was implemented. Students could choose an English or Spanish survey to answer. Students were led by teachers to a computer lab where they took the online survey. Regarding the implementation of the survey, a survey protocol designed by the researchers was given to the teachers. The average time for survey completion by participants ranged between 12 and 15 min.

Survey Analysis

A stepwise multiple regression analysis was used to determine which variables are significant predictors of an outcome variable. In our analysis, we used STEM college learning and career orientation as an outcome variable with the other eight constructs as predictor variables: (a) STEM related activity engagement; (b) teacher support; (c) school support; (d) self-esteem; (e) parental involvement; (f) teachers' effective pedagogy; (g) safety and behavior at school; and (h) technology-assisted learning. The variables that were selected in our multiple regression model were potent factors to predict the outcome variable (STEM college learning and career orientation). According to Larson-Hall (2016), significant factors included in the model have independent power to affect the outcome variable. In a stepwise multiple regression, "the choice of which factor is entered first is based on the strength of the correlation" (Larson-Hall, 2016, p. 240). In addition, a series of moderator analysis was conducted to determine if a relationship between two variables is moderated by a third variable. **Figures 1**–**4** show the moderator analyses that we conducted. For example, **Figure 1** illustrates if a relationship between students' "STEM related activity engagement" and "STEM college learning and career orientation" could be moderated by parental involvement.

Interview Questions for the Focus Group

With the preliminary results, six topics were developed to align to six significant predictors: (a) parental involvement; (b) STEM related activity engagement; (c) teacher support; (d) STEM teacher effective pedagogy; (e) technology-assisted learning; and (f) self-efficacy. There were one or two open-ended questions under each predictor, with a total of 10 questions. For example, under the topic of parental involvement, one of the questions was "In your view, what are the ways in which your school and teachers can get your parents involved in your STEM education and career readiness?" Under the topic of teacher support, one of the questions was "In your view, what are some of the key steps

that STEM teachers need to take if they want students to become resilience (or persevere) in STEM? What do they need to do to get you college ready?"

Interview Implementation

Each of the interview sessions lasted 1.5 h. Each session included an explanatory introduction, interview questions, and a closing statement. During the session, all students were required to give their most considerate answer to all of the 10 interview questions. The 12 students in this focus group all agreed to audio recording of the sessions; they consented to allow that their quotes could be included in this study anonymously.

Several quotes by students were provided in the discussion section to support our survey findings. These quotes represented the overall thinking of the students in the focus group. To increase the reliability of findings from the interview, we invited one researcher to review the results and quotes. This researcher has worked in the field of education for over 5 years; her research expertise is mixed methods research and parental involvement. An additional researcher would "arrive at similar findings from the data" (Rafuls and Moon, 1996, p. 77).

RESULTS

SPSS Version 20 was used to examine the survey data. As stated in the method section, there were nine constructs on our survey, with a combined total of 47 items. These constructs were found to be highly reliable, with reliability coefficients ranging from 0.7 to 0.9 (mean = 0.8). As mentioned above, a stepwise multiple regression analysis was used to examine eight predictor variables with students' STEM college learning and career orientation specified as an outcome variable. These eight predictor variables considered in the equation were: (a) STEM related activity engagement; (b) teacher support; (c) school support; (d) self-efficacy; (e) parental involvement; (f) teachers' effective pedagogy; (g) safety and behavior at school; and (h) technology-assisted learning. Six significant predictor variables (factors) were identified in a stepwise multiple regression model: (a) parental involvement; (b) STEM related activities engagement; (c) academic experience; (d) teacher effective pedagogy; (e) technology-assisted learning; and (f) self-efficacy. A multiple R of 0.65 was obtained, accounting for 42% (adjusted) of the variance (See **Table 1**), suggesting that these six factors helped explained 42% of variance in students' STEM learning and career orientation. **Table 1** shows that these six identified predictors independently affect students' STEM college learning and career orientation; parental involvement has the strongest correlation with students' STEM college learning and career orientation.

DISCUSSION

The purpose of this study was to discover from students' perspectives what factors may influence their STEM college learning and career orientation. The results showed that 42% of the variance on STEM college learning and career orientation can be explained by six predictors that include: (a) parental involvement; (b) STEM related activity engagement; (c) teacher

TABLE 1 | Multiple regression analysis of STEM college learning and career orientation as an outcome variable.

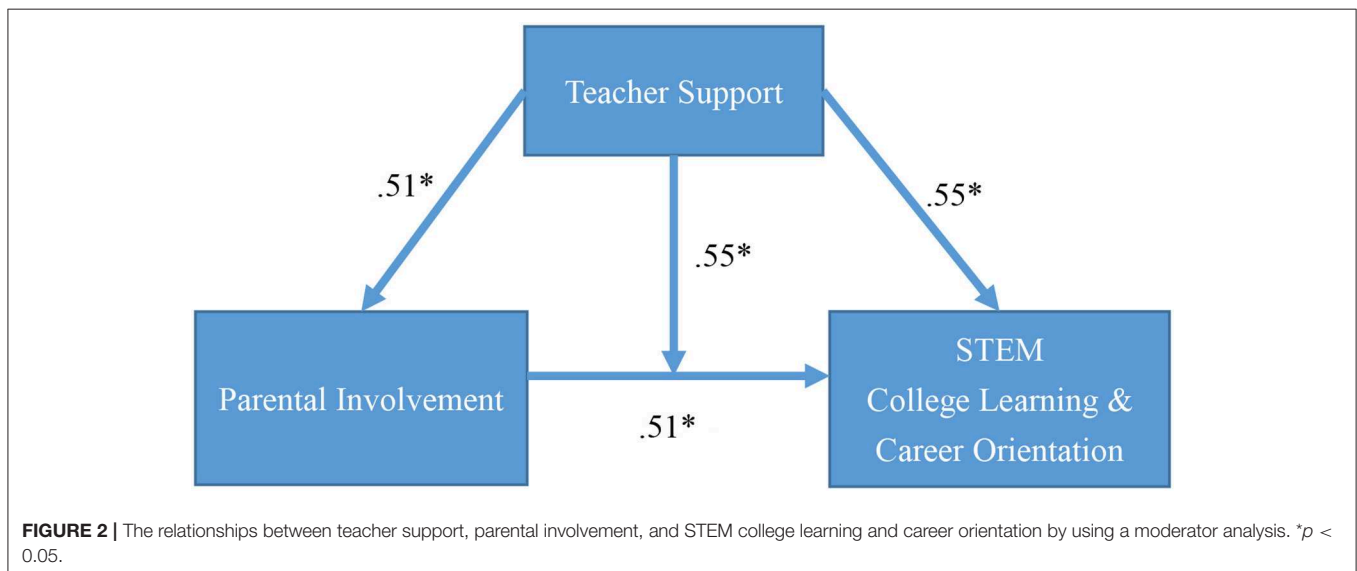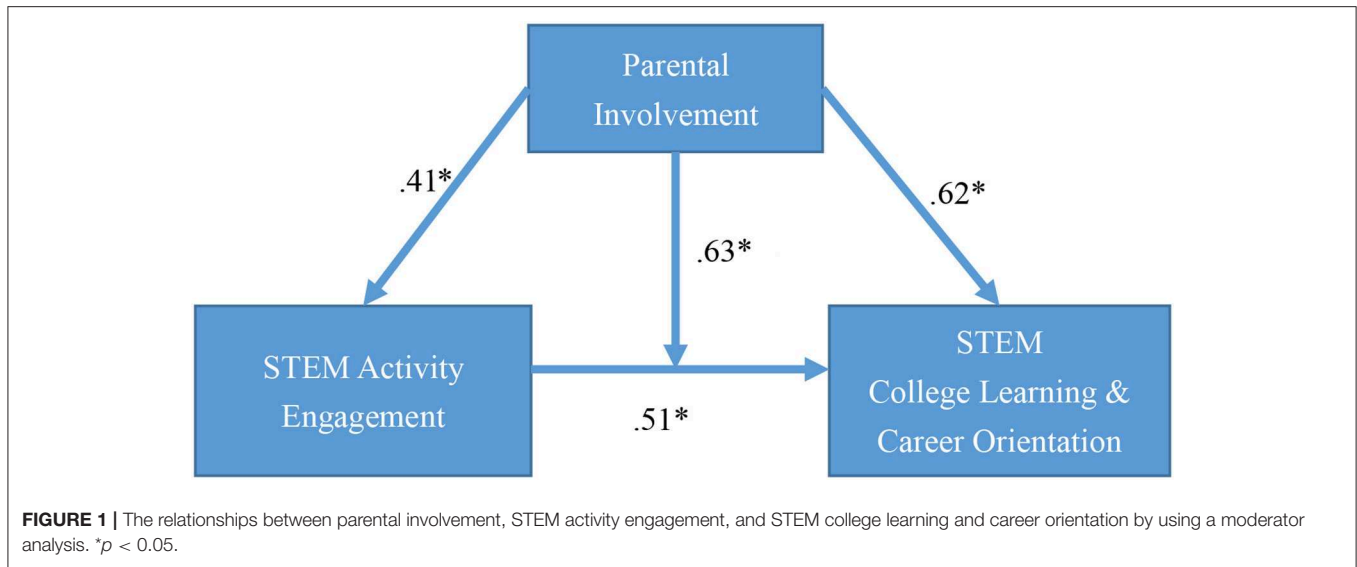| Independent variable	Multiple R	R^2_{Change}	R^2_{Adt}	F_{Change}
1. Parental involvement	0.532	0.283	0.283	436.276***
2. STEM related activity engagement	0.620	0.101	0.383	179.831***
3. Teacher support	0.641	0.027	0.409	49.922***
4. STEM teacher effective pedagogy	0.644	0.003	0.412	6.458*
5. Technology-assisted learning	0.648	0.005	0.416	9.758**
6. Self-efficacy	0.650	0.004	0.420	6.907**
Total		0.423	0.420	

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

support; (d) STEM teacher effective pedagogy; (e) technology-assisted learning; and (f) self-efficacy. This overall finding indicates that students' physical and psychosocial learning environments should elevate their beliefs and behaviors in STEM learning, which would later help predict their future STEM college and career orientation. This indication is supported by Lent et al.'s social cognitive career theory (1994). The overall finding also indicates that students' physical and psychosocial learning environments should leverage their self-efficacy, which would help enhance their educational and career interests in STEM and persistence in academic and occupational endeavors. This indication is supported by Bandura's social learning theory (1977).

The results first revealed that *parental involvement* accounted for 28% of the variance in students' STEM college learning and career orientation, and that parental involvement had a significantly positive and moderate correlation with STEM college learning and career orientation. These findings indicate that if parents get more involved in their children's STEM learning, their children would be more determined and positive about their post-secondary education and career orientation in STEM fields. When parents get involved in their children's learning activities, they should be supportive and provide positive feedback to their children. When parents give encouragement, share expectation, and present positive attitudes, their children's academic and vocational interests can be enhanced (Urdan et al., 2007; Zhang et al., 2019). When communicating with their children about academic and career decisions, parents are suggested to maintain a reciprocal conversation with their children, to help the children understand their strengths, and to work with the children to help them analyze potential pros and cons of their decisions about their future. Meanwhile, in the conversation, parents should look at their children's behaviors, emotions, and cognitions (e.g., thinking process) from the view of the children instead of from the view of the parents alone. According to Lent et al. (2000), parents' disapproval can draw children away from their original career choice and may hinder their career progress. We further analyzed: (a) the relationship between parental involvement, students' STEM related activity engagement, and students' STEM college learning and career orientation (see **Figure 1**); and (b) the relationship between teacher support, parental involvement, and students' STEM related activity engagement (see **Figure 2**). With the results in

Figure 1, we found that from students' perspectives, parental involvement could positively moderate the relationship between their STEM related activity engagement and STEM careers and degrees. With the results in **Figure 2**, we found that to enhance the relationship between parental involvement and students' STEM related activity engagement, teacher support plays a significantly critical role.

Second, the results revealed that by *engaging in more STEM related activities*, students would feel more positive about their future post-secondary education and career orientation in STEM fields. To enhance students' STEM college learning and career orientation, STEM teachers are strongly suggested to provide their students with activities aligned to the students' academic interests and learning needs. Schools are suggested to develop and offer STEM-related activities or practicum to students for enhancing the students' educational and vocational interests in STEM. The practicum aims to give students opportunities to apply STEM theories and knowledge into real-life practice. Through participation in the practicum, students' STEM knowledge, skills and abilities can be enhanced in a sustained way. In the practicum, students will be able to communicate with teachers, peers, and professionals. Through educational communication and hands-on experience, students can integrate their theoretical knowledge and real-world practice, and their academic and vocational interests in STEM fields can be enhanced (Malin and Hackmann, 2017). With the results in **Figure 1**, to enhance students' STEM related activity engagement which could further enhance their STEM careers and degrees, we suggest that teachers help parents increase their level of involvement in their children's STEM learning. Additionally, teachers should work with schools to provide parents with capacity building activity so that parents can learn how to effectively engage in the education of their children. The goals of these activities are to enhance communication and collaboration between parents, students, and teachers, to optimize positive impacts on students' STEM college learning and career orientation.
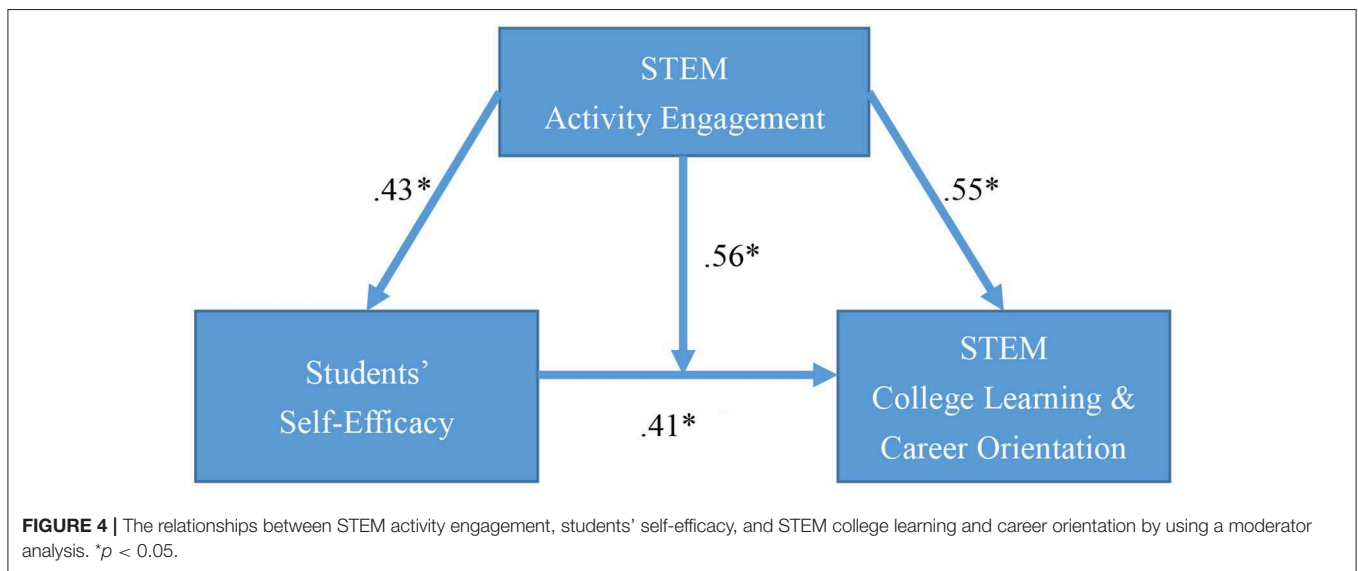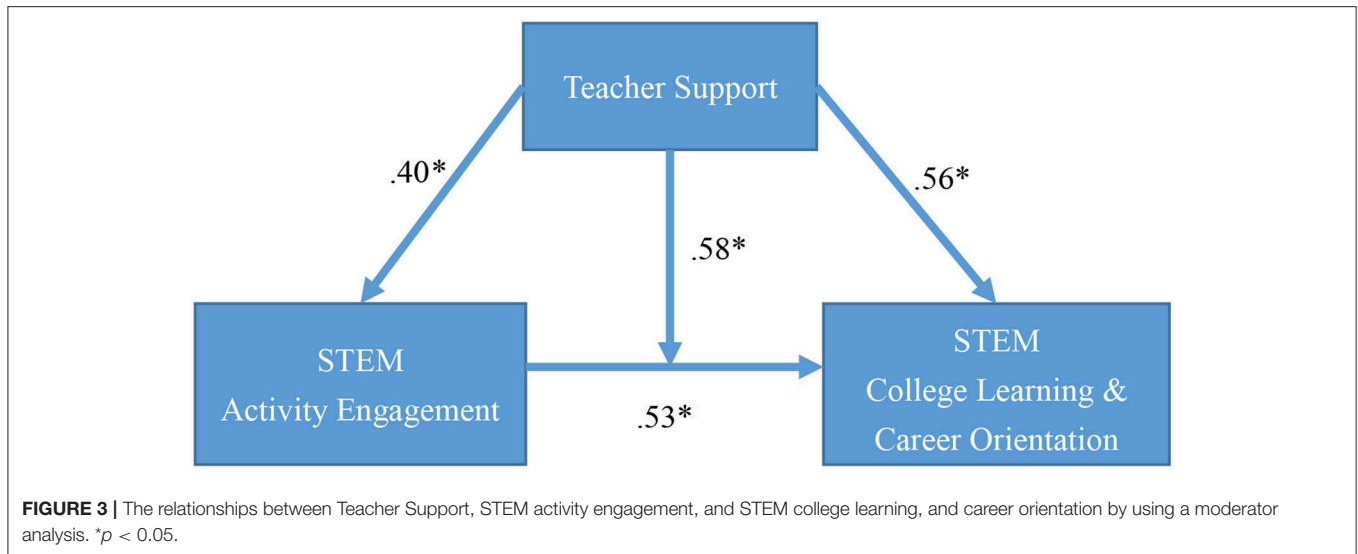
Third, the results revealed that *STEM teachers' support* in students' STEM learning accounted for enhancing students' future STEM college learning and career orientation. We further analyzed the relationship between teachers' support, students' STEM related activity engagement, and STEM college learning and career orientation (see **Figure 3**). We found that from students' perspective, teachers' support could positively moderate the relationship between students' STEM related activity engagement and STEM college learning and career orientation. Teachers' support could also enhance students' STEM related activity engagement, which could further enhance their STEM college learning and career orientation. These findings are consistent with previous studies which found that when students received support from their teachers (Walker et al., 2004), the students could develop more positive attitudes, which later may influence their perspectives about future STEM activity engagement and post-secondary education pathways. To develop or enhance students' educational and vocational interests in STEM fields, teachers are encouraged to maintain a mentoring/apprenticeship program to give students guidance and assistance in STEM learning. More specifically, this program

FIGURE 1 | The relationships between parental involvement, STEM activity engagement, and STEM college learning and career orientation by using a moderator analysis. $*p < 0.05$.

FIGURE 2 | The relationships between teacher support, parental involvement, and STEM college learning and career orientation by using a moderator analysis. $*p < 0.05$.

is to assist students with understanding real-world practices in STEM fields and effective ways to interact with professionals. Teachers should consider providing a 2-h window in their weekly schedule for their students to walk in for discussion and consultation; the aims of this discussion would be (a) to help the students solve their challenges in learning and life, (b) to enhance the students' learning interests, and (c) to assist the students with monitoring their learning growth and finishing their study in high school. Teachers are encouraged to help students develop future educational and career paths, and help the students get involved in community service. For example, teachers can to develop and participate in activities involving all their students (e.g., field trips and career talks by professionals).

Fourth, the results revealed that ***STEM teachers' teaching effective pedagogy*** could affect students' STEM college learning and career orientation. Regarding how teachers can enhance students' post-secondary education and career in STEM fields, teachers can modify their lesson plan by incorporating Trowbridge and Bybee's 5E model (Trowbridge and Bybee, 1996; Bybee et al., 2006): Engagement, Exploration, Explanation, Elaboration, and Evaluation. Ample evidence has shown the effect of 5E model on enhancing students' STEM academic performance (Lara-Alecio et al., 2012; Kim, 2016; Mupira and Ramnarain, 2018). To help strengthen students' STEM interests, Burke (2014) suggested to add "Enrichment" to the model. To pay attention to each individual's learning background and progress, teachers are encouraged to use differentiated instruction (LaForce et al., 2016). According to Tomlinson (2001), teachers can focus on adjusting lesson content, lesson process, and lesson product.

FIGURE 3 | The relationships between Teacher Support, STEM activity engagement, and STEM college learning, and career orientation by using a moderator analysis. *p < 0.05.

FIGURE 4 | The relationships between STEM activity engagement, students' self-efficacy, and STEM college learning and career orientation by using a moderator analysis. *p < 0.05.

Fifth, the results revealed that students' perceptions about **classroom technology and facilities** could influence their STEM college learning and career orientation. To enhance students' STEM college learning and career orientation, STEM teachers are advised to maintain a technology-assisted learning environment by working with school administrators (Hawkins et al., 2017). Students' learning is enhanced due to the multiple learning functions and interactive learning environments provided by using technology in the classroom. Some researchers (e.g., Hsu et al., 2015; Kaniawati et al., 2016) found computer-assisted or multimedia-assisted learning is more effective to facilitate students' STEM content knowledge learning when compared with traditional classroom learning. This is because the computer-assisted learning environment creates an opportunity for students to easily monitor their learning process and adjust their learning when they make mistakes (Hsu et al., 2015). In addition, a computer-assisted learning environment helps students gain some additional skills such as learning autonomy and computer literacy (Cerezo et al., 2014).

Sixth, the results showed that students' **self-efficacy** would help enhance their STEM college learning and career orientation. A student's self-efficacy is developed based on his/her previous learning experience, performance, and attitudes that can be directly influenced by teachers (Dalgety and Coll, 2006). To enhance high school students' self-efficacy, teachers are suggested to assist their students with goal-setting and goal achievement. Students with higher efficacy have higher goal commitment, and they are more likely to achieve their goals (Wilson and Narayan, 2016). According to Gist and Mitchell (1992) and Peterson (1993), self-efficacy manifests itself in successful completion of designated tasks. Our results further showed that students with higher self-efficacy believed more strongly that they could successfully finish STEM-related hands-on tasks and assignments ($r = 0.90$). We further analyzed the relationship between students' self-efficacy, STEM related activity engagement, and STEM college learning and career orientation (see **Figure 4**). We found that from students' perspectives, their STEM related activity engagement could positively moderate the relationship

between their self-efficacy and STEM college learning and career orientation. These students' engagement in STEM related activities could enhance their self-efficacy, which could further enhance their STEM college learning and career orientation. With these findings, we suggest that to enhance students' self-efficacy, teachers should provide their students with more resources and opportunities to engage in STEM-related hands-on activities.

Finally, in order to continue building resilience in students, schools are strongly encouraged to continue increasing efforts that are clearly connected to teacher professional development and parental capacity building; these are key protective factors that can build and support students' resilience. From our qualitative results, we found that students valued how teachers can inspire them to try and attain a college degree or career in STEM fields.

> *"I feel like the STEM program gives us opportunities.…..and it's like one on one, the teacher and the student, and it really gives us more opportunities to put our learned knowledge into practice."*
> *"The STEM program allows us to explore different aspects of different fields.……and to have us immersed into real-life situations."*

Students were cognizant of the fact that some teachers should not only bring real-life situations to STEM classrooms, but should also help identify how students can use different strategies to solve real-world problems. Additionally, teachers should invite a guest speaker to share with students how they can solve these problems in practical ways.

> *"I do think that teachers can help us focus more on real-world problems and guide us how we can solve these problems in different ways.…..STEM teachers should have someone.……someone who's really like an expert in the field.……if we can seek this kind of person in the field, it can help us understand and solve the real-world problems in a more practical way."*
> *"Some of STEM teachers.……like math and science.……just teach us content knowledge.…...we need to know some practical skills to cope with real-world problems.……we expect teachers to give us not only the knowledge but also practical skills.……give us some examples of how these skills are, what these skills look like."*

Regarding parents, the students wanted their parents to get more involved in their learning and to work with teachers to help enhance their learning performance and interests.

> *"I feel like my parents do not pay attention to my learning process, but my grades instead.……focusing on my grades is fine, but not the way they sit down with me and help my school work. I hope my parents could get more involved in school activities.……it's important and they should be involved in the school, because they can get to know our teachers and understand how they can help us meet teachers' and school's expectations.……teachers can also know how my parents think about my.……STEM education."*
> *"I feel like parents should always encourage us on our learning performance, not criticize. They should not give us too much instructional criticism.……but should help us be more focused on our learning process."*

CONCLUSION

To follow up on other studies emanating from the social cognitive career theory framework (e.g., Lent et al., 2008; Nugent et al., 2015; Gottfried et al., 2016; Zhang et al., 2019), we operationalized relevant variables focusing on high school students as our target population. The results of our study helped us to better understand that the interplay of socio-contextual, motivational, and instructional factors operating within learning environments can impact high school students' future STEM college learning and career orientation.

Our results revealed that to develop or enhance high school students' STEM college learning and career orientation, we should pay attention to their parental involvement, STEM related activity engagement, teacher support, STEM teacher effective pedagogy, technology-assisted learning, and self-efficacy. To develop and enhance high-school-aged children's STEM college learning and career orientation, parents are suggested get actively involved in their children's STEM learning. To sustain their STEM college learning and career orientation, parents should provide constant support and encouragement to their children in STEM learning. When developing and enhancing high school students' STEM college learning and career orientation, teachers should understand: (a) how each individual student may have different learning needs; (b) how to adapt instructional strategies and lesson materials to align to students' needs; (c) how to create interactive lessons using electronic learning materials; and (d) what learning resources to provide for enhancing their students' learning interests in STEM. Schools should provide students more educational and vocational STEM-related activities to further develop their STEM college learning and career orientation, as well as to put learned STEM knowledge into real-life practice. We encourage that parents, teachers, and schools work together to hopefully have a more positive impact on high school students' educational and career decisions in STEM fields.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ozgur Ozer (Harmony Public Schools). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

HR contributions are school connection, data collection, and manuscript revising. J-TL contributions are data collection, data analysis, manuscript drafting, and manuscript revising.

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