Cultural Diversity & Ethnic Minority Psychology

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Channing J. Mathews[1], Jacqueline Cerda-Smith[2], Angelina Joy[2], Jerica L. Knox[2],
Josefina Bañales[3], Michael Medina[4], and Kelly Lynn Mulvey[2]
[1] Department of Psychology, University of Virginia
[2] Department of Psychology, North Carolina State University
[3] Department of Psychology, University of Illinois Chicago
[4] Department of Applied Human Development, Wheelock College of Education and Human Development, Boston University

Objectives: Despite the well-documented scholarship highlighting ethnic–racial identity (ERI) and critical consciousness (CC) as promotive of positive academic outcomes, little research has explored what role these cultural assets may play in shaping science, technology, engineering, and math (STEM) engagement and perceptions of barriers to STEM for youth of color. This work explored relations between racially minoritized youths' patterns of ERI and CC in association with STEM engagement and perceptions of STEM career and educational barriers. *Method:* Latent class analysis and analysis of variance were used with a predominately Black and Latinx sample ($N = 265$, $M_{age} = 15.83$, $SD = 1.35$; 49% female). *Results:* Four classes emerged. Members of the *naïve affirmed advocates* class had significantly higher STEM engagement than the *disillusioned* class. Youth in the *affirmed and critical* class reported the highest perceptions of STEM-related career barriers, followed by the *affirmed advocates* class. *Conclusions:* Findings highlight the critical link between ERI and CC as promotive factors for academic engagement for racially minoritized youth in STEM and promote awareness of STEM-related barriers that may be useful to prepare and navigate future STEM challenges.

Public Significance Statement
The meanings that Black and Latinx youth ascribe to their race, coupled with their understandings of social inequity, are critical assets for youth to identify potential barriers related to their STEM-oriented educational and future career goals. Further, such beliefs may inform how they prepare for such barriers, supporting their overall persistence and success across STEM pathways.

Keywords: ethnic–racial identity; critical consciousness; science, technology, engineering, and math engagement; perceived barriers

A key aim of science, technology, engineering, and math (STEM) education research is broadening the participation of youth of color in STEM interests, academic pursuits, and careers (Honey et al., 2020). There is a persistent disparity in the number of ethnically and racially minoritized groups in the STEM workforce (National Center for Science and Engineering Statistics, 2021; National Science Board, 2018), which may reflect barriers that members of these groups face in attaining STEM skills during adolescence.

Channing J. Mathews https://orcid.org/0000-0002-4716-2299
Jacqueline Cerda-Smith https://orcid.org/0000-0002-8094-8752
Angelina Joy https://orcid.org/0000-0002-1574-7911
Jerica L. Knox https://orcid.org/0000-0001-7686-7856
Josefina Bañales https://orcid.org/0000-0003-0119-3847
Michael Medina https://orcid.org/0000-0003-1892-8432
Kelly Lynn Mulvey https://orcid.org/0000-0002-1292-9066

However, Black and Latinx[1] youth's early awareness of such barriers may help them to prepare for, and ultimately persist despite, future STEM challenges (Bravo & Stephens, 2023; Gonzalez et al., 2013; Hines et al., 2019). For example, youth of color who were able to identify societal stereotypes about their ability to become scientists were also able to identify critical supports (e.g., family, STEM teachers) that helped them to reject such barriers (Grossman & Porche, 2014). Further, STEM classroom engagement is a critical factor in fostering positive STEM self-perceptions, which can ultimately translate into pursuit of future STEM careers (Kang et al., 2019; Konowitz et al., 2022).

Youth of color may draw upon historical models of Black and Latinx STEM innovation to motivate their journey toward future STEM pathways (Mathews et al., 2022). Cultural assets, such as ethnic–racial identity and critical consciousness, may support racially minoritized youths' persistence in STEM. Ethnic–racial identity (ERI) describes the meaning and values individuals attribute to their ethnicity and race (Umaña-Taylor et al., 2014). Critical consciousness (CC) is a sociopolitical process in which individuals become aware of social inequities and develop beliefs and actions around their capacity for social change (Diemer et al., 2017). Both developmental processes serve as a lens through which youth may interpret negative racialized experiences in academic, career, and sociopolitical contexts (Bowers et al., 2020; Heberle et al., 2020; Rivas-Drake, Seaton, et al., 2014). However, minimal research has explored what role ERI and CC may jointly play in shaping STEM outcomes for youth of color.

Much of the literature that examines marginalized students' STEM experiences is concentrated in higher education (Chang et al., 2014; Graham et al., 2013). However, college is often not the students' first encounter with marginalization within school contexts (Benner & Graham, 2013). As such, youth often lean on cultural assets like ERI and CC to support their educational experiences prior to college, particularly in the face of perceived barriers (Heberle et al., 2020; Rivas-Drake, Seaton, et al., 2014; Rivas-Drake, Syed, et al., 2014). Research has documented how cultural assets, such as ERI and CC, can promote positive academic achievement, motivation, and educational expectancy outcomes for racially minoritized youth within marginalizing school spaces (Bowers et al., 2020; Heberle et al., 2020; Rapa & Geldhof, 2020; Rivas-Drake, Seaton, et al., 2014; Tyler et al., 2020). What is still unknown, however, is how ERI and CC may function in relation to STEM outcomes. Given current disparities in Black and Latinx students' access to rigorous STEM training that can be attributed to structural racism (McGee, 2020), it is important to assess how ERI and CC may work together to help youth to view STEM achievement as a tool of resistance. While it is not the sole burden of Black and Latinx students to dismantle such structures alone, a key step in the process is for youth to recognize that the structures exist to decide how to navigate and/or disrupt them (Kirshner, 2015). Thus, the present study examines what patterns of ERI and CC emerge in youth of color and how such patterns are associated with both STEM engagement and perceptions of barriers in STEM settings.

Theoretical Framework

We draw upon the integrative model of ethnic–racial identity and critical consciousness (Mathews et al., 2020). This model postulates associations between ERI and CC, linking these cultural assets with sociopolitical development outcomes (Mathews et al., 2020) and associated research that connects ERI and CC with positive academic outcomes (e.g., Rivas-Drake, Seaton, et al., 2014; Seider et al., 2020). It further identifies potential overlaps between ERI, critical reflection (CR; awareness of inequity), and critical action (actions for transformative change). This study extends the original model by exploring overlaps between ERI content and critical reflection dimensions of CC.

ERI content focuses on youth's understanding of, and meaning associated with, their ethnicity and race. ERI content is composed of several dimensions—salience, centrality, regard, and ideology—that relate to one's ethnic–racial self-concept, affect, and worldview (ethnic–racial worldview; Sellers et al., 1998). The present study focuses on two such dimensions: private regard (i.e., individuals' affect toward members of their ethnic–racial groups) and public regard (i.e., individuals' perceptions of how others perceive their ethnic–racial group), given the consistent associations between ethnic–racial affect and academic outcomes (Miller-Cotto & Byrnes, 2016; Rivas-Drake, Syed, et al., 2014). Similarly, the dimensions of CC—critical reflection, political efficacy, and critical action—have all been associated with positive academic and civic outcomes for racially marginalized young people (Bañales et al., 2020; Diemer et al., 2016; Watts & Hipolito-Delgado, 2015). However, given the systemic barriers that racially marginalized youth experience in STEM domains and youth's desires for equitable access to STEM education and careers (Calabrese Barton & Tan, 2018; Tan et al., 2013), critical reflection may play a key role in how racially marginalized youth understand the importance of STEM in their lives (Burbanks et al., 2020). Specifically, ERI and CC may function as key tools to help youth challenge such obstacles. Taken together, these dimensions of ERI and CC likely inform the ways that youth think about, relate to, and participate in STEM classrooms (i.e., STEM engagement; Wang et al., 2016) in pursuit of future STEM pathways.

As ERI is shaped by racialized experiences (e.g., discrimination, ethnic–racial socialization) and CC may develop as individuals process these experiences, the two likely inform one another in race-salient contexts (Kiang et al., 2021). Mathews et al. (2020) integrated model accounts for how the interaction of ERI and CC may differ across ethnic groups and shift according to the sociopolitical context. Further, this model posits that racialized experiences can inform individuals' understandings of social inequity, which may translate into subsequent motivation and sociopolitical action. Given that STEM classrooms are often marginalizing spaces for youth of color (Bicer et al., 2020), it is likely that components of ERI and CC inform how they engage in such spaces. For example, an analysis of Black high school students' general academic experiences highlighted the interconnection between a positive link to one's race and awareness of inequality within schools (Carter, 2008). Specifically, high-achieving Black students saw their academic success as intrinsic to who they are as individuals, and critical to the collective uplift of Black communities. Further, their recognition of racialized educational barriers (i.e., access to tutors, bias in college admissions decisions) motivates greater focus on academic success as a tool for

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[1] We use the term Latinx to be gender-inclusive, though we recognize the range of different terms used to self-identify within this ethnic–racial group (i.e., Latine, Latina, Latino). When describing specific studies, we use the terms adopted by the original authors, and we use the term Latinx to describe the group more broadly.

economic and social mobility. Thus, this integrated, positive racial self-concept, coupled with their recognition of future barriers, motivated students' resilience to achieve rather than leading them to an oppositional attitude toward schooling (Carter, 2008). This finding suggests that positive private regard coupled with a critical reflection on racialized inequities can inform positive achievement outcomes for Black youth.

Recent work further highlights that Black youth's understanding of the connection between Black communities' historical and present-day struggles for education was linked to higher educational aspirations (Adams-Bass & Chapman-Hilliard, 2021). Similar links have been drawn between Black youth and STEM classrooms, specifically regarding Afrocentric curricula that both (a) acknowledge the contributions of Black innovators to STEM and (b) name the barriers and facilitators of success in pursuing STEM pathways (Burbanks et al., 2020; Mathews et al., 2022). Recognition of Black STEM success and its potential barriers can disrupt problematic notions of intellectual inferiority for Black youth aspiring for STEM careers (Mathews et al., 2022).

ERI and CC have been associated with positive academic adjustment, particularly for Black and Latinx samples (Miller-Cotto & Byrnes, 2016; Rivas-Drake, Seaton, et al., 2014; Rivas-Drake, Syed, et al., 2014). ERI and CC also likely inform how youth of color recognize potential barriers to their educational and career journeys, particularly within STEM contexts (Cadenas & McWhirter, 2022; Grossman & Porche, 2014; McGee, 2016; Mulvey et al., 2022). Though much empirical evidence highlights how students in postsecondary contexts experience barriers to pursuing STEM education and subsequent careers due to negative experiences of racial climate (McGee, 2016, 2020) and racialized stereotypes of their intelligence (McGee & Martin, 2011), less work captures the experiences of adolescent youth within STEM contexts (Grossman & Porche, 2014). Further, less work has explored how an integrated ERI and CC can generate awareness around future barriers related to STEM and motivate STEM classroom engagement. In the present study, we focus on how patterns of ERI and CC dimensions shape STEM class engagement and perceptions of both educational and career barriers for a predominantly Black and Latino/a/ex sample.

Ethnic–Racial Identity and Academic Outcomes

ERI research has consistently explored its links to academic outcomes, particularly with respect to youth of color. Concerning private regard, multiple studies and meta-analyses have demonstrated its positive association with academic achievement, school-based attitudes, and the future relevance of education across multi-ethnic samples (Byrd & Chavous, 2011; Hurd et al., 2012; Miller-Cotto & Byrnes, 2016; Rivas-Drake, Syed, et al., 2014). Concerning public regard, its link to academic outcomes is less clear and often dependent on one's ethnic–racial group membership. For Black youth, low public regard has been associated with positive academic outcomes particularly when associated with a positive affect toward other Black people (i.e., high private regard; Chavous et al., 2003). In contrast, Latinx youth with high public regard have been found to have higher grades in high school (Rivas-Drake, 2011). However, most scholarship linking ERI to precollege academic outcomes has focused on ERI's association with academic achievement broadly, rather than specifically to STEM-related outcomes. Given evidence suggesting that youth of color draw upon their racialized identities to

navigate STEM contexts in postsecondary contexts (e.g., McGee, 2016; McGee & Martin, 2011), it is important to understand how these patterns develop while in high school.

Critical Consciousness and Academic Outcomes

CC dimensions have similarly been associated with positive academic outcomes among youth of color (e.g., Pérez-Gualdrón & Helms, 2017). Among an ethnically and racially diverse sample of college students (the majority of students of color identified as Mexican American), critical reflection was positively associated with students' self-reported grade point average (Bañales et al., 2022). Regarding grades, students' growth in critical reflection from 9th to 12th grade has been associated with higher grade point average (Seider et al., 2020). In addition, embedding opportunities for critical reflection within curricula has been found to promote sustained achievement over time (Cabrera et al., 2014; Chapman et al., 2020; El-Amin et al., 2017). Examination of ethnic studies programs focused on Mexican-American experiences have also demonstrated how critical reflection increased academic achievement among youth of color (Cammarota & Romero, 2006; Sleeter, 2011). Other research has examined the association between critical reflection and Black students' academic achievement through the education-as-resistance ideology, which suggests that Black students' awareness of racial barriers to their education motivates them to achieve in school and to challenge the status quo (Carter, 2008; O'Connor, 1997).

What has yet to be explored is if variation in adolescents' critical reflection (perceptions of inequality and egalitarianism) is associated with academic outcomes in STEM classes. This new area for research may provide important insights into mechanisms that may help students from underrepresented groups feel connected with their STEM coursework. Youth can draw on activism, environmental justice, and critical lenses when engaging with STEM content (Calabrese Barton & Tan, 2010, 2018). For example, in a STEM curriculum unit designed for Black and Latinx middle school students, youth were encouraged to apply their STEM skills to solve a community issue, such as providing electricity to an underresourced community or designing affordable and energy-saving housing options in dense urban areas (Gray et al., 2020). Further, scholars are increasingly calling for critical agency, social justice, and activism to play a role in STEM education (Miller et al., 2021; Morales-Doyle, 2017) and highlighting the importance of fostering critical science agency for youth (Schenkel et al., 2019). This study will provide clear evidence of how critical reflection is related to STEM engagement.

Educational and Career Barriers for Youth of Color

Research has long documented that groups historically excluded from STEM, including women and people of color, face barriers to their pursuit of STEM careers in educational and workplace spaces (Grossman & Porche, 2014; O'Connell & McKinnon, 2021; Schneider et al., 2018; Smeding, 2012). In particular, youth of color may encounter discrimination (Grossman & Porche, 2014; King & Pringle, 2019; Mulvey, Mathews, et al., 2022), microaggressions (Brown et al., 2016; Gushue et al., 2006), and exclusion from STEM opportunities (Janssen et al., 2022; Mulvey & Irvin, 2018). Prior research on perceptions of educational and career barriers documents that these perceptions can shape academic performance and engagement (Luzzo & McWhirter, 2001; McWhirter, 1997).

For instance, findings with college students suggest that perceptions of barriers are associated with worse occupational outcomes (Urbanaviciute et al., 2016). Further, research demonstrates that adolescents who perceive greater educational and career barriers report lower academic expectations (Jackson et al., 2006). Therefore, understanding the role of ERI and CC in shaping how youth perceive educational and career barriers may be especially important to ensuring their STEM success.

Ethnic–Racial Identity and Critical Consciousness as Promotive and Risk Factors in STEM

Both ERI and CC may serve as promotive factors for youth of color who navigate potential barriers within STEM settings. Although prior work has not explored the relationship between ERI and perceived barriers directly, scholars have indicated that ERI may play a key role in perceptions of barriers for youth (Gushue et al., 2006) and have called for more research that examines the cultural strengths that students of color bring through their identities to STEM spaces (McWhirter & Cinamon, 2021). It may be that a strong sense of private or public regard lessen the perceptions of barriers, as individuals hold and perceive positive messages about their ethnic racial group. Such messaging, coupled with a positive affect toward one's ethnic–racial group, are critical forms of affirmation that may protect youth who face specific challenges related to academics, health, or well-being (Rivas-Drake, Seaton, et al., 2014).

That said, scholars highlight mixed findings across racial groups regarding the link between ERI and potential future barriers. For example, Latino youth who believed that others saw their ethnic–racial group more positively (i.e., high public regard) have reported a higher sense of self-efficacy to attend college, despite their perceptions of individual or economic barriers (Gonzalez et al., 2013). Yet, those with stronger affinity to their Latino group demonstrated lower levels of college self-efficacy. Aligned with this research, additional work has found a direct relationship between Latina youth and perceptions of career barriers, such that those who felt more positively about their Latina identity perceived higher career barriers (Mejia-Smith & Gushue, 2017). In another study focused on African American youth, scholars found that those who had higher levels of racial pride (i.e., high private regard) and fewer perceptions of barriers reported fewer socioemotional adjustment challenges (Yu et al., 2021). Given such mixed findings, it is necessary to further investigate how both public and private regard dimensions may function together in how racially marginalized youth perceive future barriers to their success.

There has been a call in the literature to attend more carefully to the role of CC in vocational psychology, recognizing the role of CC for youth of color, in particular as they navigate educational and workplace settings (Cadenas & McWhirter, 2022). Further, prior work with Latino/a/x, Black, and Indigenous youth has documented the importance of CC for positive career expectations (Diemer & Blustein, 2006; Diemer et al., 2010; McWhirter & McWhirter, 2016). For instance, McWhirter et al. (2021) highlighted how CC can help foster college and career readiness for Latinx youth. However, components of CC may function differently in terms of perceived barriers. Critical reflection may be associated with higher perceived barriers, as those higher on critical reflection may be more aware of the inequality present in STEM spaces. Cadenas et al. (2020) underscored these nuances among youth and adults of color, highlighting that critical reflection was linked to higher perceived barriers. However,

critical reflection was a source of motivation and resilience to persist in STEM-related project development when participants made connections to their cultural identities within STEM. Thus, critical reflection may function as both a risk and a promotive factor in youth of color, given that they better recognize future STEM barriers, but that recognition may translate into motivation to overcome such obstacles. Given these findings, more work is needed to explore how the dimensions of CC function within STEM settings, with specific attention to the experiences of youth of color.

Person-Centered Approaches to Ethnic–Racial Identity and Critical Consciousness

This study uses person-centered approaches (i.e., latent class analysis [LCA]) to examine the dual influence of ERI and CC on STEM engagement and perceived barriers. Person-centered approaches are effective tools to capture integrative developmental phenomena, given their ability to operationalize multiple constructs as an integrated whole within individuals (Bergman & Trost, 2006). Several studies employ person-centered approaches to examine patterns of ERI dimensions and their associations with academic outcomes for youth of color. In a seminal study, four distinct racial identity profiles were found among Black high school youth that differed across levels of both private and public regard (Chavous et al., 2003). Among these profiles, individuals who felt positively about their racial group (i.e., high private regard) and who believed that society perceived Black people more negatively (i.e., low public regard), were more likely to stay in school and to pursue a college degree. This finding suggests that those Black youth who maintain a positive affinity for Black communities and are aware of potential societal bias against Black people may use such knowledge to help navigate future barriers related to their academic pursuits. Further, all profiles demonstrating high private regard were more likely to see the importance of school, suggesting that a positive affinity with one's racial group can facilitate positive feelings around school and academic self-concept (Awad, 2007; Okeke et al., 2009). In contrast, those with low private and public regard were more likely to drop out of school by 12th grade and had the lowest college attainment (Chavous et al., 2003). However, a subsequent study that replicated the four profiles found in Chavous et al. (2003), highlighted a contradictory association between profiles and academic outcomes. Specifically, Black high school students who endorsed the lowest levels of public and private regard maintained the highest grade point averages in both 9th and 12th grade groups (Harper & Tuckman, 2006). Such mixed findings in how patterns of racial identity beliefs relate to overall academic outcomes underscore the need to further explore the relationship between ERI beliefs and academic engagement, particularly within STEM-based contexts.

More recent work examining ethnic–racial identity profiles suggests that groups may vary according to both ethnic–racial group membership and academic engagement. One such study found that Black, Asian, and Latinx youth were characterized by different levels of ERI affiliation (i.e., exploration and commitment—including positive affect—to their ethnic–racial group). Black youth comprised the majority of the low ERI affiliation profile, whereas Asian youth were the majority of moderate ERI affiliation profile. Latinx youth comprised the majority of the high ERI affiliation profile (Cheon et al., 2020). Those youth who maintained high ERI affiliation demonstrated the highest levels of school engagement,

followed by those who were weakly identified. Another study of Black and Latinx youth underscored the link between ERI and higher academic engagement, noting that individuals whose profiles had the highest levels of both public and private regard also had the highest levels of academic engagement (Wantchekon & Umaña-Taylor, 2021). Such research suggests that youth of color who find positive connections to their race coupled with positive societal perceptions of their ethnic–racial group are ultimately successful in future academic pursuits.

Previous research examining CC profiles in youth of color have also found variation in profile membership across ethnic–racial group membership. Godfrey et al. (2019) assessed profiles of critical consciousness among racially and ethnically diverse 7th grade students. Youth categorized as perceiving lower levels of inequality with respect to race and economics who also endorse high egalitarian beliefs (i.e., acritical, contented, and efficacious) had the highest academic engagement, academic competence, and grades across the entire sample. In contrast, those individuals in profiles characterized by high perceptions of racial and economic inequality and lower levels of egalitarianism had worse overall engagement across all academic outcomes. Taken together, these findings suggest that variations in individuals' levels of perceived inequality and egalitarianism beliefs have unique implications on one's level of academic and future career engagement.

Previous research has demonstrated that dimensions of ERI or CC do not function independently of one another in their associations with developmental outcomes (Briggs et al., 2023; Chavous et al., 2003; Godfrey et al., 2019; Harper & Tuckman, 2006). Further, recent work suggests that interactive relationships may exist between dimensions of ERI and CC, suggesting that the two phenomena may work in tandem to support positive development in Black and Latinx adolescents (Anyiwo et al., 2018; Kiang et al., 2021; Mathews, 2023). One recent study linked CC profiles to individual dimensions of racial identity, such that Black youth who endorsed the greatest awareness of inequity and agency with above average social change behaviors also maintained positive affinity to their racial identity (Briggs et al., 2023). Similarly, those who demonstrated the lowest awareness of inequity, agency, and engagement in social change maintained similar positive racial affect. Given the variability in how ERI and CC dimensions can associate with one another, using person-centered approaches allows for the examination of variation in these beliefs and provides insight into how such patterns may vary across a specific population.

The Present Study

Ethnic–racial disparities in STEM enrollment and entrance into the STEM workforce are pervasive (Fry et al., 2021; National Center for Science and Engineering Statistics, 2021). As such, new and targeted research is needed to document potential mechanisms to close these gaps. The present study extends prior research documenting the importance of both CC and ERI in shaping adolescent academic outcomes by focusing on STEM contexts. Specifically, we consider STEM classroom engagement and perceived barriers given that these factors may be particularly important for youth of color as they persist in STEM settings, which have historically excluded students like them. We also focus on high school students, given that adolescence is a key developmental period for STEM motivation that shapes STEM opportunities in postsecondary settings (Jiang et al., 2020).

This study takes a person-centered approach to examining ERI, CC, and STEM outcomes, allowing for a holistic examination of study patterns and relations (Lanza & Cooper, 2016). To this end, we asked what combinations, or classes, of ERI and CC dimensions may be associated with relevant STEM-related outcomes for youth of color. Given previous work suggesting positive educational outcomes for youth of color who maintain positive regard (Carter, 2008; Chavous et al., 2003) or high levels of critical reflection (Bañales et al., 2022; Seider et al., 2020), we hypothesized that those ERI and CC classes that maintained average-to-high levels of public and private regard, in addition to high perceived inequality and egalitarianism (high critical reflection), would be associated with more positive STEM engagement. We also hypothesized that those classes with higher levels of critical reflection, particularly those with the highest endorsement of both egalitarianism and perceived inequality, coupled with lower public regard, and average-to-high private regard would be more likely to perceive both educational and career barriers. Given previous work suggesting that individuals level of positive affinity for their racial group may make them more perceptive of inequities (Bañales et al., 2024; Sellers et al., 2006; Sellers & Shelton, 2003), we also hypothesized that profiles with higher levels of private regard would be more likely to perceive future educational and career barriers.

Method

Participants

Our sample included 265 adolescents (49% female; range: 13–17 years of age; $M_{age} = 15.83$; $SD = 1.35$), a subsample of students from a larger research study (described below). Participants included in the analytic sample were from racially/ethnically minoritized backgrounds, including students who self-identified as Black or African American ($n = 124$), Latinx ($n = 83$), Multiracial ($n = 39$), Asian American ($n = 9$), Arab American ($n = 1$), Native Hawaiian/Pacific Islander ($n = 2$), and American Indian ($n = 7$). Students who identified with at least one racially/ethnically minoritized group were included in the study. Students were recruited from five public schools in the Southeastern United States.

Procedure

Participants were a part of a larger longitudinal study focused on developing inclusive secondary STEM classrooms. All students at participating schools were invited to participate and opt- informed consent letters were sent home to families. In total, 898 students who had parental consent agreed to participate and completed a digital Qualtrics survey at school. White youth ($n = 382$), those who did not report their race ($n = 43$), and those who did not complete all relevant survey measures ($n = 208$) were excluded from analyses. All participants received $10 electronic gift cards. The study was approved by the university's institutional review board.

Measures

Critical Reflection

Critical reflection was measured with six items from the critical reflection: egalitarianism and perceived inequality subscales of Critical Consciousness Scale Short (Diemer et al., 2017). Each

subscale used a 6-point Likert-type scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). The perceived inequality subscale (three items, $\alpha = .89$) included items such as, "Certain racial or ethnic groups have fewer chances to get ahead." An example from the egalitarianism subscale (three items, $\alpha = .90$) is "It would be good if groups could be equal." Each subscale was mean scored such that higher scores indicated higher average levels of perceived inequality or egalitarianism.

Ethnic–Racial Identity

Ethnic–racial identity was assessed with two measures adapted from the Multidimensional Inventory of Black Identity (Sellers et al., 1997) and the Multidimensional Inventory of Black Identity–Teen (Scottham et al., 2008). Participants responded to questions about their ethnicity, with their ethnic–racial group identification as a part of the stem of each question. *Private regard* ($\alpha = .94$) was measured by three items such as "I feel proud to be [ethnic group]." *Public regard* ($\alpha = .87$) was measured with items such as "People think that [participant's ethnic group] are as good as people from other races." All ethnic identity items were Likert-type items that ranged from 1 (*really agree*) to 5 (*really disagree*) and were reverse-coded, such that higher scores indicated higher levels of private and public regard. Each subscale was mean scored, such that higher scores indicated higher average levels of public and private regard.

STEM Engagement

STEM engagement (33 items; $\alpha = .92$) was assessed using a measure adapted from Wang et al. (2016). This measure assesses STEM classroom engagement. Participants responded to Likert-type items ranging from 1 (*strongly agree*) to 7 (*strongly disagree*). Items were reverse coded such that higher scores indicated higher levels of STEM engagement. Sample items included: "I go through the work for STEM classes and make sure that it's right," and "I look forward to STEM classes." Scores were summed, with higher scores indicating higher levels of overall STEM engagement.

Perceived Educational and Career Barriers

Perceptions of barriers was assessed using a measure adapted from Luzzo and McWhirter (2001), perceptions of barriers scale to specifically assess educational and career barriers related to STEM. The perceived educational barriers scale consisted of 21 items

($\alpha = .96$) that assessed potential challenges to education related to race, gender, social support, and socioeconomic status. The perceived career barriers scale consisted of 11 items ($\alpha = .95$) that assessed potential negative career-related encounters in STEM associated with race and gender. Participants responded to Likert-type items on both scales ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). Sample items included "Currently a barrier to my STEM educational aspirations are money problems," and "In my future STEM career, I will probably be treated differently because of my racial–ethnic background." Scores were summed for each subscale, with higher scores indicating higher perceived educational or career barriers.

Results

Preliminary Analyses

Descriptive statistics and bivariate correlations were assessed to determine associations between indicator variables (see Table 1). Critical reflection: Egalitarianism was positively associated with perceived inequality, private regard, and STEM engagement. Critical reflection: Perceived inequality was positively associated with career barriers and negatively associated with educational barriers. Public and private regard were positively associated with STEM engagement and negatively associated with perceived educational barriers. Only public regard was negatively associated with career barriers. There were no differences across outcomes for gender, age, and racial group, thus these demographic variables were dropped from analyses.

Critical Reflection and Ethnic–Racial Identity Classes

We conducted a LCA using LatentGold 5.1 (Vermunt & Magidson, 2016) to explore patterns of CC and ERI in our adolescent sample using the following indicators: egalitarianism, perceived inequality, public regard, and private regard. LCA is a statistical technique that creates latent constructs from indicator variables to create classes (Magidson & Vermunt, 2004). We compared five models and assessed model fit by identifying the most parsimonious model that explained the strongest association between critical reflection and ethnic–racial identity variables. Model fit was assessed via three indices: the likelihood ratio chi-square statistic (L^2), the Bayesian information criterion (BIC), and the bootstrapped p value. Models with the greatest reduction in L^2, the lowest BIC, and a nonsignificant p value are considered to have the best model fit for the data (Vermunt & Magidson, 2004).

Table 1
Descriptives, Reliabilities, Correlations for Indicator Variables

Measure	N	M	SD	α	Range	1	2	3	4	5	6	7
1. Egal.	265	5.11	1.23	.88	1–6	—						
2. Per. inequal.	265	3.33	1.53	.90	1–6	.26**	—					
3. Priv. reg.	265	4.03	1.06	.96	1–5	.33**	.11	—				
4. Pub. reg.	265	3.36	1.11	.90	1–5	−.09	−.11	.42**	—			
5. STEM eng.	235	4.61	0.78	.90	1–7	.31**	−.07	.29**	.17**	—		
6. Career ba.	255	3.35	0.97	.95	1–5	−.01	.37**	.01	−.24**	−.14*	—	
7. Educ ba.	242	2.77	0.89	.96	1–5	−.11	−.15*	−.25**	−.29**	−.26*	.50**	—

Note. Egal. = egalitarianism; Per. inequal. = perceived inequality; Priv. reg. = private regard; Pub. reg. = public regard; STEM eng. = STEM engagement; Career ba. = career barriers; Educ ba. = education barriers.
* $p < .05$.   ** $p < .01$.

We further assessed model fit through Akaike's information criterion that shows lower values for improved model fit and entropy, for which higher values indicates greater distinction between classes. In addition to these indicators, we also assessed local dependence between indicators with the bivariate residual statistic (BVR). A BVR above 3.84 suggests that the model does not accurately explain relationships between indicators.

Fit statistics for the five latent class models are highlighted in Table 2. Five class models were estimated using the mean scores from the critical reflection (egalitarianism and perceived inequality) and ethnic–racial identity (private and public regard) subscales. Model fit statistics were similar between the four- and five-class models, with the four-class model demonstrating the lowest max BVR and the 2nd lowest BIC. However, the five-class model maintained a lower Akaike's information criterion value compared to the four-class model and the assessment of entropy suggested that the five-class model produce greater distinction across profiles than four-class model. Thus, we conducted a bootstrap difference test between the four- and five-class solutions, which indicated that the five-class model did not fit the data significantly better than the four-class model ($p = .32$). Further examining the classes indicated across the models, the smallest class for the five-class model was only representative of less than 1% of the sample and was not conceptually interpretable. Given conceptual understandings of how critical reflection and ethnic–racial identity may work together, as well as considerations of parsimony for model fit, we proceeded with the four-class solution.

Means and standard deviations for each class are detailed in Table 3. Figure 1 depicts each class. The first class, *disillusioned* (44%), was characterized by low-to-average scores across critical reflection and ethnic–racial identity variables. The second class, *naïve affirmed advocates* (23%), showed slightly below average levels of egalitarianism, low perceived inequality, and high levels of private and public regard. The third class, *affirmed advocates* (20%), showed high scores across all ethnic–racial identity and critical reflection variables. The fourth class, *affirmed and critical* (13%), showed high support for egalitarianism and high perceived inequality, high private regard, and low public regard.

Demographic variables for each class are included in Table 4. Chi-square difference tests indicated that males and females were equally represented in all classes, except for the *affirmed and critical* class, where females were overrepresented as compared to males, $\chi^2(3) = 12.96$, $p = .01$. With respect to ethnic–racial group, Black youth were overrepresented in affirmed and critical class as compared to Latinx and Multiracial/Other class groups, $\chi^2(6) = 15.42$, $p = .02$.

We examined measures of variance explained by school among all STEM outcome variables and classes. Results from fully unconditioned models suggest that there was minimal between-school variability ($\tau00 = .06–2.63$, $z = .75–1.10$, $p = .273–.435$).

Class Associations With STEM Outcomes

To examine differences in STEM engagement and perceived barriers, two one-way analyses of variance were conducted with class as the independent variable. There was a main effect of class membership on STEM engagement, $F(3, 231) = 4.935$, $p < .001$, $\eta^2 = .06$, see Table 5. Post hoc analyses revealed that the *disillusioned* group reported lower STEM engagement than the *naïve affirmed advocates* ($p < .001$). Perceptions of educational barriers also differed by class, $F(3, 242) = 5.83$, $p < .001$, $\eta^2 = .07$. The *disillusioned* class had the highest perceptions of educational barriers, whereas the *naïve affirmed advocates* perceived the least educational barriers. Perceived career barriers also differed by class, $F(3, 255) = 12.06$, $p < .001$, $\eta^2 = .15$, such that the *disillusioned* class perceived greater career barriers than the *naïve affirmed advocates*, but fewer career barriers than both the *affirmed advocates* and the *affirmed and critical groups*. The *affirmed and critical class* perceived the highest career barriers across all groups.

Discussion

Scholars have theorized the role of cultural assets such as ERI and CC in promoting academic achievement and social justice engagement in marginalized youth (Anyiwo et al., 2018; Mathews et al., 2020). Drawing upon an integrative framework of ERI and CC (Mathews et al., 2020), we explored how patterns of ethnic–racial regard and critical reflection function as assets to ethnically and racially marginalized youths' STEM engagement and perceived barriers. Taken together, our findings support the dual significance ERI and CC in supporting youth of color's persistence in STEM pathways.

Our results indicate that ethnically marginalized individuals who feel affirmed in their ERI are supportive of equal rights, have low perceptions of social inequities (i.e., *naïve affirmed advocates*), and are more likely to be engaged in STEM classrooms than *disillusioned* youth. Further, naïve affirmed advocates perceive fewer career and educational barriers than all other classes. Members of the *affirmed advocates* and the *affirmed and critical* classes had similar perceptions of educational barriers, but those who were characterized as *affirmed and critical* were more likely to perceive career barriers in addition to educational barriers. These patterns provide insight into how youth of color may use both ERI and CC to understand potential

Table 2
Latent Class Analysis Model Summary Statistics

Model	BIC (LL)	AIC (LL)	L^2	df	p value	Max BVR	Entropy
One class	2303.97	2275.33	200.94	72	<.001	25.69	1
Two class	2262.59	2216.06	131.67	67	<.001	16.86	.86
Three class	2238.61	2174.18	79.78	62	.06	4.52	.76
Four class	2254.69	2172.36	67.96	57	.15	.30	.71
Five class	2270.69	2169.851	55.46	52	.35	.82	.77

Note. BIC (LL) = log-likelihood based Bayesian information criterion; AIC = Akaike information criteria; L^2 = likelihood ratio Chi-square; Max BVR = Maximum bivariate residuals.

Table 3
Latent Class Means and Standard Deviations by Class Group

Variable	Disillusioned $n = 117$	Naïve affirmed advocates $n = 60$	Affirmed advocates $n = 54$	Affirmed and critical $n = 34$
Egalitarianism	4.62 (1.37)	5.06 (1.29)	5.87 (1.01)	5.65 (.64)
Per. inequal.	3.02 (1.32)	2.17 (1.10)	4.75 (.24)	4.23 (1.42)
Private reg.	3.09 (.80)	4.85 (.37)	4.68 (.56)	4.83 (.35)
Public reg.	2.88 (.66)	4.62 (0.56)	3.93 (.72)	1.84 (.62)

Note. Per. inequal. = perceived inequality; Private reg. = private regard; Public reg. = public regard.

obstacles that might emerge in their educational and career journeys and empower them to prepare to overcome such barriers. Given the challenges of navigating STEM contexts for youth of color, it is important to understand what tools these youth use to succeed in STEM-based contexts in high school.

We identified four integrated ERI and CC classes among youth of color. Although we documented several positive classes, it is important to note that the largest class identified were *disillusioned*. Thus, although some youth draw on cultural assets of ERI and CC, many youth are not exhibiting high levels of regard and critical awareness. Patterns of ERI were generally aligned with previous empirical work suggesting that youth of color vary on dimensions of both private and public regard, and that those who endorse more positive affiliation with their ERI group have more positive academic outcomes (Awad, 2007; Chavous et al., 2003; Okeke et al., 2009). Specifically, ERI patterns in our *disillusioned* class aligned with the *alienated* (i.e., low private and public regard) class in previous scholarship (Chavous et al., 2003; Harper & Tuckman, 2006). ERI patterns in our affirmed and critical profile are similar to the *buffering/defensive* (i.e., high private regard and low public regard) class groups. In contrast, both the *naïve affirmed advocates*

and the *affirmed advocates* demonstrate similar patterns to the *idealized* (i.e., high private and public regard) ERI classes in both the Chavous et al. (2003) and Harper and Tuckman (2006) studies.

Patterns of CC were similar to profiles outlined in Godfrey et al.'s (2019), as well as their associations with academic outcomes. Specifically, Godfrey et al.'s (2019) *acritical, partially discontented, and efficacious* class (i.e., low perceived inequality, low egalitarianism) had similar patterns of critical reflection as our *disillusioned* class, and their *acritical, contented, and efficacious* class (i.e., low perceived inequality, high egalitarianism) maintained similar patterns of critical reflection as our *naïve affirmed advocates* group. Godfrey et al.'s (2019) *critical, but contented and efficacious* group (e.g., high perceived inequality, average egalitarianism) aligned most closely with our *affirmed advocates* group and their critical, discontented, and efficacious (i.e., midhigh perceived inequality, low egalitarianism) group most strongly aligned with our *affirmed and critical* group. Additionally, our findings aligned with Godfrey and colleagues in that those groups characterized by lower perceptions of inequality and higher endorsement of egalitarianism were more academically engaged when compared to other groups. Although past research has linked positive ERI and CC beliefs independently to academic

Figure 1
Critical Reflection and Ethnic–Racial Identity Classes
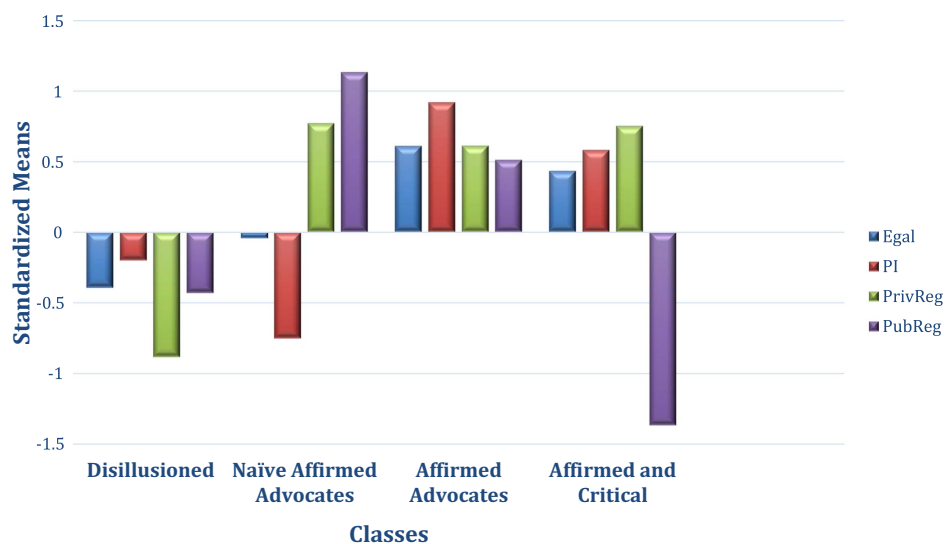
Note. Egal = egalitarianism; PI. = perceived inequality; PrivReg = private regard; PubReg = public regard.
See the online article for the color version of this figure.

Table 4

Demographic Variables by Class Membership

Variable	Disillusioned $n = 117$	Naïve affirmed advocates $n = 60$	Affirmed advocates $n = 54$	Affirmed and critical $n = 34$
Age	15.09 (.84)	15.07 (.80)	15.11 (.84)	15.26 (.86)
Gender	50% male$_a$	60% male$_a$	46% male$_a$	21% male$_a$
	46% female$_a$	40% female$_a$	52% female$_a$	74% female$_b$
Race/eth	44% Black$_a$	35% Black$_a$	46% Black$_a$	74% Black$_a$
	24% Latinx$_a$	35% Latinx$_a$	28% Latinx$_a$	18% Latinx$_b$
	32% Multi/Other$_a$	30% Multi/Other$_a$	26% Multi/Other$_a$	9% Multi/Other$_b$

Note. Percentages for gender do not sum to 100% to account for nonbinary youth. Significant column differences at the .05 level are denoted by differences in subscripts. Race/eth = race/ethnicity.

outcomes, this study extends this research to consider how these beliefs work in tandem, empirically testing previous theoretical work that suggests interrelationships between high connection to members of one's ethnic–racial group and one's awareness of social inequity (Anyiwo et al., 2018; Mathews et al., 2020).

Examining demographic differences across classes, females were overrepresented in the *affirmed and critical* classes, defined by a positive affinity for one's racial group, a negative perception of societal beliefs about their ethnic–racial group, and high awareness of societal inequity and support for equal rights among individuals. Whereas no consistent gender differences have been found in ERI and CC measures, recent work suggests that these differences may manifest if scholars consider an intersectional approach (Jones & Day, 2018). In the current sample, ethnically marginalized female participants likely experience much of their world, including STEM contexts, based on being oppressed by sexism and racism. Thus, feeling proud of other members of their ethnic–racial group, in addition to being aware of the inequities they may experience as both women and ethnically minoritized individuals may be an asset to navigating a society in which they are oppressed by compounding systems of oppression. Black students were also overrepresented in this class, which aligns with previous work suggesting that both an ethnic–racial connectedness and awareness of social inequity may work in tandem to help Black youth succeed in school. Altschul et al. (2006) found that youth who were proud of their race and were aware of racism were more likely to achieve in school. This finding supports the achievement as resistance narrative that emphasizes how Black youth draw upon their ethnic–racial identities as an asset to their success rather than a setback (Carter, 2008; Chavous et al., 2003; O'Connor, 1997).

Students who identified as Multiracial, Asian American, Arab American, or Indigenous were underrepresented in the *affirmed and*

critical class. Given the small representation of these students in our sample, we collapsed this group together; however, we acknowledge that these racial groups are not homogenous. Although the ethnic–racial identity measure used for this study has been used effectively with other racial groups (Rivas-Drake, 2011; Rivas-Drake et al., 2008), it is not clear if measures of ethnic–racial identity function well for biracial/multiracial respondents (Rogers et al., 2020). While this finding is intriguing, it is important for future research to recruit samples that will allow for the sample size to explore differences for students from these subgroups.

STEM Engagement

We found it unsurprising that the *naïve affirmed advocates* reported higher STEM engagement than those in the *disillusioned* class, but there were no differences across the other classes. In the case of the *naïve affirmed advocates,* it may be that a lack of a critical lens, coupled with a positive affinity for their ethnic–racial group, may support youth of color to navigate the STEM contexts. Youth who maintain positive affect toward their ethnic–racial group may limit their critique of inequality to protect themselves from the dissonance of seeing inequitable conditions in contrast to a positive image of their marginalized ethnic–racial group. Thus, such youth may use their positive regard to shield themselves from realities of inequity, including the emotional and cognitive challenge of connecting societal inequities to their personal STEM experiences. This may help them stay engaged and persist in STEM spaces, despite societal inequities. In this instance, higher critical reflection alone may serve as a risk factor for youth's STEM engagement. However, coupled with positive ERI beliefs, youth may not experience perceived barriers as a risk factor, but rather have greater motivation to engage in STEM contexts. Furthermore, it is possible

Table 5

Critical Reflection and Ethnic–Racial Identity Classes Predicting STEM Engagement and Perceived Barriers

CR and ERI class	STEM engagement		Perceived educational barriers		Perceived career barriers	
	M	SD	M	SD	M	SD
Disillusioned	4.41$_a$	0.72	2.96$_c$	0.75	2.75$_f$	0.79
Naïve Affirmed advocates	4.89$_b$	0.75	2.37$_d$	0.97	2.25$_g$	1.06
Affirmed advocates	4.66$_{a,b}$	0.80	2.80$_{c,e}$	1.00	3.05$_h$	1.04
Affirmed and critical	4.70$_{a,b}$	0.82	2.84$_{c,e}$	0.79	3.49$_i$	0.66

Note. Shared subscripts indicate means that do not differ significantly from one another. STEM = science, technology, engineering, and math; CR = critical reflection; ERI = ethnic–racial identity.

that youth with *naïve affirmed advocate* profiles have other unique sociocultural experiences than youth in other profiles. For instance, experiences with racial discrimination have been described as "racial awakenings" that may promote youths' ability to identify and critique structural racism in society (e.g., Anyiwo et al., 2018). It could be that youth with *naïve affirmed advocate* profiles have experienced fewer instances of interpersonal racial discrimination, which may potentially allow youth to hold more optimistic views around educational barriers and engage more in STEM.

Notably, the largest group in the sample was the *disillusioned* class, which captured those who endorsed the lowest levels of both critical reflection and regard. This group also had the lowest levels of STEM engagement. Our disillusioned profile is partly consistent with Wantchekon and Umaña-Taylor's (2021)diffuse and low regard profile, as well as Chavous et al. (2003) alienated profile describing those who feel more disconnected from their ethnic–racial group. Additionally, the disillusioned profile's association with lower STEM outcomes aligns with previous scholarship demonstrating that less affinity for one's ethnic–racial group impede overall academic engagement (Bakth et al., 2022; Rivas-Drake, 2011). However, unlike previous work, the disillusioned profile was the largest group in our sample, suggesting a potential shift in how youth are connecting to their ethnic–racial group in the current sociopolitical and academic context. It could be that more youth are perceiving higher amounts of inequities and negative perceptions toward their racial group, which may interfere with their ability to connect to, and be involved in, the school environment. Further, this sample difference may speak to contextual differences in ethnic–racial identity salience across geographical regions of the United States, given conceptualizations of ethnic–racial identity are intertwined with how privilege and oppression have been shaped within geographical locations (e.g., Latinx experiences in the South may be different from Latinx experiences in the West; Chan, 2017; Pulido & Pastor, 2013; Ortiz, 2018). This finding supports the need for teachers to integrate positive connections to ethnic–racial identity in addition to critical thinking about social inequalities related to school curriculum. Such pedagogical approaches potentially bridge STEM contexts with social issues that are linked to the experiences of ethnically and racially marginalized groups.

Perceptions of Career and Educational Barriers

Our findings concerning perceived barriers aligns with previous work examining overlaps between critical reflection and cultural identity (Cadenas et al., 2020). Specifically, the *affirmed advocates* and *affirmed and critical* groups had similar perceptions of educational barriers, with the *affirmed and critical* groups having greater perceptions of career barriers. Given that those within the *affirmed and critical* groups maintained both high perceptions of inequality and believed that others perceived their ethnic–racial group more negatively, these youth may anticipate barriers across multiple developmental stages, including the transition from education to career spaces. Prior research documents that youth of color are especially likely to perceive these barriers (Luzzo & McWhirter, 2001) and to encounter explicit and implicit barriers as they move through secondary education, higher education and into the STEM workplace (Chang et al., 2014; McGee, 2020; Pew Research Center, 2018). This may at first seem negative given the assumption that perceiving more barriers might be associated with

lower educational aspirations (Urbanaviciute et al., 2016). However, being aware of certain barriers may empower youth to prepare for how to navigate them, particularly when they have positive feelings toward their ethnic–racial group that might challenge negative assumptions of their performance or engagement in STEM. Simply perceiving barriers may not, in itself, be demotivating to persist in STEM, but guidance is necessary in how to succeed despite the presence of barriers. Future work should assess how higher awareness of inequity related to STEM is associated with persistence over time for students of color, particularly assessing how ethnic–racial identity may function as a protective factor. Further, future work should more deeply examine intersectionality (K. Crenshaw, 1991; K. W. Crenshaw, 2017), given that girls of color may encounter even more barriers to STEM than their male counterparts (Mulvey et al., 2022). As girls of color may be more likely to experience the "double bind" of both racism and sexism (Ireland et al., 2018; Polnick et al., 2020), it is critical to understand how both race and gender identities may inform how girls of color challenge perceived barriers to their future STEM educational and career aspirations (Garcia et al., 2023).

Limitations

Although the present study has many strengths, including using person-centered analyses and exploring ERI and CC in concert to understand both STEM engagement and perceptions of barriers orientation, there are some limitations. First, despite its strength in focusing on the experiences of youth of color, our sample size is somewhat small. Thus, it may be that the classes identified in this sample may not be consistent across larger populations. Further, we did not have a large enough sample size to examine differences among Multiracial, Arab American, Pacific Islander, Native American groups. We acknowledge that the experiences of members of each of these groups is distinct, which may manifest in unique ways of drawing upon both ethnic–racial identity and critical consciousness beliefs to navigate educational contexts (Gaither, 2015; Johnston-Goodstar & Roholt, 2017; Smith-Appelson et al., 2023). Further, this research was cross-sectional, which limits our ability to assess the stability of ethnic–racial identity and critical consciousness classes over time. Future research should use longitudinal methods to examine the concurrent development of ERI and CC and the relationship between these cultural assets and STEM outcomes over time.

Constraints on Generality

This study was based on survey responses from adolescent youth of color attending schools in the Southeastern United States. Thus, we expect the results to generalize to other youth of color who develop within similar environments, but note that differences may occur due to changes to the context (e.g., geographical region; higher income schools), as well as individual differences in the experiences of these youth within school spaces. Such differences have been shown in previous class analyses examining dimensions of racial identity in Black youth in association with academic achievement, where two studies found similar patterns of racial identity, but found different associations with academic achievement across the two samples (Chavous et al., 2003; Harper & Tuckman, 2006). Yet the LCA approach should be maintained to reproduce the outlined ERI and CC classes.

Conclusion

The present study documents integrated patterns of ethnic–racial identity and critical consciousness in youth of color and highlights such patterns' association with STengagement and perceived barriers. Our findings suggest that ERI and CC should be integrated more explicitly in STEM pedagogy, particularly to support the pipeline of youth of color entering STEM majors and career paths. Given the gap in the representation of individuals from ethnically marginalized backgrounds in STEM fields, it is critical to highlight cultural assets that help youth of color see STEM as an option for their future career. Thus, by centering identity and critical awareness of social inequities in STEM, scholars and practitioners can help youth reimagine a future where their identities and cultural backgrounds are affirmed, rather than dismissed in STEM environments.

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