Received: 4 September 2021 | Revised: 14 February 2022 | Accepted: 14 February 2022

DOI: 10.1002/tea.21762

RESEARCH ARTICLE

JRST | WILEY

The role of inclusion, discrimination, and belonging for adolescent Science, Technology, Engineering and Math engagement in and out of school

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Funding information
National Science Foundation, Grant/Award Number: DRL-1941992

Abstract

Women and ethnic minoritized individuals are underrepresented in science, technology, engineering, and mathematics (STEM) domains in postsecondary education and in the workforce. The aim of the current study was to examine whether adolescents' perceptions of inclusivity, belonging, and discrimination in high school STEM classes are related to their STEM class engagement in and outside of school. In this study, ethnically diverse 9th–12th grade high school students from low-income public schools in the United States ($N = 523$, $M_{\text{age}} = 15.72$, $SD = 1.24$, 49.4% female) completed measures of classroom inclusivity, perceived teacher discrimination, belonging, STEM classroom engagement, and STEM activism orientation. Path analyses revealed direct effects of inclusion and perceived discrimination on STEM activism orientation. Further, findings demonstrated direct effects of inclusion on belonging and on belonging and both STEM classroom engagement and STEM activism orientation. Finally, findings revealed a significant indirect effect of inclusion on STEM classroom engagement through belonging.

KEYWORDS
adolescents, climate, school, science, technology, engineering, and mathematics, underrepresented, welcome

1 | INTRODUCTION

In the United States, employers across several domains are struggling to find skilled workers to fill science, technology, engineering, and math (STEM) jobs (National Research Council, 2011) and we are facing a shortage of students entering STEM fields (ACT, 2011; Peterson et al., 2015). In particular, women and people of color are consistently underrepresented in STEM careers as compared to their counterparts (National Science Board, 2018). Findings suggest that an important barrier to persistence in STEM fields for these marginalized groups relates to a culture in many STEM contexts, such as school settings, that fosters discrimination, harassment, and prejudicial treatment of those from underrepresented groups (Beasley & Fischer, 2012; McGee, 2016; Reuben et al., 2014; Robnett, 2015; Shapiro & Williams, 2012). Thus, the aim of the current study is to examine relations between STEM classroom climate (perceptions of inclusivity, teacher discrimination, and belonging) and STEM outcomes in formal school settings (STEM class engagement) as well as in community or informal settings (STEM activism orientation).

2 | THEORETICAL FRAMEWORK

This study draws upon *social cognitive theory* (Bandura, 1992), which proposes a triadic reciprocal determinism model of causality that centers the interaction between behaviors, environment, and personal characteristics in explaining learning and interest in a particular domain. Importantly, *social cognitive theory* emphasizes the role of social environments for learning processes, recognizing that learning is an inherently social task (Bandura, 1986). It highlights that factors in the environment, such as whether the STEM contexts are inclusive and supportive, as well as whether individual attributes, such as one's age, gender, and ethnicity, can contribute to and possibly interact in affecting one's STEM pursuits (Bandura, 1992; Bandura et al., 1999). In the current study, we focus on the key role of STEM classroom climate in shaping both one's in-school and out-of-school STEM orientation.

3 | STEM CLASSROOM CLIMATE

Research has established the importance of school climate for shaping educational outcomes with findings documenting that students who report more positive school climate experience a wide array of positive outcomes, including positive development, reduced risky behaviors, increased health outcomes, and higher academic achievement and graduation rates (Thapa et al., 2013). Further, findings suggest that students experience different climates around STEM courses, in particular, and that experiencing supportive, positive STEM climates is associated with more positive orientation toward STEM (Aschbacher et al., 2010). However, findings also show that STEM climates are not always positive and that these “chilly climates” diminish belonging in STEM contexts (Johnson, 2012) and lead promising young women and members of underrepresented ethnic groups to leave STEM pursuits. In fact, findings suggest that exclusive climates contribute to those typically underrepresented in STEM dropping out of STEM majors (Allen-Ramdial & Campbell, 2014; Chang et al., 2014; Jones et al., 2000). This lack of belonging extends to the workforce where findings highlight that discrimination and occupational segregation contribute to marginalized individuals leaving the STEM workforce at high rates (Alonso-Villar et al., 2012; Reid, 2002).

To date, limited research has examined STEM climates at the precollege level. This is critically important work, especially given findings that suggest that there is a great deal of variability in whether adolescents perceive biased and sexist treatment in STEM contexts when it does occur and if they recognize the bias as a problem that needs to be addressed (Robnett & John, 2020). Thus, in the current project we examine perceptions of inclusivity, perceptions of teacher discrimination, and feelings of belonging in STEM classes as key indicators of STEM classroom climate.

4 | INCLUSIVITY

The importance of feeling included has been well-established (Abrams et al., 2005), with findings indicating that feeling included fosters success in school, generally (Cemalcilar, 2010), as well as in STEM contexts, in particular (Lewis et al., 2017). Further, social exclusion, especially exclusion due to one's identity or group membership, has lasting negative impacts on youth (Killen & Rutland, 2011), such as detrimental effects to one's well-being and negative academic outcomes (Buhs et al., 2006). The United Nations identifies exclusion as manifesting through rejection from group activities, denial of educational and occupational opportunities, restricted access to social supports (for instance, workforce development), inadequate access to infrastructure, and systematic inequality (United Nations, 2016). Schools can serve as inclusive communities where students, staff, and families feel welcomed and valued, creating opportunities for youth to gain experience relevant for life within a broader inclusive society (Curcic et al., 2011). This may be especially important in STEM contexts, where findings suggest that discrimination, exclusion, and a generally "chilly climate" are often pervasive in both the workplace (Gunter & Stambach, 2005) and in the classroom (Chang et al., 2014; Simon et al., 2017). However, little is known about whether different groups of students perceive their STEM classes to be inclusive and whether perceptions of inclusivity relate to STEM outcomes. The current study aims to focus on perceptions of inclusion as a key component of STEM classroom climate in order to close this gap in our understanding.

5 | DISCRIMINATION

While perceptions of inclusion, broadly, may impact one's trajectory in STEM settings, specific experiences of discrimination may also contribute to one's STEM outcomes (Mulvey et al., in press). For example, research documents that gender bias and discrimination is associated with lower engagement in STEM in experimental studies with adults (Moss-Racusin et al., 2018). Further, adolescents who experience more gender discrimination report lower feelings of school connectedness and lower STEM achievement (Rogers et al., 2021). In terms of discrimination based on race or ethnicity, findings are just as concerning: Experiencing racial discrimination while in high school is negatively associated with school success outcomes, broadly (Benner & Graham, 2013; Brody et al., 2006; Brown & Chu, 2012). Importantly, while discrimination can come from many sources within school contexts, some students report discrimination from their teachers, in particular. Discrimination from teachers can present as discrepant academic tracking practices (Legette, 2020), inequitable disciplinary approaches (Skiba et al., 2011; Skiba et al., 2014), reduced expectations for some groups of students (Ladson-Billings, 1995), and stereotyping students (Rosenbloom & Way, 2004). Less is known, however, about how perceptions of discrimination from STEM teachers, specifically, may be related to adolescents' STEM outcomes.

6 | BELONGING

While some scholars argue that school connectedness or school belonging is a dimension of school climate, others argue that school belonging is an outcome of positive school climate (Loukas, 2007). In the current study, we examine whether perceptions of inclusion and teacher discrimination in STEM classes predict STEM class belonging. Prior findings often note that positive school climate directly predicts feelings of school belonging, as demonstrated with large samples of adolescents from Turkey (Cemalcilar, 2010) and from Canada (Ma, 2003). We focus on STEM class belonging as research with college students suggests that feelings of belonging or identity are critical for both academic STEM pursuits (persisting in one's STEM major) (Lewis et al., 2017; London et al., 2011) and informal STEM pursuits, such as engaging in STEM research (Byars-Winston et al., 2016; Byars-Winston & Rogers, 2019; Graham et al., 2013). Less is known, however, about how belonging in one's STEM classes shapes outcomes for precollege students. This is an important area for research, though, as decisions during high school can shape the opportunities for postsecondary STEM engagement. For instance, findings suggest that while girls' achievement in K-12 STEM courses and enrollment in advanced STEM courses in high school are similar to boys, college women are lagging behind their White male peers in STEM (National Girls Collaborative Project, 2016). Further, ethnic minoritized individuals are less likely to enroll in advanced STEM courses in high school, which translates to low enrollment in college STEM classes and majors (National Girls Collaborative Project, 2016). Advanced course-taking in high school may be critical for ensuring that one has the academic credentials necessary to pursue further STEM education or STEM jobs (Barth et al., 2017; Gottfried, 2015; Riegle-Crumb et al., 2006). Further, research documents that informal STEM experiences may foster persistence in STEM domains (Goff et al., 2019; Habig et al., 2016), and this may be especially true for those typically underrepresented in STEM fields when these informal STEM experiences also engage with issues around equity, inclusion, and environmental justice. This typically looks like engaging in equity-oriented STEM makers programs (Calabrese Barton & Tan, 2018) and participating in citizen science projects with social justice goals (Makuch & Aczel, 2020). Thus, the current study explores relationships between STEM classroom climate and both experiences in formal educational settings (STEM class engagement) as well as those in informal settings (STEM activism orientation), as outlined below.

7 | STEM CLASSROOM ENGAGEMENT

School engagement is conceptualized as a multidimensional construct, which captures one's behavioral, emotional, cognitive, and social experiences at school (Fredricks et al., 2005; Wang et al., 2016). Engagement involves students' attachment, social bonds, participation, and even interest in school (Jimerson et al., 2003; Li, 2011). Scholars agree that school engagement is associated with positive social and academic outcomes for youth (Chase et al., 2014; Hill & Wang, 2015; Li, 2011). Further, research examining engagement in science and math classes highlights that engagement is related to motivation more generally (Fredricks et al., 2018), and documents that experiences of bias can result in lower STEM engagement (Moss-Racusin et al., 2018). The current study aims to extend this prior work by assessing how STEM classroom climate is related to STEM engagement, with particular attention to whether perceptions of belonging and discrimination are directly related to STEM engagement and/or if they are indirectly related through belonging.

8 | STEM ACTIVISM

While research has long established the role of school climate in shaping outcomes such as increased academic achievement, decreased behavioral problems, and increased psychological well-being (Wang & Degol, 2016), less research to date has explored how one's perceptions of school climate relate to one's orientation toward STEM outside of school. In the current study we focus on how perceptions of inclusion, discrimination, and belonging may be related to one's orientation toward STEM activism—a construct we define as one's efficacy around being able to take steps to solve or address a STEM-related problem in one's community. Scholars have called for increased opportunities for youth typically underrepresented in STEM fields to engage in informal STEM learning (National Research Council, 2009), to make science relevant through citizen science projects in local communities (Condon & Wichowsky, 2018; Cooper et al., 2021), and to take up environmental and social justice STEM issues (Schusler et al., 2009), including through work in maker-spaces (Calabrese Barton & Tan, 2018). Scholars note the importance of engaging youth in environmental and STEM activism (Gallay et al., 2016). While there is a rich body of literature documenting what promotes civic action in youth broadly (Flanagan & Faison, 2001), including documenting parental and peer influences on civic behavior (Diemer & Li, 2011), and discrimination as motivating civic action (Hope et al., 2019), little is known about what motivates youth to engage in STEM activism, in particular. However, findings do suggest that school climate may matter. School connectedness or school belonging has been linked to a civic orientation among students (Flanagan, Cumsille, et al., 2007). Further, findings with a sample from Chile revealed that school climate shaped school belonging which in turn was related to civic behaviors (Encina & Berger, 2021). Thus, in the current study we explore relations between perceptions of inclusion, discrimination, and belonging and STEM activism orientation.

9 | CURRENT STUDY

The aims of the current study are to examine predictors of both formal and informal ways of engaging with STEM, with attention to STEM class engagement and STEM activism orientation. We explore relations between these STEM outcomes and key school climate factors, namely perceptions of inclusivity, perceptions of teacher discrimination, and sense of STEM class belonging. We focus on adolescents, as adolescence is a key developmental period when STEM motivation begins to decline (Frenzel et al., 2012; Jacobs et al., 2002; Muenks et al., 2018) and as findings suggest that school belonging (Gillen-O'Neel & Fuligni, 2013) and school climate (Wang & Degol, 2016) may be key factors in maintaining students' engagement and interest across adolescence.

We expected that: (1) perceptions of STEM class inclusivity would be positively related to STEM class belonging and that perceptions of STEM teacher discrimination would be negatively related to STEM class belonging; (2) STEM class belonging would be positively associated with both STEM class engagement and STEM activism orientation; and (3) finally we expected that inclusivity would also be indirectly positively related to STEM class engagement and STEM activism orientation via belonging and that discrimination would be indirectly negatively related to STEM class engagement and STEM activism orientation via belonging. Further, (4) we expected that female students, and those from minoritized ethnic groups would perceive lower levels of STEM class inclusivity and higher levels of STEM teacher discrimination, given research on chilly STEM climates for those typically underrepresented in STEM fields (Allen-Ramdial & Campbell, 2014; Chang et al., 2014; Jones et al., 2000). Finally, as youth are often more aware of societal inequities with age (Elenbaas et al., 2020), we expected that, with age, adolescents would report less inclusive STEM classrooms and greater STEM teacher discrimination.

10 | METHOD

10.1 | Participants

Participants ($N = 523$, $M_{\text{age}} = 15.72$, SD = 1.24, range 13–20 years of age) were ethnically diverse high school students (9th–12th grade), with 34.2% of the sample reporting that they were White/European-American, 33.4% reporting that they were Black/African-American, 10.5% reporting that they were Latinx, 13.4% of the sample reporting that they were biracial or other, and 8.5% of the sample choosing not to report their race/ethnicity. The sample was 49.4% female, 36.3% male, 2.1% nonbinary, 1.1% unsure, and 11.1% choosing not to report their gender identity. Students were recruited from lower-income public schools (all receiving Title 1 Federal Funds) in the southeastern United States. Of these students, due to the COVID-19 pandemic, 50% reported that they were attending school virtually, 34.7% reported that they were attending school in a hybrid format, and 15.1% reported that they were attending school in person with 0.2% not reporting how they were currently attending school. We conducted a power analysis which indicated that a sample size of at least 341 would be necessary for a structural equation model with five latent variables and 30 observed variables with effect sizes at 0.25 (small to medium effects) with the desired statistical power at 0.95 and an alpha of 0.05 (Soper, 2022).

10.2 | Procedure

All students in the 9th–12th grades at participating schools were invited to participate and opt-informed consent letters were sent home to families. This study was part of a larger study to assess high school students' experiences in their STEM classes. In total, 694 students who had parental consent assented to participation and began an online survey administered through Qualtrics between November 2020 and March 2021. While 694 students assented to participation, only 523 completed all relevant survey measures, thus the sample size for all analyses was $N = 523$. Participants completed the survey from home at a time of their choosing. All participants were entered into a drawing for $10 electronic gift cards. 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." All measures can be found in Appendix S1.

10.3 | Measures

10.3.1 | Perceived STEM class inclusivity

Participants completed four items assessing how inclusive their STEM classes were for boys, girls, ethnic majority students, and ethnic minority students. These items were newly designed for this project. Example items are: "How welcoming or not welcoming are your STEM classes for girls?" and "How welcoming or not welcoming are your STEM classes for racial-ethnic minority (non-White) students?", Likert type: 1 = not at all welcoming to 6 = very welcoming. Items formed a reliable scale capturing perceptions of inclusivity, $\alpha = 0.86$.

10.3.2 | Perceived STEM teacher discrimination

Participants completed a measure of perceived discrimination by their STEM teachers, which was modified from an existing measure of general racial discrimination by teachers (see Eccles et al., 2006; Wong et al., 2003). The modified teacher discrimination scale includes an average of five items evaluating students' experiences of discrimination, due to one's identity, in class settings by STEM teachers in the past year (e.g., being disciplined more harshly, graded harder; 1 = never to 5 = every day; $\alpha = 0.94$). An example item is: "In your STEM classes, how often do you feel that STEM teachers call on you less often than they call on other kids because of who you are?"

10.3.3 | STEM class belonging

To measure students' belonging in their STEM classes, we used an adapted version of the Mendoza-Denton et al. (2002) Institutional Belonging scale, which measured students' belonging within their STEM major in college (London et al., 2011). In this adapted version of the scale, items were edited to focus on belonging in one's STEM classes. The scale consisted of 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, $\alpha = 0.94$).

10.3.4 | STEM class engagement

Participants rated how much they agreed with statements (Likert type: 1 = strongly agree to 7 = strongly disagree) that described their experience in school using a school Engagement Scale (Wang et al., 2016), which was adapted to capture engagement in STEM classes. 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." Items were reliable as a composite scale with capturing STEM class engagement, $\alpha = 0.92$.

10.3.5 | STEM activism orientation

The STEM Activism Orientation Scale was developed for this study, but was based on items from Flanagan, Syvertsen, and Stout (2007). The measure included eight items that capture students' perceptions of their preparation to engage in STEM activism to help solve a local STEM problem, for instance by organizing a petition or contacting a local official. Participants read the following prompt before completing the 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 cannot to 5 = I definitely can, $\alpha = 0.89$).

10.3.6 | Data analytic approach

Descriptive statistics were calculated first. Then, a measurement model was computed to confirm the latent factors. Finally, a path model was then estimated to examine relations between (a) inclusion, discrimination, and belonging; (b) inclusion, discrimination, belonging, and engagement as well as STEM activism orientation; (c) the potential indirect relations of inclusion, discrimination, engagement, and STEM activism orientation via belonging. All analyses were conducted using Mplus version 8, with full information maximum likelihood (FIML) estimation used to address missing data (Muthén & Muthén, 2017). FIML handles missing-at-random data by incorporating missing data patterns in the model estimation without listwise deletion of incomplete cases (Yuan & Bentler, 2000) and simulation studies suggest that FIML is robust under conditions of 50% or more missing data (Enders, 2010) and all measures in the current study had missingness levels below this amount. 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).

11 | RESULTS

After computing descriptive statistics (see Table 1 for descriptive statistics for the key variables, including means, standard deviations, and correlation matrix), a measurement model was computed to confirm the latent factors. The model fit was good: $\chi^2(349) = 704.23$, $p < 0.001$; CFI = 0.96; TLI = 0.95; RMSEA = 0.04 (confidence interval = 0.039, 0.049); SRMR = 0.05. Participants generally perceived low levels of STEM teacher discrimination and high levels of

TABLE 1 Means, standard deviations, and correlations for key variables

Variable	*M* (SD)	Possible range	1	2	3	4	5
1. Inclusivity	5.08 (0.80)	1–6					
2. Discrimination	1.44 (0.82)	1–5	−0.26***				
3. Belonging	6.84 (1.94)	1–10	0.55***	−0.19***			
4. Engagement	4.88 (0.81)	1–7	0.41***	−0.34***	0.72***		
5. Activism	3.26 (0.81)	1–5	0.27***	−0.02	0.40***	0.55***	

Note: Inclusivity = perceived STEM class inclusivity; Discrimination = perceived STEM teacher discrimination; Belonging = STEM class belonging; Engagement = STEM class engagement; Activism = STEM activism orientation.
***$p < 0.001$.

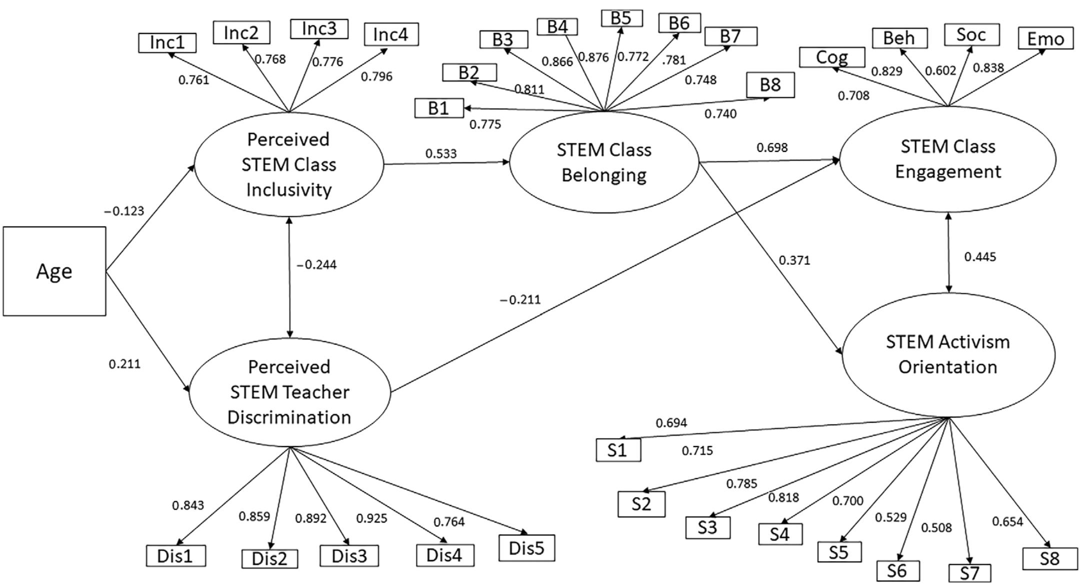

FIGURE 1 Structural equation model depicting tested path analysis. Regression weights for unidirectional pathways are standardized. Bidirectional pathways are standardized and can be interpreted as correlations. Solid lines represent paths that were significant ($p < 0.05$). Only significant paths were drawn for ease of interpretation

STEM class inclusivity. Additionally, they generally perceived that moderate to high levels of belonging and engagement in their STEM classes, as well as STEM activism orientation. Following descriptive analyses, path analyses were conducted, first including age and dummy-coded variables for race and gender in the model. Race and gender were not significant predictors of our key variables, and the model fit was improved without the inclusion of these as control variables.

Thus, in the final model we first regressed STEM class belonging on perceived STEM class inclusivity and perceived STEM teacher discrimination. Then, we regressed STEM class engagement and STEM activism orientation on STEM class belonging as well as on perceived STEM class inclusivity and perceived STEM teacher discrimination. Model fit was good: $\chi^2(376) = 749.14$, $p < 0.001$; CFI = 0.96; TLI = 0.95; RMSEA = 0.04 (CI = 0.039, 0.048); SRMR = 0.05.

First, findings revealed that, with age, participants reported lower perceived STEM class inclusivity and higher perceived STEM teacher discrimination. Moreover, there was a direct positive effect of perceived STEM class inclusivity on STEM class belonging. Further, there were direct positive effects of STEM class belonging on STEM class engagement and STEM activism orientation. Additionally, there were positive indirect effects from perceived STEM class inclusivity to STEM class engagement ($b = 0.372$; $p < 0.001$) and STEM activism orientation ($b = 0.198$; $p < 0.001$) via STEM class belonging. Finally, there was a direct negative effect from perceived STEM teacher discrimination to STEM class engagement (see Figure 1).

12 | DISCUSSION

This study presents novel findings documenting adolescents' experiences within their STEM classes. Namely, we find that, with age, adolescents report less inclusive STEM classrooms and more STEM teacher discrimination. Further, perceptions of inclusivity predict feelings of belonging in STEM classes, which predict both formal STEM class engagement as well as informal engagement with STEM (STEM activism orientation). Moreover, findings suggest that inclusivity is indirectly related to both types of engagement through belonging. Finally, we also document that the more STEM teacher discrimination adolescents report, the less engaged in their STEM classes they are. These findings document that STEM classroom climates are centrally important for adolescents' STEM outcomes both in school and out of school.

12.1 | Age-related findings

In the current study, we measured adolescents' perceptions of how inclusive their STEM classes are and how much discrimination or unfair treatment they receive from their STEM teachers. We found that, with age, adolescents report more STEM teacher discrimination and less inclusive STEM class environments. We speculate that as adolescents progress through high school, they may be more aware of the discriminatory practices happening in their STEM classes. On the other hand, we speculate that it is possible that as adolescents progress through school, their courses are increasingly tracked academically and that students recognize the ways in which academic tracking may provide boys and ethnic majority students with preferential treatment or access to opportunities in school as compared to girls and ethnic minoritized youth (Legette, 2020). The measures included in the current study captured adolescents' perceptions, thus it is difficult to ascertain whether students are more aware of the discrimination and exclusion that may be occurring in STEM classes with age or if the actual rate of unfair treatment is increasing as students move through school. Future research, which assesses inclusion and discrimination through multiple means, for instance by also including behavioral observation and/or teacher reports, could help to clarify these age-related trends. What is important, however, is that these perceptions of inclusion and discrimination are related to STEM outcomes for youth.

12.2 | Discrimination

In terms of discrimination, we find that, generally, students reported low levels of unfair treatment from their STEM teachers. This is an exciting finding, however, we did also document that the more unfair treatment by teachers in STEM classes that students report, the less engaged they are in their STEM classes. Therefore, even though students may not experience high rates of discrimination, their perceptions of discrimination may lead to disengagement. Prior research on racial discrimination in school suggests that experiencing discrimination is associated with poor academic outcomes (Benner & Graham, 2013; Brown & Chu, 2012). The pattern is more complex for gender. Some prior research suggests that raising adolescent girls' awareness of the history of discrimination against girls and women in STEM can actually foster increased science self-efficacy and valuing of STEM (Weisgram & Bigler, 2007). However, other research suggests that direct experiences of gender-bias in STEM contexts can undermine STEM engagement (Moss-Racusin et al., 2018). Our measure of discrimination captured unfair treatment because of one's identity, and thus, students may have perceived discrimination based on race/ethnicity, gender, disability, sexual orientation, or other identity categories. Findings suggest the importance of considering all types of discrimination as outcomes may differ depending on one's race, gender, school composition, and socioeconomic status (Chavous et al., 2008; Rosenbloom & Way, 2004; Seaton & Douglass, 2014). Less research has explored how discrimination associated with different dimensions of one's identity shapes STEM outcomes; however, this would be an important area for future research. Some prior research suggests that discriminatory experiences can motivate civic action for Black youth, although findings differed based on participants' reported ethnic and racial identity as well (Hope et al., 2019). Interestingly, we did not find direct effects from perceived discrimination to STEM activism orientation, a type of civic action. We speculate that experiences of discrimination by STEM teachers in school do not carry over to adolescents' experiences out of school. Additionally, our discrimination measure captured instances of interpersonal discrimination rather than systemic discrimination. Future research should explore if measures that capture awareness of systemic discrimination, such as those captured in critical consciousness assessments (Diemer et al., 2017; Diemer & Li, 2011), are more directly related to STEM activism orientation.

12.3 | Inclusivity

In terms of perceptions of inclusivity, we find that inclusivity directly predicts feelings of belonging in STEM classes, which then predicts both STEM class engagement and STEM activism orientation. Moreover, we also document indirect paths from inclusivity to both STEM class engagement and STEM activism orientation via belonging. Thus, perceptions of how inclusive STEM classes are for boys and girls as well as students from different ethnic backgrounds is a central factor in shaping feelings of belonging. Prior research documents the importance of belonging in STEM contexts both in school (Chang et al., 2014; Cheryan et al., 2017; Lewis et al., 2017; Moss-Racusin et al., 2018; Rainey et al., 2018) and out of school (Hoffman et al., 2021). The current study provides evidence that inclusion practices, in particular, may be a key way to promote feelings of belonging. These findings suggest that STEM teachers might seek additional ways to ensure that all students feel welcomed and included in their classes to encourage belonging and continued engagement with STEM in and out of school. Research in college settings document the benefits of explicit interventions that teach professors about students' identities and provide guidance regarding discriminatory teaching practices such as implicit bias and stereotype threat which shape student experiences (O'Leary et al., 2020). Future research should explore whether similar interventions at the high school level lead to changes in perceptions of inclusivity and lead to downstream changes in perceptions of belonging as well as in STEM outcomes.

Importantly, the findings suggest paths from inclusivity to belonging to both STEM engagement in formal classrooms as well as to STEM activism orientation, which is likely to involve STEM engagement and civic activism in community or other out-of-school settings. Research has long documented the importance of engagement for persistence in academic domains (Chase et al., 2014; Pitzer & Skinner, 2017; Tang et al., 2019), with findings documenting how important STEM engagement in particular is as well (Fredricks et al., 2018; Murphy et al., 2019; Wang et al., 2016). Findings also suggest the importance of all types of civic engagement for positive youth development (Flanagan, Syvertsen, & Stout, 2007). For instance, service learning that highlights social justice issues (Daniels et al., 2015), including projects focused on STEM content in particular (Newman et al., 2015), are associated with positive academic outcomes. Moreover, STEM civic engagement can promote persistence in STEM fields and STEM career interests, especially for students who are historically underrepresented in STEM fields (Mappen, 2011; Xie, 2014). These findings suggest that interventions might focus on creating inclusive classrooms and fostering feelings of belonging, in particular, to help promote STEM engagement both in and out of school. Thus, schools and teachers might draw on practices centered on social–emotional learning (Durlak et al., 2011; Taylor et al., 2017), culturally responsive pedagogy (Brown, 2017; Gay, 2010), and broadly working to foster welcoming STEM environments (Schneider et al., 2018).

13 | LIMITATIONS

Our findings demonstrate that experiences in the classroom, namely perceptions of inclusivity and perceptions of discrimination, as well as feelings of belonging, are related to both formal and informal engagement with STEM, documenting just how important creating inclusive STEM classrooms is. However, this research does have some limitations. First, the measures were all self-report measures of student perceptions and experiences and some were newly developed or adapted for this study. Thus, future research should aim to continue validating these measures with different samples as well as use multiple reporters as well to complement quantitative survey data with qualitative data to further explore what factors inform student perceptions of inclusive classrooms and to characterize the types of discrimination that students perceive. Further, despite examining participants' past experiences, this research is cross-sectional, and future studies should examine the development of perceptions, and feelings of belonging over time and explore how these relate to formal and informal STEM outcomes longitudinally. Finally, these data were collected during the COVID-19 pandemic, when students were completing school under unusual circumstances in which perceptions of STEM classroom inclusivity and discrimination may have been atypical in some ways. It will be important for research to replicate these findings with students who are attending school in person full-time.

14 | CONCLUSION

Despite these limitations, this work provides novel evidence regarding the ways in which adolescents perceive the classroom STEM climate and how these perceptions are related to their STEM engagement and their STEM activism orientation. We find that, generally, students do believe their STEM classrooms to be inclusive and that they report low levels of STEM teacher discrimination. However, we also document relations between higher levels of inclusion, higher belonging, and more STEM engagement in and out of school. Moreover, we document direct, negative impacts of perceptions of discrimination on STEM class engagement. These findings suggest the vital importance of attending to issues of climate in STEM classrooms and ensuring that students feel welcomed, included, and supported in STEM environments.

ACKNOWLEDGMENTS

The authors thank the schools, families, and students who participated in this research as well as our undergraduate research assistants and our advisory board for their assistance with this project.

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How to cite this article: Mulvey, K. L., J. 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*, 1–18. https://doi.org/10.1002/tea.21762