Contemporary Educational Psychology xxx (xxxx) 101989

Contents lists available at ScienceDirect

Contemporary Educational Psychology

journal homepage: www.elsevier.com/locate/cedpsych

There are two I's in motivation: Interpersonal dimensions of science self-efficacy among racially diverse adolescent youth

Matthew H. Kim [a,*], Ross C. Anderson [b], Nicholette DeRosia [c], Ed Madison [d], Jenefer Husman [c]

[a] University of Kentucky, Department of Psychology, Kastle Hall, Lexington, KY 40506, United States
[b] Inflexion, 360 E. 10th Avenue, Suite 300, Eugene, OR 97401, United States
[c] University of Oregon, College of Education, HEDCO Education Building, Eugene, OR 97403, United States
[d] University of Oregon, School of Journalism and Communication, Allen Hall, Eugene, OR 97403, United States
[e] University of Oregon, College of Education, HEDCO Education Building, Eugene, OR 97403, United States

ARTICLE INFO

Keywords:
Motivation
Self-efficacy
Future selves
Science
Race/ethnicity
Adolescence
Collectivism

ABSTRACT

With the increased growth of career opportunities in STEM fields, educators and policymakers have sought to better understand the nature and development of students' motivation to pursue science academic and career pathways successfully. However, our understanding of motivational constructs such as self-efficacy has mostly been based on studies of predominantly White samples, neglecting the perspectives and experiences of students from historically marginalized groups underrepresented in STEM academic and career pathways. In the present study, we examined science motivation in six high school students of color who participated in a brief, near peer mentoring program with undergraduate mentors of color. Deductive and inductive coding of semi-structured interviews with mentees and mentors revealed that science self-efficacy not only has a salient future-oriented component, but also centers around the importance of forming and maintaining interpersonal connections with others through proxy agency and help-seeking behaviors. These data point to the utility of a sociocultural perspective in expanding our understanding of self-efficacy—and motivational processes more generally—in a way that is more inclusive of the experiences of racial and ethnic minority youth.

1. Introduction

Many students pursue academic and career pathways in STEM (science, technology, engineering, and math) based on meaningful personal experiences and sincere interest in influencing their communities positively. However, students in many countries express a lack of interest in science, marked by declines in enrollment in high school and university science courses (Lyons, 2006). Transmissive pedagogy (e.g., top-down instruction), decontextualized context (e.g., instruction that does not resonate with youth), and the perceived difficulty of science coursework can decrease interest in science (Lyons, 2006). Many levels of influence—including gender, teachers, curricula, and the broader culture—interact to form attitudes toward science in school-aged children and youth (see Osborne, Simon, & Collins, 2003, for a review). These trends have prompted researchers to better understand the nature and development of science motivation and to develop strategies for enhancing STEM motivation and learning outcomes.

Theories of motivation seek to explain the nature and development of students' beliefs about learning and their values and goals for learning. Our study focuses specifically on self-efficacy, which is particularly salient in the context of science learning. Self-efficacy reflects one's beliefs that they will be successful in an activity (e.g., Bandura, 2018). Although these beliefs influence academic engagement and performance broadly, self-efficacy theory has also been applied to the study of motivation within specific achievement domains, such as science.

Much of this research has examined motivation among predominantly White populations. The motivational beliefs and processes among diverse groups of individuals in varied learning contexts remain significantly understudied. In addition to this dearth of knowledge, the racial and gender inequities in STEM fields that have led to women and students of color being underrepresented in STEM academic fields and career pathways remains a persistent challenge (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). These inequities have roots in under resourced schools (Reardon & Robinson, 2007), institutional racism (McGee, 2016), and lack of visible role models (O'Brien, Bart, & Garcia,

* Corresponding author.
E-mail addresses: matthew.kim@uky.edu (M.H. Kim), ross.anderson@inflexion.org (R.C. Anderson), nicholette.derosia8@gmail.com (N. DeRosia), madison2@uoregon.edu (E. Madison), jhusman@uoregon.edu (J. Husman).

https://doi.org/10.1016/j.cedpsych.2021.101989

2020), among other factors. Despite reporting interest in pursuing science majors on par with their White peers, students from historically marginalized groups are less likely to pursue educational and career pathways in science (e.g., Chang, Sharkness, Hurtado, & Newman, 2014).

In recent years, scholars have increasingly acknowledged the importance of examining the cultural relevance of motivation research in ways that are inclusive of the experiences of students from underrepresented groups (Kumar, Zusho, & Bondie, 2018). In contrast to theoretical models of motivation that propose universal principles and processes (often described as a "top-down" etic approach), a situative approach to motivation acknowledges the "complexity of contexts" inherent in how individuals perceive and respond to their environments (Nolen, Horn, & Ward, 2015). A situative approach also acknowledges the role of relationships and structures in shaping motivation (Nolen, 2020). The present study seeks to better understand the nature of science motivation—particularly self-efficacy—by applying a situative lens that acknowledges the sociocultural factors that shape academic motivation and achievement, particularly among youth of color. We employed a qualitative research design to systematically examine how youth reflect on their motivation to pursue science academic and career pathways through deductive and inductive coding of in-depth, semi-structured interviews.

The introduction is organized around several broad themes. We begin with a discussion of how a situative and sociocultural perspective, which examines and elevates the voices of youth of color, can help expand and shift our understanding of science motivation during adolescence. We then consider how this perspective might help broaden our understanding of self-efficacy in particular. Then, we explore how out-of-school learning environments such as near peer mentoring models can help us better understand the nature of science motivation outside of traditional classroom settings. Finally, we argue that small sample qualitative inquiry can expand our understanding of science motivation, refine motivational theories to be inclusive of marginalized groups, and improve current measurement approaches. Closely following Usher (2018) framing in her commentary challenging the theoretical and methodological assumptions guiding motivation research, we frame the current study through the *who*, *what, where*, *when*, and *how* of research on science motivation in diverse student populations.

1.1. The Who: Science Motivation Among Students of Color

There is a growing awareness among psychological scientists regarding the overrepresentation of racially homogenous (i.e., White) samples, with implications for our (mis)understanding of psychological processes as human universals or cultural specifics (e.g., Henrich, Heine, & Norenzayan, 2010; Nielsen, Haun, Kartner, & Legare, 2017). Notably, there have been increasing efforts to achieve greater representation of racial, ethnic, and cultural minorities within educational psychology (e.g., Matthews & Lopez, 2020) and motivation science in particular (Usher, 2018). In fact, a special issue in *Contemporary Educational Psychology* recently highlighted a dialogue amongst motivation scholars around issues of diversity as it relates to theory building and methodological advances in motivation science (Koenka, 2020).

Theories of motivation often situate psychological and learning processes primarily within the individual. However, empirical research examining the educational experiences of racial and ethnic minority youth reveals a more complex picture. Students of color, such as Black and Latinx youth, often hold a sense of self that reflects a *collectivist* orientation (Allen & Bagozzi, 2001; Carson, 2009; Vargas & Kemmelmeier, 2013). This perspective suggests that motivation to pursue science depends on the presence and quality of interpersonal relationships and community ties, particularly for minoritized youth. A mixed-methods study of undergraduate students from Jamaica revealed that academic motivation derives largely from sociocultural factors—such as familial and religious factors—which emphasize interconnections between individuals and systems (Clayton & Zusho, 2016). Using qualitative and quantitative research methodologies, King and McInerney (2019) described and demonstrated the collectivist, rather than achievement oriented, goals of Filipino adolescence. Specifically, rather than the mastery/performance and approach/avoidance goal distinctions often presented in etic approaches to goal theory research, open-ended responses showed that youth identified a goal orientation called *family-support goals* that was culturally relevant and important for Filipino youth (King & McInerney, 2019). A separate study reveals how academic motivation of Black and Latinx students might derive from *communalism*, which emphasizes the importance of social bonds, rather than from self-oriented reasons. This mixed-methods study showed that a STEM curriculum that emphasized communal learning opportunities was effective in enhancing student engagement for Black and Latinx youth (Gray, McElveen, Green, & Bryant, 2020). Curiously, researchers often conflate the terms collectivist, communal, and interpersonal, perhaps reflecting the "conceptual clutter" that exists in this research area. Later in the introduction, we propose a framework that organizes these research themes that could facilitate our understanding of how these studies fit together.

The experiences and perspectives of individuals from historically marginalized groups can and should inform our understanding of motivation among diverse adolescent youth (Usher, 2018). Indeed, much of what we know about self-efficacy is based on research with predominantly White samples and in Eurocentric contexts. In contrast, researchers can ask how these motivational processes play out in individuals from racial/ethnic minority groups that have been historically marginalized in the United States. In the present study, we worked with youth from racially diverse backgrounds to better understand whether and how these individuals define and exhibit science self-efficacy in ways that might differ from students who identify with the dominant culture.

1.2. The What: Self-Efficacy in Science

Self-efficacy reflects an individual's beliefs about their ability to succeed; self-efficacy beliefs in a task or domain (such as science) and valuing this engagement are foundational components underlying a sense of personal agency (Bandura, 2018). This focus on the individual is consistent with an enduring tradition in motivation research that examines how these processes unfold within the self; indeed, concepts such as *self*-efficacy, *self*-determination theory, and *individual* interest seem to reinforce this view of motivation as a phenomenon that resides within the individual. Indeed, one of the primary sources of self-efficacy is personal experiences of mastery (Usher & Pajares, 2008).

However, it is instructive to note that the origins of self-efficacy come from Bandura's work on observational learning. Humans learn about societal norms and individual skills through observations of other humans in various naturalistic settings (Bandura, 1986). In addition to mastery experiences, humans develop beliefs about one's efficacy through observations of other successful models. Therefore, it is clear that interpersonal factors play a role in the development of self-efficacy. But there is more to the story than this. In the previous section, we described how some individuals possess fundamentally different orientations toward the self (e.g., individualist vs. collectivist) and that some individuals consider family-oriented and religious-oriented goals to be as important as personal goals. It is also the case that some cultures are characterized by a communal orientation in which the self simply cannot be understood unless it is in relationship with others (Markus & Kitayama, 1991). Therefore, merely acknowledging that observing others can shape self-efficacy is not the same as saying that a collectivist orientation might change the nature of self-efficacy. That is, the effect of a collectivist orientation cannot be reduced to an understanding of the impact of observation. Table 1 summarizes the key differences in

Table 1
Summary of key differences in emphasis between individualist and collectivist research framings of motivation.

Feature	Individualist	Collectivist
Self-efficacy	One's beliefs that they will be successful in an activity (Bandura, 2018)	**Question:** How do interpersonal factors shape understanding of "self" as part of self-efficacy?
Theoretical approach	Top-down, "etic" approach	Bottom-up, "emic" approach
Motivational processes	Culturally universal principles; positivist	Situative; interpretivist (Nolen, 2020)
Conceptual representations of the self	Self-oriented, independent (Markus & Kitayama, 1991)	Interdependence, communalism (Gray et al., 2020)
Adolescence	Period of identity development (self-exploration)	Period of increasing sense of generativity and contribution (serving others; Fuligni, 2019)
Sampling	Predominantly White samples; reflecting the dominant culture	Minoritized youth; issues of assimilation, acculturation, and discrimination become salient (DeCuir-Gunby & Schutz, 2014)
Methodology	Quantitative, survey methods, large samples	Qualitative, interview/ethnographic methods, small samples
Learning environment	Top down: Teacher to student in large classroom settings	Egalitarian: One-on-one or small group collaborative learning

emphasis between individualist and collectivist framings of self-efficacy and other aspects of motivation research.

Therein lies the tension that we are trying to navigate. We ask: Is there a place to consider not only the observational factors that contribute to self-efficacy development, but also the individualist/collectivist orientations that human beings possess? We believe that the recent trend towards acknowledging the sociocultural factors that influence development demands that this tension not only be recognized, but also embraced and better understood. In particular, we anticipate that examining self-efficacy for future oriented goals is an ideal context in which to understand self-efficacy with a collectivist framing. Self-efficacy is future oriented and influences future planning (Bong & Skaalvik, 2003). Possessing beliefs that one can accomplish a task can lead students to seek out challenges. In one study, competence beliefs significantly predicted intentions to pursue future science-related activities (Lau & Roeser, 2002). Participation in science and math activities predicted American students' self-beliefs, which in turn predicted the number of science and math courses taken in high school (Simpkins, Davis-Kean, & Eccles, 2006). Research from four OECD countries using TIMSS data revealed links between high academic achievement in a science domain with enhanced motivation in the same domain, which in turn predicted domain-specific aspirations (Guo, Marsh, Parker, Morin, & Dicke, 2017). In summary, across differing contexts there is evidence that self-efficacy also impacts future planning. The present study aims to broaden our understanding of the nature of the interpersonal factors that shape the development of self-efficacy beyond an individualist frame.

1.3. The Where: Near Peer Mentoring Programs

Research on motivation tends to focus on formal school and classroom contexts, neglecting the out-of-school environments in which learning and motivational processes develop. Rather than possessing a stable, domain-general set of motivational beliefs and values that apply across situations, students' motivation often depends on features of the context. A sense of belonging is a critical aspect of motivation among minoritized youth (O'Brien et al., 2020), particularly for Black adolescents (Gray, Hope, & Matthews, 2018), and results from interpersonal factors, instruction, and institutional opportunity structures. In addition to teacher-student relationships and peer friendships, mentoring programs outside of formal instruction can also support opportunities for interpersonal connection and motivation. Mentoring programs can be especially beneficial for underrepresented minorities (Tsui, 2007), women (McCormick, Barthelemy, & Henderson, 2014), and first-generation college students (Harrell & Forney, 2003) in STEM fields. These benefits are thought to operate through increased feelings of belonging in school and the development of positive science identities. For instance, mentoring from a faculty member strengthened female undergraduate students' scientific identity development, which in turn predicted greater intentions to persist in science (Hernandez et al., 2017).

In contrast to traditional mentoring models, near peer mentoring programs have emerged as an informative context for studying learning processes and outcomes. In contrast to adult mentors or teachers who transmit content knowledge from expert to novice, a near peer is an individual who occupies the space between peer and expert in a learning spectrum and has recently gone through a set of experiences that a mentee will be facing in the near future. Often, a near peer is just a few years older in age than the mentee, which allows for a greater degree of affinity between both individuals. Research has shown positive impacts of near peer mentoring programs on academic outcomes such as first-semester grades (Zaniewski & Reinholz, 2016) and interest and engagement in STEM learning (Tenenbaum, Anderson, Jett, & Yourick, 2014).

The present study draws from qualitative data collected from high school mentees and undergraduate near peer mentors who participated in a brief science mentoring program. While the current study is not intended to examine the program's effectiveness on motivation or academic outcomes, we instead seek to understand how students of color reflect on their motivation to pursue science within the context of a mentoring relationship.

1.4. The When: Science Motivation and Near Peer Mentoring in Adolescence

Adolescence is a developmental period during which motivational beliefs and values undergo dramatic change. Much has been written about the observed decrease in academic motivation during middle school and high school (e.g., Gottfried, Fleming, & Gottfried, 2001; Wang & Eccles, 2012). However, an often-overlooked aspect of adolescence is that it is often a time in which individual identity exploration and development concides with a growing disposition among youth to develop a sense of purpose and to contribute to their communities. Indeed, we see that as adolescents develop a stronger ability to reason abstractly and as their social worlds expand, they are more likely to be interested in and make generative contributions to their communities and broader society (Fuligni, 2019). In a series of studies, finding meaning in and purpose for learning—sometimes known as self-transcendent purpose—was associated with enhanced academic self-regulation and better academic outcomes among adolescents and young adults; interestingly, self-oriented motives for learning did not yield academic benefits (Yeager et al., 2014). Taken together, these studies point to how a collectivist and social lens might expand our understanding of motivation during this developmental period, especially for youth of color.

The unique developmental capacities and needs of adolescents also point to the promise of near peer mentoring programs. Adolescents become more interested in developing their own sense of identity and purpose along with a greater need for affiliation among same-aged peers (McLean, 2005). The closeness in roles between near peer and mentee, often referred to as *social congruence*, allows for a greater degree of trust and informality between individuals (e.g., Lockspeiser, O'Sullivan, Teherani, & Muller, 2008; Schmidt & Moust, 1995). Near peers also possess greater knowledge in the learning spectrum. While this knowledge can be content-specific, it can also refer to institutional knowledge regarding unspoken norms and expectations—particularly salient for students who experience marginalization in school and other contexts. *Cognitive congruence* refers to the closeness in maturity and age between near peer and mentee that allows the near peer to use language and examples that the mentee readily understands (e.g., Cornwall, 1980; Lockspeiser et al., 2008). This congruence creates greater accessibility between near peer and mentee, as the near peer is perceived as being "just like them," providing a foundation of shared experiences upon which to build a meaningful relationship. However, the role of *cultural congruence*, or similarities in experience of race, culture, and marginalization for near peer adolescents of color, has been understudied. Given the increasing salience of ethnic and racial identity that also emerges during this developmental period, the present study examines science motivation during the critical years of adolescence.

1.5. The How: Qualitative Inquiry

Traditional methods for testing well-defined hypotheses and generating results that characterize between-group differences in motivation mask considerable intra-individual complexity in motivational processes. While these approaches continue to be important in expanding our understanding of how motivational beliefs and values shape learning and achievement, these methods are limited in their ability to expand our understanding of how the sociocultural context influences motivation, learning, and achievement (Nolen, 2020). What are the roles of identity and group membership in how individuals perceive themselves and their futures in science? How do experiences of gender and racial discrimination shape motivation to learn and future academic and career aspirations? How might self-efficacy take shape and manifest differently for students of color in science? These are just some of the questions that cannot readily be examined using currently available self-report, Likert-type survey assessments alone (e.g., DeCuir-Gunby & Schutz, 2014). Moreover, many of these measurement tools continue to reflect a self-oriented understanding of these motivational processes, which might mask the interpersonal or communal aspects of motivation that students in certain racial and ethnic groups might find to be more important or salient. Qualitative approaches can elevate student voices and experiences and provide detailed insights to help the field understand science motivation in a more inclusive manner. In the present study, we examined whether and how students' open-ended reflections around science motivation and achievement resembled (or differed from) the content of commonly used survey questions in self-efficacy, interest, and future plans.

1.6. Study aims

By examining the who, what, where, when, and how of research on science motivation in diverse student populations, we have sought to present a concise but comprehensive picture regarding some of the limitations inherent in much of the theoretical and empirical work in this area. We have highlighted the potential misapplication of motivation theory—grounded mainly in research on White samples—to racial, ethnic, and cultural minority students (the who). We have considered how a sociocultural perspective can expand our understanding of self-efficacy and its future-oriented nature (the what). We have considered differences in motivation beyond the classroom, such as near peer mentoring programs (the where). We have focused our attention on adolescence and emerging adulthood, critical periods of identity development that intersect with the development of motivation for academic and career pursuits (the when). Finally, we have considered the role of qualitative inquiry as particularly well suited to understanding the complexity of motivational processes such as self-efficacy in youth of color (the how). In summary, the present study seeks to advance our understanding of science motivation in a small sample of diverse youth by considering how motivational processes unfold in nontraditional learning environments characterized by relationship building and interpersonal aspects. We pursued the following three research aims:

1. Using semi-structured interviews, characterize how high school students describe their efficacy and future plans in science. Examine the degree to which students' open-ended responses align with the content of traditional Likert-type survey questions commonly used to assess these motivational processes, with an eye to understanding the students' framing of "self" in the context of their efficacy beliefs.
2. Using an adapted grounded theory and constant comparison approach, identify other themes related to self-efficacy and future plans that emerged around the students' experience in the near peer mentoring relationship.
3. Use interview data from mentors to triangulate evidence from mentee interview data to better understand the interpersonal dimensions of science motivation.

2. Method

2.1. Participants

The current investigation was part of a larger study designed to develop and test a video-based classroom intervention to enhance science motivation, identity development, and learning outcomes among adolescent youth from groups underrepresented in STEM. As part of this larger study, the research team designed and hosted a brief summer science mentoring program. Participants were recruited from two separate summer research programs at the University of Oregon in the United States; the study was approved by the University of Oregon Institutional Review Board, and informed consent and assent were obtained from all students as well as from parents of minor youth. One program was designed for undergraduates to gain hands-on experience in scientific research in various natural science labs. The other program was a residential academic experience for high school students. Both programs were designed to reach and support students from racial/ethnic minority or low-income backgrounds. In consultation with program directors, we identified a group of six undergraduate mentors that possessed qualities that would make them personable and effective mentors, as well as a group of six high school mentees that would be receptive to one-on-one mentoring.

Mentors prepared a short biographical profile of themselves with information about their personal and educational backgrounds, academic and career interests and goals, and fun facts about themselves. Mentors and mentees were matched together using a multi-method process. Based on previous research on near peer mentoring programs, we matched individuals by gender (e.g., Destin, Castillo, & Meissner, 2018). We also used information from the written biographical profiles to inform our decisions about matching. These profiles were provided to mentees before their first interaction together to help mentees learn about the person who would mentor them. An interesting aspect of the present study was that the mentors were, in a way, mentees themselves as part of their summer research experience in university science labs. This "double-identity" will be considered later when interpreting the results. Due to the small number of mentors and mentees (i.e., six pairs), matching on other dimensions beyond gender and interests was not possible. Table 2 presents self-reported descriptive, non-identifying demographic information from the mentor and mentee surveys.

2.2. Procedure

Near peer mentors and mentees engaged in a series of coordinated activities during the four-day mentoring program. Activities included structured time for mentees to shadow their near peer mentors working in their science labs. Mentors guided mentees through informal hands-

Table 2
Mentors and mentees participating in the science mentoring program.

Mentoring pair	Near peer mentor	Mentee
Pair #1	Male, Asian, biology major	Male, Native Hawaiian or Other Pacific Islander, high school freshman
Pair #2	Female, Black, biology major	Female, Black, high school sophomore
Pair #3	Female, race/ethnicity unreported, human development and health major	Female, Black, high school senior
Pair #4	Male, White, human physiology major	Male, race/ethnicity unreported, high school sophomore
Pair #5	Female, White, human physiology major	Female, Asian, high school senior
Pair #6	Male, Black, doctorate in chemistry	Male, White, high school freshman

Note. Some students who self-reported their racial identity as "White" or left that question blank referred to their Hispanic/Latino descent during the mentoring program and the interviews. However, a standalone ethnicity question was not originally included in the student survey.

on lab experiences, such as pipetting and looking through microscopes. Activities also included structured and unstructured time for mentors and mentees to socialize and share meals. It was presumed that mentoring would unfold naturally as part of these activities. A sample schedule is provided in Fig. 1. Mentors and mentees completed a research questionnaire at the beginning of the program. In addition, the research team conducted individual semi-structured interviews with each mentor and mentee.

2.3. Survey measures

The research questionnaire included questions about students' self-efficacy for science and future plans in science using well-validated measures. *Self-efficacy* was measured using a six-item scale used in a study of motivation in American Indian adolescents in Hoffman and Kurtz-Costes (2018) and adapted from the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, García, & McKeachie, 1991). A sample item was: "Even if the work in science class is hard, I can learn it." *Future plans* (or intentions to pursue science pathways) was measured using a four-item measure used in Hulleman and Harackiewicz (2009). A sample item was: "I want to have a job that involves science someday." As shown in Table 4, we found that mentees participating in the summer mentoring program reported high levels of science self-efficacy and future plans related to science. Because the participants were a self-selected group of high school students (i.e., they chose to spend part of their summer doing science in a university setting), it is not surprising that the means were relatively high. Therefore, we focus the rest of our attention on the qualitative coding of the students' open-ended interview responses, to understand whether and how students' reflections mapped onto the self-focused aspects of self-efficacy and future plans that were assessed using the survey measures, and what interpersonal aspects emerged.

2.4. Interview Protocol

In addition to the survey, all mentees and mentors participated in a video-recorded individual interview. Each student was interviewed by two members of the research team, which included four of the authors. Interviews were conducted using a semi-structured protocol in which questions were followed up with probes depending on the students' responses. The interviews with mentees took place at the end of the mentoring experience. Interview questions focused on the students' reflections of their mentoring experience (e.g., After participating in this summer experience, have any of your previous thoughts or perceptions about studying and pursuing STEM changed?), lessons learned from working with their mentor (e.g., When thinking about the mentor that you worked with, what do you think were the most important lessons you were able to learn from them today?), potential barriers that students might face in pursuing a science career (e.g., What do you think will be things that might be barriers to your interests?), and whether and how the mentoring experience has changed their academic and career plans (e.g., After working with your mentor this summer, are there other future roles in STEM you can see yourself pursuing?). Additionally, we interviewed the mentors on Day 2 of the mentoring experience, with questions prompting reflections on what they experienced and observed with their mentees (e.g., Is there anything that you wish you could do with your mentee to understand their scientific work or their pathway in science better?) and their own process of being mentored and supported along their science pathway (e.g., When you think about your own future pursuits in science, what do you think will be things that will best support those pursuits?)

2.5. Analysis Plan

Commensurate with the aims of the study, we analyzed data in multiple phases using Dedoose software (Dedoose Version 8.3.45, 2020). First, we provided descriptive information about each case, including

8:20 to 9:00am	Breakfast
9:20 to 10:50	Mentoring Session #1: Meet your mentor
11:20 to 11:45	Vlog about your first mentoring session
12:00 to 12:45pm	Observe research presentations
1:00 to 1:45	Lunch
2:10 to 3:20	Mentoring Session #2
3:45 to 4:45	[Name redacted for peer review] lab tour
5:00 to 5:50	Dinner
5:50 to 6:20	Outdoor games
6:35 to 8:35	Evening games and activities
8:35 to 8:55	End-of-day briefing
8:55 to 9:55	Movie: Hidden Figures
10:30	Lights Out

Fig. 1. Sample schedule for mentees.

students' self-reported levels of science self-efficacy and future plans in science at the beginning of the mentoring program. Second, we coded data across the mentee cases using a deductive process informed by the two motivational constructs examined in this study—self-efficacy and future plans. Third, we used an inductive adapted grounded theory process of constant comparison to develop additional codes within each construct that emerged from the data across mentee cases (Charmaz, 2014). During initial coding of the first transcript from a randomly selected mentee, the second author, experienced in the grounded theory approach, used line-by-line coding to identify subthemes within each thematic code. For instance, the researcher identified *help-seeking* as a potentially significant subtheme under self-efficacy, reflecting an interpersonal dimension. The researcher used memoing techniques to ask questions of the data within each theme to probe deeper and compare coding from transcript to transcript. For instance, the researcher considered whether *developing agency through the vicarious experience and modeling of others* was an important theme across all the mentees and mentors.

In the next step, the third author recoded the mentee data with existing codes to ensure full saturation of codes across cases, which may have been missed in the initial coding, and to add, inductively, any additional subcodes deemed important. This collaborative approach to grounded theory research can enrich theory development through the integration of the reflexivity of two distinct researchers (Author, 2016). This author modified one sub-code, "support from adults," to be more inclusive of "support from others," showing that participants were supported in their science self-efficacy by friends and near peers in addition to teachers, family members, and other adults. Additionally, this author analyzed the mentor data, using the self-efficacy and future plans codes, to triangulate the findings from mentee data and explore collectivist versus individualist themes around the pursuit of science pathways further. Two codes were added focusing on "observation of competence/confidence" to code for instances where mentors observed the mentee doing well, and "mentor supports" to capture the supports that influence the mentor's mentorship.

2.6. Researcher Reflexivity

Each of the authors reflected on their experiences and identities and how they might influence the research process, particularly the coding and interpretation of student responses. The first author is a developmental psychologist, and the second author is an educational scientist. The lead author was trained as a developmental psychologist in a positivist scientific tradition; therefore, the study's broad framing proceeds linearly, with etic theoretical and methodological approaches serving as a starting point for the research. However, the project team's intellectual diversity ensured that this top-down conceptual organization was also combined with research approaches that were able to capture the nuance associated with different conceptualizations and operationalizations of motivation from minoritized youth. The first author identifies as Asian American and male, and the second author identifies as White and male. Both first and second authors participated in the individual interviews with students and have extensive research experience in adolescent development, motivation, and identity. The second author, who conducted the initial grounded theory coding and analysis, has training and experience in grounded theory and phenomenological qualitative methodological traditions and research on motivation in adolescent development from both psychological and sociocultural perspectives. The third author identifies as a white, working class woman who has experience working with racially and culturally diverse students of all ages, youth program development, and qualitative research. The fourth author identifies as Black and male, was involved in interviewing students, and has extensive experience in conducting interviews around sensitive topics. The fifth author identifies as White, first-generation, Queer, and female, and has extensive experience conducting research and developing programs focused on supporting marginalized students' STEM career pathways. Together, the team engaged in collaborative sensemaking that sought not to elevate a particular approach but sought to negotiate different research perspectives while honoring and elevating the students' voices that were the primary focus of this study.

3. Results

Because well-defined motivation theories were driving this inquiry, qualitative coding and analysis did not follow a complete grounded theory approach. Instead, we adopted a *modified grounded theory approach* to identify salient themes for a small sample of high school students of color experiencing a brief, intensive near peer mentoring experience. The second author identified salient ideas as subthemes within each of the two major themes—self-efficacy in science and future plans to pursue science. These subthemes were developed inductively during the first coding across transcripts of the six high school mentees. Subtheme codes added late into coding were applied to the first transcripts analyzed to ensure full saturation. These perspectives of high school students of color informed exploration of each major theme, with the aim of expanding the current theorizing in each area and understanding the potential role of near peer mentorship in science motivation. A list of inductive codes within each motivation construct is presented in Table 3. After completing a second round of coding by the third author, additional codes were added to that table, including those reflecting the mentor perspective. Table 4 includes a descriptive profile of each mentee. All names are pseudonyms to protect student privacy.

3.1. Self-Efficacy in Science

As can be seen in the mentee profiles in Table 4, students possessed relatively high levels of science self-efficacy before being mentored, and each experienced unique hands-on mentoring experiences. The analysis of the data within the theme of self-efficacy produced six subthemes: sense of agency, proxy agency, help-seeking, collaboration, support from adults, and leadership. Sense of personal agency, proxy agency, and help-seeking were the most salient ideas across the mentees, reflecting both individualistic and collectivist orientations. Five of the six mentees felt their confidence to succeed buoyed by the experiences shared by their mentors and their hands-on engagement in the lab. For instance, the youngest female student in our sample, Nova, shared that her mentor's stories of struggle boosted her own self-beliefs:

> *… she struggled in high school, and because people would say, oh no, you won't be able to do this, oh, maybe you should go to a community college. But instead of her listening to what they had to say, she knew that she would be able to succeed. And, so, because of her belief, she was able to make it … and, so, I thought that that was very inspiring, because for me,*

Table 3
Inductive codes within each motivation construct.

Motivation construct	Codes
Science self-efficacy	Sense of agency Proxy agency Help seeking Collaboration Support from others Leadership Observation of competence/confidence* Mentor supports*
Future plans in science	Getting multiple perspectives Persevering Taking pride Self-transcendent purpose

Note. *Denotes that code was only used for mentor data.

Table 4
Profiles of High School Student Cases.

Mentee Name	Gender, Race/Ethnicity, Grade	Subscale Means	Lab Experience	Illustrative Quote
Franco	Male, Native Hawaiian/Other Pacific Islander, 9th grade	Self-efficacy: 6.00 Future plans: 6.00	In a biology lab studying fish	"we used this paraffin stuff for the fish tails of the zebra fish…we had to try and fold it up, but that was difficult. We kept breaking them..if they're folded up…we can put it so that it turns into wax….eventually we can use that data for tests, RNA, and that stuff…The lab was a lot messier than I thought it would be
Nova	Female, Black, 10th grade	Self-efficacy: 5.17 Future plans: 5.67	In a biology lab studying fish	"I learned a lot more about fish than I ever thought I could. So, I learned that they have like a little hatchery, so there's two different room…they also have eggs hatch inside, like a little miniature refrigerator…I learned about how exactly you're able to see the bone…they inject the fish…it stains their bones red. So it's easier to see their bones…I thought that that was really cool.
Destiny	Female, Black, 12th grade	Self-efficacy: 5.67 Future plans: 5.33	In a biology lab studying worms	The lab was different…I had like higher expectations like, Oh it's gonna be like…organized and clean but…it was likea real environment…there was like so many numbers of everything….I felt kind of like realistic…Like being in there made me feel like ready to be a scientist and try new things.
Miguel	Male, Hispanic/Latino, 10th grade	Self-efficacy: 5.17 Future plans: 4.00	Neuroscience lab working with EEG	"…being able to study the brain like that is really interesting … we had 64 cables that were like networks and we plugged them into certain sections and … they'd run [data] through code which I learned yesterday…"
Kim	Female, Asian, 12th grade	Self-efficacy: 5.30 Future plans: 6.00	In a biology lab studying worms	"My first impression was like, wow this person seems really devoted to science. This is awesome. I'll get to work with someone who is really passionate about science…it was just a very open experience and every step that she helped me with whether it be like getting a plate and like scooping worms and or like, plating them and trying to adjust the microscope to my liking… I felt really close to her and also her mentor as well.
Rafael	Male, Hispanic/Latino, 9th grade	Self-efficacy: 4.33 Future plans: 3.67	In a chemistry lab	"[The lab] was very full of beakers and boxes of people's stuff…we were measuring the Aluminum and Gallium minerals on the scale in the lab and then putting them into the mixture into the water aluminum compound and then putting them into the centrifuge and letting them do its thing…[it was] exhilarating."

Note. Subscale scores ranged from 1 to 6, with 6 indicating higher motivation. Student names are pseudonyms.

sometimes for myself, I'm like, 'Oh, I can't do this or I can't do that' … I limit myself.

In this way, self-efficacy in science may develop for students of color, in part, through proxy agency, where the vicarious experience of hearing about self-efficacy beliefs, success, and competence of a near peer like them becomes a component of their own self-efficacy beliefs. This perspective was shared by all three female mentees—Nova, Destiny, and Kim. Of the male mentees, all of whom were younger than their female counterparts, only Miguel focused on the role of proxy agency, sharing how he watched his brother succeed in high school and how that modeling made an impression on his own self-efficacy and choices. Destiny, who already possessed high levels of science self-efficacy and future plans, reflected on how her mentor's confidence to succeed, even when others doubted her, affected her own thinking:

Well she was a first-generation college student, so, like everything she was saying I can relate to. So, like, she had a lot of perseverance … even if someone tells you no, like, the worst thing you can hear is 'no' … but once you, like, hear 'no', like, it doesn't mean stop, it just means, like, find another way to try something new or go after something else.

Examining the reflections of the mentors helped us triangulate interview data from mentees and added to our understanding of interpersonal dimensions of science motivation. The mentors in our study highlighted the different ways that mentoring had on their own self-efficacy and motivation and what they observed in their high school mentee. Hearkening back to the idea of how mentees observed the confidence of their mentors, many of the mentors themselves also marveled at the confidence and competence of their mentees. Miguel's mentor shared: "I was really surprised. I don't know if it was just me in high school but, [Miguel] is this like so focused most of the day, like I would have been zoning out but it's like the level of maturity." Rafael's mentor was also impressed with his confidence, performing a quick calculation in his head as his mentor reached for his phone calculator. The mentors also reflected on how they saw their own self-efficacy development follow an unexpected path. Nova's mentor shared,

It was mainly about like school, like going through school and how you don't have to really like fit into a certain box to become a scientist. You don't have to get straight A's. There's not like a specific path that you have to follow to be successful. Everyone has their own journey and gets to a certain place that they are in their own way and so if it takes you … because [Nova] was explaining to me that she's not good at math and I'm not either, but I'm still pursuing a pre-med track and I'm doing what I need to do to accomplish my goal. So it's perfectly, it's possible.

Other mentors shared a similar sentiment with their mentees, supporting the mentees' self-efficacy development, in part, through challenging key beliefs—that someone has to be a certain kind of student to pursue science and those seemingly successful science students, like themselves, do not have their own academic struggles.

For the young women of color in the sample, the shared experience at the intersection of gender and race played a role. The oldest of the female mentees—Destiny and Kim—who were entering their senior year, had both faced lower expectations and beliefs from others regarding their potential. When they heard these shared experiences from their female mentors of color, it bolstered their own self-efficacy to succeed in the challenges that lay ahead. The signals that came from their experience in the external world, such as feeling stupid for not understanding concepts quickly or feeling like they do not belong in science because they are from an underrepresented group, affected their own internal sense of agency in science. Hearing about these shared experiences from their mentors, who were on their way toward a successful career in science, provided an important reinforcing perspective and shift in framing the challenge as an opportunity. For instance, Kim shared the following reflections from her mentor.

… she is half Latin and half White and so I asked her if that ever bothered her, if she felt excluded. And she said it was weird not, like being, being like the minority in this … it's not the most diverse place … even for me at [my high school], there's only a 5 percent diversity rate. So, it's hard for I guess us to connect with other people … But as she grew up, she saw other people saying you always have to step outside your comfort zone to grow up and explore options. I think because I've always been the minority for my whole entire life. And it gets to me sometimes, saying like, 'Oh why do I not see other people like me.' But I think her idea of … stepping outside your comfort zone, it gets to me because I myself I get uncomfortable in many situations, but I realize when I'm uncomfortable I should live up to it and just go forward no matter how awkward I get.

Mentors also shared the ways in which their experiences of being mentored by others taught them how to be a mentor. It is illuminating to see how Kim's mentor described her own self-efficacy and sense of competence in being a mentor to Kim. Importantly, both Kim and her mentor spoke about their own identities as marginalized individuals as part of their reflections on self-efficacy. For instance, Kim's mentor shared,

Freshman year I joined this program for underrepresented minorities in STEM careers so that actually got me into a lab itself. So that was very helpful. That whole program and now that I am in my lab Heather is really an amazing mentor and she kind of sets the standard for how supportive and cohesive mentee and mentor role should be. You really are like one person who works together and steps each step together. So she was a great role model for me and it really helps me. And encourages me to do the same as I get older and become a mentor role.

An interesting part of our study was that the undergraduate mentors were themselves mentees in the university science labs where they were spending their summers. Consistent with this "double identity," mentors commented on how their own mentors in the lab equipped them with the tools to help their own mentee develop a greater sense of self-efficacy. Nova's mentor shared that the first thing she did with Nova in the lab was introduce her to her own mentor, which illustrates a multi-generational mentorship process. Destiny's mentor shared about how her experience with a mentor helped give her the tools to help her own mentee.

Destiny had a hard time picking the worms at the beginning. She would gouge into the Eiger plate and stuff which really reminded me of like when I was first starting because I couldn't get one worm and then it would get stuck on the pick and then it was like frustrating. And then I remember [my mentor] being like no okay … like do this gently and try again and take a deep breath. So, I found myself saying a lot of what she told me at the beginning to [Destiny]. And just at the end … she got it after a couple like "Ahh I can't do this!"

An important proactive and agentic component to generate self-efficacy in science was help-seeking, a communal dimension of self-efficacy. This strategy related to overcoming the tendency to be too shy to ask for help. As Nova shared about her mentor,

… She also struggles with asking for help, because she says that she's an introvert. And so for her it's hard … she tries to build enough courage to ask, because she knows that her mentor could help her. And so for me, that's exactly what I want to have happen for me is for me to build up enough courage for me to be able to go and ask for help. And it doesn't have to be a teacher, like it could be a friend that knows what's going on, or my parent if she knows what to do. And, so, I don't have to be overwhelmed when I'm trying to figure stuff out.

Franco shared the perspective that other things that get in the way of seeking help are pride, ego, and the belief that a lack of knowledge or skill indicates an inadequacy to succeed in science. He shared,

… it's like so many people think it's about pride and ego. And, like, that science has to be, you have to be really smart. You have to know everything. But it's not true. I mean, when I was with [my mentor], he didn't know some things. He asked … we have to be open to find people and get answers because if we don't we're stuck. And just searching and searching …

Central to the development of self-efficacy is that modeling and observation of others can enhance one's beliefs that they can also be successful. Interviews from mentors revealed how their own self-efficacy development was supported by the modeling and guiding of others alongside them through challenges. For instance, Miguel's mentor shared,

Whenever I thought about mentorship when I was younger I always thought kind of like a [parent] … someone kind of in the background is watching everything. But in my experiences … [mentoring is] almost a peer led discussion and having the mentor kind of just being there to answer questions and kind of you know keep everything on the right path but not … leading the path … like a smaller power differential between like who says what … You know whenever I meet with my mentor she'll tell me something and I'll say in my own words she's like that's close but not quite. I think that's a valuable thing and … I hope I can inspire mentees I have in the future …

Other aspects of developing self-efficacy in science, which were not as consistent across mentees, included making decisions to not procrastinate, not being too critical and harsh with oneself, shifting into the attitude and perspective of a leader, feeling confident to take on harder classes, and the importance of collaboration to complement one's skills with the skills of others.

3.2. Future Plans in Science

Prior work with predominantly White samples has demonstrated that beliefs about one's abilities to be successful are inherently future-oriented. As Table 3 indicates, the analysis of the data within the theme of future plans to pursue science produced four subthemes: getting multiple perspectives on plans, persevering, taking pride, and self-transcendent purpose. All mentees, except for Franco and Miguel, described a self-transcendent purpose in their pursuits or the pursuits of their mentors in science. All mentees described how the firsthand experience in the lab and the exposure to their mentors' stories helped them clarify new possibilities for their own futures. Students talked about short-range plans, such as courses they would like to take in high school, and long-range plans, such as the primary field they want to pursue or the kind of job they seek.

Often, those short-range plans tied into their long-range pursuits. For instance, the younger female mentee, Nova, who had shared her dreams of pursuing a veterinarian career, shared how she wanted to take more courses in biology and chemistry because she realized how both can tie into her dream career path. Another older female mentee, Destiny, recognized how her focused high school experience in photography and web design left her curious about more integration of science and technology and more exposure to technology in science in the mentoring program:

> *… I kind of wish to touch more on the technology part of it because, like, I'm leaving my high school, we do majors so I'm leaving with photography and web design, and so I wish you would touch a little bit more on the technology part of everything … but I do see myself doing that and science and I do like engineering … any AP Science class honestly would just be like really fascinating … you can always ask why and why and why and why forever, and just honestly … that's just so intriguing to me …*

The scale means presented in Table 4 indicated that most of the high school mentees already possessed plans to pursue futures in science prior to entering the mentoring experience. However, the experience in the program seemed to reinforce or solidify plans and intentions for most of the students. For instance, Miguel, who reported a mean of 4.0 (out of 6.0) on the future plans scale, shared,

> *I mean I came in here with science being locked away like something I wasn't interested in … But I feel like I can walk out of here knowing, knowing a field of science that I'm actually really interested to [pursue], which is being a meteorologist. I'm really interested in becoming that, but that was like fourth grade me. But now its slowly coming back because I was able to see all these fields.*

Even though students were not necessarily engaged in the science domain of highest interest for them, their experience in the lab and engaging with a mentor served as a catalyst for connecting their past and present interests to their future plans.

Kim shared an important insight she gained through the experience with her mentor. As the excerpt below details, she recognized that the future is uncertain, interests may change, and choices in the present can lead in many directions:

> *I know college students even, a lot of them don't know what they want to do yet because there's so many careers out there that once you to kind of stick to one, that's your path. Of course, you can always change it and go back to school and find a new passion … It's like, 'oh my gosh I have to choose one career and I have to stick with it.' But that's never the case … It's your path. You can go wherever you want. You are able to, if you don't like your major, switch it! … You're not restricted to what one person says you have to. I believe like having multiple inputs is always nice because I've had a lot. It's an adventure.*

Intentions and plans to pursue science in the future were tied to ideas about broadening what it takes to do science, who does science, and what purpose drives people to pursue science. For instance, Nova shared, "I would say for a scientist, you can't be afraid to make mistakes because people make mistakes all the time. We're human. That's what we do." Carrying a self-transcendent purpose with a collectivist orientation to their goals was a consistent driver for the high school mentees plans to pursue science, and several mentees also recalled similar reasons from their mentors. Purposes varied considerably. Nova wanted to help animals as a veterinarian and Franco wanted to support his family. Rafael thought becoming a good scientist meant doing work that was beneficial toward society and the environment, and Kim wanted to put her time, skills, and effort toward helping her community with issues of food insecurity.

Mentors also reflected on how their roles as mentors might influence their own sense of purpose and future plans. Along the thread of a collectivist orientation to future plans and purpose in pursuing science, mentors presented a common thread of self-transcendent purpose and modeling for others, as key to their self-efficacy and motivation to succeed. For instance, Franco's mentor shared, "So I want to be that role model for my siblings that want to eventually go to college and kind of guide a path for them to follow if they want to. And definitely I want to help them understand like life is hard, but you find a way to make it through things. And if you're passionate about something then you can definitely achieve it." Similarly, Destiny's mentor shared, "I definitely want to do it again. I love being someone that someone else can look up to and be like okay … 'She has done this. I can do this, too' … I love being that person and I love being able to give advice or help others out. Yeah just providing that support that mentorship. I like it. I want to like help other generations do what they can."

All mentees mentioned facing some internal challenges in pursuing their future plans in science, such as losing focus with the distraction of peers or social media. Two female mentees and one male mentee identified the biased expectations as one of the biggest external barriers they could potentially face. As Kim shared,

> *Most of the people here, they're an older generation and their mindsets more like a male-dominated society. And we can't get away from that until that generation retires and it's a little hard because it also influences my generation as well … For me, personally, yes it's my race. And it's also my gender because I'm very much the minority. A female Vietnamese woman trying to pursue something that is also a very competitive field.*

Generally, all mentees, especially the young women, developed an awareness of the potential societal challenges they will confront alongside a heightened passion for their pursuits and self-efficacy to be strategic and succeed.

4. Discussion

The present study sought to better understand the nature of science motivation among a small, racially-diverse group of high school mentees who participated in a brief near peer science mentoring program with undergraduate mentors. Descriptive, deductive, and inductive approaches to coding and analyzing semi-structured interview data with mentees and mentors revealed new insights into the nature of self-efficacy in science and future plans in science. Results indicated that our understanding of these motivational constructs, particularly among adolescent youth of color, might be enhanced by moving away from an individual-centered understanding of motivation (consistent with findings from Clayton & Zusho, 2016, Gray et al., 2020, and King & McInerney, 2019) and toward the interpersonal factors and social connections that influence motivation to pursue science pathways. Data from mentors triangulated mentee data and provided additional layers to our understanding of the interpersonal dimensions of science motivation. We organize our discussion around three broad themes that reflect a collectivist approach to self-efficacy. We conclude with limitations and directions for future research.

4.1. A Collectivist Approach to Understanding Self-Efficacy

The high school students in our study emphasized the importance of hearing stories about the struggles their mentors managed, the roadblocks they overcame, and the unique perspectives and experiences in STEM pursuits as students of color, generally, and women of color in STEM, specifically. Illustrated by our qualitative analysis, most mentees saw themselves and their futures in relation to those experiences shared by their mentors. This interpersonal aspect of present and future selves in science resonates with the cultural foundations of collectivist and interpersonal identity in African American, Latinx, and Asian American communities, among others (Allen & Bagozzi, 2001; Morton, Gee, & Woodson, 2020; Vargas & Kemmelmeier, 2013). Cultural psychologists use the distinction of individualistic versus collectivistic based on whether people emphasize personal or social identities (e.g., Markus & Kitayama, 1991). Results from the present study reveal the contrast of conceptualizing motivation constructs from an individualistic and intrapersonal orientation to a collectivistic and interpersonal orientation.

Recent conceptualizations of culturally responsive teaching (Hammond, 2015) suggest that this collectivist perspective is highly salient for most marginalized communities, including communities of color in the United States, requiring that schools and educators consider how to reframe their content and instruction through a collectivist lens to be more culturally responsive for non-White students. In her research on African American college students, Carson (2009) identified a challenging incongruence between the collectivist orientation of African American students and the individualistic orientation of faculty and the university setting as a whole. To understand the motivations and purpose of academic pursuits for students of color, Carson implored institutions and faculty to learn how the collectivist orientation plays out in the cultural and racial identities of students. Similarly, in our study, both mentees and mentors expressed a range purposes—mostly transcending self-interest—as a driving force for their interest and future plans in science. Emphasizing this point, mentees reported building self-efficacy through the vicarious confidence-building experiences of their racially or culturally similar mentors. Their desire to help others and contribute to the social good further illuminates the vital importance of the collectivist and interpersonal in their sense of self and motivations in science. We turn now to three interpersonal dimensions of self-efficacy—proxy agency, help seeking, and future orientation—that emerged from our data and may be particularly salient among adolescent youth of color as these individuals consider and pursue academic and career pathways in science.

Proxy agency. Bandura (2018) suggested that proxy agency plays a role in the social cognitive development of the self and motivation. In our study, proxy agency developed through shadowing mentors in a lab, hearing stories of overcoming adversity and the biases of others, learning about strategies firsthand, and taking proactive steps to take control of one's present and future. Proxy agency also appeared to have a reciprocal, reaffirming, and intergenerational quality for the mentors, who expressed the opportunity to model for others was meaningful for their own self-efficacy and was reinforced by the modeling they received from their mentors.

From a collectivist orientation, the development of one's self-efficacy may be inseparable from the proxy agency developed and demonstrated by culturally- or racially-similar near peer mentors. In our sample of students of color, the mentoring experience made visible the importance of hearing stories from mentors who became confident and avoided internalization of the doubts, discouragement, pressure, or lower expectations of others. Within these near peer mentoring relationships, some racial and gender affinity helped to establish cultural congruence, which may be just as important as social and cognitive congruence for effective near peer mentoring for students of color. Agentic engagement has been promoted as a distinct form of engagement that relates to how students proactively foster motivationally supportive environments around them, regardless of the conditions (Reeve, 2013). In many instances, the proxy agency of mentors channeled by their mentees reflected ideas about how students intended to take action to increase and act on their confidence in science and other academic demands. These results suggest that to understand self-efficacy in students of color, researchers should add or adapt items or scales to include the interpersonal and collectivist dimensions of proxy agency.

Help seeking. For racial and ethnic minority students, many of whom come from cultural and family backgrounds that emphasize strong family and community ties, academic motivation might depend not primarily on personal, trait-like characteristics, but rather environmental features that reflect the broader ecology of the developing person. In fact, research has revealed that for undergraduate Hispanic women, interest and persistence in STEM was most closely correlated with family and school experiences, as well as support from their families (Talley & Ortiz, 2017). Indeed, one of the themes that emerged from the interview data from mentors revealed the importance of multi-generational mentoring as a necessary ingredient for academic and career success. We also know that *whom* students are able to connect with is important as well. Research illustrates that Black students who are randomly assigned to a Black teacher in elementary school are more likely to graduate from high school and enroll in college compared to Black students who did not have a Black teacher (Gershenson, Hart, Hyman, Lindsay, & Papageorge, 2018). Hearkening back to our discussion of cultural congruence (i.e., similarities in experience of race, culture, and marginalization), students of color who can form meaningful relationships with same-race mentors and teachers can promote greater help-seeking behaviors and lead to enhanced learning outcomes.

One of the aims of the present study was to examine how commonly used survey measures designed to assess self-efficacy overlap with the open-ended responses provided by our diverse sample of adolescent youth. None of the six questions in our self-efficacy scale makes any reference to the influence or impact of others on their beliefs about their ability to succeed. For example, items such as "I can do even the hardest work in science if I try" or "I am certain I can figure out how to do the most difficult science problems" imply that one's ability to succeed resides primarily or exclusively within the individual. However, our findings reveal the important roles that proxy agency and help seeking play in the development of individual self-efficacy. In fact, we argue that for some individuals, these interpersonal dimensions are inextricably linked to their individual pursuit of academic and career pathways in science. Future survey development work could seek to explicitly acknowledge and examine the ecological influences of self-efficacy development, alongside the qualitative work that is integral to our understanding of these motivational processes. For instance, items reflecting proxy agency and help seeking could include, "I can rely on my friends and family to support me to complete even the hardest work in science if I try hard" and "I am certain that with modeling from an adult or peer, I can figure out how to do the most difficult science problems." Future measurement work can identify how these items relate to existing individualistic self-efficacy items.

Future orientation. Our findings lend support to the complexity of how high school students conceptualize their future plans and intentions as it relates to science. In fact, the themes that emerged from students' open-ended responses—getting multiple perspectives, persevering, taking pride, and self-transcendent purpose—reflect a complex web of cognitive, affective, and social processes.

Our students' descriptions of their future plans and interests reflect themes that might seem incongruent from an individualistic perspective of motivation but cohere well when considered from a perspective that emphasizes the importance of relationships, social bonds, resilience, and adaptability. Put another way, rather than an individualistic framing of motivation that can perpetuate the idea of scientific "brilliance" that situates interest and success in science as a characteristic that resides within the individual, emphasizing interpersonal connections, relationships, and collaborative achievement as an important aspect of motivation might resonate more with certain learners, particularly students of color. Further, experiences of racism, microaggressions, and poverty are often faced by youth from marginalized groups. Understanding how passion, interest, and pursuits evolve as students of color experience setbacks and adversity, yet remain resilient, will continue to remain an important area for future research.

We might also consider how students navigate the process of choosing between different academic and career pathways. Vocational interests reflect trait-like preferences for activities, also known as general interest orientations (Holland, 1997; Rounds & Su, 2014). There are six general interest orientations, collectively known as RIASEC—realistic, investigative, artistic, social, enterprising, and conventional. In this framework, the social interest orientation is of particular relevance to our findings. Social interest orientation is defined as "a preference for the manipulation of others to inform, train, develop, cure, or enlighten" (Wille et al., 2020)—reflecting a self-transcendent purpose. A strong social vocational orientation would likely predispose a student to a future pathway that serves others. For instance, vocational interests were stronger predictors of STEM major choice for German high school students compared to expectancy and value beliefs (Wille et al., 2020). An integrative framework that incorporates the role of social motivation could help illuminate the processes by which adolescent youth of color navigate academic and career pathways in high school and college.

It is instructive to examine the quantitative scale of future plans used in this study. The four-item scale assesses students' future plans to pursue academic and science career pathways but does so at a superficial level. For example, the item, "My experience in this summer program makes me want to take more science courses" does not provide students with an opportunity to explain the nature of their experience and relationships developed. Enrolling in courses may be a proximal action, but it remains entirely individualistic. Our research shows that students are motivated due to the importance of a task to one's community and to broader society—that is, a self-transcendent purpose. Students—both high school mentees and their undergraduate mentors—spoke about how their interest in science is service-oriented and connected to a collectivist purpose beyond their self-interest. Our study suggests that conceptualizing future plans to reflect interpersonal factors that emphasize engaging in science socially and contributing in a meaningful way to one's family, community, and the world, at large, may be more inclusive of adolescent youth to envision future plans in science.

4.2. Limitations and directions for future research

Given the small sample used in the present study, our findings do not generalize to a broader population of high school students. Although demonstrating generalizability was not an aim of the study, it would nonetheless be important to broaden aspects of our approach to examine which aspects of mentoring are perceived as meaningful for which groups of students. As previously noted, we were only able to match mentors and mentees on same gender. It would be important to examine the influence of intersectional identities in the mentor–mentee matching process on student motivation. Although we observed some students specifically reflecting on their dual identities as women of color, would a different mentor–mentee matching process prompt similar or different themes around motivation and achievement? This would be an important question for future research.

Although we used individual interviews in the present study, we also see considerable value in conducting focus groups with students. Our study revealed the importance of interpersonal connections in the development of science motivation; encouraging students to share their views in an interactive social setting might yield insights inaccessible in an individual setting. To better understand the role of race, ethnicity, and culture in science motivation, caucus groups might provide additional space for students of color to openly share their perceptions and insights about science with other students who share their identity. Race-based caucusing has become an increasingly common technique in teacher education programs to help educators reflect on their shared experiences and how their identity might shape their perspectives and beliefs about education (Varghese, Daniels, & Park, 2019). Similarly, focus groups that adopt a caucusing method might yield additional insights into self-efficacy through an identity lens.

Recruitment for the brief summer near peer mentoring program was targeted and not drawn from a broader participant pool. As previously noted, we consulted with program directors to identify a group of undergraduate mentors that possessed qualities that would make them personable and effective mentors, as well as a group of high school mentees that would be receptive to one-on-one mentoring. All students already had some preexisting interest in science. Therefore, our youth sample might not reflect the broader population of high school and undergraduate students. Future research could adopt stratified purposeful sampling techniques to examine the nature of science motivation for students who do not already possess an initial interest in science, or for students who are identified by their teachers as poor performers in science, as examples. Examining motivation for science among a broader pool of students would expand understanding of how to shape STEM motivation for students, more generally. We also noted earlier that mentors in our study were mentees themselves as part of a university science lab in which they were mentored by professors and research staff. It would be illuminating to further examine this potential "double identity" amongst mentors and how such an identity could shape their understanding of what it takes to succeed in science.

5. Conclusion

In the present study, we used a qualitative approach to examine the nature of science motivation among six high school students of color who participated in a brief, near peer mentoring program with undergraduate student mentors of color. Deductive and inductive coding of semi-structured interviews revealed that science self-efficacy has a salient future-oriented component and centers around the importance of forming and maintaining interpersonal connections with others. These data expand our understanding of motivational phenomena in a way that is inclusive of the experiences of racial and ethnic minority youth and adds to the growing body of literature that calls for greater attention to the collectivist dimensions of motivational processes that may be particularly salient for minoritized youth.

.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by funding from the National Science Foundation (DRL1759442). The authors would like to thank Tracy Bousselot, Kristine Chadwick, Rachel Guldin, Maya Lazaro, and Michael Rea for their invaluable contributions to the study. The authors would also like to thank the Oregon Young Scholars Program and the Summer Program for Undergraduate Research at the University of Oregon, as well as the undergraduate student mentors and high school student mentees who participated in the study. The authors also thank two anonymous reviewers for their feedback on this manuscript.

References

Allen, R., & Bagozzi, R. (2001). *Consequences of the black sense of self. Journal of Black Psychology, 27*(1).

Author (2016). Withheld for blind review.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (2018). *Toward a psychology of human agency: Pathways and reflections. Perspectives on Psychological Science, 13*(2), 130–136.

Bong, M., & Skaalvik, E. M. (2003). *Academic self-concept and self-efficacy: How different are they really?. Educational Psychology Review, 15*(1), 1–40.

Carson, L. R. (2009). *"I am because we are:" Collectivism as a foundational characteristic of African American college student identity and academic achievement. Social Psychology of Education, 12*(3), 327–344.

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). *What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. Journal of Research in Science Teaching, 51*(5), 555–580.

Charmaz (2014). Constructing grounded theory (introducing qualitative methods series). California: SAGE.

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). *The role of efficacy and identity in science career commitment among underrepresented minority students. Journal of Social Issues, 67*(3), 469–491.

Clayton, K. E., & Zusho, A. (2016). *A cultural heuristic approach to the study of Jamaican undergraduate students' achievement motivation. British Journal of Educational Psychology, 86*, 8–36.

Cornwall, M. G. (1980). *Students as teachers: Peer teaching in higher education*. Amsterdam: Centrum Onderzoek Wetenschappelijk Onderwijs.

Creswell, J. W., & Plano-Clark, V. (2018). *Designing and conducting mixed method research* (3rd ed.). Thousand Oaks, CA: Sage Publications.

DeCuir-Gunby, J. T., & Schutz, P. A. (2014). *Researching race within educational psychology contexts. Educational Psychologist, 49*(4), 244–260.

Destin, M., Castillo, C., & Meissner, L. (2018). *A field experiment demonstrates near peer mentorship as an effective support for student persistence. Basic and Applied Social Psychology, 40*(5), 269–278.

Eccles, J. S. (2005). Subjective task value and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), Handbook of competence and motivation. New York: Guilford.

Eccles, J. S., & Wigfield, A. (2020). *From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. Contemporary Educational Psychology, 61*, 101859.

Fortus, D., & Vedder-Weiss, D. (2014). *Measuring students' continuing motivation for science learning. Journal of Research in Science Teaching, 51*(4), 497–522.

Fuligni, A. J. (2019). *The need to contribute during adolescence. Perspectives on Psychological Science, 14*(3), 331–343.

Gershenson, S., Hart, C. M. D., Hyman, J., Lindsay, C., & Papageorge, N. W. (2018). *The long-run impacts of same-race teachers (No. w25254)*. National Bureau of Economic Research.

Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (2001). *Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. Journal of Educational Psychology, 93*(1), 3–13.

Gottfried, A. E., Marcoulides, G. A., Gottfried, A. W., & Oliver, P. H. (2009). *A latent curve model of parental motivational practices and developmental decline in math and science academic intrinsic motivation. Journal of Educational Psychology, 101*(3), 729–739.

Gray, D. L., Hope, E. C., & Matthews, J. S. (2018). *Black and belonging at school: A case for interpersonal, instructional, and institutional opportunity structures. Educational Psychologist, 53*(2), 97–113.

Gray, D. L., McElveen, T. L., Green, B. P., & Bryant, L. H. (2020). *Engaging Black and Latinx students through communal learning opportunities: A relevance intervention for middle schoolers in STEM elective classrooms. Contemporary Educational Psychology, 60*, 101833.

Grigg, S., Perera, H. N., McIlveen, P., & Svetleff, Z. (2018). *Relations among math self-efficacy, interest, intentions, and achievement: A social cognitive perspective. Contemporary Educational Psychology, 53*, 73–86.

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J. S., & Dicke, T. (2017). *Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional comparison processes and expectancy-by-value interactions. Learning and Instruction, 49*, 81–91.

Hammond, Z. (2015). *Culturally responsive teaching and the brain*. Thousand Oaks, CA: Corwin.

Harrell, P. E., & Forney, W. S. (2003). *Ready or not, here we come: Retaining Hispanic and first-generation students in postsecondary education. Community College Journal of Research and Practice, 27*, 147–156.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). *The weirdest people in the world?. Behavioral and Brain Sciences, 33*, 61–135.

Hernandez, P. R., Bloodhart, B., Barnes, R. T., Adams, A. S., Clinton, S. M., Pollack, I., et al. (2017). *Promoting professional identity, motivation, and persistence: Benefits of an informal mentoring program for female undergraduate students. PLoS ONE, 12*(11), e0187531.

Hidi, S., & Renninger, K. A. (2006). *The four-phase model of interest development. Educational Psychologist, 41*(2), 111–127.

Hidi, S., Renninger, K. A., & Krapp, A. (2004). *Interest, a motivational variable that combines affective and cognitive functioning. Motivation, emotion, and cognition* (pp. 103–130). Routledge.

Hoffman, A. J., & Kurtz-Costes, B. (2018). *Promoting science motivation in American Indian middle school students: An intervention. Educational Psychology*. https://doi.org/10.1080/01443410.2018.1527019.

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources.

Hulleman, C. S., & Harackiewicz, J. M. (2009). *Promoting interest and performance in high school science classes. Science, 326*, 1410–1412.

King, R. B., & McInerney, D. M. (2019). *Family-support goals drive engagement and achievement in a collectivist context: Integrating etic and emic approaches in goal research. Contemporary Educational Psychology, 58*, 338–353.

Koenka, A. C. (2020). *Academic motivation theories revisited: An interactive dialog between motivation scholars on recent contributions, underexplored issues, and future directions. Contemporary Educational Psychology, 61*, 101831.

Krapp, A., & Prenzel, M. (2011). *Research on interest in science: Theories, methods, and findings. International Journal of Science Education, 33*(1), 27–50.

Krosnick, J. A., Holbrook, A. L., Berent, M. K., Carson, R. T., Hanemann, W., Kopp, R. J., et al. (2002). *The impact of "no opinion" response options on data quality: Non-attitude reduction or an invitation to satisfice?. Public Opinion Quarterly, 66*, 371–403.

Kumar, R., Zusho, A., & Bondie, R. (2018). *Weaving cultural relevance and achievement motivation into inclusive classroom cultures. Educational Psychologist, 53*(2), 78–96.

Lau, S., & Roeser, R. W. (2002). *Cognitive abilities and motivational processes in high school students' situational engagement and achievement in science. Educational Assessment, 8*(2), 139–162.

Lockspeiser, T. M., O'Sullivan, P., Teherani, A., & Muller, J. (2008). *Understanding the experience of being taught by peers: The value of social and cognitive congruence. Advances in Health Sciences Education, 13*, 361–372.

Lyons, T. (2006). *Different countries, same science classes: Students' experiences of school science in their own words. International Journal of Science Education, 28*(6), 591–613.

Matthews, J. S., & Lopez, F. (2020). *Race-reimaging educational psychology research: Investigating constructs through the lens of race and culture. Contemporary Educational Psychology, 61*, 101878.

Markus, H. R., & Kitayama, S. (1991). *Culture and the self: Implications for cognition, emotion, and motivation. Psychological Review, 98*(2), 224–253.

McCormick, M., Barthelemy, R. S., & Henderson, C. (2014). *Women's persistence into graduate astronomy programs: The roles of support, interest, and capital. Journal of Women and Minorities in Science and Engineering, 20*(4), 317–340.

McGee, E. O. (2016). *Devalued Black and Latino racial identities: A by-product of STEM college culture?. American Educational Research Journal, 53*(6), 1626–1662.

McLean, K. C. (2005). *Late adolescent identity development: Narrative meaning making and memory telling. Developmental Psychology, 41*(4), 683–691.

Meyer, J., Fleckenstein, J., & Koller, O. (2019). *Expectancy-value interactions and academic achievement: Differential relationships with achievement measures. Contemporary Educational Psychology, 58*, 58–74.

Morton, T. R., Gee, D. S., & Woodson, A. N. (2020). *Being vs. becoming: Transcending STEM identity development through Afropessimism, moving toward a Black X Consciousness in STEM. The. Journal of Negro Education, 88*(3), 327–342.

Nielsen, M., Haun, D., Kartner, J., & Legare, C. H. (2017). *The persistent sampling bias in developmental psychology: A call to action. Journal of Experimental Child Psychology, 162*, 31–38.

Nolen, S. B. (2020). *A situative turn in the conversation on motivation theories. Contemporary Educational Psychology, 61*, 101866.

Nolen, S. B., Horn, I. S., & Ward, C. J. (2015). *Situating motivation. Educational Psychologist, 50*, 234–247.

O'Brien, L. T., Bart, H. L., & Garcia, D. M. (2020). *Why are there so few ethnic minorities in ecology and evolutionary biology? Challenges to inclusion and the role of sense of belonging. Social Psychology of Education, 23*, 449–477.

Osborne, J., Simon, S., & Collins, S. (2003). *Attitudes towards science: A review of the literature and its implications. International Journal of Science Education, 25*(9), 1049–1079.

Pintrich, P. R., Smith, D. A., García, T., & McKeachie, W. J. (1991). A manual for the use of the motivational strategies for learning questionnaire (MSLQ). Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning.

Reardon, S. F., & Robinson, J. P. (2007). *Patterns and trends in racial/ethnic and socioeconomic academic achievement gaps*. In H. A., Ladd, & E. B., Fiske (Eds.), *Handbook of research in education finance and policy*. Lawrence Erlbaum.

Reeve, J. (2013). *How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. Journal of Educational Psychology, 105*(3), 579–595.

Renninger, K. A., & Hidi, S. (2011). *Revisiting the conceptualization, measurement, and generation of interest. Educational Psychologist, 46*, 168–184.

Rounds, J., & Su, R. (2014). *The nature and power of interests. Current Directions in Psychological Science, 23*(2), 98–103.

Schmidt, H. G., & Moust, J. H. C. (1995). *What makes a tutor effective? A structural equations modeling approach to learning in problem-based curricula. Academic Medicine, 70*, 708–714.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). *Math and science motivation: A longitudinal examination of the links between choices and beliefs. Developmental Psychology, 42*(1), 70–83.

Talley, K. G., & Ortiz, A. M. (2017). *Women's interest development and motivation to persist as college students in STEM: A mixed-methods analysis of views and voices from a Hispanic-serving institution. International Journal of STEM Education, 4*(5).

ten Cate, O., van de Vorst, I., & van den Broek, S. (2012). *Academic achievement of students tutored by near peers. International Journal of Medical Education, 3*, 6–13.

Tenenbaum, L. S., Anderson, M. K., Jett, M., & Yourick, D. L. (2014). *An innovative near-peer mentoring model for undergraduate and secondary students: STEM focus. Innovative Higher Education, 39*, 375–385.

Tsui, L. (2007). *Effective strategies to increase diversity in STEM fields: A review of the research literature. The Journal of Negro Education, 76*(4), 555–581.

Usher, E. L. (2018). *Acknowledging the whiteness of motivation research: Seeking cultural relevance. Educational Psychologist, 53*(2), 131–144.

Usher, E. L., & Pajares, F. (2008). *Sources of self-efficacy in school: Critical review of the literature and future directions. Review of Educational Research, 78*(4), 751–796.
Vargas, J. H., & Kemmelmeier, M. (2013). *Ethnicity and contemporary American culture: A meta-analytic investigation of horizontal-vertical individualism-collectivism. Journal of Cross-Cultural Psychology, 44*(2), 195–222.
Varghese, M., Daniels, J. R., & Park, C. C. (2019). *Structuring Disruption within University-Based Teacher Education Programs: Possibilities and Challenges of Race-Based Caucuses. Teachers College Record, 121*(4), n4.
Vedder-Weiss, D., & Fortus, D. (2011). *Adolescents' declining motivation to learn science: Inevitable or not?. Journal of Research in Science Teaching, 48*(2), 199–216.
Wang, M. T., & Eccles, J. S. (2012). *Adolescent behavioral, emotional, and cognitive engagement trajectories in school and their differential relations to educational success. Journal of Research on Adolescence, 22*(1), 31–39.
Wigfield, A., & Eccles, J. S. (2000). *Expectancy-value theory of achievement motivation. Contemporary Educational Psychology, 25*, 68–81.
Wigfield, A., Tonks, S., & Eccles, J. S. (2018). *Expectancy value theory in cross-cultural perspective*. In D. M., McInerney, & S., Van Etten (Eds.), *Big Theories Revisited* (pp. 165–198). Information Age Publishing.
Wille, E., Stoll, G., Gfrorer, T., Cambria, J., Nagengast, B., & Trautwein, U. (2020). *It takes two: Expectancy-value constructs and vocational interests jointly predict STEM major choices. Contemporary Educational Psychology, 61*, 101858.
Yeager, D. S., Henderson, M. D., Paunesku, D., Walton, G. M., D'Mello, S., Spitzer, B. J., et al. (2014). *Boring but important: A self-transcendent purpose for learning fosters academic self-regulation. Journal of Personality and Social Psychology, 107*(4), 559–580.
Zaniewski, A. M., & Reinholz, D. (2016). *Increasing STEM success: A near-peer mentoring program in the physical sciences. International Journal of STEM Education, 3*(14).