Received: 13 February 2023 | Revised: 24 April 2023 | Accepted: 4 May 2023

DOI: 10.1002/pits.22946

RESEARCH ARTICLE

WILEY

Factors that predict adolescents' engagement with STEM in and out of school

Kelly Lynn Mulvey[1] | Jacqueline Cerda-Smith[1] | Angelina Joy[1] | Channing Mathews[2] | Emine Ozturk[1]

[1]North Carolina State University, Raleigh, North Carolina, USA

[2]University of Virginia, Charlottesville, Virginia, USA

Correspondence
Kelly Lynn Mulvey, North Carolina State University, Campus Box 7650, 628C Poe Hall, Raleigh, NC 27695, USA.
Email: klmulvey1@ncsu.edu

Funding information
National Science Foundation

Abstract

Maintaining adolescents' engagement with STEM (science, technology, engineering, and math) in and out of school may help ensure that adolescents are prepared to enter the STEM workforce. This study aims to extend prior work by documenting internal and external factors that matter for both STEM class engagement as well as engagement with STEM outside of school through STEM activism. Participants included ninth and tenth grade students ($N = 852$) from ethnically diverse public schools in the Southeastern United States, approximately evenly divided by gender. Findings from regression analyses revealed that girls and participants who perceive educational barriers to STEM were less engaged in STEM classes, whereas those who reported learning about more male scientists in class, and those who reported higher levels of belonging, STEM growth mindset, and STEM motivation were more engaged in STEM classes. Those who reported higher critical motivation, critical action, belonging, and STEM motivation were more engaged in STEM activism outside of school. Findings suggest that STEM teachers and out-of-school program developers may learn new ways to engage students from each other. Further, findings highlight some factors that may promote engagement in STEM both in and out of schools such as belonging and STEM motivation.

KEYWORDS
activism, engage, motivate, school, science, youth

1 | INTRODUCTION

Research documents that interest in science, technology, engineering, and math (STEM) often wanes throughout adolescence (Aschbacher et al., 2013; Lei et al., 2019). However, there is a critical need for STEM workers (National Science Board, 2021), which highlights the importance of maintaining adolescents' STEM engagement as they will soon enter the workforce. Importantly, formal STEM class engagement is only one way to maintain connections to STEM. Adolescents may also engage with STEM in their local communities, particularly through civic science, environmental justice, or STEM activist activities (Flanagan et al., 2022; Gallay et al., 2021; Makuch & Aczel, 2020; Mulvey, Mathews, et al., 2022). Recent research documents that psychological factors such as inclusion, belonging, and perceptions of discrimination predict both formal classroom engagement as well as engagement in STEM outside of school (STEM activism orientation; Mulvey, Mathews, et al., 2022). The current study aims to extend this prior work by documenting other school and individual factors that matter for both STEM class engagement as well as engagement with STEM outside of school through STEM activism.

1.1 | Theoretical framework: engagement as multidimensional construct

Scholars have long lauded the importance of engagement for future career attainment (Bargmann et al., 2022; Conner & Pope, 2013; Rowan-Kenyon et al., 2012). Unfortunately, research also demonstrates that engagement in formal school, and in STEM in particular, tends to decline across adolescence (Aschbacher et al., 2013; Lei et al., 2019). Even subtle forms of disengagement with STEM during adolescence are associated with a reduced likelihood of pursuing a STEM career (Almeda & Baker, 2020). However, theoretical work argues that scholars should consider engagement to be a multidimensional construct and to recognize that engagement both in school and outside of school contexts may be critical for student outcomes (Fredricks, 2011). During adolescence, youth have exposure to a range of developmental contexts including both school (Eccles & Roeser, 2013) and community settings (Eccles & Gootman, 2002). In these settings, focusing on opportunities for engagement may be especially important, as engagement has been linked to numerous healthy developmental outcomes for adolescents, including better academic achievement, higher educational attainment, and overall better well-being (Griffiths et al., 2009; Wang et al., 2015). Although more research has focused on formal school engagement, Fredricks (2011) argues that out-of-school engagement may be just as important to explore, given that youth spend more than 50% of their time out-of-school (Mahoney et al., 2005). Importantly, this perspective also highlights that a focus on engagement is key because engagement is responsive to contexts and sensitive to change (Fredricks, 2011).

In research on STEM engagement, in particular, scholars have begun to examine engagement in STEM programs outside of school (National Research Council, 2009). Findings demonstrate that youth can develop interest and excitement about STEM topics outside of school for instance through programs held at museums, zoos, or aquariums (Hoffman et al., 2021), maker-space activities (Calabrese Barton & Tan, 2018), and through civic science (Flanagan et al., 2022; Gallay et al., 2021). Further, recent research demonstrates that both formal school engagement and out-of-school engagement in STEM (feeling capable of addressing local STEM problems) are related to feeling that one belongs in their STEM classes and that STEM classes are inclusive for all students

(Mulvey, Mathews, et al., 2022). This work provides insight into some factors that schools may harness to maintain adolescents' STEM engagement in and out of school; however, prior research on engagement drawing on a dynamic systems perspective on engagement highlights that numerous factors in one's learning context matter for development of engagement (Ainley, 2012).

Thus, the aim of the current study is to understand what additional factors may shape engagement with STEM in and out of school. In particular, we focus on both external factors (perceptions of educational and career barriers, sense of belonging to STEM) and internal orientations (critical consciousness, STEM motivation, and growth mindset). Additionally, given that adolescence is often a developmental period where school motivation wanes (Muenks et al., 2018), but when students become increasingly attuned to social issues in the world around them, we explore both engagement in formal school classes and engagement with STEM out-of-school, through STEM activism orientation (Mulvey, Mathews, et al., 2022). STEM activism orientation is conceptualized as efficacy towards solving or addressing STEM problems in one's local community (Mulvey, Mathews, et al., 2022).

1.2 | External factors that may shape engagement

Adolescents are often motivated by external factors in their lives and their perceptions of these factors may shape the ways in which they engage with educational opportunities. In the current study, we focused on three types of external factors: perceptions of barriers, sense of belonging, and explicit school content, namely learning about diverse scientists. Such factors are important for examining contextual aspects of learning that are most critical for STEM persistence, particularly with respect to girls and ethnic minoritized groups.

1.2.1 | Perceptions of educational and career barriers

Research has long documented that awareness of structural and social forces that may limit educational and vocational opportunities might influence historically marginalized individuals' decisions in schools and workplace settings (McWhirter, 1997). Furthermore, awareness of these barriers may, in part, explain ability-attainment gaps for women and ethnic minoritized individuals (McWhirter, 1997). Further, research from a social cognitive career theory perspective highlights that perceptions of barriers may explain why one may hold an interest in a particular domain, but ultimately choose not to pursue a career that aligns with that interest (Lent & Brown, 2019). Prior research on perceptions of educational and career barriers has also documented gender and race differences, with girls and ethnic minoritized participants more likely to report barriers (Luzzo & McWhirter, 2001; McWhirter, 1997). Therefore, the current study aims to explore whether perceptions of career and educational barriers are related to adolescents' engagement with STEM in school and their efficacy around engagement with STEM problems in their community, out-of-school.

1.2.2 | Belonging in STEM classes

The need to belong is central for adolescents (Baumeister & Leary, 1995), with recent findings from higher education settings (London et al., 2011), informal learning contexts (Zhao et al., 2022) and secondary school (Mulvey, Mathews, et al., 2022) highlighting that a sense of belonging may be especially important in STEM settings. Further, the persistence framework indicates that feeling like one belongs in STEM has been theorized to be critically important for persistence in STEM (Graham et al., 2013). However, findings also suggest that adolescents do not always feel that they belong in STEM settings, with research indicating that girls and ethnic minoritized students often feel marginalized, excluded, or undervalued in STEM settings (Mulvey, Hoffman, et al., 2022; Rainey et al., 2018; Robnett & John, 2020). Thus, the current study aims to explore the role of belonging in concert with other key internal and external factors in shaping in-school and out-of-school STEM engagement.

1.2.3 | Learning about diverse scientists

An additional external factor explored in this study is students' learning experiences. Prior research examining undergraduate biology textbooks documents that the vast majority of scientists represented in these textbooks are White and male (Wood et al., 2020). Additionally, an analysis of geology textbooks found that 94% of authors mentioned were male (Phillips & Hausbeck, 2000). Furthermore, there have been calls to address the lack of diversity in STEM textbooks in high school as well (Ceglie & Olivares, 2012), with findings suggesting that men are vastly overrepresented in high school textbooks (Ragusa, 2013). Importantly, research also suggests that learning about diverse scientists can benefit youth, with findings documenting positive outcomes from interventions focused on “scientist spotlights” that feature non-White and gender diverse scientists (Hoffman & Kurtz-Costes, 2019; Schinske et al., 2016; Yonas et al., 2020). However, it is unknown if the diverse scientists that students may learn about are related to their formal and informal STEM engagement. Thus, the current study explicitly asked students to identify scientists who they had learned about and explored whether the diversity of these scientists was related to engagement.

1.3 | Internal orientations that may shape engagement

While external factors are certainly important drivers for engagement, the current study also focuses on internal orientations or psychological strengths that students may draw upon when engaging with STEM. In particular, the current study explores critical consciousness, STEM motivation, and STEM growth mindset. Such factors have been documented as promotive of individuals' academic outcomes, but have not been explored in concert in association with STEM engagement outcomes.

1.3.1 | Critical consciousness

Scholars have identified school as a context that can support youth's critical consciousness development, which involves an awareness of social and political inequalities in society (critical reflection), motivation to address these injustices (critical motivation), and the capacity to take action to rectify oppression and injustice (critical action; Diemer et al., 2015; Freire, 1973; Watts et al., 2011). Research has often focused on factors that promote development of critical consciousness; for instance, classroom spaces where both students and teachers are learning, where social support is provided, and where students have the opportunity to engage in small group discussion (Jemal, 2017). Luter et al. (2017) demonstrated this principle by examining differences between students who were enrolled in a course focused on developing critical consciousness through engaging neighborhood reform and students enrolled in traditional classrooms. Students engaged in the process of identifying the roots of structural challenges facing their neighborhood (i.e., critical reflection) and constructed both virtual and physical representations of a re-imagined and revitalized neighborhood (i.e., critical action). Scholars found that those engaged in the community-based course had higher standardized test results, particularly in math and science (Luter et al., 2017). Research also documents the ways in which critical consciousness predicts career development and attainment of higher status employment (Diemer, 2009; Diemer et al., 2010). Further, scholars demonstrated that critical consciousness among Latino/a/e students may prompt engagement in school and in extracurricular activities (McWhirter & McWhirter, 2016), although this prior research did not center on STEM engagement.

Moreover, in the current study, we explore each dimension of critical consciousness as separate predictors of engagement. Scholars have highlighted the differential impacts of individual dimensions of critical consciousness in relation to academic outcomes. For example, Seider et al. (2020) found that growth in critical reflection and critical action was associated with a higher GPA at the end of high school, but this was not the case for critical motivation. In another study, scholars highlighted how one STEAM (science, technology, engineering, art, and math) based school used critical reflection to link the English language and science curricula, ultimately resulting in deeper connections and critical engagement of a windmill engineering activity that was relevant to the local neighborhood context (Upadhyay et al., 2021). Thus, research is needed that more carefully explores critical reflection and action and relations to engagement. It may be that critical action, for instance, is more related to STEM engagement outside of school as our measure captures STEM activism orientation and prior research has linked critical action to other types of civic engagement, such as voting behavior (Diemer & Li, 2011).

1.3.2 | STEM motivation

Research from the expectancy value theory of academic motivation identifies motivation as students' interest, goals, and persistence in pursuing a particular topic or field (Wigfield & Eccles, 2000). Within this framework, motivation is understood to be shaped by one's expectancies for how well one will do in a particular task as well as how much they value a task (Wigfield & Eccles, 2000). While there is debate in the field about the relationship between motivation and engagement, evidence suggests that engagement often follows motivation, with engagement seen as an overarching educational outcome (Guthrie & Wigfield, 2000; Rosenzweig & Wigfield, 2016). Research drawing on expectancy value theory documents that motivational constructs such as self-efficacy, self-concept, and task value are all important predictors of STEM engagement in school (Murphy et al., 2019). For instance, research suggests that when math was more connected to socially-relevant topics students reported greater self-efficacy which was related to increased participation in math class (Dasgupta et al., 2022). Further, research suggests that intrinsic motivation drives engagement with science for early adolescents (Lee et al., 2016). However, less is known about the role of STEM motivation in predicting engagement out of school.

1.3.3 | STEM growth mindset

Implicit beliefs one holds about intelligence may also shape one's engagement with STEM. Growth mindset refers to implicit beliefs that intelligence is malleable, while fixed mindsets suggest that intelligence may not be changeable (Dweck, 2017). Meta-analyses document that interventions to promote growth mindsets can lead to improvements in academic outcomes, such as academic achievement, especially for vulnerable subgroups (Burnette et al., 2022; Sisk et al., 2018; Yeager & Dweck, 2020). In terms of engagement, in particular, although less work has focused on STEM engagement, findings do suggest a positive relationship between growth mindset and mathematics engagement (Bostwick et al., 2017, 2020). Further, while interventions to promote growth mindset are commonly situated in formal educational spaces, interventions around STEM growth mindset have also been conducted out-of-school (Law et al., 2021), which suggests that growth mindset may be meaningful for in- and out-of-school STEM engagement.

2 | CURRENT STUDY

The current study aims to explore both internal and external factors that may shape adolescents in-school STEM engagement as well as their engagement with STEM out-of-school. Specifically, while much work has focused on formal school engagement, a growing body of research on civic science indicates the importance of promoting efficacy around and opportunities to engage in civic action to help address STEM problems in one's community (Flanagan et al., 2022). Little is known, though, about what prompts an orientation towards STEM activism out-of-school or about whether those factors are similar to or different from factors that are associated with more formal classroom STEM engagement. Thus, the following study examines both types of engagement outcomes for a sample of adolescents. Adolescence is a key developmental period to address these questions as this is often a time where students' engagement, motivation, and interest in STEM begin to decline (Aschbacher et al., 2013; Lei et al., 2019). We expected that both internal and external factors would be positively associated with engagement in school. However, we expected that dimensions of critical consciousness may be more important for STEM activism orientation (out-of-school STEM engagement), while perceptions of educational and career barriers might be more important for formal school STEM engagement.

3 | METHOD

3.1 | Participants

Participants included ninth (57.89%) and tenth (42.11%) grade students ($N = 852$, $M_{age} = 15.06$ years, SD = 0.62) from public schools in the Southeastern United States, approximately evenly divided by gender (47.6% male, 47.5% female, 1.9% nonbinary, 0.6% unsure, and 2.0% prefer not to say) with ethnic representation reflective of the schools (43.4% White, 26.8% Black, 13.7% Latino/a/x, and 15.9% other or prefer not to say). We conducted a power analysis which indicated that a sample size of at least 254 would be necessary for a multiple regression analysis with 10 predictors variables with effect sizes at 0.10 (small effects) with the desired statistical power at 0.95, and an α of .05 (Faul et al., 2007).

3.2 | Procedure

All students in the ninth and tenth grades at participating schools were invited to participate and IRB approved opt-out informed consent letters were sent home to families. This study was part of a larger study to assess students' experiences in their STEM classes. Students who had parental consent assented to participation and began an online survey administered through Qualtrics between January of 2022 and April of 2022. Participants completed the survey at school during a time selected by the school administration, using school-provided devices. All participants were provided a $10 electronic gift card for completing the survey. At the beginning of the survey, students were provided with the following definition of STEM: "In this survey, we will use the term 'STEM'. This refers to Science, Technology, Mathematics and Engineering."

3.3 | Measures

3.3.1 | STEM class engagement

Participants rated how much they agreed with statements that described their experience in school using a school Engagement Scale (Wang et al., 2016), which was adapted to capture engagement in STEM classes (Mulvey, Mathews, et al., 2022). The measure captured four different types of engagement (cognitive, behavioral, social, and emotional) using a 7-point scale (Likert-type: 1 = strongly agree to 7 = strongly disagree). Cognitive Engagement was measured using questions such as, "I go through the work for STEM classes and make sure that it's right." Behavioral engagement was measured using questions like "I put effort into learning STEM." Questions, such as "I enjoy learning new things about STEM," were used to measure Emotional Engagement. Social engagement was measured with questions including "I try to help others who are struggling in STEM." Higher scores indicated higher levels of engagement. Items were reliable as a composite averaged scale, capturing overall STEM class engagement, $\alpha = .92$.

3.3.2 | STEM activism orientation

The STEM Activism Orientation Scale (Mulvey, Mathews, et al., 2022) was based on items from Flanagan et al. (2007). The measure included items that capture perceptions of how prepared one is to engage in STEM activism to help solve a local STEM issue by taking some kind of action such as organizing a petition or contacting a local official. Participants read the following prompt and then completed eight items: "If you found out about a problem in your community or school that you wanted to do something about (e.g., high levels of lead were discovered in the local drinking water, or you notice that certain neighborhoods do not have access to a recycling center while others do), how well do you think your STEM experiences in school have prepared you to do each of the following to solve the problem?" An example item is: Apply your STEM knowledge to express your views on the problem (1 = I definitely can't to 5 = I definitely can, $\alpha = .92$). Average scores were computed, with higher scores indicating higher activism orientation.

3.3.3 | Critical consciousness

Participants completed a short measure of critical consciousness (Diemer et al., 2017) validated for use with adolescents (Rapa et al., 2020). This measure includes three averaged subscales: critical reflection (six items capturing perceived inequality and egalitarianism, $\alpha = .78$), critical motivation (3 items, $\alpha = .74$), and critical action (3 items, $\alpha = .88$). An example of critical reflection is: "All groups should be given an equal chance in life." An example of critical motivation is: "It is important to confront someone who says something you think is racist or prejudiced." An example of critical action is: "Participated in a political party, club, or organization." For critical reflection and motivation, participants responded on a six-point scale (Likert-type: 1 = strongly disagree to 6 = strongly agree). For critical action, participants indicated how often they had engaged in the listed actions over the past 2 years (1 = never did this to 5 = at least once a week).

3.3.4 | STEM class belonging

To measure students' belonging in their classes, we used an adapted version (Mulvey, Mathews, et al., 2022) of the Mendoza-Denton et al. (2002) Institutional Belonging scale. In this adapted version of the scale, items were focused on belonging in STEM classes (eight items). An example item from the scale reads, "How much do you feel that you fit in within your STEM classes?" (1 = Definitely do not fit in to 10 = Definitely fit in, $\alpha = .94$).

3.3.5 | Scientists learned about in school

To measure students' learning about diverse scientists in school, students were asked to name up to three scientists who they had learned about in school. Four research assistants coded the names provided, ascertaining the gender and race of each scientist. Inter-rater reliability was computed based on 25% of participants and Cohen's kappa = 0.98. For analytic purposes, two variables were created one capturing number of male scientists named (0–3) and one capturing number of White scientists named (0–3).

3.3.6 | Perceived barriers

Students completed a measure capturing their perceptions of educational and career barriers they may face (Luzzo & McWhirter, 2001). Specifically, 11 items measure participants' perceptions of career barriers (Likert-type: 1 = Strongly disagree to 5 = Strongly agree, $\alpha = .95$). An example item is: "In my future career I will probably experience negative comments about my racial/ethnic background (such as insults or rude jokes)." Further, 21 items measure participants' perceptions of educational barriers (Likert-type: 1 = Strongly disagree to 5 = Strongly agree, $\alpha = .97$). Participants responded to the question "How much do you agree that these are currently a barrier to your educational aspirations (goals)?" (example item: Lack of support from teachers).

3.3.7 | STEM motivation

STEM motivation was measured using a measure adapted from Wang et al. (2013). Participants completed 11 Likert-type items capturing STEM motivation (1 = Not at all true; 7 = Very true; $\alpha = .90$). Items include measures of self-concept, interest, and expectancies, for instance: "How good would you be at learning something new in STEM?" and "How much do you like STEM?"

3.3.8 | STEM growth mindset

Participants completed two items assessing their STEM growth mindset (Law et al., 2021). Specifically, they indicated how much they agreed with these two statements (Likert-type: 7 = Strongly agree to 1 = Strongly disagree): growth ("Most people can learn to be good at STEM") and fixed ("You have to be born with the ability to be good at STEM"). Scores were computed by reverse coding the fixed mindset score and adding it to the growth mindset score (possible range: 2 - 14, with higher scores indicating higher growth mindset).

3.4 | Data analytic plan

Descriptive statistics (including intra-class correlations; ICCs and Variance Inflation Factor; VIF) were calculated first using SPSS, see Table 1. These analyses revealed that ICCs were quite small for all variables (0.01–0.08); therefore, multi-level modeling accounting for nesting within schools was not required. They also confirmed that all VIF values were below 2.0; thus, multicollinearity was not a concern. Then, multiple regression analyses were conducted examining predictors of engagement in and out of school, with gender, grade, and ethnic majority status as controls. All analyses were conducted using the MLR estimator (as some of our variables were skewed) in Mplus Version 8, with full information maximum likelihood estimation (FIML) used to address missing data (Muthén & Muthén, 2017), as FIML handles missing data by incorporating missing data patterns in the model estimation without listwise deletion of incomplete cases (Yuan & Bentler, 2000). To assess model fit, four goodness-of-fit indices were used: comparative fit index (CFI), Tucker–Lewis index (TLI), standardized root-mean-square residual (SRMR), and the root mean square error of approximation (RMSEA). Models with a CFI and TLI at or above 0.95, and an SRMR and RMSEA at or below 0.08 were considered acceptable fitting models (Hu & Bentler, 1999).

TABLE 1 Means, SD, and correlations.

	M (SD)	Possible range	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. STEM Class Engagement	4.59 (0.83)	1–7														
2. STEM Activism Orientation	2.95 (0.98)	1–5	0.40**													
3. Career Barriers	2.57 (0.98)	1–5	−0.29**	0.02												
4. Educational Barriers	2.64 (0.92)	1–5	−0.38**	−0.04	0.58**											
5. Critical Reflection	4.02 (1.06)	1–6	0.07	0.14**	0.18**	0.05										
6. Critical Motivation	4.63 (1.11)	1–6	0.24**	0.19**	−0.03	−0.08	0.57**									
7. Critical Action	1.59 (0.95)	1–5	−0.11**	0.35**	0.21**	0.22**	0.04									
8. Belonging	6.63 (1.96)	1–10	0.58**	0.39**	−0.25**	−0.24**	0.03	0.18**	0.03							
9. STEM Motivation	52.06 (10.69)	11–77	0.66**	0.33**	−0.20**	−0.24**	0.09*	0.19**	−0.08*	0.61**						
10. STEM Growth Mindset	9.93 (2.33)	2–14	0.46**	0.12**	−0.29**	−0.34**	0.06	0.20**	−0.22**	0.34**	0.31**					
11. Male Scientists	2.87 (0.46)	0–3	−0.01	0.01	−0.02	−0.02	−0.05	0.01	0.01	−0.12	−0.05	−0.04				
12. White Scientists	2.95 (0.31)	0–3	9.05	−0.05	−0.01	0.01	0.01	0.01	−0.15*	−0.06	0.03	0.10	0.15*			
13. Gender	0.50 (0.50)	0–1	−0.07	−0.09*	−0.17**	−0.08	−0.13**	−0.16**	−0.01	0.04	−0.02	−0.09*	0.07	−0.08		
14. Majority Race	0.45 (0.49)	0–1	0.03	−0.02	−0.25**	−0.20**	−0.15**	−0.06	−0.13**	0.03	0.05	0.02	−0.01	0.03	−0.08*	
15. Grade	0.42 (0.49)	0–1	0.03	−0.01	−0.07	0.05	0.07	0.02	−0.06	−0.01	0.01	0.06	−0.04	−0.04	0.01	0.07

Note: See measures for possible range. Gender (0 = Female, 1 = Male), Majority race (0 = Non-White, 1 = White), Grade (0=9th, 1=10th).

**$p < .001$; *$p < .05$.

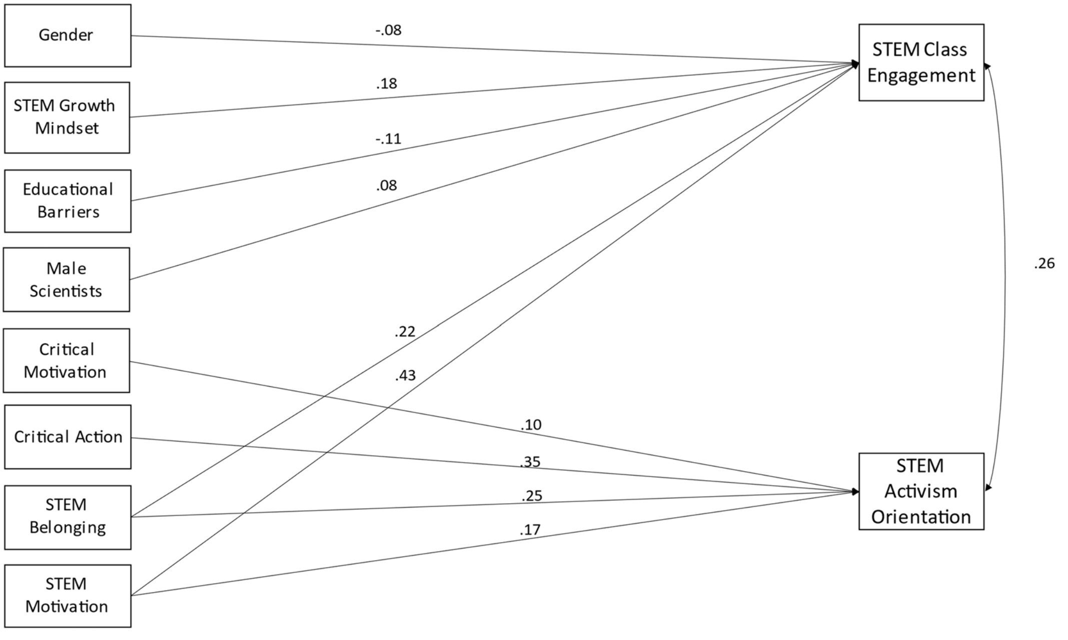

FIGURE 1 Model predicting STEM class engagement and STEM activism orientation. *Note*: Career barriers, critical reflection, White scientists, grade, and ethnic majority status were not significant predictors and thus are not shown. Only significant pathways are displayed.

TABLE 2 Regression analysis.

	School STEM engagement		STEM activism orientation (out of school STEM engagement)	
	Standardized estimates (SE)	Significance (*p*)	Standardized estimates (SE)	Significance (*p*)
Gender	−0.082 (0.03)	.008	−0.058 (0.04)	.111
Majority race	−0.013 (0.03)	.669	0.048 (0.03)	.155
Grade	0.012 (0.03)	.667	0.018 (0.03)	.590
Critical reflection	−0.004 (0.04)	.916	0.040 (0.05)	.381
Critical motivation	0.065 (0.04)	.089	0.098 (0.04)	.028
Critical action	−0.017 (0.03)	.601	0.354 (0.04)	<.001
Career barriers	−0.018 (0.05)	.713	0.087 (0.05)	.076
Educational barriers	−0.110 (0.05)	.018	−0.025 (0.05)	.604
Belonging in STEM classes	0.228 (0.04)	<.001	0.247 (0.05)	<.001
STEM growth mindset	0.181 (0.04)	<.001	0.056 (0.04)	.160
STEM motivation	0.430 (0.04)	<.001	0.174 (0.05)	<.001
Learning about male scientists	0.079 (0.04)	.032	0.069 (0.06)	.237
Learning about White scientists	0.015 (0.03)	.579	−0.019 (0.03)	.478

Note: Gender (0 = Female, 1 = Male), majority race (0 = Non-White, 1 = White), grade (0=9th, 1 = 10th).

4 | RESULTS

Descriptive statistics revealed that participants reported higher than average (higher than the mid-point) school engagement (t (589) = 31.78, $p < .001$), STEM activism orientation (t (674) = 11.91, $p < .001$), perceptions of educational barriers (t (518) = 3.62, $p < .001$), STEM growth mindset (t (642) = 31.98, $p < .001$), critical motivation (t (702) = 39.43, $p < .001$), critical reflection (t (700) = 25.35, $p < .001$), belonging (t (681) = 21.70, $p < .001$), STEM motivation (t (748) = 34.65, $p < .001$), and learning about White scientists (t (254) = 73.32, $p < .001$) and male scientists (t (254) = 47.15, $p < .001$). They reported lower than average critical action (t (692)) = −25.70, $p < .001$).

The regression model demonstrated good model fit: χ^2 (22) = 66.22, $p < .001$; CFI = 0.93, TLI = 0.92; RMSEA = 0.05, (CI = 0.04, 0.06); SRMR = 0.04. Multiple regression analysis indicated that girls ($\beta = -0.082$, $p = .008$) and participants who perceive educational barriers to STEM ($\beta = -0.110$, $p = .018$) were less engaged in STEM classes, whereas participants who reported learning about more male scientists ($\beta = .079$, $p = .032$), and who reported higher levels of belonging ($\beta = .228$, $p < .001$), STEM growth mindset ($\beta = .181$, $p < .001$), and STEM motivation ($\beta = .43$, $p < .001$) were more engaged in STEM classes, see Figure 1 and Table 2. In regard to STEM activism orientation, those who reported higher critical motivation ($\beta = .098$, $p = .028$), critical action ($\beta = .354$, $p < .001$), belonging ($\beta = .247$, $p < .001$), and STEM motivation ($\beta = .174$, $p < .001$) were more likely to be engaged in STEM outside of school, see Figure 1. No other control variables were significant.

5 | DISCUSSION

Findings reveal that STEM engagement in and out of school are related. Consistent with our hypotheses, we found that similar and different internal and external factors predicted each type of engagement. STEM class belonging and motivation were associated with both types of engagement. Key dimensions of critical consciousness were more important for STEM activism orientation, whereas scientists learned about in school, growth mindset, and perceived educational barriers were more important for in-class engagement.

5.1 | External factors

5.1.1 | Perceptions of educational and career barriers

Participants who perceived educational barriers to STEM were less engaged in STEM classes, although we did not document differences for STEM engagement out-of-school. This finding is in line with prior work demonstrating that educational barriers can impede students' academic trajectories (Lent et al., 2001; Luzzo & McWhirter, 2001). Importantly, however, perceptions of career barriers were not related to adolescents' STEM engagement at school and neither type of barrier was associated with STEM activism orientation. This is interesting as it suggests that interventions may need to focus just on reducing educational barriers to keep adolescents engaged in school and that STEM activism may be a place where perceptions of barriers are less relevant. Maintaining engagement while still in secondary school may be especially important as students often need to complete specific courses while in high school to be competitive for entry into college or specific STEM majors. Thus, focusing on reducing perceptions of educational barriers as well as keeping students engaged through connections to STEM in their community may be critical pathways to continued STEM focus during this key developmental period.

5.1.2 | Belonging

Consistent with prior research (Mulvey, Mathews, et al., 2022), we found that belonging in STEM classes was a central predictor for both types of engagement. Extensive prior research has documented that feeling included and welcomed into STEM spaces predicts a host of positive outcomes for youth (Mulvey, McGuire, et al., 2022; Robnett & John, 2020) and that feelings of belonging continue to be centrally important in higher education settings as well (Chang et al., 2014; Cheryan et al., 2017; London et al., 2011; Moss-Racusin et al., 2018; Rainey et al., 2018). Our findings support this and document just how important belonging is, even when considered in light of numerous other internal and external factors. Thus, a key challenge for secondary school educators moving forward will be how to build or maintain students' sense of belonging in STEM, as our findings suggest that feeling that one belongs in STEM class is important not only for in-class STEM engagement but also STEM engagement out of school.

5.1.3 | Learning about scientists

Finally, our findings document that students who reported learning about more male scientists were more engaged in their STEM classes. This may seem counter-intuitive, as learning about primarily stereotypical scientists may lead those who are not male or White to feel as though they do not belong in STEM. However, participants in this study overwhelming named male and White scientists when asked which scientists they had learned about. Thus, these data were highly skewed and this finding may in fact indicate an accurate representation of who students are learning about in their STEM classes (predominantly male and White scientists). It is surprising, however, that even following calls from the educational and research community to diversify the STEM curriculum (Ceglie & Olivares, 2012), that students in the current study were still overwhelmingly naming stereotypic (White, male) scientists. For example, students commonly named scientists such as Albert Einstein, Isaac Newton, Charles Darwin, and Robert Hooke. It may be that students are learning about diverse scientists, but that they recalled more stereotypic scientists when prompted, or it may be that the curriculum still primarily covers stereotypic scientists. Educators should work to explicitly teach students about scientists who are counter-stereotypic to provide a more accurate and inclusive picture of who contributes to STEM.

5.2 | Internal factors

5.2.1 | Motivation

In terms of motivation, we find that both STEM motivation and critical motivation were associated with higher engagement in STEM classes and in higher STEM activism orientation. It is not surprising that STEM motivation was related to STEM class engagement, especially given findings that suggest that motivational factors are central for academic outcomes (Murphy et al., 2019). However, this study also documents that STEM motivation is important for engagement with STEM in one's community. This is an important finding as out-of-school STEM engagement, in particular, feeling like one can solve STEM problems in one's community, may help propel students towards a life-long STEM orientation.

5.2.2 | Critical consciousness

We also find that critical motivation, or a desire and confidence to address injustices in one's society, was related to out of school engagement (STEM activism orientation). While prior work with a sample of Latino/a/e students has demonstrated that critical consciousness may prompt engagement in school and in extracurricular activities (McWhirter & McWhirter, 2016), the current study extends this finding to STEM engagement. It may be that critical motivation drives students to want to learn all that they can and to want to engage in STEM activism in their community. Thus, teachers and afterschool STEM program directors may seek to make explicit connections between STEM injustices and their teaching. Relatedly, we also find that critical action was related to STEM activism orientation, although the mean score for critical action was quite low for participants. Therefore, providing students with opportunities to engage in STEM-relevant critical action in and out of school may be especially beneficial for students' STEM engagement. For instance, STEM critical action might be encouraged through civic science projects (Flanagan et al., 2022) or environmental justice lessons (Calabrese Barton & Tan, 2010; Gallay et al., 2021; Makuch & Aczel, 2020).

5.2.3 | STEM growth mindset

We also document that STEM growth mindset is a predictor of STEM engagement in formal school, extending prior research which documented a positive relationship between growth mindset and mathematics engagement (Bostwick et al., 2017, 2020). A growth mindset in STEM may help students to stay engaged even when they face challenging concepts in STEM. Specifically, students may be more likely to persist when facing challenging content if they believe that their STEM skills will improve with practice. Increasingly, growth mindset interventions have been adopted to promote educational achievement (Burnette et al., 2022), and our findings suggest that one way in which having a growth mindset may help is by fostering continued engagement in STEM classes. Interestingly, STEM growth mindset was not associated with STEM activism orientation. This may be because one has more autonomy in selecting what types of STEM engagement they wish to pursue in out-of-school settings and thus students can focus their STEM activism in areas where they have high self-efficacy and where a growth mindset may be less relevant.

5.3 | Demographic variables

We documented that the only demographic variable that was significantly associated with engagement was gender: girls were less engaged in their formal STEM classes, although there were no gender differences for STEM activism orientation. Prior work also demonstrates that participating in out-of-school STEM activities is particularly beneficial for girls as it supports their STEM career interests and positive relationships (Dabney et al., 2012; Price et al., 2018). These findings may explain why girls are often underrepresented in STEM occupations (Pew Research Center, 2021), and are consistent with some earlier studies. For instance, research using a latent profile approach documented that girls were more likely to exhibit profiles associated with lower levels of school engagement than were boys (Yu et al., 2021). Findings with a sample of youth from New Zealand also documented that adolescent girls showed a steeper decline in science engagement than did boys (Darr, 2012). However, prior research has not always documented gender differences in STEM engagement (Wang et al., 2013), and our findings suggest that gender differences may emerge in some types of engagement (namely, formal school STEM engagement), but not others (STEM activism).

5.4 | Limitations and future directions

The current study documents different internal and external factors that are relevant for adolescents' continued engagement with STEM in and out of school. However, it is not without some limitations. First, the study is cross-sectional and therefore cannot make directional claims. Future research should aim to explore these relationships over time to identify which factors are associated with maintenance or growth of STEM engagement across adolescence. Further, this research centered on self-report measures, but would be strengthened by more objective measures such as an analysis of the curriculum taught to assess whether students were exposed to more diverse scientists than they recalled. Finally, this study was conducted in 2021, as students may have still been impacted by the COVID-19 pandemic. For instance, students may have had less opportunity to engage in critical action due to community restrictions in place for the pandemic. Thus, future research should aim to replicate this study at a different time.

6 | CONCLUSION

Despite these limitations, our study documents that STEM engagement in and out of school are related and that key internal and external factors may promote this engagement. Namely, findings highlight the role of belonging, STEM motivation, and critical motivation for both types of STEM engagement. Thus, STEM teachers and out of school program developers may focus on building a welcoming community, encouraging students to see STEM as a tool to address societal injustices, and maintaining students' overall STEM motivation to promote STEM engagement in and out of school.

ACKNOWLEDGMENTS

We appreciate the support of our school district partners, the students who participated in the study, their parents for allowing them to participate, and our amazing team of research assistants. This work was supported by the National Science Foundation [DRL-1941992,2020].

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions. Materials and analysis code for this study are available by emailing the corresponding author.

ETHICS STATEMENT

This study was approved by the IRB at North Carolina State University (20526). Opt-out consent forms were sent home with potential participants, and those with parental consent also assented to participate in the study.

ORCID

Kelly Lynn Mulvey http://orcid.org/0000-0002-1292-9066

REFERENCES

Ainley, M. (2012). Students' interest and engagement in classroom activities. In S. L. Christenson, A. L. Reschly & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 283–302). Springer. https://doi.org/10.1007/978-1-4614-2018-7_13

Almeda, M., & Baker, R. S. (2020). Predicting student participation in STEM careers: The role of affect and engagement during middle school. *Journal of Educational Data Mining*, *12*(2), 33–47.

Aschbacher, P. R., Ing, M., & Tsai, S. M. (2013). Boosting student interest in science. *Phi Delta Kappan*, *95*(2), 47–51. https://doi.org/10.1177/003172171309500211

Bargmann, C., Thiele, L., & Kauffeld, S. (2022). Motivation matters: Predicting students' career decidedness and intention to drop out after the first year in higher education. *Higher Education*, *83*(4), 845–861.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497–529.

Bostwick, K. C. P., Collie, R. J., Martin, A. J., & Durksen, T. L. (2017). Students' growth mindsets, goals, and academic outcomes in mathematics. *Zeitschrift für Psychologie*, *225*(2), 107–116. https://doi.org/10.1027/2151-2604/a000287

Bostwick, K. C. P., Collie, R. J., Martin, A. J., & Durksen, T. L. (2020). Teacher, classroom, and student growth orientation in mathematics: A multilevel examination of growth goals, growth mindset, engagement, and achievement. *Teaching and Teacher Education*, *94*, 103100. https://doi.org/10.1016/j.tate.2020.103100

Burnette, J. L., Billingsley, J., Banks, G. C., Knouse, L. E., Hoyt, C. L., Pollack, J. M., & Simon, S. (2022). A systematic review and meta-analysis of growth mindset interventions: For whom, how, and why might such interventions work? *Psychological Bulletin*. Advance online publication.

Calabrese Barton, A., & Tan, E. (2010). It changed our lives: Activism, science, and greening the community. *Canadian Journal of Science, Mathematics and Technology Education*, *10*(3), 207–222. https://doi.org/10.1080/14926156.2010.504480

Calabrese Barton, A., & Tan, E. (2018). A longitudinal study of equity-oriented STEM-rich making among youth from historically marginalized communities. *American Educational Research Journal*, *55*(4), 761–800. https://doi.org/10.3102/0002831218758668

Ceglie, R., & Olivares, V. (2012). Representation of diversity in science textbooks. In H. Hickman & B. J. Porfilio (Eds.), *The new politics of the textbook* (pp. 49–68). Brill.

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. https://doi.org/10.1002/tea.21146

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin*, *143*(1), 1–35. https://doi.org/10.1037/bul0000052

Conner, J. O., & Pope, D. C. (2013). Not just robo-students: Why full engagement matters and how schools can promote it. *Journal of Youth and Adolescence*, *42*(9), 1426–1442.

Dabney, K. P., Tai, R. H., Almarode, J. T., Miller-Friedmann, J. L., Sonnert, G., Sadler, P. M., & Hazari, Z. (2012). Out-of-school time science activities and their association with career interest in STEM. *International Journal of Science Education, Part B*, *2*(1), 63–79. https://doi.org/10.1080/21548455.2011.629455

Darr, C. W. (2012). Measuring student engagement: The development of a scale for formative use. In S. L. Christenson, A. L. Reschly & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 707–723). Springer US. https://doi.org/10.1007/978-1-4614-2018-7_34

Dasgupta, N., Thiem, K. C., Coyne, A. E., Laws, H., Barbieri, M., & Wells, R. S. (2022). The impact of communal learning contexts on adolescent self-concept and achievement: Similarities and differences across race and gender. *Journal of Personality and Social Psychology*, *123*(3), 537–558. https://doi.org/10.1037/pspi0000377.supp

Diemer, M. A. (2009). Pathways to occupational attainment among poor youth of color: The role of sociopolitical development. *The Counseling Psychologist*, *37*(1), 6–35. https://doi.org/10.1177/0011000007309858

Diemer, M. A., & Li, C.-H. (2011). Critical consciousness development and political participation among marginalized youth. *Child Development*, *82*(6), 1815–1833. https://doi.org/10.1111/j.1467-8624.2011.01650.x

Diemer, M. A., McWhirter, E. H., Ozer, E. J., & Rapa, L. J. (2015). Advances in the conceptualization and measurement of critical consciousness. *The Urban Review*, *47*(5), 809–823.

Diemer, M. A., Rapa, L. J., Park, C. J., & Perry, J. C. (2017). Development and validation of the critical consciousness scale. *Youth & Society*, *49*(4), 461–483. https://doi.org/10.1177/0044118X14538289

Diemer, M. A., Wang, Q., Moore, T., Gregory, S. R., Hatcher, K. M., & Voight, A. M. (2010). Sociopolitical development, work salience, and vocational expectations among low socioeconomic status African American, Latin American, and Asian American youth. *Developmental Psychology*, *46*(3), 619–635.

Dweck, C. S. (2017). The journey to children's mindsets—and beyond. *Child Development Perspectives*, *11*(2), 139–144. https://doi.org/10.1111/cdep.12225

Eccles, J. S., & Gootman, J. A. (2002). *Community programs to promote youth development*. National Academy Press.

Eccles, J. S., & Roeser, R. W. (2013). Schools as developmental contexts during adolescence. In R. Lerner, & M. Easterbrooks (Eds.), *Handbook of psychology* (Vol. 6, 2nd ed., pp. 321–337). Wiley/Blackwell.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191. https://doi.org/10.3758/BF03193146

Flanagan, C., Gallay, E. E., & Pykett, A. (2022). Civic science: Addressing racial inequalities in environmental and science, technology, engineering, and math education. *Child Development Perspectives*, *16*(4), 223–230.

Flanagan, C. A., Syvertsen, A. K., & Stout, M. D. (2007). *Civic measurement models: Tapping adolescents' civic engagement*. CIRCLE.

Fredricks, J. A. (2011). Engagement in school and out-of-school contexts: A multidimensional view of engagement. *Theory into Practice*, *50*(4), 327–335.

Freire, P. (1973). *Education for critical consciousness*. Bloomsbury Publishing.
Gallay, E., Flanagan, C., & Parker, B. (2021). Place-based environmental civic science: Urban students using STEM for public good. *Frontiers in Education*, *6*(325). Advance online publication. https://doi.org/10.3389/feduc.2021.693455
Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A.-B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science*, *341*(6153), 1455–1456. https://doi.org/10.1126/science.1240487
Griffiths, A.-J., Sharkey, J. D., & Furlong, M. J. (2009). Student engagement and positive school adaptation. In R. Gilman, E. Huebner & M. Furlong, (Eds.), *Handbook of positive psychology in schools* (pp. 197–212). Routledge.
Guthrie, J. T., & Wigfield, A. (2000). Engagement and motivation in reading In M. Kamil & P. Mosenthal (Eds.), *Handbook of reading research* (3, pp. 403–422). Erlbaum.
Hoffman, A. J., & Kurtz-Costes, B. (2019). Promoting science motivation in American Indian middle school students: An intervention. *Educational Psychology*, *39*(4), 448–469. https://doi.org/10.1080/01443410.2018.1527019
Hoffman, A. J., McGuire, L., Rutland, A., Hartstone-Rose, A., Irvin, M. J., Winterbottom, M., Balkwill, F., Fields, G. E., & Mulvey, K. L. (2021). The relations and role of social competencies and belonging with math and science interest and efficacy for adolescents in informal STEM programs. *Journal of Youth and Adolescence*, *50*(2), 314–323. https://doi.org/10.1007/s10964-020-01302-1
Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*, 1–55. https://doi.org/10.1080/10705519909540118
Jemal, A. (2017). Critical consciousness: A critique and critical analysis of the literature. *The Urban Review*, *49*(4), 602–626. https://doi.org/10.1007/s11256-017-0411-3
Law, F., McGuire, L., Winterbottom, M., & Rutland, A. (2021). Children's gender stereotypes in STEM following a one-shot growth mindset intervention in a science museum. *Frontiers in Psychology*, *12*, 1602.
Lee, C. S., Hayes, K. N., Seitz, J., DiStefano, R., & O'Connor, D. (2016). Understanding motivational structures that differentially predict engagement and achievement in middle school science. *International Journal of Science Education*, *38*(2), 192–215. https://doi.org/10.1080/09500693.2015.1136452
Lei, R. F., Green, E. R., Leslie, S.-J., & Rhodes, M. (2019). Children lose confidence in their potential to "be scientists", but not in their capacity to "do science". *Developmental science*, *22*(6):e12837. https://doi.org/10.1111/desc.12837
Lent, R. W., & Brown, S. D. (2019). Social cognitive career theory at 25: Empirical status of the interest, choice, and performance models. *Journal of Vocational Behavior*, *115*, 103316. https://doi.org/10.1016/j.jvb.2019.06.004
Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., & Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of math/science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology*, *48*, 474–483. https://doi.org/10.1037/0022-0167.48.4.474
London, B., Rosenthal, L., Levy, S. R., & Lobel, M. (2011). The influences of perceived identity compatibility and social support on women in nontraditional fields during the college transition. *Basic and Applied Social Psychology*, *33*(4), 304–321. https://doi.org/10.1080/01973533.2011.614166
Luter, D., Mitchell, A., & Taylor, H. (2017). Critical consciousness and schooling: The impact of the community as a classroom program on academic indicators. *Education Sciences*, *7*(1), 25.
Luzzo, D. A., & McWhirter, E. H. (2001). Sex and ethnic differences in the perception of educational and career-related barriers and levels of coping efficacy. *Journal of Counseling & Development*, *79*(1), 61–67.
Mahoney, J. L., Larson, R. W., & Eccles, J. S. (2005). *Organized activities as contexts of development: Extracurricular activities, after school and community programs*. Psychology Press.
Makuch, K. E., & Aczel, M. R. (2020). Eco-citizen science for social good: Promoting child well-being, environmental justice, and inclusion. *Research on Social Work Practice*, *30*(2), 219–232.
McWhirter, E. H. (1997). Perceived barriers to education and career: Ethnic and gender differences. *Journal of Vocational Behavior*, *50*(1), 124–140. https://doi.org/10.1006/jvbe.1995.1536
McWhirter, E. H., & McWhirter, B. T. (2016). Critical consciousness and vocational development among latina/o high school youth: Initial development and testing of a measure. *Journal of Career Assessment*, *24*(3), 543–558. https://doi.org/10.1177/1069072715599535
Mendoza-Denton, R., Downey, G., Purdie, V. J., Davis, A., & Pietrzak, J. (2002). Sensitivity to status-based rejection: Implications for african american students' college experience. *Journal of Personality and Social Psychology*, *83*(4), 896–918. https://doi.org/10.1037/0022-3514.83.4.896
Moss-Racusin, C. A., Sanzari, C., Caluori, N., & Rabasco, H. (2018). Gender bias produces gender gaps in STEM engagement. *Sex Roles*, *79*(11-12), 651–670. https://doi.org/10.1007/s11199-018-0902-z
Muenks, K., Yang, J. S., & Wigfield, A. (2018). Associations between grit, motivation, and achievement in high school students. *Motivation Science*, *4*(2), 158–176. https://doi.org/10.1037/mot0000076.supp

Mulvey, K. L., Hoffman, A. J., & McGuire, L. (2022). Fairness and opportunity in STEM contexts: Gender, stereotypes and moral judgments. In M. Killen & J. Smetana (Eds.), *Handbook of moral development* (pp. 236–252). Routledge. https://doi.org/10.4324/9781003047247

Mulvey, K. L., Mathews, C., Knox, J., Joy, A., & Cerda-Smith, J. (2022). The role of inclusion, discrimination, and belonging for adolescent science, technology, engineering and math engagement in and out of school. *Journal of Research in Science Teaching*, *59*, 1447–1464. https://doi.org/10.1002/tea.21762

Mulvey, K. L., McGuire, L., Mathews, C., Hoffman, A. J., Law, F., Joy, A., Hartstone-Rose, A., Winterbottom, M., Balkwill, F., Fields, G., Butler, L., Burns, K., Drews, M., & Rutland, A. (2022). Preparing the next generation for STEM: Adolescent profiles encompassing math and science motivation and interpersonal skills and their associations with identity and belonging. *Youth & Society*, 0044118X221085296. https://doi.org/10.1177/0044118X221085296

Murphy, S., MacDonald, A., Wang, C. A., & Danaia, L. (2019). Towards an understanding of STEM engagement: A review of the literature on motivation and academic emotions. *Canadian Journal of Science, Mathematics and Technology Education*, *19*(3), 304–320.

Muthén, L. K., & Muthén, B. (2017). *Mplus user's guide: Statistical analysis with latent variables, user's guide*. Muthén & Muthén.

National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*. National Academies Press.

National Science Board. (2021). *The STEM labor force of today: Scientists, engineers and skilled technical workers*. National Science Board Science & Engineering Indicators. https://ncses.nsf.gov/pubs/nsb20212

Pew Research Center. (2021). *STEM jobs see uneven progress in increasing gender, racial and ethnic diversity*. https://www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/

Phillips, J., & Hausbeck, K. (2000). Just beneath the surface: Rereading geology, rescripting the knowledge-power nexus. *Women's Studies Quarterly*, *28*(1/2), 181–202.

Price, C. A., Kares, F., Segovia, G., & Loyd, A. B. (2018). Staff matter: Gender differences in science, technology, engineering or math (stem) career interest development in adolescent youth. *Applied Developmental Science*, *23*, 239–254. https://doi.org/10.1080/10888691.2017.1398090

Ragusa, G. (2013). *STEM literacy and textbook biases in k-122013 IEEE frontiers in education conference (FIE)*, October 23–26, 2013.

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International Journal of STEM Education*, *5*(1), 10.

Rapa, L. J., Bolding, C. W., & Jamil, F. M. (2020). Development and initial validation of the short critical consciousness scale (CCS-S). *Journal of Applied Developmental Psychology*, *70*, 101164.

Robnett, R. D., & John, J. E. (2020). "It's wrong to exclude girls from something they love." adolescents' attitudes about sexism in science, technology, engineering, and math. *Child Development*, *91*(1), e231–e248. https://doi.org/10.1111/cdev.13185

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist*, *51*(2), 146–163. https://doi.org/10.1080/00461520.2016.1154792

Rowan-Kenyon, H. T., Swan, A. K., & Creager, M. F. (2012). Social cognitive factors, support, and engagement: Early adolescents' math interests as precursors to choice of career. *The Career Development Quarterly*, *60*(1), 2–15.

Schinske, J. N., Perkins, H., Snyder, A., & Wyer, M. (2016). Scientist spotlight homework assignments shift students' stereotypes of scientists and enhance science identity in a diverse introductory science class. *CBE—Life Sciences Education*, *15*(3), ar47. https://doi.org/10.1187/cbe.16-01-0002

Seider, S., Clark, S., & Graves, D. (2020). The development of critical consciousness and its relation to academic achievement in adolescents of color. *Child Development*, *91*(2), e451–e474.

Sisk, V. F., Burgoyne, A. P., Sun, J., Butler, J. L., & Macnamara, B. N. (2018). To what extent and under which circumstances are growth mind-sets important to academic achievement? Two meta-analyses. *Psychological Science*, *29*(4), 549–571.

Upadhyay, B., Coffino, K., Alberts, J., & Rummel, A. (2021). Steam education for critical consciousness: Discourses of liberation and social change among sixth-grade students. *Asia-Pacific Science Education*, *7*(1), 64–95. https://doi.org/10.1163/23641177-bja10020

Wang, M.-T., Eccles, J. S., & Kenny, S. (2013). Not lack of ability but more choice: Individual and gender differences in choice of careers in science, technology, engineering, and mathematics. *Psychological Science*, *24*(5), 770–775. https://doi.org/10.1177/0956797612458937

Wang, M.-T., Chow, A., Hofkens, T., & Salmela-Aro, K. (2015). The trajectories of student emotional engagement and school burnout with academic and psychological development: Findings from Finnish adolescents. *Learning and Instruction*, *36*, 57–65. https://doi.org/10.1016/j.learninstruc.2014.11.004

Wang, M.-T., Fredricks, J. A., Ye, F., Hofkens, T. L., & Linn, J. S. (2016). The math and science engagement scales: Scale development, validation, and psychometric properties. *Learning and Instruction*, *43*, 16–26. https://doi.org/10.1016/j.learninstruc.2016.01.008

Watts, R. J., Diemer, M. A., & Voight, A. M. (2011). Critical consciousness: Current status and future directions. *New Directions for Child and Adolescent Development*, *2011*(134), 43–57. https://doi.org/10.1002/cd.310

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*(1), 68–81. https://doi.org/10.1006/ceps.1999.1015

Wood, S., Henning, J. A., Chen, L., McKibben, T., Smith, M. L., Weber, M., Zemenick, A., & Ballen, C. J. (2020). A scientist like me: Demographic analysis of biology textbooks reveals both progress and long-term lags. *Proceedings of the Royal Society B: Biological Sciences*, *287*(1929), 20200877. https://doi.org/10.1098/rspb.2020.0877

Yeager, D. S., & Dweck, C. S. (2020). What can be learned from growth mindset controversies? *American Psychologist*, *75*(9), 1269–1284.

Yonas, A., Sleeth, M., & Cotner, S. (2020). In a "scientist spotlight" intervention, diverse student identities matter. *Journal of Microbiology & Biology Education*, *21*(1), 25.

Yu, J., McLellan, R., & Winter, L. (2021). Which boys and which girls are falling behind? Linking adolescents' gender role profiles to motivation, engagement, and achievement. *Journal of Youth and Adolescence*, *50*(2), 336–352. https://doi.org/10.1007/s10964-020-01293-z

Yuan, K.-H., & Bentler, P. M. (2000). 5. Three likelihood-based methods for mean and covariance structure analysis with nonnormal missing data. *Sociological Methodology*, *30*(1), 165–200.

Zhao, M., Mathews, C. J., Mulvey, K. L., Hartstone-Rose, A., McGuire, L., Hoffman, A. J., Winterbottom, M., Joy, A., Law, F., Balkwill, F., Burns, K. P., Butler, L., Drews, M., Fields, G., Smith, H., & Rutland, A. (2022). Promoting diverse youth's career development through informal science learning: The role of inclusivity and belonging. *Journal of Youth and Adolescence*, *52*, 331–343. https://doi.org/10.1007/s10964-022-01694-2

How to cite this article: Mulvey, K. L., Cerda-Smith, J., Joy, A., Mathews, C., & Ozturk, E. (2023). Factors that predict adolescents' engagement with STEM in and out of school. *Psychology in the Schools*, *60*, 3648–3665. https://doi.org/10.1002/pits.22946