Received: 7 March 2021 | Revised: 2 June 2022 | Accepted: 26 June 2022

DOI: 10.1002/cdq.12338

ARTICLE

School counseling practices related to postsecondary STEM participation

Richard Gearns[1,2] | **Angela M. Kelly**[3] | **Mónica F. Bugallo**[4]

[1]Institute for STEM Education, Stony Brook University, Stony Brook, New York, USA

[2]Sachem High School East, Sachem Central School District, Ronkonkoma, New York, USA

[3]Department of Physics & Astronomy and Institute for STEM Education, Stony Brook University, Stony Brook, New York, USA

[4]Department of Electrical & Computer Engineering, Stony Brook University, Stony Brook, New York, USA

Correspondence
Angela M. Kelly, Department of Physics & Astronomy and Institute for STEM Education, 092 Life Sciences, Stony Brook University, Stony Brook, NY 11794, USA.
Email: angela.kelly@stonybrook.edu

Funding information
National Science Foundation, Grant/Award Numbers: 1647405, 1840953; National Grid

Abstract
This qualitative exploratory cross-case analysis analyzed the beliefs and practices of high school counselors related to science, technology, engineering, and mathematics (STEM) academic advisement, postsecondary planning, and career participation. Interviews were conducted with high school counselors ($N = 13$) who were purposively sampled to represent a diversity of schools in terms of demographic variables. Findings indicated that high school counselors perceived that (a) sociocultural factors influenced student preparation for STEM, career planning, and decision making; (b) students' STEM-related career goals and academic behaviors were sometimes misaligned, and academic advisement often mediated this tension; and (c) their professional STEM knowledge, beliefs, and practices were influenced by professional preparation, workplace characteristics, and their academic experiences. Implications include the need for early, sustained high school STEM counseling and academic advisement; accessible professional development in STEM preparation and careers to promote multiple pathways and reduce school counselor bias; and encouraging family involvement in STEM career decision making.

KEYWORDS
career planning, equity, high school, school counseling, STEM

INTRODUCTION

Research has indicated that high school counselors influence student aspirations and achievements related to science, technology, engineering, and mathematics (STEM) disciplines, facilitating career pathways that are often dependent upon disciplinary preparedness through appropriate course selection and career awareness (Schmidt et al., 2012). Students experience disparate levels of access to

STEM gateway courses, parental guidance, vocational information, and interactions with school counselors possessing significant STEM knowledge (Feller, 2009). Researchers have suggested the need for studies examining contextual barriers and supports that influence students' academic and career aspirations in STEM, particularly for students who have been traditionally underrepresented in these fields (Mau & Li, 2018; Rottinghaus et al., 2018). The purpose of the present study is to identify high school counselors' beliefs and practices related to STEM academic advisement, postsecondary planning, and participation.

REVIEW OF LITERATURE

Role of school counseling and academic advisement in college readiness

School counselors are uniquely positioned to identify and address inequality that may impede the successful transition of high school students to postsecondary study and careers (Holcomb-McCoy, 2007). Research has shown that school counselors are key facilitators of career exploration and attainment for students traditionally underrepresented in STEM, both in sharing the range of career opportunities and helping students overcome barriers to participation (Rottinghaus et al., 2018). The sequence of courses students take in high school, which may be influenced by school counselor intervention, has had a significant influence on college enrollment and persistence in STEM programs (Tyson et al., 2007).

School counselor ability to foster and support college-bound intentions depends on whether they work on college preparation early, the ease with which they collaborate to nurture college aspirations, and the availability of resources for postsecondary preparation (McKillip et al., 2012). However, research has found that only 20% of public school counselor time is typically devoted to college planning, and just 25% of school counselors viewed themselves as integral to the college admissions process (Clinedinst & Koranteng, 2017). In some instances, school counselors spent very little time on college planning to meet the immediate emotional needs of students and perform administrative tasks (Osborn & Baggerly, 2004). These workplace constraints present opportunities for research on optimizing school counselor involvement in college and career planning, particularly in STEM fields that promote socioeconomic mobility.

Socioeconomic and demographic factors in college and career readiness

The way students plan and develop their academic portfolio, career aspirations, and baseline knowledge of workforce expectations plays a crucial role in their future success. Many students, particularly first-generation students, have unaligned ambitions; they may have a career future in mind but limited awareness about the academic steps needed to reach their goals (Schneider et al., 2013). To maximize their effectiveness, school counselors need to assess the social and academic capital students possess and supplement where they are lacking (McKillip et al., 2012).

College and career counseling and academic advisement have not benefited all students equally. Students of higher socioeconomic status typically experience limited benefit from a strong student–school counselor relationship, whereas a strong relationship for students of lower socioeconomic status tends to increase their likelihood of attending college (Belasco, 2013). When students cannot get the information they need at home, the school counselor may become influential and this is often the case for students from lower socioeconomic status (Kimura-Walsh et al., 2009). This has been problematic in high-need schools where school counselors have been less likely to provide college support and mentoring (MacAllum et al., 2007).

The influence of high school counselors has also been found to vary by race. African American students, for example, have been much more likely than White or Hispanic students to name their

high school counselor as the person who most influenced them to attend college (Cholewa et al., 2016). Providing a supportive college-going culture in schools promotes student self-efficacy (Quimby & O'Brien, 2004). However, students from ethnic groups traditionally underrepresented in STEM have reported exposure to course gatekeeping experiences that led to feelings of self-doubt regarding college readiness (Martinez & Deil-Amen, 2015). These negative experiences have been shown to be associated with reduced expectations for attending college, which may adversely impact students' science and mathematics coursetaking and subsequent achievement (Kelly, 2013; West-Olatunji et al., 2010).

Counseling and academic advisement practices related to STEM education

Several researchers have advocated for school counselor-initiated STEM career planning, including gatekeeping course advisement, a focus on academic rigor, promotion of strategic goal setting, and attention toward students traditionally underrepresented in STEM (Feller, 2009; Schmidt et al., 2012). However, many school counselors do not possess enough knowledge to advise about STEM careers and could be more helpful if they made explicit connections between coursework and career goals (McCuen & Greenberg, 2009).

Researchers and policy makers have used the metaphor of the leaky STEM pipeline to illustrate diminishing participation as fewer students reach the pathways and milestones needed to succeed in STEM as they progress vertically through schooling (Cannady et al., 2014). The U.S. Department of Education (USDOE, 2014) defined college and career ready students as students who successfully completed algebra I & II, geometry, and calculus, as well as biology, chemistry, and physics. Students who take science precursors, a second year of chemistry, or 1 or 2 years of physics are more likely to demonstrate interest in STEM as a career and persist in STEM degree attainment (Sadler et al., 2014).

For potential STEM students, school counselors often need to encourage students to take precursor courses at the appropriate time in high school. However, school counselors and teachers have sometimes experienced pressure to encourage students to graduate with easier coursework rather than risk student failure (Gearns et al., 2018; Kelly, 2013). Also, these courses are not consistently available to all students (Kelly & Sheppard, 2008, 2010, 2019). In 2011–2012, only 75% of U.S. high schools offered chemistry, 63% offered physics, and 50% offered calculus (USDOE, 2014). School counselors who are not aware of the importance of these courses to STEM career participation may not advocate for students to take them as electives (Gearns et al., 2018).

Conceptual framework

The guiding theoretical basis for the present study is derived from psychosocial theory that characterizes students' academic and career choices and actions, and how school counselors might interact with students to influence career aspirations and academic behaviors. The *theory of planned behavior* suggests that students make academic decisions based upon their confidence, identity, and sense of controllability (Ajzen, 2002). The theory states that human behavior is guided by likely consequences, the normative expectations of others, and beliefs about inhibiting factors. STEM careers may be viewed as achievable if students have the confidence they may overcome potential obstacles and envision themselves in those careers (Ajzen, 2002; Lent et al., 1994). Students' personal beliefs about the relevance, likelihood, and importance of academic behaviors in meeting valued outcomes may result in the intentions necessary to perform specific tasks. This is consistent with the *theory of reasoned action* proposed by Ajzen and Fishbein (1980), which suggests intention is the main predictor of actual behavior. Intention is informed by attitudes regarding the outcomes of behaviors, as well as perceived behavioral control and social influences (Ajzen & Kruglanski, 2019). Students require knowledge of STEM pathways and vocational choices to identify goals and behaviors that

are consistent with their aspirations (Bugallo et al., 2015; Christian et al., 2021; Kelly, 2016). School counselors often play a significant role in facilitating career information seeking and formulating academic choices that match intended careers (Trusty & Niles, 2004), and the theories of planned behavior and reasoned action may explain the importance of school counselor actions in informing students' intentions.

This conceptual framework incorporates the notion that sociocultural attitudes, normative behaviors, and active school counselor intervention through career exploration and information facilitation help determine where students set their career aspirational goals. The rationale for this work is based upon studies that suggested the potential importance of high school counselor-initiated course advisement and career planning in facilitating access to STEM fields (Schmidt et al., 2012). Because students aspiring to successful STEM postsecondary study require specific courses for postsecondary preparation (Chen, 2009; McCuen & Greenberg, 2009), these students may require school counselors with STEM-specific knowledge, beliefs, and practices to help them choose, sequence, and prepare for needed coursework. Student attributes—self-efficacy, career intention, and the value seen in a potential career—determine how external factors influence aspirational goals. School counselors may beneficially moderate these influences when they have the knowledge and skills to help students manage the relationship between these attributes increasing the likelihood that students will set their sights on larger and higher aspirational goals (Brown et al., 2016).

Through an analysis of high school counselors' beliefs and practices, this work will identify ways in which intentional, sustained high school counseling and academic advisement practices may lead to expanded and more equitable participation in STEM. This qualitative, exploratory cross-case study examined the following research questions:

In what ways and to what extent do high school counselors interact with students to impact high school preparation for postsecondary STEM study and careers?

How do high school counselors' views of students' career aspirations, academic potential, and sociocultural capital influence their STEM-related counseling and academic advisement practices?

METHODOLOGY

Research design

A qualitative exploratory observational design was employed to examine high school STEM counseling and academic advisement practices in various socioeconomic high school contexts. An exploratory study is one that examines an area where research is needed to generate new data, insights, and potential causal mechanisms about the phenomenon studied (Patton, 1990). Multiple individual cases were examined to observe processes and outcomes in relation to contextual variation, with the goal of enhancing generalizability. This naturalistic approach was taken to examine the phenomenon of STEM counseling and academic advisement by capturing participants' perspectives and experiences. Interview data were analyzed inductively to identify emerging patterns, while a deductive approach was employed to evaluate data convergence and divergence with the a priori conceptual framework. The research was conducted by three STEM education researchers—one was also a high school physics teacher, one a former high school science teacher, and one a university computer engineer. This human subjects research was approved by the Stony Brook University Institutional Review Board (#574341).

Participants and context

The qualitative research design required rich contextual information for the selection of interview subjects using the maximum variation sampling technique (Patton, 1990). The majority of the interviewed school counselors were recruited from university-based school district networks. Of the 68

school counselors initially invited to participate in the research, 24 expressed their willingness to be interviewed. Nine school counselors met the criteria established by the researchers to diversify the participant pool, which represented a wide range of student population sizes, demographics, socioeconomic status, student-to-school counselor ratios, and counselor work experience, as evidenced in Table 1. However, four additional school counselors were recruited after the initial recruitment phase but prior to data analysis because they fit the selection criteria and diversified the participant profile in terms of socioeconomic diversity. The research subjects ($N = 13$) ranged in experience from a single year to 36 years. Two of the 13 high school counselors also served in a supervisory capacity.

Demographic, academic, and socioeconomic data were obtained from the state website; this included the ethnic composition of the student population, school/district enrollment and locale, graduation rate, socioeconomic status, and median household income (NYSED, 2020). Other academic measures included the percentage of students qualifying for Regents diplomas, awarded to students who passed four total culminating standardized examinations in English, mathematics, science, and social studies; Advanced Regents diplomas were awarded to students who passed at least eight standardized examinations.

Data collection and analysis

Interview protocol

This study employed a semistructured interview protocol developed from prior research and refined after two pilot interviews with practicing school counselors and analysis of school counselor responses from a previously validated professional development survey (Gearns et al., 2018). The protocol allowed for both open-ended and more direct theoretically driven questioning, allowing the interviewers to member check and expand upon the responses of the research subjects dynamically. School counselor responses in the 1-h interviews conducted by one of the two researchers redirected the questioning focus of the research in some topic areas and narrowed the focus in others. The protocol consisted of 24 questions across four domains: (1) department structure, (2) school counselor practices, (3) perceptions, and (4) STEM knowledge. The researchers employed member checking (Korstjens & Moser, 2018) in two ways, by follow-up questioning during the interviews themselves to clarify relevant points, and by postinterview contact to resolve ambiguous responses.

Coding process

The qualitative interview data were coded in three iterative stages utilizing open, axial, and selective coding methods in an iterative process. The conceptual framework of the present study proposed that students' career intentions predict academic choices and behaviors (Ajzen & Fishbein, 1980), and students make academic decisions based upon confidence and sense of controllability (Ajzen, 2002). Consequently, the coding process sought to capture the dynamic social and behavioral influences related to STEM career aspirations.

In the first stage of coding, recordings were played while the transcripts were read to match verbal inflection. Open codes were developed "in vivo," or derived from the data themselves. There were 32 open codes capturing concepts that interconnected the role and position of the school counselor to students, teachers, administrators, and parents within their school community. The initial open codes were analyzed for similarities and grouped to develop higher order categories. In the second stage, axial codes were identified through interconnections among the open codes to form larger categories with an eye toward situational context, cause and effect, intervening circumstances, and perceived intentional and unintentional consequences. The initial 32 open codes were distributed and consolidated among 13 categories. In the third stage, the selective coding process, the researchers

TABLE 1 School district and counselor characteristics.

District and locale	Counselor experience (years)[a]	School counselor-to-student ratio[b]	School or district enrollment	School majority demographics	Graduation rate 2016–2017 (%)	Regents diploma (%)	Advanced Regents diploma (%)	Median household income 2017 ($)	Free/reduced lunch (%)
A Urban	Brendan (7) Sam (1,8)	100	400 school	Black/African American 73% Hispanic/Latino 25%	82	79	0	52,800	83
B Suburban	Tyler (14)	250	4951 district	Hispanic/Latino 59% Black/African American 22% White 15%	86	50	29	71,400	75
C Suburban	Patricia (19) Jeni (14)	265–270	8999 district	White 49% Hispanic/Latino 24% Black/African American 19%	84	50	32	72,600	53
D Suburban	Brittany (20,10)	220	5992 district	Hispanic/Latino 42% White 31% Black/African American 20%	87	46	37	84,400	53
E Suburban	Noelle (36) Mia (14)	260	13,303 district	White 77% Hispanic/Latino 13% Asian/Native Hawaiian 6%	92	33	54	91,500	26
F Suburban	Nina (12)	200	6438 district	White 51% Asian/Native Hawaiian 37% Hispanic/Latino 9%	94	15	77	118,900	18
G Suburban	Alexa (10)	190	1566 district	White 70% Hispanic/Latino 21%	93	28	63	122,600	24
H Suburban	Matteo (20)	180	5373 district	White 83% Hispanic/Latino 8% Asian/Native Hawaiian 6%	94	23	69	142,900	11

(Continues)

TABLE 1 (Continued)

District and locale	Counselor experience (years)[a]	School counselor-to-student ratio[b]	School or district enrollment	School majority demographics	Graduation rate 2016–2017 (%)	Regents diploma (%)	Advanced Regents diploma (%)	Median household income 2017 ($)	Free/reduced lunch (%)
I Suburban	Aldo (14)	215	6365 district	White 60% Asian/Native Hawaiian 34% Hispanic/Latino 4%	98	13	84	163,800	6
J Suburban	Lucas (2)	160	1752 district	White 89% Hispanic/Latino 5% Asian/Native Hawaiian 4%	98	12	86	207,700	1

[a]Two school counselors had teaching experience prior to becoming counselors. This is reported as (years counseling, years teaching).
[b]Counselor-to-student ratio as reported by the counselor. Ratio reflects the counselor's individual school and a secondary educational setting.

further refined the categories to develop core concepts. The researchers examined how student–school counselor interactions fit within the conceptual framework of the theories of planned behavior and reasoned action. This iterative analysis process provided a means for the emergence and consolidation of three common themes. The initial 32 open codes were consolidated into 13 axial codes and further developed into the three major themes.

Trustworthiness

Several strategies were incorporated into the research design to establish credibility and trustworthiness. First, the researchers used triangulation in reviewing the findings; this permitted independent analysis of the data and allowed cross-case comparison of the findings, reducing selective perception and interpretation bias (Patton, 1990). Two researchers performed the coding, analysis, and interpretation of data and reached a reliability threshold of >90% agreement through extended discussion. Second, transferability was supported by a thick descriptive data narrative. Finally, reflexivity was enacted through a process of self-reflection whereby the researchers discussed how their viewpoints, assumptions, and values affected their coding choices (Korstjens & Moser, 2018).

FINDINGS

Qualitative data analysis revealed several notable trends in how school counselors characterized students' decision-making processes, identified sociocultural influences on STEM access and participation, and provided STEM-related advisement. Three main themes emerged. These were (a) sociocultural factors related to STEM participation, (b) STEM counseling and academic advisement practices and challenges, and (c) student performance and aspirations related to STEM study and careers.

Sociocultural factors in STEM participation

The school counselors shared that familial influence was often a factor that contributed to students choosing coursework that positioned them for postsecondary STEM, and family and individual aspirations sometimes did not align with the school counselor's perceptions of how realistic these expectations were. Tyler, a school counselor in a suburban district with a large population of ethnic minorities in STEM, partly attributed lack of postsecondary STEM participation among his students to their lower socioeconomic standing and the relative scarcity of parents working in STEM fields. He noted that many students were first-generation college bound and their parents did not always possess the academic capital to encourage course choice. He commented, "I think the math and science for our kids can be scary because there is no one to help them at home. There's not a lot of positive reinforcement for the science and math." Although he saw STEM as a means to facilitate social mobility, his students were often behind their peers in other school districts, and preparing them for a career in STEM meant they often had to double up on advanced science and mathematics coursework in their senior year.

Aldo concurred with Tyler's views on familial influence but his observations stemmed from his experiences in a wealthier district with a 98% graduation rate, stating, "The parents in the community know that [STEM] is a wanted field right now. There's good job market. So they'll push their kids to it." He worked with parents who had more academic knowledge and could advise their children to maximize their STEM access. Parental social and cultural resources were often viewed by the school counselors as crucial to the aspirations of their children.

Brendan, a school counselor from an urban high-need school, agreed with Tyler's observation while stressing his responsibility to be realistic about what students could accomplish. He advocated realistic decision making with both students and parents:

> *Brendan*: We are looking at things that a kid may not be seeing or families may not be seeing. Yeah, you want your kid to be an engineer, but there's evidence that says that may not be – and it's not about the kid's intelligence… they may not have had the resources or the classes or the experiences that are going to allow them to be successful.

Sam, a fellow school counselor of Brendan from an urban school, related that it was important to speak to students and their families in a way that they were not diminishing their aspirations but supporting them. This was a particularly important consideration with STEM preparation, since many families viewed this as a pathway to economic security. Although he wanted to help students achieve that goal, he articulated educational, financial, and social ramifications if his students did not succeed. He questioned whether counseling marginally prepared students toward STEM careers was appropriate. He recalled his own undergraduate experience and the tradition of "weed out" course attitudes and the lack of support for STEM undergraduates. He observed:

> *Sam*: Should I even be counseling these students toward a STEM class, knowing that Physics 101 is designed for people who got at least a 3 on the AP Calc exam. Our AP Calc passage rate is hovering in the 15 to 20% range… Knowing that we have gaps in the rigor… what is my place in that? Should I be encouraging kids… because certainly my experience in college was that those resources are much less forthcoming in STEM.

Sam's comments are also notable in that he indicated his beliefs and actions were formulated by his own experiences in college. Although his perspective reflected a desire to maximize his students' postsecondary success, his reluctance expressed some bias related to lack of support in college STEM programs. School counselors without STEM backgrounds, such as Aldo and Sam, often shared this view and did not encourage this path if they believed students might fail.

STEM counseling and academic advisement practices

School counselors shared practices related to fostering pathways to STEM postsecondary study and careers. For many students, this included early access to algebra 1 in eighth grade, which positioned them to take more advanced courses before graduation. The advisement of school counselors was often essential for students to take advantage of this opportunity. Alexa, a high school counselor who also served as the department supervisor in a suburban district, explained that she often intervened with less advantaged students, particularly English language learners: "Sometimes we have students whose families—and it's not their fault in any way—but they are not aware of the opportunities that are available to students."

Tyler further emphasized the importance of early acceleration in science and mathematics, stating that "… if a kid hasn't been tracked in [science and mathematics] from the time they're in seventh or eighth grade… a lot of times, they're behind in what they need to do." He explained that there was little opportunity for upper-level vertical advancement in mathematics and science if students were not taking advanced courses in middle school. Mia, a school counselor in a middle-class suburban district, shared that her district was implementing policies to increase the percentage of eighth-grade students in advanced science and mathematics to 75%, which would optimize student access to advanced STEM courses in junior and senior year.

The school counselors frequently discussed similar efforts to preserve student postsecondary options by encouraging rigorous coursetaking. Noelle, a school counselor with 36 years of experience

in a middle-class suburban district, shared that her approach was to emphasize being the best student possible by striving for coursetaking rigor. She advised students to take a fourth year of mathematics even if they had met the graduation requirement of 3 years:

> *Noelle*: You really need to be taking it for four years… I don't know where you're gonna end up and when you're a junior in college and you want to change your major, I want you to have the background to be able to do that.''

Students in wealthier school districts were more likely to pursue this rigor without school counselor intervention. Lucas, who worked in a well-resourced district, had a caseload of just 160 students and commented that his students with STEM aspirations tended to enroll in "2 years of chemistry, followed by 2 years of physics; some are trying to get that AP Bio course in." Since many of his students had STEM ambitions, they usually took his advice even if they had not previously planned this type of schedule.

The school counselors discussed other ways in which students might develop STEM career interest. One frequently mentioned academic advisement tool was career inventory software. Students were generally introduced to these programs in ninth or 10th grade as a means to learn about college and career options. Usage seemed to vary, with school counselors from more affluent schools with smaller caseloads using it less frequently than those in schools with fewer resources and larger caseloads. The software provided data that could be disaggregated, which allowed for increased school counselor efficiency. Patricia, a counseling director from an economically disadvantaged district, stated that this program helped students recognize how precursor electives "align directly to their future," and it helped school counselors identify and groom multiple students simultaneously.

Nina, a school counselor in a wealthy suburban school district, shared that student interest in STEM was sometimes promoted through participation in science extracurriculars, science research classes, dual credit college coursework, and access to engineering electives. Matteo, also from a well-resourced district, elaborated on targeting students and providing exposure to engineering design and skills through related electives:

> *Matteo*: And as they're coming in, getting them into our Design and Drawing for Production class in ninth grade, and then in tenth grade is our Foundations of Engineering, and the Principles of Engineering the following year. And then they either take an AP like Computer Science, or they do Digital Electronics.

These efforts illustrate the strategies school counselors implemented to foster student interest in STEM, which involved early interventions to promote advanced science and mathematics, targeting students with potential, and disseminating science and engineer career information through software platforms, engineering electives, and extracurriculars.

School counselors shared a variety of situations that made their job challenging. Large student caseloads, lack of time for professional development, frequent interruptions in their workday, extensive paperwork, and high information demands from students, parents, and other faculty were some chronic issues. Some school counselors also admitted their lack of knowledge about how to guide students toward STEM coursework that matched career aspirations.

Patricia expressed her frustration at not having the time to adequately handle her role as a college and career school counselor when crises arose, since she often had to postpone meetings with juniors or seniors needing college advice. With a caseload of 285–300 students, she noted that "things get missed," which she lamented since the many first-generation students in her district were "… definitely more reliant on the [school] counselor to guide them through the process… the majority of students are doing this on their own." For example, some of her STEM-oriented students had not taken advanced mathematics or science in eighth grade, so they had to take multiple advanced science and mathematics

courses simultaneously in 11th and 12th grade. A smaller caseload may have allowed her to help students maximize their postsecondary STEM potential.

School counselors often shared they had limited knowledge about many STEM professions. They understood their role in encouraging students to consider STEM careers, but sometimes felt overwhelmed by the demands of the job that inhibited their professional development in STEM counseling and academic advisement. School counselors often recognized they were not keeping up with STEM fields and often sought outside resources to help direct their students, as Noelle remarked, "There's thousands of careers within that [STEM] and you need to be able to kind of open that door for them to know that they can go research those things." Since most of the school counselors relied on external resources to inform students about STEM careers, continued professional development in STEM advisement may have allowed them to provide more immediate, targeted information tailored toward students' needs and interests.

Student career aspirations and performance related to STEM

Several school counselors shared the tensions they experienced when students' academic and career aspirations did not match their choices in terms of course selection, performance, and college selection. This inconsistency between behaviors and intentions was a particular challenge in advising students who intended to study STEM-related disciplines. Jeni, a school counselor in a high-need school district, discussed her conversations with students interested in STEM majors, and the need for them to set goals for high achievement on standardized performance measures: "If they are not already taking [SATs and grades] seriously, they really need to know how difficult the [STEM] programs are. And if they're setting goals for themselves, they have to shoot to hit those numbers."

In addition to the standardized metrics, Jeni pushed those who were aiming for STEM majors to select the courses that best prepared them for those careers, particularly physics. Although the high-performing students were typically accelerated into physics by sophomore or junior year, those who were not in the top track often opted instead for half-semester courses such as anatomy and physiology. Lucas, a school counselor from a high-performing district, shared that he was recommending physics for students aspiring to engineering majors. Unlike Jeni, Lucas counseled students who were already more likely to take advanced science and mathematics courses. He also attributed this to the socioeconomic profile of the families in the community, many of whom worked in STEM fields. However, he found that advisement was particularly important for those students "who are looking for engineering but might not be elite in their grades." These students were largely open to encouragement and advice from school counselors.

Several school counselors mentioned the value of strong professional knowledge about STEM, which allowed them to communicate accurate expectations regarding prerequisite coursework and the demands of STEM majors. Brittany, a school counselor in a low-socioeconomic-status district, discussed how ongoing STEM professional development improved her ability to advise students on engineering careers. She explained how she revised her approach to advising students as her knowledge improved:

> *Brittany*: I think a student who is really interested in engineering and is not 100% sure really needs to commit to it as soon as possible… if they have to go into an engineering major, it's going to take them probably exactly four years. But if they go in as undecided or liberal arts, it will probably take them longer.

This type of "backward planning" was her strategy for informing students of the challenges of majoring in engineering, with a particular focus on course selection and knowledge of academic demands. In this way, students could plan their precollege course pathway and had more realistic expectations of their academic commitments in college.

DISCUSSION

The novelty of these findings is in highlighting the challenges and opportunities in the disciplinary-specific nature of STEM counseling and academic advisement, which leads to careers with documented disparate participation in terms of socioeconomic status and ethnicity. Targeted, intentional high school counseling and academic advisement practices may lead to more diversified participation in STEM, which may be socially and economically advantageous for traditionally underrepresented groups (Rottinghaus et al., 2018). These practices are important to understand since students often form career aspirations based on their access to information for goal setting, academic choices, and career expectations (Ajzen, 2002).

The research questions in the present study addressed two lines of inquiry: (1) the nature and extent of school counselors' interactions with students in terms of preparation for postsecondary STEM study and careers, and (2) how school counselors' views of students' career aspirations, academic potential, and sociocultural capital influence their STEM-related counseling and academic advisement. The findings from this research suggest three major thematic elements. First, sociocultural factors often influenced student preparation for STEM, career planning, and decision making, as well as how school counselors perceived different socioeconomic classes of students. Second, students' career goals and academic behaviors were sometimes misaligned, and school counselors described ways in which their practices mediated this tension. Third, school counselors' professional knowledge, beliefs, and practices were influenced by professional preparation, workplace characteristics, and their own academic experiences. These three themes were related to students' planned behavior and reasoned action, given that student career intentions are often influenced by school counselor advisement and sociocultural factors.

The school counselors indicated several notable trends in sociocultural influences on STEM career planning and intentions. Students may not develop STEM career goals if they are not consistent with their identities, sense of controllability, and sociocultural values (Ajzen, 2002; Ajzen & Fishbein, 1980). Some students from disadvantaged backgrounds did not have support for STEM aspirations; in this sense, they often did not understand the expectations and preparation required for STEM fields. The need for school counselors educated in STEM career expectations and transcript planning is acute, particularly for students with lower socioeconomic standing and limited familial academic capital who are more reliant upon school counselor intervention (Belasco, 2013; MacAllum et al., 2007). Well informed career goals may lead to early academic behaviors that consistently reinforce students' preparedness for STEM study, since student motivation often depends upon the likelihood that certain actions will facilitate desired goals (Ajzen, 2002). This should occur as early in the STEM pipeline as possible to compensate for potential missed prerequisite coursework in advanced science and mathematics, a chronic problem for students attending less-resourced schools (Kelly & Sheppard, 2009; USDOE, 2014).

School counselors reported several challenges associated with recruiting students with potential for success in STEM fields, as well as working with less-prepared students in these areas. This is a social justice issue since school counselors in wealthier districts reported their students often had significant sociocultural supports, reasoned academic actions, and histories of rigorous coursetaking. Beliefs and expectancies about career goals strengthen behavioral intentions; in the present case, knowledge of STEM academic pathways increases the likelihood that students will sense control over their ability to meet academic thresholds for success (Ajzen & Kruglanski, 2019). Active counseling and academic advisement interventions were discussed to expose nontraditional students to STEM fields, particularly those with less stellar academic profiles. These interventions exemplify how intentional advisement might positively influence students' postsecondary opportunities at a crucial point in students' academic lives.

However, some school counselors reported their discomfort and tension when students aspired for STEM if they were not perceived as well positioned for success. These findings move beyond

prior research by demonstrating that school counselors may also be influenced by limited STEM disciplinary knowledge and personal biases when counseling students who do not fit their conception of a "STEM" person. These biases may have been based upon their own reluctance to study STEM subjects, which have an elitist connotation and are often presumed to require brilliance (Leslie et al., 2015). This perspective might be mediated through professional education that provides specific training in coursework profiles that match STEM college majors and careers. Specificity in STEM communications may clarify students' expectations and the possibilities for societal advancement. By doing so, students may engage in planned behaviors that are consistent with realistic career expectations (Ajzen & Kruglanski, 2019).

Implications

The findings present several implications for counseling and academic advisement policy and practice. First, early and consistent counseling and academic advisement interactions with students will maximize their likelihood of taking advanced science and mathematics coursework early in the pipeline, which contributes to postsecondary STEM readiness. These communications are particularly important for students from low socioeconomic status and those traditionally underrepresented in STEM. Access to high-quality STEM counseling and academic advisement is typically limited for underresourced schools (Rottinghaus et al., 2018), where students may be dissuaded from pursuing advanced science and mathematics to prioritize graduation rates (Kelly, 2013; Nehmeh & Kelly, 2018). Preservice school counseling programs should include training and coursework on culturally relevant practices that advocate for students traditionally underrepresented in STEM to persist in preparatory STEM coursework and careers. Student–school counselor interactions may be more frequent if there is a reconceptualization of school counselor workload; diminishing administrative tasks may facilitate more substantive and frequent counseling and academic advisement.

Second, school counselors and their students should be aware that there are multiple pathways to participate in STEM postsecondary study. Some school counselors identified their strategies for encouraging less-well-prepared students to strengthen their transcripts. In doing so, students would be better situated to formulate and pursue STEM career aspirations by completing gateway coursework (Cannady et al., 2014; Trusty & Niles, 2004). Others discussed STEM-related extracurriculars, engineering electives, and science research as mechanisms to promote interest. It is important for school counselors to understand that not all students may fit their preconceived notions of who is suitable for STEM; a broader approach is necessary to maximize and diversify participation in these fields.

A third implication is the necessity of school counselor educators to modify their curricula to prepare future school counselors for advising students regarding STEM occupations. School counselors, who come from a variety of disciplines, may not have an understanding of what is required to be successful in these majors. The ASCA National Model recommended that school counselors collaborate with other professionals throughout the field to increase collective knowledge as well as advocate for best practices to improve the academic experiences of all students (ASCA, 2019). Counselor educators may be a powerful ally in this effort.

Finally, the school counselors in the present study alluded to the importance of families in influencing or unintentionally inhibiting student aspirations toward STEM. A focus on holistic counseling and academic advisement that includes both students and families may alleviate this tension. Interventions aimed toward strengthening interactions between school counselors and families have been shown to promote higher academic achievement, especially for students traditionally underrepresented in STEM (Mitchell & Bryan, 2007).

Limitations

There are several limitations to the present study. First, the relatively small number of school counselor participants, though purposefully sampled, may not be representative of school counselors from other regions in the United States. Second, the school counselor-to-student ratios as reported by the research subjects are quite favorable and align with the ASCA recommendation of 250 to 1 (ASCA, 2019). These findings may not describe school counselor–student relationships in schools with significantly larger school counselor–student ratios. Additionally, the interview transcripts were the sole source of data; additional observational data would triangulate findings and strengthen the validity and reliability of the analysis. However, observing school counselor–student interactions has additional ethical considerations so the study was limited to self-reported school counselor data. Third, the researchers, all STEM educators, have biases and perspectives that may have influenced the coding of the transcripts and the interpretation of cross-case analysis. Although they bracketed their findings through iterative discussions, their viewpoints may have been influenced by a latent advocacy for diversifying participation in STEM.

Future research

The findings from the present study may be expanded upon exploration of the integral nature of school counseling practices in relation to diversifying and expanding the talent pool for STEM careers. Large-scale collection of observational, baseline data on STEM academic advisement practices throughout the K-12 pipeline could inform future randomized, controlled intervention trials. Such interventions might include intensive professional development with diversity training; how STEM college studies are related to high school curricula; and informative discussions with engineers, STEM researchers, and university faculty to learn about engineering pathways. Other interventions might include the expansion of school counselor licensure requirements to include STEM-specific training. Furthermore, research on how specific school counselor–student interactions influence students' academic behaviors and career goals may provide insights on identifying nontraditional students for STEM career pathways.

Conclusions

The findings from this study and future work may communicate the importance of school counselors in facilitating access and support for STEM careers, which provide tangible paths to socioeconomic mobility. This is particularly important for traditionally underrepresented students in STEM, who often need early, sustained interventions to advance through the pipeline to achieve their aspirations. Their challenges were often characterized by their own limited knowledge of STEM career pathways, in addition to large student caseloads, high information demands, administrative burdens, and limited resources. Students' career aspirations were often misaligned with academic performance and course choices. However, high school counselors have largely been an untapped ally in increasing the opportunities for a greater and more diverse population of students in STEM subjects. Their efforts in STEM academic advisement have tremendous potential for increasing the number of curious, scientifically literate students prepared to pursue STEM careers.

ACKNOWLEDGMENTS
This research was supported by the National Science Foundation (Broadening Participation in Engineering #1647405) and Research Experiences for Teachers #1840953. and National Grid.

ORCID

Richard Gearns https://orcid.org/0000-0003-4978-673X
Angela M. Kelly https://orcid.org/0000-0003-1393-1296
Mónica F. Bugallo https://orcid.org/0000-0003-2963-1474

REFERENCES

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology*, *32*(4), 665–683. https://doi.org/10.1111/j.1559-1816.2002.tb00236.x

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Prentice Hall.

Ajzen, I., & Kruglanski, A. W. (2019). Reasoned action in the service of goal pursuit. *Psychological Review*, *126*(5), 774–786. https://doi.org/10.1037/rev0000155

American School Counselor Association (ASCA). (2019). *ASCA national model: A framework for school counseling programs* (4th ed.). Author.

Belasco, A. S. (2013). Creating college opportunity: School counselors and their influence on postsecondary enrollment. *Research in Higher Education*, *54*(7), 781–804. https://doi.org/10.1007/s11162-013-9297-4

Brown, P. L., Concannon, J. P., Marx, D., Donaldson, C., & Black, A. (2016). An examination of middle school students' STEM self-efficacy, interests and perceptions. *Journal of STEM Education: Innovations and Research*, *17*(3), 27–38. https://www.jstem.org/jstem/index.php/JSTEM/article/view/2137

Bugallo, M. F., Kelly, A. M., & Ha, M. (2015). Impact of a university-based electrical and computer engineering summer program for high school students. *International Journal of Engineering Education*, *31*(5), 1419–1427.

Cannady, M. A., Greenwald, E., & Harris, K. N. (2014). Problematizing the STEM pipeline metaphor: Is the STEM pipeline metaphor serving our students and the STEM workforce? *Science Education*, *98*(3), 443–460. https://doi.org/10.1002/sce.21108

Chen, X. (2009). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education*. Department of Education.

Christian, K. B., Kelly, A. M., & Bugallo, M. F. (2021). NGSS-based professional development for implementing engineering design in STEM instruction. *International Journal of STEM Education*, *8*(21). https://doi.org/10.1186/s40594-021-00284-1

Cholewa, B., Burkhardt, C. K., & Hull, M. F. (2016). Are school counselors impacting underrepresented students' thinking about postsecondary education? A nationally representative study. *Professional School Counseling*, *19*(1), 144–154.

Clinedinst, M., & Koranteng, A. (2017). *2017 state of college admission*. National Association for College Admissions Counseling.

Feller, R. (2009). STEM centric career development: Sputnik II or a thud? *Career Planning & Adult Development Journal*, *25*(1), 19–35.

Gearns, R., Kelly, A. M., & Bugallo, M. F. (2018). *Professional development for high school guidance counselors to facilitate precollege STEM preparation*. Proceedings of the 2018 American Society for Engineering Education Annual Conference & Exposition, Salt Lake City, UT, United States. https://peer.asee.org/30897

Holcomb-McCoy, C. (2007). *School counseling to close the achievement gap: A social justice framework for success*. Corwin Press.

Kelly, A. M. (2013). Physics teachers' perspectives on factors that affect urban physics participation and accessibility. *Physical Review Physics Education Research*, *9*(1), Article 010122. https://doi.org/10.1103/PhysRevSTPER.9.010122

Kelly, A. M. (2016). Social cognitive perspective of gender disparities in undergraduate physics. *Physical Review Physics Education Research*, *12*(2), Article 020116. https://doi.org/10.1103/PhysRevPhysEducRes.12.020116

Kelly, A. M., & Sheppard, K. (2008). Newton in the Big Apple: Access to high school physics in New York City. *The Physics Teacher*, *46*(5), 280–283. https://doi.org/10.1119/1.2909745

Kelly, A. M., & Sheppard, K. (2009). Secondary physics availability in an urban setting: The relationship to academic achievement and course offerings. *American Journal of Physics*, *77*(10), 902–906. https://doi.org/10.1119/1.3191690

Kelly, A. M., & Sheppard, K. (2010). The relationship between the urban small schools movement and access to physics education. *Science Educator*, *19*(1), 14–25.

Kelly, A. M., & Sheppard, K. (2019). *Access to elite urban science schools in the U.S.: Opportunity, disparate impact, and equal protection*. Teachers College Record. https://www.tcrecord.org/Content.asp?ContentID=22951

Kimura-Walsh, E., Yamamura, E. K., Griffin, K. A., & Allen, W. R. (2009). Achieving the college dream? Examining disparities in access to college information among high achieving and non-high achieving Latina students. *Journal of Hispanic Higher Education*, *8*(3), 298–315. https://doi.org/10.1177/1538192708321648

Korstjens, I., & Moser, A. (2018). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120–124. https://doi.org/10.1080/13814788.2017.1375092

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, *45*(1), 79–122. https://doi.org/10.1006/jvbe.1994.1027

Leslie, S. J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, *347*(6219), 262–265. https://doi.org/10.1126/science.1261375

MacAllum, K., Glover, D. M., Queen, B., & Riggs, A. (2007). *Deciding on postsecondary education: Final report*. National Postsecondary Education Cooperative.

Martinez, G. F, & Deil-Amen, R. (2015). College for all Latinos? The role of high school messages in facing college challenges. *Teachers College Record*, *117*, Article 030301.

Mau, W. C. J., & Li, J. (2018). Factors influencing STEM career aspirations of underrepresented high school students. *The Career Development Quarterly*, *66*(3), 246–258. https://doi.org/10.1002/cdq.12146

McCuen, R. H., & Greenburg, J. (2009). Educating guidance counselors on engineering as a career and academic choice. *Journal of Professional Issues in Engineering Education and Practice*, *135*(3), 91–94. https://doi.org/10.1061/(ASCE)1052-3928(2009)135:3(91)

McKillip, M. E. M., Rawls, A., & Barry, C. (2012). Improving college access: A review of research on the role of high school counselors. *Professional School Counseling*, *16*(1), 49–58. https://doi.org/10.1177/2156759X1201600106

New York State Education Department (NYSED). (2020). *New York State education at a glance*. https://data.nysed.gov

Mitchell, N. A., & Bryan, J. A. (2007). School-family-community partnerships: Strategies for school counselors working with Caribbean immigrant families. *Professional School Counseling*, *10*(4), 399–409. https://doi.org/10.1177/2156759X0701000413

Nehmeh, G., & Kelly, A. M. (2018). Urban science teachers in isolation: Challenges, resilience, and adaptive action. *Journal of Science Teacher Education*, *29*(6), 527–549. https://doi.org/10.1080/1046560X.2018.1474425

Osborn, D. S., & Baggerly, J. N. (2004). School counselors' perceptions of career counseling and career testing: Preferences, priorities, and predictors. *Journal of Career Development*, *31*(1), 45–59. https://link.springer.com/article/10.1023/B:JOCD.0000036705.02911.df

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Sage.

Quimby, J. L., & O'Brien, K. M. (2004). Predictors of student and career decision-making self- efficacy among nontraditional college women. *The Career Development Quarterly*, *52*(4), 323–339. https://doi.org/10.1002/j.2161-0045.2004.tb00949.x

Rottinghaus, P. J., Falk, N. A., & Park, C. J. (2018). Career assessment and counseling for STEM: A critical review. *The Career Development Quarterly*, *66*(1), 2–34. https://doi.org/10.1002/cdq.12119

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2014). The role of advanced high school coursework in increasing STEM career interest. *Science Educator*, *23*(1), 1–13.

Schmidt, C. D., Hardinge, G. B., & Rokutani, L. J. (2012). Expanding the school counselor repertoire through STEM-focused career development. *The Career Development Quarterly*, *60*(1), 25–35. https://doi.org/10.1002/j.2161-0045.2012.00003.x

Schneider, B., Broda, M., Judy, J., & Burkander, K. (2013). Pathways to college and STEM careers: Enhancing the high school experience. *New Directions for Youth Development*, *2013*(140), 9–29. https://doi.org/10.1002/yd.20076

Trusty, J., & Niles, S. G. (2004). Realized potential or lost talent: High school variables and bachelor's degree completion. *The Career Development Quarterly*, *53*(1), 2–15. https://doi.org/10.1002/j.2161-0045.2004.tb00651.x

Tyson, W., Lee, R., Borman, K. M., & Hanson, M. A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk*, *12*(3), 243–270. https://doi.org/10.1080/10824660701601266

U.S. Department of Education. (2014). *Civil rights data collection data snapshot: College and career readiness*. U.S. Department of Education, Office for Civil Rights.

West-Olatunji, C. W, Shure, L., Pringle, R., Adams, T., Lewis, D., & Cholewa, B. (2010). Exploring how school counselors position low-income African American girls as mathematics and science learners. *Professional School Counseling*, *13*(3), 184–195. https://www.jstor.org/stable/42732892

How to cite this article: Gearns, R., Kelly, A. M., & Bugallo, M. F. (2023). School counseling practices related to postsecondary STEM participation. *The Career Development Quarterly*, 1–16. https://doi.org/10.1002/cdq.12338