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Does ethnic-racial visual representation in STEM college recruitment materials impact recruitment? A naturalistic field experiment

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Introduction: Higher education institutions often rely on STEM viewbooks that display a diverse student body to recruit ethnic-racial minoritized students (ERMs) into STEM. However, the impact of visual representation in recruitment efforts on ERM psychological and behavioral outcomes has yet to be experimentally tested.
Methods: In a first-of-its-kind study, we conducted a naturalistic field experiment targeting admitted college students across eight higher education institutions. Students were given the opportunity to read a STEM viewbook displaying either White and Asian (non-ERM) or Black and Latinx (ERM) STEM professionals.
Results: Unexpectedly, students across all ethnic-racial backgrounds (N = 290) demonstrated stronger STEM engagement, identity, and intentions after reading the non-ERM viewbook compared to the ERM viewbook. Moreover, exploratory student gender analyses revealed that male students (across all ethnic-racial groups) exhibited relatively higher STEM identities, STEM intentions, and recruitment responsive behavior, driven by greater engagement with the non-ERM viewbook.
Discussion: Though college recruitment efforts use diverse visual displays within viewbooks with the goal to increase their student diversity, this naturalistic experiment presents inconclusive evidence for the effectiveness of this commonly-used recruitment method.

KEYWORDS
college viewbooks, diversity initiatives, exemplars, STEM identity, STEM intention, STEM recruitment, STEM underrepresentation

Introduction

The United States continues to struggle to fill science, technology, engineering, and mathematics (STEM) careers with qualified professionals (AAAS, 2011; Fayer, Lacey, and Watson, 2017), in part because STEM suffers from an underrepresentation of adults from ethnic-racial minoritized (ERM) groups (NSF, 2019). Black, Latinx, and Native Americans account for 35% of the U.S. population but earn only 24% of STEM bachelor's degrees, 23% of STEM master's degrees, and 15% of STEM doctoral degrees (NSF, 2019). Beyond underrepresentation, ERM students in STEM experience subtle and overt cues signaling they do not fit the prototypical STEM group member (Dasgupta, 2011), a mental representation typically associated with White and Asian individuals (Chambers, 1983; Finson, 2003; Zhang et al., 2025). Consequently, ERM students often feel like imposters in STEM and perceive a divergence between their self-concept and STEM (Walton, and Cohen, 2007), doubt their STEM ability and belonging (Carlone and Johnson, 2007), and are less likely to pursue and persist in STEM (for a review, see Kuchynka, Gates, and Rivera, 2020).

To improve ERM students' participation in STEM, researchers have proposed increasing visual representation of ERM professionals in STEM fields (Erba, Phillips, and Geana, 2012; Hartley and Morphew, 2008; Osei-Kofi and Torres, 2015). Visual representation refers to displays of ERM individuals and women in STEM-related domains, including, but not limited to, college promotional materials, media, and advertisements. Higher education institutions commonly distribute viewbooks (e.g., promotional brochures, recruitment materials) that visually display a diverse student body to promote diversity in enrollment (Pippert, Essenburg, and Matchett, 2013). However, do college recruitment efforts that utilize diverse visual representations effectively promote STEM participation among ERM students? To address this question, we conducted a naturalistic experiment targeting admitted college students across eight higher education institutions, aiming to increase ERM students' behavioral interest in STEM and STEM-related social cognitions (e.g., identity and belonging).

Ethnic-racial visual representation as a STEM recruitment strategy

Higher education institutions and organizations often utilize "model diversification" – the visual representation of ERM individuals—in promotional materials to signal a commitment to diversity and inclusion (Avery and Mckay, 2006; Gündemir et al., 2017; Peñaloza, 2018). In advertising, model diversification in promotional materials validates and recognizes ERM individuals and their identities. Specifically, increasing ERM visual representation in marketing campaigns fosters feelings of inclusion, social acceptance (Licsandru and Cui, 2019), and perceived similarity (Avery, Hernandez, and Hebl, 2004). Although positive effects of ERM visual representation on consumer reactions have been documented, to our knowledge nothing is known about the effectiveness of college promotional materials in recruiting ERM individuals specifically into STEM, a pressing societal issue given their significant underrepresentation across STEM education and career pipelines (NSF, 2019).

College recruitment materials often utilize diverse visual representation to promote perceptions of a welcoming environment and facilitate ethnic-racial identification with the institution (e.g., feelings of similarity with represented individuals; Boyer et al., 2006; Hartley and Morphew, 2008). This is particularly important in STEM, where individuals across ethnic-racial groups mentally represent White or Asian men as the prototypical group members (Chambers, 1983; Finson, 2003). While prototypes reflect learned associations, they can be modified by exposure to salient exemplars, which in turn influence self-concepts, identities, attitudes, and behaviors (Dasgupta and Rivera, 2008; Fiske and Taylor, 2017; Rivera and Benitez, 2016; Gao et al., 2026). In the current research, ERM STEM professional exemplars made salient through college viewbooks should, at least momentarily, modify ERM students' STEM-related cognitions and behaviors

Erba et al. (2012). conducted perhaps the only experiment manipulating ERM visual representation in college promotional materials, but in the domain of journalism, examining its impact on Black students' evaluations of Black and White men and women exemplars. Black students favored all-Black student representation the most and all-White student representation the least. Notably, these images were not individuals in STEM, nor did they assess student outcomes beyond image appeal. The present research systematically evaluates how experimentally manipulating diverse visual representation in STEM college recruitment materials impacts students' STEM recruitment behavior, beliefs, and intentions.

Intersectionality and STEM visual representation

Although the primary goal of the current research is to experimentally examine the impact of diverse visual representations in STEM on ERM students, this effect may be complicated by intersectionality processes involving ERM and gender (Kuchynka, Eaton, and Rivera, 2022). Intersectionality refers to the concept that individuals' experiences are shaped by unique, interlocking, and co-constructed social identities that result in complex interactions (Cole, 2009; Crenshaw, 2018). Stereotypes vary by gender and ethnic-racial group (Ghavami, and Peplau, 2013), and thus visual displays of different group members may activate different mental associations. In STEM, stronger associations exist between competence and (a) White men relative to White women, and (b) White women relative to Black and Latinx women (Eaton et al., 2020). Descriptive research on intersectional visual representations in college STEM viewbooks demonstrates that White (or sometimes Asian) men are most depicted as scientists, whereas Black and Latinx scientists are nearly absent; women appear less frequently than men; and when women are included, they are typically portrayed as White or Asian and either as supporters of White men or as "token scientists" (Osei-Kofi, and Torres, 2015; Shachar, 2000).

Women and men from different ethnic-racial groups respond differently to diverse visual representations (Erba et al., 2012). Among White students, women report more favorable reactions than men toward representations that include both White and Black students in college viewbooks (Erba et al., 2012). White women may be more accepting of ERM representation compared to White men because of stigma solidarity—a sense of commonality in shared experiences and status among individuals who identify with disadvantaged groups in a given domain (e.g., women and Black individuals in STEM; Craig and Richeson, 2016). Relatedly, because men represent the STEM prototype, those who are defensive about maintaining their valued status in STEM may react negatively (e.g., by withdrawing support) to diversity initiatives (Danbold and Huo, 2017).

Altogether, the empirical evidence suggests that the impact of diverse visual representation on STEM-related identity, intentions, and behaviors may differ by gender and ERM identity, such that women across ethnic-racial groups may react more positively to diverse STEM representation than men.

Overview of experiment and hypotheses

As noted, the impact of visual representation on recruitment efforts remains an understudied strategy for increasing representation in STEM. Most STEM-based academic support programs use a variety of recruitment methods, such as viewbooks, presentations, and networking, yet no research has systematically and experimentally evaluated the effectiveness of these approaches (Chang, et al, 2016). To address this empirical gap, we conducted a naturalistic field experiment with ERM and non-ERM admitted students across eight higher education institutions. Students were randomly assigned to receive a STEM viewbook that displayed either ERM or non-ERM professionals.

Hypotheses 1a-1e

Admitted ERM students in the STEM viewbook condition displaying ERM professionals will exhibit stronger (a) STEM viewbook engagement, (b) STEM identity, (c) STEM intentions, (d) STEM attitudes, and (e) STEM recruitment behavior compared to those in the STEM viewbook condition displaying non-ERM professionals. We did not expect admitted non-ERM students to exhibit these effects.

Exploratory research question

How will the STEM viewbook conditions displaying ERM vs. non-ERM professionals impact admitted female vs. male students' STEM viewbook engagement and STEM-related identities, intentions, attitudes, and recruitment behavior?

Open practices statement

All hypotheses and study variables are preregistered at AsPredicted (https://aspredicted.org/NR4_R2G). The data and code for the study are accessible at (https://osf.io/8m4cj/?view_only=20bab4ff627545dca4b6529b91330e0b).

Method

Participants

An estimated 15,000 admitted students—regardless of ethnic-racial identity or intended majors—across eight higher education institutions in central and northern New Jersey that were part of the Garden State LSAMP received an email from their university containing a link to one of two electronic versions of a recruitment STEM viewbook. The experiment adopted a one-way, two-level (STEM Professionals Visual Representation: ERM viewbook vs. non-ERM viewbook) between-participants factor design. In this field experiment, we sought to create a naturalistic context in which admitted students perceived the email and viewbook as standard campus life material rather than part of a psychology study (Pippert, Essenburg, and Matchett, 2013). To minimize suspicion and maintain ecological validity, the Institutional Review Board waived signed informed consent. In sum, participants who read the viewbook and completed the survey reflect admitted students engaging in typical college admission procedures. A total of 831 admitted students clicked the email link to view the STEM viewbook, and 290 viewed the entire viewbook and completed all measures, which were programmed in Qualtrics (2024). See Figure 1 for samples sizes across the course of the experiment and Table 1 for demographics of the final participants.

Independent variable

STEM professionals visual representation

As shown in Figure 1, admitted student participants were systematically presented with one of two STEM viewbooks, each consisting of six pages. Four pages displayed either four ERM (ERM viewbook condition) or four non-ERM (non-ERM viewbook condition) STEM professionals, along with their biographies. The ERM viewbook condition included two Black and two Latinx professionals, whereas the non-ERM viewbook condition included two White and two Asian professionals. Both conditions always displayed two men and two women. To isolate the effect of professionals' ethnicity/race, visual representations (images and names) varied by condition, but all biographies were identical across conditions. Images and names were selected to reflect prototypical ethnic-racial group names.

Pilot testing (one-sample t-tests, all test values = 3) with students ($N = 49$) from a northeastern university assessed image quality [1 [low quality], 3 [average], 5 [high quality]] and the ethnic-racial prototypicality [1 [not at all typical], 3 [typical], 5 [very typical]]. Participants rated image quality as above average [$M = 3.60$, $SD = 0.83$; $t(44) = 28.86$, $p < .001$] and the prototypicality as higher than typical (Latinx: $M = 3.21$, $SD = .79$; $t(23) = 20.75$, $p < .001$; Asian: $M = 3.20$, $SD = 0.94$; $t(23) = 15.18$, $p < .001$; Black: $M = 3.63$, $SD = 0.89$; $t(22) = 18.57$, $p < .001$; White: $M = 4.14$, $SD = 0.79$; $t(24) = 27.49$, $p < .001$).

Biographies were based on true success stories of ERM STEM professionals (https://www.blackengineer.com/news/black-engineer-the-most-read-stem-stories-of-2019/). For example, one biography for "Aaron" (White) and "Jose" (Latinx) read:

> "I grew up the son of farmers. With my good grades and interests in agriculture, my teachers encouraged me to go to college and even medical school. I wasn't interested in medicine, but I knew early on that I wanted to be a professor. I teach and research air breathing fish."

The remaining two pages—the cover and end pages—were identical across conditions. The cover page asked, "Have you considered a STEM career?" and listed benefits such as "Community Impact" and "Top Salaries." The end page also highlighted STEM career benefits (e.g., "Innovative Jobs") and included the names of the eight participating higher education institutions (also see Participants and Design).

Dependent variables

STEM viewbook engagement

We operationalized engagement as the average time spent viewing the ERM vs. non-ERM viewbook. Each page was presented individually, and viewing time was measured in seconds. Because Pages 1 and 6 were identical across conditions,

FIGURE 1
STEM Professionals Visual Representation Condition and Number of Participants who Viewed each Page. ERM, ethnic-racial minority viewbook; Non-ERM, non-ethnic-racial minority viewbook. All ns reflect the total number of students who viewed the page across both ERM and non-ERM conditions. Of the 578 students who clicked on page 6 the STEM viewbook, 290 completed all measures and therefore constitute the final student sample. All images were purchased and licensed through Shutterstock.

we averaged the time spent on these two pages as a test of random assignment –times should not differ by condition. Pages 2–5 contained biographies of the four STEM professionals (one per page). Greater average viewing time on these pages indicated higher engagement. (Summing up the times across the four pages instead of averages yielded the same pattern of results.)

Overall quality of viewbook

Participants responded to two items—"Overall, how informative was the pamphlet?" and "Overall, how would you rate the pamphlet?"—on a 5-point scale ranging from 1 (not at all) to 5 (very). Higher scores mean greater viewbook quality ($r = .85$).

STEM identity

Following Dennehy and Dasgupta (2017) and Kuchynka et al. (2021), participants responded to three items—"How important is STEM to you?", "How useful is STEM to you?", and "How much do you care about doing well in STEM?"—on 7-point scales ranging from 1 (not at all) to 7 (extremely). Higher scores mean stronger STEM identity ($\alpha = .95$).

STEM attitudes

Following Dennehy and Dasgupta (2017), participants responded to two sematic differentials ranging from −3 to +3, anchored by hate–love and boring–fun, which measured global appraisals of STEM. Higher scores mean stronger positive attitudes toward STEM ($\alpha = .88$).

STEM intentions

We operationalized intentions as the perceived likelihood of pursuing STEM. Following Dennehy and Dasgupta (2017), participants responded to two items—"How likely are you to learn more about the STEM?" and "How likely are you to

TABLE 1 Participant demographics ($N = 290$).

Variable	Percentages
Age (mean years)	21.42 (6.51)
Gender	
Male	37.5
Female	61.9
Other	0.7
Ethnic-racial group	
Black or African-American	19.7
Latinx or Hispanic	27.0
Middle Eastern or North African	3.3
White or European American	12.5
Asian or Asian American	30.3
American Indian or Alaska Native	0.0
Multiracial	5.3
Other Identity	2.0
First generation	
Yes	40.1
No	50.1
I don't know	9.9

Numerical values for each variable and its levels are percentages, except for Age, which is reported as a mean (SD).

pursue a major in STEM?"—on 7-point scales ranging from 1 (very unlikely) to 7 (very likely). Higher scores mean stronger psychological intentions ($r = .83$).

STEM recruitment behavior

We operationalized STEM recruitment behavior as seeking additional information about STEM opportunities at the participant's university. After completing the above measures, participants were given the option to learn more about STEM opportunities and majors by clicking a link that redirected them to their institution's STEM resources. Responses were coded dichotomously: 0 = did not elect to receive information and 1 = elected to receive more information.

Demographics

Participants reported standard demographic information, including ethnic-racial identity, gender, and age (see Table 1).

Procedure

At the beginning of the fall semester, the eight participating higher education institutions systematically sent one of two emails to all admitted students. Each email displayed four images of either the ERM or non-ERM STEM professionals (from the STEM viewbooks; see Figure 1) and prompted students "to click on the link to learn more about STEM opportunities." Students who clicked a link (via Qualtrics) were first presented with one of two STEM viewbooks, followed by the dependent variables and demographic measures in the order listed above.

Results

Data preparation and preliminary analyses

The independent variable procedure allowed students to spend as much or as little time reading the STEM viewbook (i.e., the STEM Viewbook Engagement measure; see above). However, the open-ended nature of reading the viewbook created the possibility that students might leave their browsers open, resulting in long, unattended durations that do not reflect actual engagement. To identify these outliers, we calculated the mean and standard deviation for time spent (seconds) viewing each page within the viewbook ($N = 761$, $M = 12.75$, $SD = 144.34$, median = 4.76). We excluded participants ($n = 4$) who scored one standard deviation above the mean. Results were unchanged whether excluding participants with scores one or two standard deviations above the mean. Analyses that included participant gender excluded participants who did not identify as a man or a woman ($n = 2$). Because of the open-ended nature of the viewbook, time spent reading was highly skewed and kurtotic, with a heavy right tail distribution (Skewed = 21.75, $SE = .09$; Kurtosis = 497.89, $SE = .17$).[1]

An independent samples t-test on time spent viewing the cover and end pages (Pages 1 and 6), which were identical across the two viewbooks, yielded no difference between conditions [ERM $M = 7.52$, $SD = 7.05$, non-ERM $M = 7.91$, $SD = 7.92$; $t(282) = .43$, $p = .66$], suggesting successful random assignment. Also, participants rated the overall quality of the viewbooks comparably between the two conditions (ERM $M = 3.31$, $SD = 1.04$, non-ERM $M = 3.28$, $SD = 0.98$), $t(288) = .17$, $p = .70$.

Table 2 lists all zero order correlations among study variables, and Table 3 presents descriptive statistics by STEM professionals visual representation condition.

Hypothesis 1a-1e tests

To test Hypotheses 1a-1d, we conducted a MANOVA with STEM viewbook engagement, STEM identity, STEM intentions, and STEM attitudes as dependent variables, and STEM Professionals Visual Representation (0 = ERM viewbook; 1 = non-ERM viewbook) and Participants' Ethnic-Racial Group (0 = ERM, 1 = non-ERM) as fixed factors. The multivariate effect of Visual Representation was marginally significant, $F(4, 281) = 2.17$, $p = .07$, $\eta_p^2 = .03$, but the multivariate effect of

[1]The skewed and kurtotic distribution of viewing time (measured in seconds) is not a measurement artifact but rather a feature of naturalistic engagement with pamphlets and websites, where rapid drop-off in attention is expected and theoretically meaningful (see Fink, 2009; Flether et al., 2023). Because a primary dependent variable is user engagement, raw viewing provides the most direct and interpretable measure of this behavior.

TABLE 2 Zero-order correlations among measured variables .

Variable	1	2	3	4	5	6	7
1. Viewbook condition	–						
2. Ethnic-racial group	.01	–					
3. Gender	.06	−.07	–				
4. STEM viewbook engagement	.13*	−.06	−.06	–			
5. STEM identity	.04	.05	−.07	.10	–		
6. STEM intentions	−.03	−.01	−.10	.10	.79**	–	
7. STEM attitudes	.01	.05	−.08	.06	.74**	.74**	–
8. STEM recruitment behavior	.11	.09	.03	−.13*	−.27**	−.21**	.75**

Ethnic-racial group (0 = ethnic-racial minority, 1 = non-ethnic-racial minority) and gender (1 = men, 2 = women) of participants. STEM recruitment behavior 1 = choosing to learn more about STEM opportunities, 2 = not choosing to learn more about STEM opportunities).

*$p < .05$.

**$p < .01$.

TABLE 3 Descriptive statistics as a function of STEM professionals visual representation condition.

STEM variable	Condition	
	ERM	Non-ERM
Viewbook engagement	6.17 (0.88)	9.14 (0.91)
Identity	5.69 (0.15)	5.78 (0.12)
Intentions	5.81 (0.13)	5.82 (0.14)
Attitudes	5.51 (0.11)	5.55 (0.11)
Recruitment behavior	77.4%	85.6%

ERM, ethnic-racial minority STEM viewbook; non-ERM, non-ethnic-racial minority STEM viewbook. Numerical values for each variable and its levels are means (SDs), except for recruitment behavior, which is reported as the percentage of participants who elected to receive more information about STEM.

Participants' Ethnic-Racial Group and the interaction were not significant (*ps* > .29). A significant pairwise comparison emerged for STEM viewbook engagement—participants from all ethnic-racial groups spent more time viewing the non-ERM than the ERM STEM viewbook [$|M_{diff}| = 2.97$, $SE = 1.27$, $p = .02$, 95% CI (0.48, 5.45); see Table 3]. The pairwise comparisons were not significant for STEM identity, STEM intentions, and STEM attitudes (*ps* > .49).

Next, to test Hypotheses 1e, we conducted a chi square test of independence to examine STEM recruitment behavior (dichotomous: 1 = choosing to learn more about STEM opportunities, 2 = not choosing to learn more about STEM opportunities) as a function of Visual Representation. Unexpectedly, but consistent with the above engagement effect, participants in the non-ERM condition were more likely to choose to learn about STEM opportunities than participants in the ERM condition [χ^2 (1, $N = 277$) = 6.67, $p = .01$], with 86.8% selecting to learn more in the non-ERM condition compared to 74.5% in the ERM condition. A follow-up chi square test examined if this effect was moderated by participants' ERM group. The likelihood of choosing to learn more about STEM did not differ by condition [ERM: χ^2 (1, $N = 137$) = 1.03, $p = .31$; non-ERM: χ^2 (1, $N = 121$) = 2.45, $p = .12$].

In sum, although our main hypotheses were not supported, participants, regardless of the their ethnic-racial group identity, demonstrated higher levels of STEM viewbook engagement and STEM recruitment behavior after viewing White and Asian STEM professionals compared to Black and Latinx STEM professionals in the STEM viewbook.

Exploratory analyses

Why and Which Participants Demonstrate Stronger STEM Recruitment Behavior after Reading the Non-ERM vs. ERM STEM Viewbook?

To address this question, we conducted a moderated mediation model analysis using Hayes' (2013) PROCESS macro (Model 8) with 10,000 bootstrap samples, and used bias-corrected bootstrapped standard errors for indirect effects. STEM Professionals Visual Representation (ERM vs. non-ERM viewbook) was entered as the predictor, STEM recruitment behavior as the criterion, STEM viewbook engagement as the mediator, and Participants' Ethnic-Racial Group (ERM vs. non-ERM) as the categorical moderator. The omnibus model was significant (Cox and Snell = .05, Nagelkerke = .09, $p = .005$). Engagement (time spent) with the STEM viewbook mediated the effect of non-ERM professionals representation on STEM recruitment behavior among non-ERM participants [$b = -.29$, $SE = .25$, 95% *CI* (−0.96, −.03)], but not among ERM participants [$b = -.27$, $SE = .32$, 95% *CI* (−1.17, 0.13)]. Non-ERM participants spent longer viewing the STEM viewbook in the non-ERM vs. the ERM condition and this effect indirectly predicted stronger STEM recruitment behavior.

Does Gender of Participants Moderate the Impact of STEM Professionals' Visual Representation on STEM Viewbook Engagement, Identity, Intentions, Attitudes and Recruitment Behavior?

To address this question, we first conducted a MANOVA with four continuous dependent variables (STEM Viewbook Engagement, Identity, Intentions, Attitudes, and Recruitment Behavior) and two fixed factors: STEM Professionals Visual Representation (0 = ERM; 1 = non-ERM) and Participants'

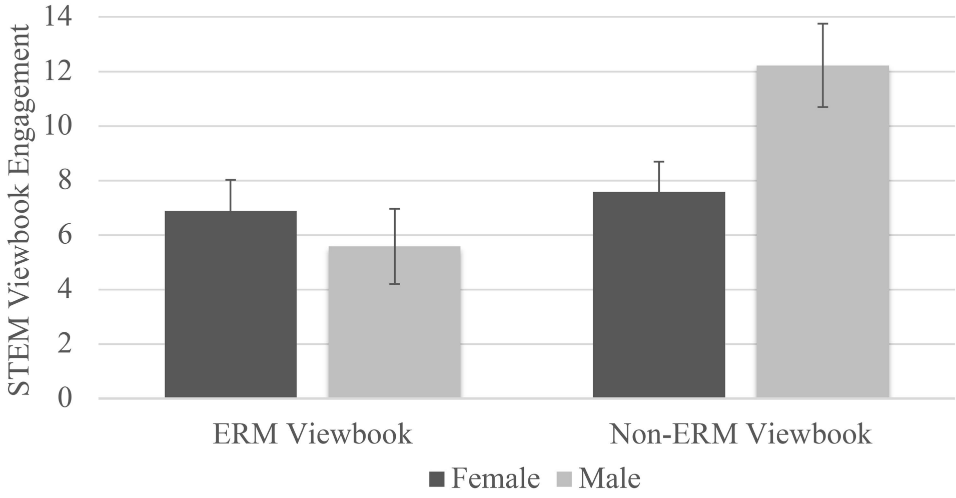

FIGURE 2
Effect of STEM professionals visual representation condition and participants' gender on STEM viewbook engagement. ERM Viewbook, ethnic-racial minority viewbook; Non-ERM Viewbook, non-ethnic-racial minority viewbook. Time measured in seconds.

Gender (1 = men, 2 = women).[2] The multivariate effect of Visual Representation, $F(4, 279) = 2.72$, $p = .03$, $\eta^2_p = .04$, and its interaction with Gender, $F(4, 279) = 2.92$, $p = .02$, $\eta^2_p = .04$, were significant.

Pairwise comparisons revealed that male students spent significantly more time viewing the non-ERM viewbook compared to the ERM viewbook [$|M_{diff}| = 6.63$, $SE = 2.05$, $p < .001$, 95% CI (2.58, 10.67)], whereas no difference was observed among female students ($p > .67$). Between-group pairwise comparisons within each condition showed a consistent pattern: male student participants, compared to female student participants, were more engaged [$|M_{diff}| = 4.62$, $SE = 1.89$, $p < .01$, 95% CI (0.91, 8.37); see Figure 2], and exhibited stronger STEM identity [$|M_{diff}| = 0.52$, $SE = 0.25$, $p < .05$, 95% CI (0.03, 1.01); see Figure 3] and STEM intentions [$|M_{diff}| = 0.69$, $SE = 0.27$, $p = .01$, 95% CI (0.15, 1.22) see Figure 4] in the non-ERM STEM viewbook condition, but no differences emerged in the ERM condition ($ps > .46$). No significant effects emerged on STEM attitudes ($ps > .24$). These findings suggest that men's STEM-related psychological outcomes are boosted when they are exposed to White and Asian STEM professionals, but not when exposed to Black and Latinx STEM professionals.

Next, we ran a chi square test to examine the STEM Professionals Visual Representation X Participants' Gender interaction effect on STEM recruitment behavior. No significant effects emerged for both female [χ^2 (1, $N = 162$) = 1.21, $p = .27$] and male [$\chi^2 = 1.92$ (1, $N = 94$), $p = .17$] student participants.

Finally, to investigate whether engagement with the STEM viewbook underlies men's stronger STEM identity and STEM intentions in the non-ERM viewbook condition, and whether these, in turn, indirectly predict STEM recruitment behaviors, we conducted three moderated mediation model analyses using Hayes' (2013) PROCESS macro (Model 8) with 10,000 bootstrap samples. We estimated indirect effects using bias-corrected bootstrapped standard errors. As shown in the conceptual model in Figure 5, STEM professionals' visual representation (ERM vs. non-ERM viewbook) was entered as the predictor, participants' gender as the moderator, STEM engagement as the mediator, and STEM identity, intentions, and recruitment behavior as the outcome variables.

Engagement with the STEM viewbook mediated the link between STEM Professionals Visual Representation and (a) STEM identity among male students [$b = .07$, $SE = .04$, CI (.03,.18)], but not among female students [$b = .007$, $SE = .02$, CI (−.02,.06)]; (b) STEM intentions among male students [$b = .08$, $SE = .05$, CI (.004, .19)], but not among female students [$b = .008$, $SE = .02$, CI (−.02, .05)]; and (c) STEM recruitment behavior among male students [$b = −.60$, $SE = .56$, CI (−.04, −2.15)], but not among female students [$b = −.06$, $SE = .12$, CI (−.38,.14)]. Altogether, these data suggest that male students, relative to female students, exhibited stronger STEM identity and intentions and were more likely to seek STEM opportunities at their higher education institution because of greater engagement with the viewbook featuring White and Asian STEM professionals.

General discussion

Since higher education institutions rely on ERM visual representation in promotional materials to recruit a diverse student population (Hartley and Morphew, 2008; Pippert et al., 2013), naturalistic field experiments are needed to investigate their impact. In the first of its kind, the present field experiment provided admitted students across eight higher education institutions in central and northern New Jersey with the opportunity to view a STEM viewbook featuring visual representations of either White and Asian (non-ERM) or Black and Latinx (ERM) STEM professionals. Both viewbooks included similar representations of men and women STEM

[2]We also tested a three-way interaction of STEM Professionals Visual Representation X Participants' Ethnic-Racial Group X Participants' Gender Identity; it was not significant (p=.14).

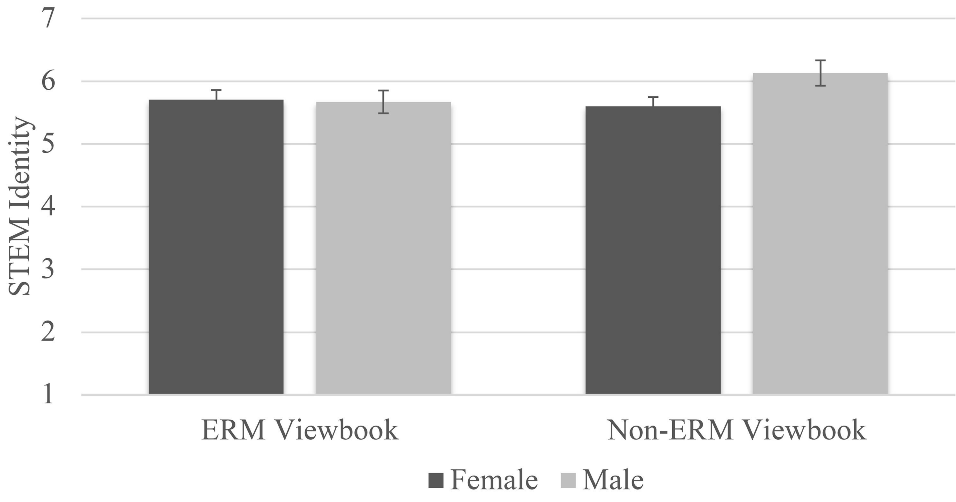

FIGURE 3
Effect of STEM professionals visual representation condition and participants' gender on STEM identity. ERM Viewbook, ethnic-racial minority viewbook; Non-ERM Viewbook, non-ethnic-racial minority viewbook.

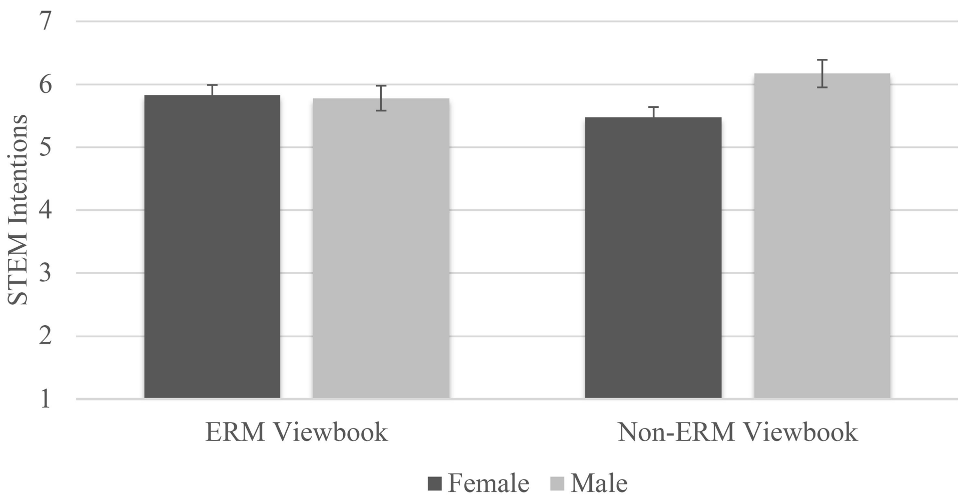

FIGURE 4
Effect of STEM professionals visual representation condition and participants' gender on STEM intentions. ERM Viewbook, ethnic-racial minority viewbook; Non-ERM Viewbook, non-ethnic-racial minority viewbook.

professionals but varied their ethnic and racial group memberships to isolate its effect on admitted students' STEM-related outcomes. The experimental results were unexpected but consistent across the dependent variables. Participants, regardless of their ethnic-racial background, demonstrated stronger STEM engagement and more frequent STEM recruitment behaviors when exposed to the non-ERM viewbook relative to the ERM viewbook.

Additional analyses revealed a consistent pattern when comparing male to female admitted student participants. Male students were more engaged (i.e., longer time viewing) and exhibited stronger STEM identities and intentions in the non-ERM relative to the ERM STEM viewbook condition. From a different experimental conditions' perspective, male and female students reported comparable STEM identities and STEM intentions in the ERM STEM viewbook condition, but male students (across ethnicity-racial backgrounds), relative to female students, experienced an advantage or "boost" in the non-ERM viewbook condition. Finally, analyses suggest that male students' relatively high levels of STEM identities and intentions and actual recruitment behavior were a function of their greater engagement with the non-ERM viewbook relative to the ERM viewbook. These effects did not emerge among female students.

The non-ERM STEM viewbook included visual representations of White and Asian men and women in prestigious fields in STEM (e.g., aerospace engineering). Prior content analyses indicate that college viewbooks often display STEM group members in ways that position White men as holding the most valued—and thus highest status—identities in STEM, while White and Asian women are frequently portrayed

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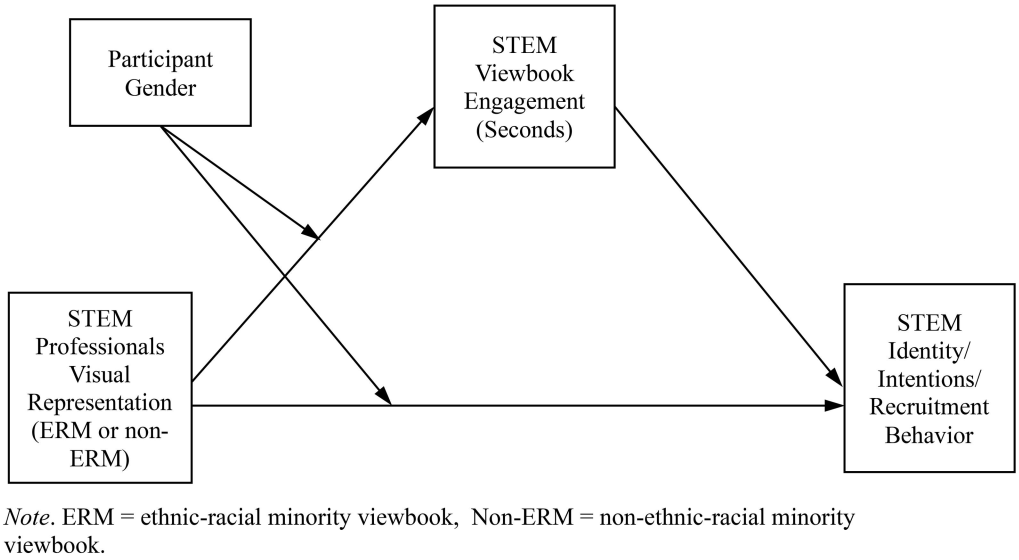

FIGURE 5
Conceptual moderated mediation model. ERM, ethnic-racial minority viewbook; Non-ERM, non-ethnic-racial minority viewbook.

as "helpers," "supporters," or "tokens" alongside White men (Osei-Kofi, and Torres, 2015; Shachar, 2000). Indeed, these displays—and the near absence of Black, Latinx, and Native American STEM professionals—maintain the dominant narrative that White men are most valued in STEM (Osei-Kofi and Torres, 2015).

Displays of tokenism in which the high-status group includes one or two individuals from underrepresented groups signal to perceivers that low-status groups "share" the privileges of the high-status group (Laws, 1975). Such an approach alleviates concerns about discrimination while maintaining the dominance of the high-status group. Moreover, perceivers' own social status—presently, STEM viewbook male readers—may have motivated them to attend more to the high-status men than to low-status women in STEM (see DeWall and Maner, 2008; Goodwin, et al., 2000). Finally, high-status and dominant group members are generally more likely to attend to stereotype-consistent information (e.g., non-ERM men in STEM) than to stereotype-inconsistent information (e.g., ERM women in STEM; see Goodwin et al, 2000). Taken together, these prior findings are consistent with our data, which show that male students were more engaged with the STEM viewbook when it included stereotype-consistent information (non-ERM) than when it included stereotype-inconsistent information (ERM).

Interestingly, the male students' advantage disappeared in the ERM condition, where male and female students exhibited equivalent STEM identities, intentions, and recruitment behaviors. Boosts in STEM outcomes among male students, whose gender group is more stereotypically associated with science than women (Nosek et al., 2009), only emerged when they were exposed to images of White men in the non-ERM STEM condition. This finding is somewhat consistent with stereotype lift (Priest et al., 2024; Walton and Cohen, 2003), which, in the context of STEM, refers to increases in psychological (e.g., math self-concept; Rossi et al., 2022) and performance (but see Johnson et al., 2012) outcomes among individuals from a group that is *not* the target of a negative stereotype, relative to individuals from a group that is the target of a negative stereotype. A recent meta-analysis showed that men experience a boost in performance on math tests when they are aware of the stereotype that men are better than women at math (Priest et al., 2024). To the extent that the men STEM professionals in the non-ERM condition cued the male-STEM stereotype, this could explain the boost among male participants.

The STEM ERM college viewbook included Black and Latinx men and women, which represent counter-stereotypical exemplars who should in theory foster feelings of belonging and domain identification among ERM students. However, since ERM individuals are rarely displayed in STEM college viewbooks (Osei-Kofi and Torres, 2015), the visual representation of ERM STEM professionals may have been perceived as an "exception to the rule" (see Richards and Hewstone, 2001), and thus not strong enough of a manipulation to promote STEM psychological and behavioral outcomes among ERM students. In fact, ERM individuals react negatively when they perceive an organization is inflating its actual diversity (Wilton et al., 2020).

Limitations and future directions

The present naturalistic field experiment provides informative data on the impact of ERM and non-ERM visual representation in a STEM college viewbook on admitted college students' STEM-related psychological and behavioral outcomes, but it is not without limitations. First, based on reporting in the *Method* section, among admitted students who received an email invitation to view the STEM viewbook, approximately 6% clicked the viewbook link, and about 2% viewed the entire viewbook and completed all measures. Although this final response rate is low, it may be attributed to several factors. For example, while the email was sent to all admitted students, some may have enrolled at other institutions and thus ignored communications from the admitting institution. Second, recipients may have overlooked the email because it appeared to be spam or phishing, or simply due to the high volume of emails in their inbox. Finally, we were limited to sending a single email invitation; however, typical admissions practices include multiple emails, social media outreach, university websites, phone calls, and text messages. This multi-pronged strategy may have yielded a higher participation rate in the present study.

The low response rate also raises concerns about self-selection bias and the representativeness of the final sample. Although a valid concern, self-selection bias does not provide a plausible *post-hoc* explanation for our results. In terms of representativeness, recently available data indicate that Black and Hispanic enrolled students across the eight participating higher education institutions comprise approximately 18% and 28% of the student population, respectively, vs. 19.7% and 27% in the present sample. These similarities suggest that students from ERM groups were proportionately represented in our sample relative to their broader populations at the participating institutions. This match is especially important given the primary goal of the present research: to understand how college recruitment efforts that utilize diverse visual representations affect ERM students' STEM recruitment and participation. Nevertheless, future intervention research—and institutional practices—should consider these issues when designing STEM recruitment efforts.

Second, boosts in STEM outcomes were particularly evident among male students exposed to images of two White men, along with one Asian woman and one White woman, in the non-ERM STEM condition. As noted above, the men STEM professionals presented in the viewbook may have activated male-STEM stereotype associations among male participants, contributing to these boosts. It may also be the case that male students experienced an advantage because, under certain conditions, men are more susceptible to visual advertising than women. Boscolo et al. (2021) experimentally examined gender differences in visual attention and attitudes using print advertisements that varied in gender targeting (male-focused, female-focused, and neutral) among Brazilian university students. Although no gender differences were found in the female-targeted condition, differences did emerge for male-targeted advertisements: men students attended more to visual stimuli and evaluated the ads more positively than women students (but see Lee and Jung, 2025). These data suggest a possible mechanism whereby male students paid more attention to the male-STEM stereotype visual cue, thereby boosting STEM outcomes. Future research using STEM college viewbooks should further investigate this issue by systematically manipulating both the gender (and ERM) dimensions of STEM professionals, and by directly testing visual attention as a potential mediator.

Third, the present research operationalized engagement as the average time spent viewing the STEM viewbook, which was created and presented within a Qualtrics-formatted study. In practice, however, viewbooks like the ones we created may be presented across multiple social media platforms. In these online contexts, assessment of potential students' (and their parents' and guardians') engagement could be extended to behavioral indicators such as likes, comments, shares, and saves. These metrics, which indicate how individuals interact with social media content, would provide opportunities to capture both active, real-time engagement with the viewbook and perceptions of its value, as reflected in users' willingness to share it with others.

Finally, a strength of our data is that they were collected from admitted students across eight distinct institutions, which increases the potential generalizability of our findings. However, we were unable to empirically test whether institutional differences influenced responses to the STEM viewbooks because the sample size ($N = 290$) did not provide sufficient power for a 2 (STEM Professionals Visual Representation) X 8 (Higher Education Institutions) between-participants design. Future research with direct control over recruitment efforts should consider this issue when designing studies and testing generalizability across multiple institutions.

Conclusion

The present research is a first step in unraveling the nuanced ways that STEM visual representation impacts students who vary in their ethnic-racial (and gender) identities. Though college recruitment efforts use diverse visual displays within viewbooks with the goal to increase their student diversity, this naturalistic experiment presents inconclusive evidence for the effectiveness of this commonly-used recruitment method. Because of the lack of exposure to ERM STEM professionals across communication domains (e.g., the media, advertisements), college recruitment efforts may require more than isolated visual displays of diversity to promote ERM STEM recruitment.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: all hypotheses and study variables are preregistered at AsPredicted (https://aspredicted.org/NR4_R2G). The data and code for the study are accessible at (https://osf.io/8m4cj/?view_only=20bab4ff627545dca4b6529b91330e0b).

Ethics statement

The studies involving humans were approved by Rutgers University Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SK: Writing – review & editing, Data curation, Validation, Conceptualization, Investigation, Methodology, Software, Writing – original draft, Project administration, Formal

analysis. AG: Writing – review & editing. LR: Project administration, Conceptualization, Methodology, Supervision, Writing – original draft, Funding acquisition, Writing – review & editing, Resources.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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