

Advancing Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations

Beyond Broadening Participation

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Editors

Committee on Advancing Antiracism,
Diversity, Equity, and Inclusion in
STEM Organizations

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This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report:

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Preface

This report provides no simple answers to racial obstacles that date back beyond the origins of American history. The authors—a consensus committee of experts appointed by the National Academies of Sciences, Engineering, and Medicine—were selected for their deep engagement on issues of antiracism, diversity, equity, and inclusion in Science, Technology, Engineering, Mathematics, and Medicine (STEMM); as such, we are well aware of the challenge in using evidence-based action to remedy unfair systems, structures, and institutions that advantage some and disadvantage others on the basis of race and ethnicity. Undaunted, we tackled our charge to identify racist and biased conditions that create systemic barriers and impede the full talent pool of our nation from pursuing and advancing in STEMM careers. This report recommends actionable strategies, based on the scientific evidence reviewed herein and based on the lived experiences of practicing STEMM scientists, engineers, and medical professionals.

Readers of this report may wonder why the National Academies was asked to focus on structural racism, as opposed to racism at individual and intrapersonal levels. As this report shows, based on decades of research and analysis, racial disparities in STEMM careers do not rest on individual deficiency in candidates or even primarily on the individual racism of institutional and organizational gatekeepers. Racism is embedded in our society. For example, wealth disparities across generations contribute to and result from segregated neighborhoods; segregated neighborhoods contribute to unequal school quality, which deprives whole student cohorts of the opportunity to consider, prepare, and enter a career in STEMM. Further, racial wealth gaps affect families' ability to pay for STEMM college

(preparation, extracurricular experiences, tuition, and living expenses). Thus, creating conducive contexts will require structural changes, as recommended in this report.

Another example of structural racism addressed in this report rests in organizations' arrangements to monitor, incentivize, and value diversity, equity, and inclusion. It is incumbent on organizations and institutions to address racial biases that individual decisionmakers are unlikely to notice, identify, or prioritize because, as the evidence shows, they may not recognize how their own, perhaps inadvertent, individual decisions contribute to overall patterns. The report reviews the diversity science that demonstrates and the lived experiences that exemplify how structural racism requires active antiracist change at a system level. This report's formal conclusions and recommendations are bold, actionable, and, we believe, necessary.

This report was many years in the making, with many voices demanding its necessity. In July of 2015, members of the Board on Behavioral, Cognitive, and Sensory Sciences (chaired by Susan Fiske) sought funding to examine and understand police split-second choices to shoot unarmed Black men. Unfortunately, these efforts did not raise sufficient interest. However, in the summer of 2020, following the murder of George Floyd and the Black Lives Matter protests, federal agencies and private foundations prioritized sponsoring a National Academies report on antiracism and diversity, equity, and inclusion, focused on STEMM. With Congresswoman Eddie Bernice Johnson's call for the National Academies to act on this topic, it was an idea whose time had finally come.

Independently, the National Academies' Roundtable on Black Men and Black Women in Science, Engineering, and Medicine, founded and chaired by Cato Laurencin (and on which Gilda Barabino serves as a member), sponsored dozens of events on this and related topics. Among other priorities, members of the Roundtable underscored the need to include lived experience as well as social and behavioral science in an examination of antiracism and diversity, equity, and inclusion in STEMM organizations.

As co-chairs, we bring different qualifications and experiences but a shared drive to work together to guide the study process. We offer our extended bios in Appendix E to illustrate with our respective lived experiences the report's major themes: how the history of race impinges on the present-day disparities; the lived experience of race from both majority and minoritized groups, starting with school and going through careers, with increases in gatekeeping power; and discovering how systems affect individuals, small groups and teams, and organizations. The systems in place disadvantage some, to the advantage of others. Thus, we both seek to make the systems more equitable.

Each of the committee members has a distinctive biography and path to this report (see Appendix E). Just as no single path leads to a STEMM

career, each committee member's unique experiences, scholarship, leadership, and service led them to this important work and added immeasurably to the report. So, too, the talented and dedicated National Academies staff, led by Layne Scherer and supported by Emily A. Vargas, kept us alert, organized, and on track for the high-speed journey from start to finish. We are grateful for the opportunity to offer evidence-based and experience-sensitive recommendations at this crucial juncture in our nation's route to antiracism, diversity, equity, and inclusion in STEMM. On the way, we have encountered some who wonder about our approach.

Our work began with a thorough review of the literature to illuminate how historical policies, practices, and laws can have lasting effects. At the direction of our Statement of Task, the committee included lived experiences as an essential component of the evidence base. We reviewed the scientific evidence of how the roles of managers, decisionmakers, and gatekeepers contribute to and perpetuate patterns and practices that inhibit STEMM diversity, with intent or unconsciously. Finally, we examined rigorous studies of racial discrimination and the diversity science literatures, including the bases for inaccurate assumptions about interest in STEMM among marginalized racial and ethnic groups. Thus, the report shows that patterns exist in the data and are not matters of opinion or moral judgements.

We recognize that term *racism* may challenge some readers. The committee uses this term because it is scientifically accurate (as demonstrated in this report) and included in the committee's charge, even if it makes readers uncomfortable. Despite the discomfort that accompanies complex and enduring social, cultural problems, we encourage readers to engage the evidence in this report and view the committee's evidence-based recommendations to make STEMM settings more diverse, inclusive, and equitable—and more antiracist.

This report is written for those who aim for STEMM but encounter systemic obstacles—and for those in a position to remove the barriers and pave the way forward.

Gilda A. Barabino, *Co-Chair*

Susan T. Fiske, *Co-Chair*

Committee on Advancing Antiracism,
Diversity, Equity, and Inclusion in Stem Organizations

Acronyms

AAMC	American Association of Medical Colleges
AANAPISI	Asian American and Native American Pacific Islander-Serving Institutions
AAPI	Asian American and Pacific Islander
ACE	American Council on Education
HBCUs	Historically Black Colleges and Universities
HBLGUs	Historically Black Land-Grant Institutions
HSIs	Hispanic Serving Institutions
HWLGUs	Historically White Land-Grant Institutions
IRB	Institutional Review Board
MSIs	Minority Serving Institutions
NCES	National Center for Education Statistics
NCSES	National Center for Science and Engineering Statistics
NDB	National Institutes of Health's Data Book
NIH	National Institutes of Health
NSF	National Science Foundation
OMB	Office of Management and Budget
PI	Principal Investigator
PWI	Predominantly White Institution

SEM	Science, Engineering, and Medicine
STEM	Science, Technology, Engineering, and Mathematics
STEMM	Science, Technology, Engineering, Mathematics, and Medicine
TCUs	Tribal Colleges and Universities

Summary

Science, technology, engineering, mathematics, and medical (STEMM)¹ organizations² in the United States, like all organizations, operate within the broader context of the nation’s history, policies, and contemporary societal norms. While the connections between STEMM organizations and the national context may not seem obvious in day-to-day activities, they are foundational to the culture and climate of educational and professional environments. Recently, the murders of George Floyd, Breonna Taylor, Ahmaud Arbery, and Rayshard Brooks led to a critical reckoning in the United States with its history and the impact of racialized policies. In the wake of racial justice protests, there has been a groundswell of pledges from individuals, organizations, and associations to dismantle systemic racism. However, even as countless organizations have made public statements in support of these efforts, U.S. society as a whole still lacks a concerted approach to bring about needed sustainable, structural change.

To address the questions raised by STEMM organizations seeking such change, the National Academies of Sciences, Engineering, and Medicine

¹The committee and the sponsors agreed to include medicine in the fields to be studied, so STEM became STEMM. There are instances in this report for which there is only evidence or data related to science, technology, engineering, and mathematics, and in those instances “STEM” is used.

²For the purposes of this report, STEMM organizations include universities, nonprofit organizations, hospitals, and private industry.

appointed the Committee on Advancing Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations.³ The committee was asked to:

- review the research and evidence from lived experience on the ways in which racism (at the individual and group levels, and through conditions that create systemic barriers) impedes STEMM careers for historically minoritized racial and ethnic groups;
- identify principles for sustainable change of organizational culture to address racism and promote diversity, equity, and inclusion; these might entail discussion of the role of training, ways to motivate buy-in at all levels of the STEMM organization, and ways to stay the course in adopting a strategy and goals aimed at addressing racism and its role as a barrier to a STEMM career;
- review and synthesize the existing research on methods to improve the recruitment, retention, and advancement of members of historically minoritized racial and ethnic groups pursuing STEMM careers; and identify promising policies and practices for changing existing systems and structures;
- identify examples of effective strategies to advance antiracism in STEMM organizations, including roles for members within organizations; and
- define a research agenda to address gaps in knowledge in the evidence base to advance antiracism, diversity, equity, and inclusion.

To address the statement of task, the National Academies appointed the committee—including experts in the science of antiracism, diversity, equity, and inclusion;⁴ social and cognitive psychology; industrial and organizational psychology; sociology; and individuals with experience implementing programs in STEMM organizations.

COMMITTEE APPROACH

The challenges experienced by minoritized people in STEMM are deeply rooted in history, law, cultural and institutional practices, and interpersonal biases and assumptions—all factors that must be understood in depth to discern ways forward. At the same time, it is important to recognize

³The study was supported by the Alfred P. Sloan Foundation, the Fred Kavli Endowment Fund, the Gordon and Betty Moore Foundation, the Heising-Simons Foundation, National Institutes of Health, the National Science Foundation, the Ralph J. Cicerone and Carol M. Cicerone Endowment for NAS Missions, the Rita Allen Foundation, and the Shanahan Family Charitable Foundation.

⁴See pages 3 and 4 for definitions of antiracism, diversity, equity, and inclusion.

that while there may be some shared experiences, these sociocultural factors differ for different minoritized groups and individuals, precluding a one-size-fits-all solution. Thus, the committee elected to focus on the challenges facing Black Americans in STEMM to demonstrate the inquiry that is required, noting the prominence of work on this topic both within the Academies and in the broader research community. This focus is in no way intended to diminish the importance of addressing challenges facing other minoritized groups, but rather meant to provide guidance for future work to address their concerns, including a call for additional research that investigates the unique racialized issues facing these groups in the research agenda. To the extent that information about Indigenous, Latine,⁵ Asian American, and people from other minoritized groups exists in the scientific literature, it is included as a part of the evidence-base of this report.

To address its charge to review evidence from lived experience on the ways in which racism impedes STEMM careers for historically minoritized racial and ethnic groups, the committee leveraged the expertise from the National Academies' Roundtable on Black Men and Black Women in SEM, a panel of leaders focused on increasing the representation, retention, and inclusion of Black men and Black women in science, engineering, and medicine. Structured interviews with members of the Roundtable and other members of the National Academies who identify as Black or African American critically contribute to and complement the body of published and peer-reviewed research evidence on antiracism, diversity, equity, and inclusion in STEMM facing Black Americans and are intended to provide important accounts that illustrate not only the challenges these professionals faced, but also the support they found helpful in their education and career.

To carry out its work systematically, the committee agreed upon definitions that reflect the disciplinary research and committee deliberations:

- *Antiracism* is an active, intentional, and dynamic set of actions that dismantle and disrupt *racism*, which is the combination of policies, practices, attitudes, cultures, and systems that affect individuals, institutions, and structures unequally and that confer power and privilege to certain groups over others, defined according to the social constructions of race and ethnicity (see glossary in Appendix D for additional definitions).

⁵In this report, the committee elected to use gender-neutral “Latine” rather than “Latino/s” or “Latinx.” Latine is a term “created by gender non-binary and feminist communities in Spanish-speaking countries. The objective of the term is also to remove gender from Spanish, by replacing it with the gender-neutral Spanish letter E, which can already be found in words like *estudiante*” (for more information, see <https://elcentro.colostate.edu/about/why-latinx/#:~:text=Latine%20is%20also%20a%20gender,found%20in%20words%20like%20estudiante>).

- *Diversity* is the fair representation of different aspects of human characteristics, identities, and perspectives in the composition of a group. Diversity is contextual and benefits from specific definitions for the areas to which it applies. It can be a product of antiracist actions as well as a measure against racism.
- *Equity* is an outcome from fair conditions (policies, practices, structures, cultures, and norms) in which all individuals and groups have the opportunities and resources they need for general well-being or success in specific metrics (such as pay or advancement). Equity is aligned with justice and may require the systemic redistribution of power, access, and resources. Equity should not be confused with equality, which is the treatment of all individuals in the same manner regardless of their starting point.
- *Inclusion* is the feeling or sense of belonging in an environment, where all individuals, regardless of and with respect to their backgrounds, feel that they have a voice and the support for full participation in that environment. An inclusive culture is reinforced with equitable policies, practices, programs, and structures. In an inclusive environment, leaders take an active role in reflecting, learning, and listening to all members of the community to sustain a culture of dignity, respect, and trust.

Although the committee used these definitions to conduct its work, it recognizes that there are other ways to interpret and define these constructs and concepts and that they are fluid and likely to change over time.

THE CONTEXT, CULTURE, AND CONSEQUENCES

Today, people from minoritized groups comprise a growing part of the U.S. population, but that growth has not been reflected in increases in STEMM education and careers. The evidence shows that minoritized individuals face numerous systemic barriers, including macro-level policies and practices that have negatively impacted their accessibility, representation, and ability to thrive in STEMM careers. Racial biases at the individual and interpersonal levels also impede STEMM careers for people from minoritized groups. These biases lead to minoritized people experiencing a range of adverse consequences in STEMM environments, which generally spur one of three responses: exiting the field, implementing strategies to fit in, and/or collectively mobilizing to transform the STEMM environment. Further barriers can come in the form of gatekeepers—individuals in institutions or organizations who are in a position to permit or prevent access to resources—who play an important role in determining who is and who is not included in STEMM by defining the skills, identities, and

values necessary for individuals to persevere in these fields (see Chapter 6). Gatekeepers' conscious and unconscious biases, cognitive mechanisms, and social motives may act to keep the status quo intact and inhibit efforts to promote antiracism, diversity, equity, and inclusion. While gatekeepers may seem like unlikely change agents, the committee recognizes them as a key part of a multi-tiered strategy for change. Finally, even when diversity is increased in STEMM organizations, there can be challenges that hinder the success of minoritized individuals. Scientific research increasingly relies on individual scientists training or working together in small teams, sometimes referred to as "team science." As calls to increase team science continue, many STEMM organizations and professionals may be motivated to provide support for diverse teams. In such circumstances, careful consideration should be given to the evidence on the dynamics of diverse teams and common challenges that can arise.

Recent research on the ways that unexamined bias or racism affect and operate in STEMM environments offers promising directions. As this report describes, the evidence calls for leadership and decisionmakers to interrogate the values that guide organizational operations and interrogate, too, how these values manifest in norms, policies, and practices, and, consequently, to make cultural and operational changes that reflect antiracist values. Values take tangible form in the ways that leaders allocate resources, such as funding, personnel, and professional development opportunities across the organization. Interrogating the underlying values in candidate selection criteria, for example, can identify where bias appears and provide opportunities for leaders, human resource directors, and other decisionmakers to implement more equitable processes.

Finally, this report emphasizes that the concepts of antiracism, diversity, equity, and inclusion are not goals for which a simple checklist will indicate success. Rather, they are goals that reflect culture change, accomplished by the creation of environments that focus on inclusive excellence, where all participants have access to educational and professional opportunities, feel included, and have the resources to actualize their full potential. In order to do this, STEMM organizations will require ongoing leadership, resources, and commitment to ensure that these values become part of an intentionally maintained organizational culture. Leadership and managers of STEMM organizations should anticipate resistance to changes in the allocations of resources, as shifts to behavioral norms and expectations on campus and in the workplace can result in confusion and other emotional reactions. Since there is no single way to approach culture change, this report provides nine frameworks that outline different perspectives to the process (see Table S-1).

To build and sustain antiracism, diversity, equity, and inclusion, STEMM organizations need to review, evaluate, and revise their policies

TABLE S-1 Examples of Culture Change Frameworks for Organizations

The Antiracist Organization: Dismantling Systemic Racisms in the Workplace
Daniels, S. (2022)

Four-Factor RACE Model:

1. Recognize the Problem: Do you understand the people most impacted by racism?
 2. Analyze the Impact: Organizational analyses should include both quantitative and qualitative data
 3. Commit to Action: Address leaders who are resistant to change
 4. Empower for Change: Assist people in feeling a part of the change
-

How to Promote Racial Equity in the Workplace
Livingston, R. (2020)

Five-Step Plan:

1. Problem Awareness: Do I understand what the problem is?
 2. Root-Cause Analysis: Where does the problem come from?
 3. Empathy: Do I care about the problem and the people who are impacted?
 4. Strategy: Do I know how to correct the problem?
 5. Sacrifice: Am I willing to do so?
-

Elevating Equity: The Real Story of Diversity and Inclusion
Bersin, J. (2020)

Five Essential Strategies for Diversity, Equity, and Inclusion (DEI) Excellence:

1. Listen, hear, and act (listening to employees is a top driver of excellence)
 2. Strengthen Human Resource capabilities in all roles (DEI must permeate the talent supply chain from hiring, to promoting and helping people grow)
 3. Engage senior leader commitment (diversity training has limited value, but leadership commitment can make a big difference)
 4. Set goals and measure success
 5. Create accountability for results (drive DEI across the entire ecosystem)
-

Advancing Black Leaders
Roberts, L.M., et al. (2019)

1. Move away from the business case and toward a moral one
 2. Encourage open conversations about race
 3. Revamp DEI programs—promote sustained focus on racial equity
 4. Manage career development across all life stages (from early in one's career and throughout)
-

Getting Serious About Diversity: Enough Already with the Business Case
Ely, R.J., and Thomas, D.A. (2020)

1. Promote the Learning and Effectiveness Paradigm
 2. Build talent
 3. Actively work against discrimination and subordination
 4. Embrace a wide range of styles and voices
 5. Make culture differences a resource for learning
-

continued

TABLE S-1 Continued

Organizational Transformation Is an Emotional Journey
White, A., Smets, M., and Canwell, A. (2022)

1. Address the unsustainable status quo
 2. Detach from the status quo
 3. Develop a purposeful vision
 4. Lead emotional transformation
 5. Include both the rational and emotional
 6. Align key performance indicators, funding, resources, and people
 7. Make transformation the new normal
-

AAC&U's Committing to Equity and Inclusive Excellence: Campus Guide for Self-Study and Planning
AAC&U (2015)

Action steps:

1. Know who your students are and will be
 2. Commit to frank, hard dialogues about the climate for minoritized students on your campus, with the goal of affecting a paradigm shift in language and actions
 3. Invest in culturally responsive practices that lead to the success of minoritized students
 4. Set and monitor equity goals and devote aligned resources to achieve them
 5. Develop and actively pursue a clear vision and goals for achieving high-quality learning
 6. Expect and prepare all students to produce culminating or signature work
 7. Provide support to help students develop guided plans to achieve essential learning outcomes, prepare for and complete signature work, and connect college with careers
 8. Identify high-impact practices best suited to your students and your institution's quality framework
 9. Ensure that essential learning outcomes are addressed and high-impact practices are incorporated across all programs
 10. Make student achievement—specifically, minoritized student achievement—visible and valued
-

From Equity Talk to Equity Walk: Expanding Practitioner Knowledge for Racial Justice in Higher Education
McNair, T.B., et al. (2020)

1. Start asking about why these inequities exist
 2. Start to question privilege and biases in the systems and structures that perpetuate inequities, specifically racial inequities
 3. Stop using language that masks who the students really are
 4. Stop believing that the accepted norm should be from the dominant culture's viewpoint
-

continued

TABLE S-1 Continued

Equity in Science: Representation, Culture, and the Dynamics of Change in Graduate Education

Posselt, J.R. (2020)

Moving Scientific Institutions Toward Equity:

1. Acknowledge the racialized and gendered beliefs, standard practices, and power dynamics that are root causes of inequities
 2. Coordinate systemic actions in the multiple contexts and levels at which equity is created or impeded
 3. Leverage bottom-up, top-down, and inside-out forces for change
 4. Equity-minded learning and retooling for individuals and organizations, facilitated by cultural translators who span social, professional, and/or disciplinary boundaries
 5. Cultivate, expect, and reward the use of knowledge, skills, and labor that support equity as new generations are trained and enter the labor market
-

How Colleges Change: Understanding, Leading, and Enacting Change

Kezar, A. (2013)

Systemic institutional change is best achieved by converging bottom-up (“grass roots” initiatives) and top-down (individuals in positions of power) efforts. Three phases of culture change:

1. Mobilize: Develop initial awareness of the need for change (data); create vision; galvanize support for change through discussion; mobilize leadership and collective action
 2. Implement: Choose strategies; pilot; change policies; select process and structures; identify professional development; evaluate results and reorient; celebrate successes; scale-up or down
 3. Institutionalize: Disseminate results; review; commit; persist
-

and practices to create educational and working environments that increase access for people from minoritized groups. While many interventions have focused on “fixing the person,” the committee and this report encourage a multi-tiered strategy that calls for change at the institutional and team levels. The combination of removing barriers for entry and for participation, while implementing practices that convey belonging, will allow a STEMM organization to move from broadening participation by the numbers to fostering a culture of inclusion, thriving, and success.

CONCLUSIONS AND RECOMMENDATIONS

The committee’s conclusions and recommendations are presented in the order that they appear in the report. Readers are encouraged to refer to the individual chapters for additional context and supporting evidence. While addressing each recommendation in isolation may produce some change, the committee believes that the multi-tiered, multi-faceted approach to implementing the recommendations concurrently, as discussed throughout the report, will achieve the greatest possible impact.

Addressing Structural Racism and Institutional Racism in STEMM

CONCLUSION 2-1: *The history of systemic racism in the United States, including both written laws and policies and a culture of practices and beliefs, has harmed Black, Indigenous, Latine, Asian American, and other people from minoritized racial and ethnic groups that continue to this day. This history provides critical context for understanding the unequal representation of minoritized populations in science, technology, engineering, mathematics, and medicine higher education and workplaces.*

CONCLUSION 2-2: *The policies, programs, and practices of Historically Black Colleges and Universities and Tribal Colleges and Universities are examples of providing intentional and culturally responsive student and faculty support. Predominantly White institutions of higher education and other science, technology, engineering, mathematics, and medicine organizations can look to these institutions as guides and adopt these systems to increase support for people from minoritized racial and ethnic groups.*

RECOMMENDATION 2-1: Federal funding agencies, private philanthropies, and other grantmaking organizations should provide increased opportunities for grants, awards, and other forms of support to increase understanding of how the policies, programs, and practices of Historically Black Colleges and Universities (HBCUs) and Tribal Colleges and Universities (TCUs) support students and faculty. Notably, one issue for further investigation should be understanding the core principles of historically-based minority serving institution (MSI)-based programs and how to translate them to predominantly White institutions of higher education and other science, technology, engineering, mathematics, and medicine organizations. In addition, predominately white institutions should seek sustainable partnerships with all MSIs (HBCUs, TCUs, Hispanic Serving Institutions, and Asian American, Native American, and Pacific Islander Serving Institutions).

Improving Population and Demographic Data

CONCLUSION 3-1: *Although the representation of minoritized persons in science, technology, engineering, and mathematics higher education is increasing, the collective attainment of science and engineering degrees for Black people, Indigenous people, and Latine people does not reflect their corresponding growth in the U.S. population.*

CONCLUSION 3-2: *Currently-available data on students who intend to study science, technology, engineering, and mathematics in their undergraduate degrees leave out important information on educational outcomes including persistence, completion, and transfer to other degree programs.*

RECOMMENDATION 3-1: To understand the relative persistence of students in science, technology, engineering, and mathematics (STEM) higher education, data collection organizations, such as the National Center for Science and Engineering Statistics and the National Center for Education Statistics, should collect and share online with the public information on the demographics of students entering college planning to study STEM and their subsequent educational outcomes, disaggregated by race and ethnicity, gender, and field of study, including:

- How many complete a STEM degree,
- How many switch to and complete a non-STEM degree, and
- How many leave college without a degree.

Understanding the Lived Experience and Other “Ways of Knowing”

CONCLUSION 4-1: Oral history and other means of exploring the lived experiences of scholars from historically and systemically minoritized groups in science, technology, engineering, mathematics, and medicine offer valuable insights that supplement findings from other kinds of research. These methods should be continued and expanded.

Leveraging STEMM Professionals and Organizations

CONCLUSION 5-1: There are a few noteworthy ways to describe how people from historically and systemically minoritized groups respond to racism in science, technology, engineering, mathematics, and medicine (STEMM) educational and professional environments. These responses can be loosely grouped as follows: exiting the field, implementing strategies to fit in, and collectively mobilizing to transform the STEMM environment.

RECOMMENDATION 5-1: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people’s individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Improve numerical diversity through the admission, hiring, and inclusion of minoritized individuals at all levels of an organization:
 - a. Establish information systems across institutions using common metrics for comparison purposes to collect data, track success, and identify areas of numeric disparities. Results should be transparent, up-to-date, and accurate.
 - b. Hire more minoritized individuals, especially in positions where minoritized role models are often missing (e.g., leadership, mentorship), with the aim of building a critical mass.

- c. Determine if the institutional diversity statement reflects the reality of the institutional environment, and directly address discrepancies.
- d. Adapt curriculum, physical environment, media stories, and other content to incorporate more examples of minoritized role models.

RECOMMENDATION 5-2: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Create and provide continued investment in evidence-based programs that connect minoritized individuals to ingroup peers, institutional resources, and professional networks. These investments require significant expertise in their designs and execution, and they may not yield immediate results; however, they can increase a sense of welcome and belonging through the ability to connect with individuals from similar racial and ethnic backgrounds. Types of programs may include the following types of resources:
 - a. Summer bridge programs.
 - b. Living-learning communities.
 - c. Peer and near-peer mentorship programs.
 - d. Active work to form relationships with national-level affinity societies (e.g., Society for the Advancement of Chicanos and Native Americans in STEM, National Society for Black Engineers, American Indian Science and Engineering Society, etc.), create local chapters, and provide opportunities for minoritized individuals to connect with them.

RECOMMENDATION 5-3: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Create and provide continued investment in programs that facilitate working relationships between minoritized individuals and high-status professionals:
 - a. Create and invest in mentorship programs, while hiring more minoritized faculty.
 - b. Conduct additional research examining the roles of other high-status individuals such as champions and sponsors on fostering STEMM careers for minoritized individuals.

RECOMMENDATION 5-4: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Develop interpersonal environments and institutional norms that promote inclusion, dignity, belonging, and affirmations of kindness:
 - a. Actively recognize minoritized individuals' contributions to STEMM across multiple mediums such as portraits, media stories, awards, etc.
 - b. De-center White professional norms in culture, dress, and appearance.
 - c. Conduct additional research examining which features of the physical environment are most likely to promote sustainable antiracism, diversity, equity, and inclusion in STEMM.
 - d. Emphasize and recognize the importance of communal values in STEMM work.
 - e. Redesign STEMM curriculum to incorporate Indigenous ways of knowing, and actively involve Indigenous communities in the development of this process.
 - f. Create cultural norms that communicate the strengths and struggles of minoritized groups.
 - g. Provide access to culturally responsive mental health providers or resources with experience in addressing racial stress, trauma, and aggressions for minoritized individuals who have experienced distress and would like to pursue these options.
 - h. Conduct biannual "cultural audits" to determine if the institution is fostering an environment of inclusion.

RECOMMENDATION 5-5: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

- a. Use evidence-based design and implementation practices to build curriculum initiatives that increase access to discovery, including, for example, course-based research experiences.

Addressing Individual Bias and Persistent Inequality

CONCLUSION 6-1: *Like other people, gatekeepers often have attitudinal biases, cognitive mechanisms, and social motives that keep the White status quo intact. Racial bias is not only more automatic, but also more ambivalent and ambiguous than most people think. That means that individuals, including gatekeepers, may not be able to monitor their own bias impartially, and may unwittingly perpetuate it.*

RECOMMENDATION 6-1: Leaders of science, technology, engineering, mathematics, and medicine (STEMM) organizations and directors of human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

- Create organizational-level or unit-level information systems to collect data on the decisions of gatekeepers. Data collected may include, but not be limited to hiring, admissions, promotion, tenure, advancement, and awards. Data should be examined in the aggregate to identify patterns of bias exhibited by gatekeepers based on race and ethnicity.
- Include responsibilities related to advancing antiracism, diversity, equity, and inclusion in leadership role descriptions and requirements for advancement into management.
- Develop systems with more widely shared, inclusive decisionmaking processes and shared authority over the allocation of resources, which should limit the negative consequences that occur when gatekeeping is concentrated in a select few individuals.

CONCLUSION 6-2: Additional research is needed to examine the psychological impacts of perpetuating racism from the perspective of the gatekeeper in science, technology, engineering, mathematics, and medicine.

Understanding the Challenges and Leveraging the Strengths of Diverse Work Teams

CONCLUSION 7-1: For teams in science, technology, engineering, mathematics, and medicine organizations, increased numeric representation of minoritized individuals is critical; however, numeric diversity alone is an insufficient condition to yield positive team performance. Conditions that foster inclusion are also essential.

RECOMMENDATION 7-1: Gatekeepers who manage teams, including but not limited to principal investigators and heads of laboratories and research groups, should be intentional about creating the following conditions. These can support positive team performance outcomes and help reduce instances of interpersonal bias.

- Increase the numeric representation of minoritized individuals on teams, by working toward building a critical mass, a necessary but not sufficient attribute of building an inclusive environment.
- Create team norms that centralize a positive climate, in which it is known that all team members, including minoritized individuals, are supported, heard, and respected.
- Develop interdependent teams in which everyone is cooperating and working toward an established common goal.

- Ensure that team members feel psychologically safe on the team, and if not, identify the specific factors that are preventing psychological safety and work to address them.
- Work to promote equal status among team members. Remove asymmetric power differentials among team members, especially between White team members and minoritized team members.
- Incorporate greater diversity in developing team roles, and make sure all team members have clear roles and expectations, including access to professional development and pathways to advancement.

Understanding Organizations and the Role of Leadership in Developing a Culture of Antiracism, Diversity, Equity, and Inclusion

CONCLUSION 8-1: Although standardized tests, such as the SAT, GRE, and MCAT, may not be biased as instruments, they often replicate the educational inequities endured by students from historically minoritized racial and ethnic groups, and they are not consistent predictors of academic and professional success. Reliance on standardized test scores can exacerbate racial inequities in admissions and financial aid decisions for undergraduate, graduate, and medical programs.

CONCLUSION 8-2: Racial discrimination continues to be a significant factor in hiring processes and wages. In terms of hiring, Black people are less likely to receive callbacks than less-credentialed White people. In terms of wages, across occupations Black people and Latine people have lower median weekly earnings than their White and Asian counterparts. Analyses of salary levels and start-up packages by race/ethnicity for science, technology, engineering, mathematics, and medicine faculty are lacking but recent data suggest that White men receive higher salaries and larger start-up packages than scientists who are women or who are not White.

CONCLUSION 8-3: People from minoritized racial and ethnic groups encounter significant race-related barriers in academia that affect their career advancement and retention, including but not limited to bias in tenure and promotion, challenges to align with the dominant culture, and everyday discrimination from colleagues and students including microaggressions and tokenism.

CONCLUSION 8-4: Lack of diversity within organizations can limit access to career resources for people from minoritized racial and ethnic groups, such as mentorship, sponsorship, and professional networks, that could support their development.

RECOMMENDATION 8-1: Organizational leaders should take action to redress both individual bias and discrimination as well as organizational processes that reproduce harm and negative outcomes for people from

minoritized racial and ethnic groups at critical points of access and advancement. This action should include a review of evaluation criteria and decisionmaking practices (i.e., in admissions, hiring and wage-setting, and promotion and advancement) to understand if and to what degree existing standards perpetuate underlying racial and ethnic inequities.

- Admissions offices at colleges and universities, as well as admissions decisionmakers in graduate programs, should assess the alignment or divergence of their current admissions policies and criteria with values of antiracism, diversity, equity, and inclusion, and develop holistic admissions strategies that offer a systematic, contextualized evaluation of applicants on multiple dimensions.
- Hiring managers, directors of human resources, and supervisors should measure and review the application, offer, and acceptance rates in their organization, as well as the salaries, resource packages, and academic tracks and titles of new hires, for instances of racial and ethnic discrimination in the hiring process. As a result, these leaders should, as appropriate, implement proactive outreach and recruitment to increase applications from people from minoritized racial and ethnic groups, trainings and resources to eliminate bias in the hiring process for managers, and updated policies to reduce bias and discrimination in setting wages.
- Directors of human resources and supervisors should measure, evaluate, and address the presence of bias and discrimination in rewards, key assignments and promotion, the proportion of people from historically minoritized backgrounds leaving their positions and their reasons for doing so, and the access to culturally relevant mentorship for students and employees.

CONCLUSION 8-5: The process of cultural change toward antiracism, diversity, equity, and inclusion in STEMM organizations can be complex, multi-layered, and uneven in its progress due to the significant demands from leadership and participants. Cultural change around antiracism, diversity, equity, and inclusion, can involve personal reflection and challenges to individual beliefs, all of which cause discomfort.

RECOMMENDATION 8-2: Leaders, managers, and human resource departments in science, technology, engineering, mathematics, and medicine organizations should anticipate resistance to antiracism, diversity, equity, and inclusion efforts and investigate with rigorous empirical tools, the impacts of training on different types of antiracism, diversity, equity, and inclusion outcomes (hiring, climate, promotion, retention, leadership roles, resource allocation).

RECOMMENDATION 8-3: Presidents, chief executive officers, and leaders of science, technology, engineering, mathematics, and medicine organizations, including those in higher education and the private sector,

should use a framework (such as those listed below) to evaluate the institution's values and norms and identify specific ways to address norms that impede diversity and promote a culture that is genuinely accessible and supportive to all. These top-level leaders should work with managers, supervisors, and other mid-level leaders who influence the local culture within organizations and can be a critical part of implementation. The evaluation should include review of:

- Institutional policies and practices for instances of bias with regard to race and ethnicity;
- Policies and practices for entrance into the organization (admissions, hiring, or nomination), advancement (promotion and tenure), and other rewards;
- Analysis of resource allocation by race and ethnicity such as wages and bonuses, mentorship, professional development opportunities, physical materials or assets, and other items or forms of support;
- Mentorship, training, and professional development opportunities to build skills specific to supporting Black students, Indigenous students, and students and trainees from historically minoritized racial and ethnic groups;
- Culturally-aware mentorship and management training for supervisors, administrators, and other leaders; and
- The results of regular climate surveys to evaluate the working conditions and environment.

CONCLUSION

The release of this report coincides with a growing awareness of the persistent challenges of racism, diversity, equity, and inclusion and with an increased interest in addressing these issues in STEMM. The scientific evidence and lived experiences presented in this report offer critical insights and provide the strong foundation for the committee's conclusions and recommendations. Taken together, this information provides a clear pathway for STEMM organizations, institutions, and professionals to engage in sustainable and structural changes required to advance ADEI.

1

Introduction

Every individual, regardless of race, ethnicity, or country of origin, deserves the opportunity to pursue an education or career in science, technology, engineering, mathematics, and medicine (STEMM) in a welcoming, supportive, and antiracist environment. Yet despite significant investments by federal, state, and local governments, philanthropies, and the private sector to address diversity, equity, and inclusion in STEMM organizations, there are still substantial barriers that produce inequitable opportunities and outcomes. As a result, Black people, Indigenous people, Latine¹ people, Asian American people, and people from other systematically minoritized racial and ethnic groups face inequities in STEMM higher education and the workforce. Black people, for example, account for 11 percent of all jobs but only nine percent of STEMM jobs, while Latine and Hispanic individuals account for 17 percent of all jobs but only eight percent of STEMM jobs (Fry, 2021). Of all medical residents, only 7.8 percent identified as Hispanic, 5.8 percent identified as Black, and less than one percent identified as American Indian, Alaska Native, Native Hawaiian, or other Pacific Islander (American Association of Medical Colleges, 2021).

The economic prosperity of the United States and that of its residents depends on the nation's continued success in STEMM. The Bureau of Labor Statistics project that by 2030 employment in science, technology, engineering, and mathematics (STEM)² occupations will increase by 10.5 percent

¹This term is used in the report to represent Latine and Hispanic people, except in instances where the data and research use "Hispanic" specifically.

and in medical occupations by 16 percent, compared to only 7.5 percent for non-STEM occupation (BLS, 2022). STEM jobs³ have higher-than-average wages than non-STEM jobs—\$95,420 versus \$40,120 in 2021 (BLS, 2022)—and employment rates that are more resistant to economic shocks; unemployment in STEM jobs reached nine percent in 2020, for example, versus 16 percent for non-STEM jobs (Board, 2021). This makes pursuing careers in STEM fields highly attractive. However, the cumulative and compounding effects of an array of racialized societal factors—including the history, culture, ideology, and interactions of institutions and policies that systematically disadvantage people from minoritized groups—create substantial barriers that make it difficult for almost half of the nation’s population to join and thrive in the STEM workforce.

Challenges, however, begin long before people from systematically minoritized groups enter the workforce or higher education programs. As early as fourth grade, reading and math scores for Black students, for example, lag behind those of White and Asian students (National Center for Education Statistics, 2022a,b). This gap is correlated, at least in part, to a school’s racial composition, where the achievement of Black students is lower in schools with a higher percentage of Black students compared to those who attend schools with a lower percentage of Black students (Bohrstedt, 2015). A similar gap exists for Hispanic students (Hemphill and Vanneman, 2011). By eighth grade, 85 percent of White students have passed algebra one, a milestone in STEMM preparedness, compared to 65 percent of Black students and 72 percent of Latine students (Office for Civil Rights, 2018). In postsecondary education, Black, Hispanic, and White students declare STEM majors at roughly the same rate (Xie, 2015; Griffith, 2010), but while 58 percent of White students earn a STEM baccalaureate degree, only 43 percent of Latine students and 34 percent of Black students earn a STEM baccalaureate degree, with 40 percent of Black students and 37 percent of Latine students switching out of STEM majors before earning their degree (Riegle-Crumb et al., 2019).

STUDY ORIGIN AND STATEMENT OF TASK

Over the last 20 years, based on the inequities described above, the National Academies has convened numerous committees and workshops and issued over 80 reports exploring various aspects of the need to make

²While the committee’s charge is to address antiracism, diversity, equity, and inclusion in STEMM, this report also uses the term STEM when data or studies cited only refer to science, technology, engineering, and mathematics and do not include medicine.

³These data include employees of all races.

STEMM more equitable, diverse, and inclusive. (See Appendix A for a summary of previous, related reports.) Common themes that have emerged from this robust body of work include the need to:

- Develop and institute inclusive leadership practices in STEMM institutions;
- Foster an environment that provides social and behavioral support for underrepresented/under-resourced individuals across STEM education and careers;
- Support and increase pathway programs that focus on underrepresented/under-resourced individuals; and,
- Fortify data collection, evaluation, and accountability of diversity, equity, and inclusion programs.⁴

More recently, the National Academies' Committee on Advancing Diversity, Equity, Inclusion, and Antiracism in 21st Century STEMM Organizations, under the auspices of the Board on Behavioral, Cognitive, and Sensory Sciences and the Board on Higher Education and Workforce, hosted a national summit that "highlighted how racism operates at different levels in STEMM settings; reviewed policies and practices for confronting systemic racism; and explored ways to advance diversity, equity, and inclusion in STEMM settings" (the National Academies of Sciences, Engineering, and Medicine, 2021). The summit also explored "the empirical and experiential evidence related to the ways in which systemic racism and other barriers impede STEMM careers for historically minoritized racial/ethnic groups, and ways to address these barriers" (the National Academies, 2021).

The summit represented the first step in responding to a letter sent by Representative Eddie Bernice Johnson (D-TX), chair of the House Committee on Science, Space, and Technology. In this letter, Representative Johnson asked the National Academies to act on research and policy issues related to "diversity, equity, inclusion, and the racial biases in the nation's systems that disadvantage people from minoritized backgrounds in pursuit of science, engineering, and medical studies and careers" (the National Academies, 2021). To build on this important work, the National Academies convened the Committee on Advancing Diversity, Equity, Inclusion, and Antiracism in 21st Century STEMM Organizations to review the literature on bias and racism in science, technology, engineering, mathematics, and medicine workplaces; review

⁴The National Academies' collection of publications on Diversity, Equity, and Inclusion is available at <https://nap.nationalacademies.org/collection/97/diversity-equity-and-inclusion>

approaches to increase racial and ethnic diversity, equity, and inclusion in STEMM organizations (e.g., universities, nonprofit organizations, and industry); offer best policies and practices for diversity, equity, inclusion, and antiracism initiatives; and outline goals for relevant, future research and for organizational strategic planning. The Statement of Task for the committee's work is provided in Box 1-1.

To respond to its Statement of Task, the committee conducted an intensive literature review, convened a series of evidence-gathering activities, including public workshops with presentations on strategies for diversity in STEMM organizations, system and culture change theories and practices, and operationalizing antiracism, diversity, equity, and inclusion in

BOX 1-1

Statement of Task: Committee on Advancing Diversity, Equity, Inclusion, and Antiracism in 21st Century STEMM Organizations

The National Academies of Sciences, Engineering, and Medicine will appoint an interdisciplinary committee to review the literature on bias and racism in science, technology, engineering, and mathematics, and medicine (STEMM) workplaces; approaches to increase racial and ethnic diversity, equity, and inclusion (DEI) in STEM organizations (e.g., universities, nonprofit organizations, and industry); and offer best policies and practices for DEI and antiracism initiatives, as well as outline goals for relevant, future research and for organizational strategic planning. The committee's final consensus report will:

Review the research and evidence from lived experience on the ways in which racism (at the individual and group level and conditions that create systemic barriers) impedes STEMM careers for historically minoritized racial and ethnic groups;

Identify principles for sustainable organizational culture change to address racism and promote DEI; including discussion of the role of training, ways to motivate buy-in at all levels of the STEMM organization, and stay the course in adopting a strategy and goals aimed at addressing racism and its role as a barrier to a STEMM career;

Review and synthesize the existing research on methods to improve the recruitment, retention, and advancement of members of historically minoritized racial and ethnic groups pursuing STEMM careers; and identify promising policies and practices for changing existing systems and structures;

Identify examples of effective strategies to advance antiracism in STEMM organizations, including roles for members within organizations; and

Define a research agenda to address gaps in knowledge in the evidence base to advance antiracism, diversity, equity, and inclusion.

STEMM organizations. The committee also commissioned four papers on the following topics:

- Antiracism, Diversity, Equity, and Inclusion in STEMM: A Focus on Research on Indigenous People
- Antiracism, Diversity, Equity, and Inclusion in STEMM: A Focus on Research on Latine and Hispanic People
- Antiracism, Diversity, Equity, and Inclusion in STEMM: A Focus on Research on Asian American People
- Challenges and Counter-Arguments to Antiracism, Diversity, Equity, and Inclusion in STEMM

The committee cites data from the first three papers focused on Indigenous, Latine and Hispanic, and Asian American people in this report, while the fourth report on challenges and counter-arguments served to deepen the committee's understanding of key issues. All four papers can be found in the report's public access file on the National Academies website.⁵

The committee also jointly sponsored a workshop with the National Academies Roundtable on Black Men and Women in SEM⁶ during which presenters shared their lived experiences and expertise in leading antiracist programs. In addition to being responsive to its charge, the committee recognized that understanding lived experiences is important and would complement the scientific literature on diversity, equity, and inclusion.

STUDY APPROACH AND SCOPE

Beginning in fall 2021, the National Academies conducted an extensive nomination and appointment process to assemble the Committee on Advancing Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations. This included a public call for nominations for experts in diversity science, social and cognitive psychology, industrial and organizational psychology, sociology, human resources, and higher education, as well as experienced practitioners who have led diversity, equity, and inclusion programs. In accordance with the National Academies' policies, careful consideration was given to the balance and composition of the committee's

⁵The public access file for this report can be found at <https://www8.nationalacademies.org/pa/ManageRequest.aspx?key=48997>

⁶The National Academies Roundtable on Black Men and Black Women in SEM is a panel of leaders focused on increasing the representation, retention, and inclusiveness of Black men and Black women in science, engineering, and medicine: <https://www.nationalacademies.org/our-work/roundtable-on-black-men-and-black-women-in-science-engineering-and-medicine>

expertise and experience and a thorough examination of potential conflicts of interest was conducted to ensure the transparency and integrity of the study process. Through this process, the committee identified areas where additional expertise would be needed, and invited additional experts to present data and research and commission literature reviews to complement the committee's expertise.

In its approach to the Statement of Task, the committee carefully considered the scope and presentation of the complex issues of antiracism, diversity, equity, and inclusion. The challenges experienced by minoritized people in STEMM are deeply rooted in history, law, cultural and institutional practices, and interpersonal biases and assumptions—factors that must be understood in depth to discern ways forward. At the same time, while there may be some shared experiences, these sociocultural factors differ for different minoritized groups and individuals, precluding a one-size-fits-all solution. Thus, the committee elected to focus on the challenges facing Black Americans in STEMM to demonstrate the inquiry that is required, noting the prominence of work on this topic both within the Academies and in the research community. This focus is in no way intended to diminish the importance of addressing challenges facing other minoritized groups but rather to provide guidance for future work to address their concerns, including a call for additional research that investigates the unique racialized issues facing these groups in the research agenda. When the committee turned to the National Academies for precedent, it found that the committee tasked with creating the report *Measuring Racial Discrimination* (2004) fulfilled its charge in a similar manner.

With this focus, the committee leveraged the expertise and experience of the National Academies Roundtable on Black Men and Black Women in SEM to respond to its charge on reviewing evidence on the “lived experience,” recognizing that the existing literature may not fully capture these perspectives. Thus, the committee conducted a series of structured interviews with Roundtable members to provide illustrative, humanizing examples to supplement the scientific literature (see Chapter 4). The narratives provide a window into the impacts of racism, providing a deeper understanding of the harms that minoritized people experience, as well as the ways that people find mentorship, support, and other guidance on their paths from a STEMM education to a career in STEMM.

Definitions and Terminology

To guide its work, the committee identified key concepts and terms in the Statement of Task that it needed to define, such as STEMM, race, antiracism, diversity, equity, and inclusion. Further, the committee sought to determine which organizations to include in its review.

STEMM and STEMM Organizations

To determine how broadly to define STEMM, the committee referred to the National Science Foundation's definition, which includes chemistry, computer and information science and engineering, engineering, geosciences, life sciences, materials research, mathematical sciences, physics and astronomy, psychology, social sciences, and STEM education and learning research (National Science Foundation, n.d.). In addition, the committee considered fields that rely on middle-skill occupations, which are those that require significant STEM expertise but do not require a bachelor's degree (the National Academies, 2017). Included in this expansive definition of STEM are skilled technical occupations such as aircraft mechanics and service technicians, first-line supervisors of construction trades and extraction workers, and heavy vehicle and mobile equipment service technicians and mechanics. To address the second "M" in STEMM, the committee included fields that employ individuals in the broad range of health care occupations as defined by the Bureau of Labor Statistics, which include health care practitioners, technical occupations, and health care support occupations, such as medical equipment preparers and pharmacy aids (BLS, 2021).

Next, the committee determined the range of STEMM organizations on which it would focus, which included universities, STEMM-focused non-profit organizations, industry, professional societies, hospitals, and medical centers; however, when the committee conducted its review of the literature, it did not limit itself to publications focused exclusively on STEMM. The intent was to capture findings from a broader range of research and thinking on antiracism, diversity, equity, and inclusion. Thus, the committee hopes that its recommendations and supporting evidence, which are directed at STEMM organizations, will also be relevant and implementable beyond STEMM organizations.

Race and Ethnicity

Critically, the committee deliberated about how to define and use the term race, recognizing the complexity and inherent biases associated with this construct. Ultimately, the committee adopted a definition of race as developed by researchers and recognized by the Smithsonian (2022), described in Chapter 3 of the present report:

There exist many different ways to describe race. Many researchers choose to recognize race as a social construction, "based on observed phenotypic manifestations of presumed, underlying genetic differences" (Brown et al., 1999). The committee, in their deliberations, also referenced the Smithsonian Institution definition of race: "a human-invented, shorthand term used to describe and categorize people into various social groups

based on characteristics like skin color, physical features, and genetic heredity. Race, while not a valid biological concept, is a real social construction that gives or denies benefits and privileges” (Smithsonian).

The committee also took care to acknowledge the ways in which race, as well as ethnicity, exist as fluid categories. As social constructs, these concepts have changed over time, as the Census Bureau notes:

Race and ethnicity categories generally reflect social definitions in the United States and are not an attempt to define race and ethnicity biologically, anthropologically, or genetically. We recognize that the race and ethnicity categories include racial, ethnic, and national origins and socio-cultural groups (BLS, August 2021).

The committee notes that the nature of race in the United States has evolved since the first census of 1790, as further discussed in Chapter 3; furthermore, the committee acknowledges that the concept of race will continue to evolve beyond this report. As such, the committee has agreed upon set definitions for the purpose of this report. The definitions employed here are largely based on the 1997 Office of Management and Budget’s definitions for race and ethnicity, used in U.S. Censuses (see Box 1-2). Chapter 3 provides more in-depth explanations of each racial category.

BOX 1-2

Race and Ethnic Categories from the U.S. Census Bureau

- *American Indian or Alaska Native:* A person having origins in any of the original peoples of North and South America (including Central America) and who maintains tribal affiliation or community attachment.
- *Asian:* A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent; for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
- *Black or African American:* A person having origins in any of the Black racial groups of Africa.
- *Hispanic or Latino [Latine]:* A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.
- *Native Hawaiian or Other Pacific Islander:* A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific islands.
- *White:* A person having origins in any of the original peoples of Europe, the Middle East, or North Africa

SOURCE: U.S. Census Bureau (2022), <https://www.census.gov/programs-surveys/decennial-census/decade/2020/planning-management/release/faqs-race-ethnicity.html>

The committee also faced the decision about whether to capitalize the letter “w” in White. Consistent with the National Academies’ practice of capitalizing the first letter of racial and ethnic designations, the committee decided to capitalize the “w” in White. While the committee acknowledges that this may be controversial, it felt that the alternative lowercase “w” could implicitly affirm that Whiteness is the standard and racial norm, thus ignoring the way Whiteness functions in institutions and communities.

The committee also carefully considered whether to include other identities and other dimensions of diversity, such as gender, age, and disability, as they related to the Statement of Task. The committee came to the consensus that race and ethnicity would be the primary factors and primary lens of analysis for its work. Despite this specific focus, the committee acknowledges and recognizes that, consistent with intersectionality theory (Crenshaw, 1989), individuals belong to multiple identity groups, each associated with varying structures of privilege, power, and oppression, and these factors subsequently shape unique experiences. Thus, the report presents examples in which other identities are included to elucidate findings.

Finally, the committee deliberated extensively on the terms it would use to discuss people from minoritized groups and those in power within STEM contexts. The committee took numerous factors into consideration, including the importance of contemporary context, the acknowledgement of history, terms favored by individual racial and ethnic groups, the dynamic aspect of language, experiences of mistreatment and racism, numeric underrepresentation, existing structures and systems of oppression, the role of power in STEM, the use of active versus passive language, the use of nouns versus verbs, the consideration of who is centered (and who is not), and how to name those in power (i.e., gatekeepers). This careful deliberation yielded consensus on the terminology used in this report: people from groups who have been systemically minoritized based on their race or ethnicity, minoritized people, and people from minoritized racial and ethnic groups.

In certain instances, the committee includes “Black people, Indigenous people, and Latine people” in advance of these terms to emphasize the specific and pronounced ways people from these groups have been impacted by racism. Although the committee acknowledges limitations to the agreed upon terms, they represent an honest effort to best represent the literature and the lives of the people represented.

Systemic and Structural Factors

Despite substantial investments in programs aimed at helping people from systematically minoritized groups enter, persist, succeed, and thrive in STEM, significant gaps persist. As this report will show, the root cause of

these gaps does not reflect the abilities or interests of individuals. Rather, they are the result of systemic and structural issues arising from the legacies of policies and practices designed to disadvantage people from historically minoritized groups along with institutional cultures that, intentionally or otherwise, create exclusionary and discriminatory environments based on biased notions of success and prestige. Indeed, students from systematically minoritized groups may feel compelled to persist and meet standards that are inherently biased against them, rather than feel at ease, welcomed, valued, and respected for who they are.

Past efforts to increase participation from systematically minoritized groups in STEMM have fallen short. Many such efforts do not acknowledge the historical context of discrimination that minoritized individuals experience or they do not adequately focus on the policies, processes, and power structures that create racial and ethnic bias in STEMM. In this report, statistics describing the discrepancies in wages, hiring, degree completion, and other dimensions illustrate these points, and the report provides specific descriptions of the populations and characteristics for each statistic. This report explores the factors that produced system and structural barriers for minoritized groups, such as the historic redlining of predominantly Black neighborhoods, disproportionate funding of White-majority versus minority serving land grant institutions, and discouraging Black veterans from attending college. It examines how systemic and structural issues operate at the organizational, group, individual, and interpersonal levels and discusses theories of organizational change and practices that have been successful in changing organizational culture to create diverse, equitable, and inclusive environments in which everyone can thrive.

However, simply creating diverse, equitable, and inclusive environments is not sufficient to ensure that historically minoritized groups have frictionless access to STEMM education and professional pathways. Rather, organizations and the individuals within them need to be *antiracist*—to engage in an active, intentional, and dynamic set of actions that dismantle and disrupt the policies, practices, attitudes, cultures, and systems that confer power and privilege to White people over others (see Glossary for the fullest version of the committee’s definition of antiracism). Being antiracist requires understanding and acknowledging the history of racial disparities in America, and it requires a daily commitment to fighting racism that each individual and each institution carries out with intention.

ORGANIZATION OF THE REPORT

This report aims to synthesize the existing body of research on antiracism, diversity, equity, and inclusion in STEMM organizations; given increasing interest in these issues and the growing evidence base, it is

unlikely it will be the last. The report organizes this synthesis into three distinct parts: establishing the broader context of the issues in the United States; describing the challenges for STEMM organizations; and proposing recommendations for change. Throughout, the committee does not present antiracism, diversity, equity, and inclusion as a single set of goals that organizations can work toward, achieve, and then declare the job done. Instead, the committee takes the view that these efforts demand sustained attention, leadership, and resources to flourish. The recommendations outlined in this report provide guidance to actors and stakeholders across the STEMM enterprise to build this type of effort into existing systems.

Part I: Broader Context of Antiracism, Diversity, Equity and Inclusion in the United States

Part I establishes the historical and contemporary context for the issues of antiracism, diversity, equity, and inclusion in STEMM organizations. The committee describes how actions taken against certain racial and ethnic groups in U.S. history have had persistent, negative effects. The report draws connections between historic events, and similarly racialized policies, and the issues that confront people in STEMM organizations today. The committee contends that understanding the history of the United States is critical not only to understand how present-day racial and ethnic bias and discrimination operate, but also to imagine how to dismantle the systems of oppression that presently impact systematically minoritized groups based on their race and ethnicity.

Figure 1-1 illustrates the ways that the different levels of analysis in this report interact in a nested fashion, as the historical and societal context provide context for STEMM organizations, which in turn influence the professional and educational environments in which groups and teams operate, all of which impact the microclimates in which individual people learn and work.

Chapters 2 and 3 provide the context and background related to the issues outlined in the Statement of Task. Chapter 2 begins with a review of U.S. history and how critical policies and practices are foundational to racism in present day America. Chapter 3 includes the history of data collection by race and ethnicity in the United States, as well as information about the dynamic nature and limitations of racial and ethnic categories. The chapter also includes data on racial and ethnic representation at different education and career levels in STEMM. Finally, Chapter 4 highlights the lived experience of Black people involved in STEMM through structured interviews with members of the National Academies Roundtable on Black Men and Black Women in SEM. This chapter, which also includes information about the nature of evidence and ways of knowing, uses excerpts from these interviews as illustrations of issues seen in the data.



FIGURE 1-1 Diagram illustrating the nested relationship between history and society, STEMM organizations, groups and teams, and individuals.

Part II: Describing the Challenges for STEMM Organizations

Part II of the report, comprising Chapters 5, 6, 7, and 8, explores how antiracism, diversity, equity, and inclusion are manifest in modern day STEMM contexts. Part II reviews the layers within STEMM organizations and how the larger culture and climate of an organization can influence the working environments of specific groups or teams, which may have their own microcultures and microclimates that directly impact the individuals in that unit, as Figure 1-1 illustrates.

Within this general context, Part II examines how individuals, groups and teams, and organizations operate, particularly in relation to antiracism, diversity, equity, and inclusion. The chapters also explore how policies, practices, and programs can shift norms, values, and behaviors at each level. The emphasis on changes further upstream, within organizations or groups and teams, does not preclude the work or responsibility of individuals, particularly those in leadership, gatekeeping, and decisionmaking roles; however, the report focuses on changes to structures, systems, and institutions as a way to guide and shape individual behavior.

Part III: Recommendations

Finally, Part III of the report offers a vision for future directions in STEMM antiracism, diversity, equity, and inclusion research. Chapter 9 outlines a research agenda, a detailed set of issues that the committee recommends for future investment, prioritization, and investigation. The research agenda provides a roadmap for future work to address existing

gaps in data collection and research. Pursuing this research will contribute to a greater understanding of the landscape and the changing culture and climate. It will also inform evidence-based strategies for structural, systemic, and institutional changes centered on antiracism, diversity, equity, and inclusion.

In addition to the core content, there are three appendices that supplement this report. Appendix A summarizes four previous, related National Academies reports. Appendix B contains summary tables for completion rates by degree type, by race and ethnicity, and by gender. Appendix C provides an overview of the process for the structured interviews that appear in Chapter 4. Appendix D includes the biographies of the committee members.

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PART I

The Historical and Contemporary Context for Structural, Systemic, and Institutional Racism in the United States

To best understand “the conditions that create systemic barriers,” as described in the Statement of Task, the committee examined evidence on the historical context of the United States. The current chapter begins with definitions of structural, systemic, and institutional bias, and describes how they collectively function at a macro level to perpetuate widespread disparities on the basis of race. The chapter then examines how the origins of race and racism came to be established at the inception of the United States. These racist belief systems created a false racial hierarchy under which non-Hispanic White people are believed to be superior, and Black people, Indigenous people, and systematically minoritized racial and ethnic people are considered inferior.

This chapter then reviews the evidence on the codification of racism through national laws, policies, and numerous other mechanisms. Further, the codification of racism is examined across multiple sectors in society, including education, housing, employment, criminal justice, and health, all of which, as the chapter demonstrates, underlie entry into science, technology, engineering, mathematics, and medicine (STEMM).¹

¹This chapter will use both STEM (to refer to science, technology, engineering, and mathematics) and STEMM (to refer to science, technology, engineering, mathematics, and medicine). In many references to undergraduate education, STEM will be used rather than STEMM, to indicate the lack of professional medical degrees in the data sets most often provided by the National Center for Science and Engineering Statistics. Many references used in this chapter refer to STEM or medicine, and the separation of STEM vs. STEMM should be seen as intentional to reflect the studies that researchers have conducted.

For instance, the committee finds these laws, policies, and practices have created unfair barriers to home ownership, lost opportunities for building generational wealth, and lost educational opportunities for minoritized people. These data together point to a major key finding: the codification of racism strengthened and continually reinforced the false racial hierarchy by systematically advantaging non-Hispanic White people and systematically disadvantaging Black, Indigenous, and other minoritized people. This review of structural, systemic, and institutional racism will serve as a frame for understanding how history has shaped STEMM institutions in the United States.

The chapter also reviews the literature on how minority serving institutions (MSIs) emerged as a critical higher educational resource when higher educational opportunities were severely limited for minoritized people. The committee found that even though MSIs on average have continually faced significant underfunding, they have advanced representation by helping many minoritized students obtain STEMM degrees. This chapter ends by setting the stage for the remainder of this report. It discusses how the structural, systemic, and institutional racism in the broader United States is reflected in STEMM, but also reproduced in STEMM. The chapter ends with conclusions focused on dismantling the false racial hierarchy, and implementing the strengths of MSIs.

DEFINING STRUCTURAL, SYSTEMIC, AND INSTITUTIONAL RACISM

First, some definitions that will be particularly pertinent for subsequent chapters in this report. Systemic and structural racism are forms of racism that are pervasively and deeply embedded in and throughout systems, laws, written or unwritten policies, entrenched practices, and established beliefs and attitudes that produce, condone, and perpetuate widespread unfair treatment of minoritized people (Bonilla-Silva, 1997). Though they are often used interchangeably along with institutional racism, they each refer to distinct concepts. *Systemic racism* is perpetuated discrimination within a system that has been based on racist principles, practices, and focuses on the involvement of whole systems (Feagin, 2013; Fitzgerald, 2021), and it focuses on the involvement of whole systems, and often all systems—for example, political, legal, economic, health care, school, and criminal legal systems—including the structures that uphold those systems (Feagin and Ducey, 2018).

Structural racism describes “cultural values in a society that are so ingrained in daily life that they are seen simply as the way things are” (Fitzgerald, 2021; Lucas, 2008), and it refers to wider political and social disadvantages within society, such as higher rates of poverty for Black and

Indigenous communities or high rates of death from COVID-19 among minoritized people (Bailey et al., 2021; Bleich and Ard, 2021). Structural racism shows up as inherited disadvantage and its reciprocal inherited advantage, and is evident in the differential distribution of both material conditions and access to power by “race” (Jones, 2000). Institutional racism denotes policies and practices within and across institutions that, intentionally or not, produce outcomes that chronically favor White people and put individuals from other racial and ethnic groups at a disadvantage (Roundtable on Community Change, 2017).

The current chapter focuses on each of these macro-level forms of racism together and how they impede STEM careers for minoritized racial and ethnic people. First, the committee reviews the origins of race and racism in the United States.

THE ORIGINS OF RACE AND RACISM IN THE UNITED STATES

The written concept of race as it is commonly used today did not exist until the 17th century, when it was used to codify slavery (Rugemer, 2013). Leading philosophers and scientists of the time argued that race was a biological construct and wrongly claimed that there are genetically distinct human races; they further argued that White people were the biologically superior race who had the right to enslave biologically inferior non-White people. This biological construct of race provided the scientific rationale for racial hierarchies of humans in terms of intelligence, industriousness, ingenuity, sexuality, and criminal behavior. Scientific proof of such hierarchies was based on various “scientific” studies, such as measuring pain tolerance, pseudoscientific intelligence testing, or measuring brain sizes—measurements that were later shown to be fraudulent (e.g., Gould, 1978). It was not until the mid-20th century that polygenesis and biology-based racism were widely disproven and race became a subject for anthropologists and sociologists (Gannon, 2016; Yudell et al., 2016).

It is important to recognize that racial categories are often huge groupings based on the social interpretation of how one looks in a race-conscious society such as the United States. They are the substrate on which racism has operated historically and continues to operate day to day. However, every racial category comprises people with different ethnicities, countries of origin, histories, languages, and cultures (Smedley and Smedley, 2005). In addition to the history covered in this section, there are substantial literatures and research on the meaning of race in the United States. Social scientists and novelists such as E. Franklin Frazier, W.E.B. Du Bois, Toni Morrison, and James Jackson have contributed to the psychological and social understanding of race. These ideas and debates can deepen and broaden the understanding and related conclusions among social scientists.

While this report does not include a specific analysis of this body of work, the committee respects how this research has shaped the meaning of race in the United States over time.

Slavery was not the only overt expression of the racism that was foundational in the history of what would become the United States (Banaji et al., 2021; Harvey, 2016). The colonization of the Western Hemisphere saw extreme expressions of racism in the way European settlers stole the land of, pushed aside, marginalized, mistreated, and committed genocide against the Indigenous peoples of North America. As with slavery, colonizers justified their theft of land, natural resources, culture, and identity with the view that White people were superior to all other peoples (Harvey, 2016). It was not until 1924 that the U.S. government recognized Indigenous Americans born in the United States as citizens. The right to vote took more time. In fact, there were some states that prevented Native Americans from voting up until 1957 (Library of Congress, n.d.).

Racism directed at minoritized people, including Latine individuals, also dates back to the founding of the United States (Carrigan and Webb, 2003; Jung et al., 2011). Lynchings and mob brutality against Mexican Americans were common in the 19th century and into the early 20th century (Carrigan and Webb, 2013). People of Latine heritage were also pushed into segregated communities, forbidden from serving on juries, and made to attend designated “Mexican” schools throughout the Southwest (Antman and Cortes, 2013; Denis, 2015; Donato and Hanson, 2019; Powers, 2008; Villalobos, 1972; Wollenberg, 1976). In the U.S. territory of Puerto Rico, the federal government was responsible for violence against Puerto Ricans as well as birth control experimentation and sterilization promotion (Gibson-Rosado, 1993; Junod and Marks, 2002).

Racism toward Asian Americans became prominent in the 19th century when many Asian individuals, in particular Chinese individuals, served as indentured laborers in major national projects and events, including during the California gold rush and the construction of the transcontinental railroad (Gandhi, 2013; Kanazawa, 2005; Ngai, 2021). In the 19th and 20th centuries, “yellow peril” scares led to anti-Asian immigration and naturalization laws (Congress of the United States, 1882). The 20th century saw a major violation of American civil rights with the forced removal of approximately over 100,000 Americans of Japanese ancestry from their homes, including those whom were U.S. citizens by birth, and their incarceration in internment camps (National Archives, n.d.; Shoag and Carollo, 2016). Laws restricting immigration and naturalization of Asian individuals persisted until the Immigration and Nationality Act of 1965 (U.S. House of Representatives, 1965).

Taken together, the original definitions of race and racism, as established at the inception of the United States, created a false racial hierarchy

under which non-Hispanic White people are believed to be superior and Black people, Indigenous people, and systematically minoritized racial and ethnic people are believed to be inferior.

THE CODIFICATION OF RACISM: AN EXAMINATION OF MULTIPLE SECTORS IN U.S. SOCIETY

The present section examines what happened after this false racial hierarchy was conceptualized in the United States, namely the codification of racism in national laws, policies, practices, formal and informal rules and regulations, in addition to other mechanisms. This section begins by examining some of the earliest examples occurring at the inception of the country, and moves through U.S. history. In addition to spanning time, this section examines multiple sectors of society in which racism was codified, including education, housing, employment, criminal justice, and health. Across these sectors, the committee finds that the codification of racism restricted how Black people, Indigenous people, and other minoritized people were allowed to live, whether and where they were allowed to go to school, other educational opportunities they had access to, the careers they could pursue, the wealth they could accumulate and pass on to their children, and other aspects of everyday life that underlie entry and accessibility into STEMM educational and professional spaces.

Therefore, this section demonstrates the codification of racism strengthened and continually reinforced the false racial hierarchy through the systematic advantage of non-Hispanic White people and the systematic disadvantage of Black people, Indigenous people, and other minoritized people. Though the majority of formal practices and policies have long since been revoked, the history demonstrates that this legacy has had a lasting effect on the ability of minoritized people to have a career in STEMM (Clotfelter et al., 2015).

Separate and Unequal

In response to the ratification of the 13th, 14th, and 15th Amendments to the Constitution, southern state legislatures passed what were known as “Black Codes” that limited the rights of formerly enslaved people, exploited them as a labor source, and took advantage of the crime exception in the 13th Amendment to criminalize activities and force newly freed enslaved people into servitude again (Hinton and Cook, 2021). These laws also denied Black Americans the opportunity to rent or buy land, forced them to sign annual employment contracts that paid the lowest wages possible, prohibited them from voting, included measures to

prevent prospective employers from paying Black workers higher wages, and often excluded Black children from attending newly created free public schools.²

In the 1870s, many southern states and localities also adopted laws that codified the social interaction between Black and White individuals. These so-called “Jim Crow” laws varied across jurisdictions, but overall, they enforced segregation of Black individuals in the realms of schooling, transportation, public accommodations, and in access to public facilities such as pools and drinking fountains. Over time, many states and localities beyond the South also adopted Jim Crow-inspired restrictions on the social interaction of Black and White individuals.

Jim Crow laws seemingly violated the Civil Rights Act of 1875, but in 1896, in *Plessy vs. Ferguson*, the Supreme Court ruled they did not (*Plessy v. Ferguson*, 163 U.S. 537 [1896]). Instead, the majority opinion articulated a doctrine of “separate but equal” that justified segregation, and thus Jim Crow relations, while formally requiring that facilities for Black and White individuals be equal. Between the inception of Jim Crow laws, through the waning of Jim Crow in the 1960s, and even after, researchers painstakingly documented inequality in the facilities for Black and White individuals. In education, they found racial inequality in the number of school days (for example, Norton, 1926), teacher qualifications (Norton, 1926), per-pupil expenditure (Phillips, 1932), teacher-student ratio (Moses, 1941), facilities (Moses, 1941; Strayer, 1949), and curriculum (Strayer, 1949; Wallace, 1951). In the context of health, they found Black individuals had less access to hospital beds and being accepted into a hospital in general (Beardsley, 1986; Cornely, 1946), less access to beds for treatment of specific illnesses such as tuberculosis (Cornely, 1946), and less access to treatment for disabilities (Cornely, 1946).

Jim Crow laws reinforced enslavement-era norms with the backing of the State, potentially endowing any violation with criminal implications. Moreover, beyond legal ramifications, the Jim Crow era was replete with extralegal enforcement. The Tuskegee University Archive documents that between 1882 and 1968 a total of 3,446 African Americans were lynched in the United States. In addition, some 1,297 Whites were also lynched, often for violating Jim Crow social barriers (Tuskegee University Archives Repository, 2010). Many victims were falsely accused of rape, murder, robbery, or other serious crimes, while others were lynched for perceived disrespect of White individuals.

²For more on Black Codes and Jim Crow laws, refer to Du Bois (1935), *Black Reconstruction in America: Toward a History of the Part Which Black Folk Played in the Attempt to Reconstruct Democracy in America, 1860–1880*; Foner (1988), *Reconstruction: America’s Unfinished Revolution, 1863–1877*; or Oshinsky (1996), *Worse than Slavery*.

While lynchings were focused on one to three targets owing to some episodic perceived violation, oftentimes Black progress in general was the reason for a false accusation that was used to justify more widespread destruction within a community. For example, in many locales, when Black individuals started to gain ownership of small businesses and began to accrue wealth, White individuals would often respond by forming mobs, burning down the business district, raping and/or murdering Black people, and running all surviving Black individuals out of town. Bustling Black communities in Tulsa, Oklahoma (1921; Parrish, 1922), Rosewood, Florida (1923; Dye, 1996), and Wilmington, North Carolina (1898; Tyson, 1998) fell victim to such violence, as did other communities. While these attacks are rarely called lynchings, they share with lynchings the defining features of extralegal pursuit and violent brutality toward Black individuals.

Because lynching and other extralegal violence was woven deeply into the experience and psyche of White and Black America, it is impossible to convey the historic and present implications of the Jim Crow era without also conveying the reality of lynching and violence targeted against Black individuals and Black communities. Jim Crow, and its violent enforcement, were designed and deployed to enforce Black subservience and White supremacy. The visibility and brutality of the violence served as a warning to any who might dare challenge Jim Crow relations specifically or White supremacy in general.

Jim Crow laws lasted well into the 1960s and were only dismantled as a result of the civil rights movement. But the effort to dismantle Jim Crow was widely resisted, and the legacy of that resistance remains impactful even now. For example, pools were often segregated in the Jim Crow era, both in the South and elsewhere. In the wake of *Brown v. Board of Education*, which effectively ruled separate but equal unconstitutional, many communities closed and even filled-in their public pools when pressed to desegregate them (e.g., Smith, 2012, p. 40). Now, decades later, many U.S. communities still lack public pools, a lingering and consequential legacy of the resistance to treating everyone with fairness and equality (Gershon, 2019). Additional evidence emerged demonstrating that many Black families in the rural South were denied Federal Emergency Management Agency (FEMA) loans when a natural disaster damaged their homes because they did not have a deed to their home, which was required to obtain a FEMA loan. Black persons during the Jim Crow era were excluded from the legal system, and as a result, as many as one-third of Black-owned land in the South was passed from generation to generation as “heir’s property” without a deed (Dreier and Ba Tran, 2021). It was only in 2021 that FEMA announced that it would no longer require people living on inherited land to prove they own their

home in order to be eligible for disaster relief (Dreier, 2021). Therefore, Jim Crow was a social arrangement that attended to matters great (e.g., housing, schooling) and small (e.g., swimming). It was ensconced in law and backed-up by legal and extralegal violence. The Jim Crow era was finally ended through civil rights struggle, but many of its damaging consequences remain.

UNEQUAL EDUCATIONAL OPPORTUNITIES

Jim Crow laws also created segregated education and educational opportunities on the basis of race. The Supreme Court may have decided that “separate but equal” was the law of the land in its *Plessy v. Ferguson* decision, but “equal” was not put into practice when it came to education (Anderson, 1988; Walker and Archung, 2003). School segregation persisted into the 1960s, not only for Black children, but also Latine students and Indigenous students (Darling-Hammond, 1998; Orfield et al., 1997), and it was not limited to primary and secondary education. It also had profound effects on postsecondary education.

Though there were exceptions, Black students did not begin to enter predominantly White colleges and universities until the 1960s. In fact, before the end of the Civil War, only 40 Black students had graduated from colleges and universities, all in Northern states (Titcomb, 2022). Even the first university dedicated to the education of Black Americans, Cheyney University in Pennsylvania, founded in 1837, focused its curriculum on trades and agriculture (Allen, 1988; Cheyney University, n.d.).

In the decades after the Civil War, Black students were prohibited from attending Southern colleges because of Jim Crow laws and legal segregation, and they had limited access to Northern schools because of quota systems. In response, religious denominations began establishing institutions of higher education specifically to educate the children of formerly enslaved people and to train them to teach other Black Americans (Haynes, 2006). By 1880, there were over 40 Black colleges and universities in the United States, and from the late 19th century to the late 20th century, Historically Black Colleges and Universities (HBCUs) provided undergraduate training for many Black Americans across various sectors (Jackson and Nunn, 2003) including U.S. armed forces, and 80 percent of all Black federal judges (Thurgood Marshall College Fund, n.d.). (See section below for a greater discussion on MSIs.)

In 1890, Congress passed the Second Morrill Act that required states to establish land-grant institutions for Black students, or the states would have to demonstrate that admission to the 1862 land grant institution was not restricted on the basis of racial identity. This has resulted in the creation of 19 historically Black land-grant institutions, also known as

the 1890 land-grant universities (Lawrence, 2022).³ While the Second Morrill Act was intended to create an educational system that provided opportunity for all Americans, a study by the Association of Public and Land-Grant Universities found that these 1890 land-grant institutions were being short-changed by their home states, which were supposed to match federal funding to all land-grant universities established by the First and Second Morrill Acts on a one-to-one basis. Even today, while all states are meeting the one-to-one matching requirement for their original Morrill Act institutions, 61 percent of 1890 land-grant institutions did not receive 100 percent of the one-to-one matching funds from their respective states between 2010–2012 for extension or research funding, depriving those institutions of \$57 million (Lee and Keys, 2013).

In the decades before the civil rights era, constrained educational opportunities were not limited solely by Jim Crow laws to Southern schools and were not imposed only on Black students. Northern colleges and universities, for example, had quotas limiting the number of Black individuals, as well as non-Protestant Christians and Jews, among other groups. It was not until the 1970s that institutions of higher education throughout the United States abolished segregation for non-White students and quotas for non-Christian students (Byrd-Chichester, 2000; Halperin, 2019). However, even today, many institutions of higher education continue to reflect anti-Asian biases, in part by excluding Asian and Asian American students from programs designed to help students from historically racialized and marginalized populations on the premise that they are “model minorities.” This view overlooks the fact that Asian and Asian American people are a highly diverse group in terms of ethnic background, socioeconomic status, and cultural practices (Gutierrez et al., 2021). While it is true that Asian American and Pacific Islander students as a group account for approximately 18 percent of the students admitted at 91 of the nation’s most selective colleges and universities (Carnevale and Quinn, 2021)—triple their representation in the college-going population—Asian Americans from specific nations or cultures are underrepresented among those attending colleges (e.g., Her, 2019).

Racially-based educational policies were not restricted to colleges and universities or to Black students. Indigenous children were forced to attend segregated boarding schools, where they were punished for speaking their tribal languages in an effort to force assimilation into White culture (Loring, 2009). The well-known phrase “kill the Indian in him and save the man” captured the assimilation era sentiment. In the 1800s,

³Title III of the Higher Education Act of 1965 defined an HBCU as a school of higher learning that was accredited and established before 1964, and whose principal mission was the education of African Americans.

California schools routinely denied access to Chinese American students based on their ancestry, and even after the California Supreme Court ruled this practice unlawful, the California state legislature passed a law allowing school districts to establish segregated schools under the separate but equal doctrine (Equal Justice Initiative, n.d; Urban and Jorae, 2011; Wollenberg, 1976). During the 1920s, the segregation of Mexican American children became widespread in California and Texas. Latine students routinely attended segregated schools until 1931, when a judge in San Diego prohibited a school board from turning away Mexican American students—a ruling based on the judge’s opinion that Mexican American children were White (Carter, 1970; Noltemeyer et al., 2012). With the landmark 1954 case *Brown v. Board of Education*, the U.S. Supreme Court finally outlawed all state laws establishing racial segregation in schools, but the California Supreme Court’s *Roberto Alvarez v. The Lemon Grove School Board* ruling in 1931 was the first successful local school desegregation court decision (Alvarez, 1986; Hudson and Holmes, 1994).

Even legislation that its sponsors intended to be race-neutral, such as the 1944 Servicemen’s Readjustment Act, otherwise known as the GI Bill, was turned into a mechanism for discriminating against Black Americans. Of the approximately 16 million World War II veterans eligible for the GI Bill, approximately 1.2 million were Black veterans. While President Franklin Roosevelt intentionally created the GI Bill to avoid discrimination on the basis of race, Veterans Administration counselors, particularly those in Southern states, pushed Black veterans into vocational and trade schools rather than academic institutions (Turner and Bound, 2002). Researchers estimate that the segregated system of higher education turned away 55 percent of Black veterans seeking the educational benefits of the GI Bill (Perea, 2015).

The impact of these racist tactics was compounded by the fact that serious underfunding of HBCUs limited opportunities for the large number of Black veterans who did want to pursue higher education (Turner and Bound, 2002). With limited government investment in their infrastructure, HBCUs could not accommodate the influx of so many students, compared to well-funded White institutions. A survey of historically Black colleges in 1945 found that 45 percent of institutions enrolled fewer than 250 students, and 92 percent of the institutions had enrollment of less than 1,000 students (Jenkins, 1946). Moreover, of the approximately 100 public and private institutions of higher education listed as “Colleges for Negroes” by the Office of Education, 28 were classified as sub-baccalaureate teachers’ colleges or junior colleges (Office of Education and U.S. Department of Health, Education, and Welfare, 1960), and none of the HBCUs offered accredited engineering or doctoral programs (Geiger, 2021; Turner and Bound, 2002).

The lack of formal secondary education for many Black soldiers prior to their wartime service also impeded their access to higher education

(Turner and Bound, 2002). The end result of lack of preparation and overt discrimination was that 28 percent of White veterans went to college on the GI Bill while only 12 percent of Black veterans did (Turner and Bound, 2002). In addition, 86 percent of the skilled, professional, and semiskilled jobs went to White veterans, while 92 percent of the nonskilled and service positions went to Black veterans with the same training (Humes, 2006).

Progress has been uneven. A 2018 study found that the college enrollment gap between Black and Hispanic students and White students narrowed between 1986 and 2014, in large part a result of increasing high school graduation rates of Black and Hispanic students (Baker et al., 2018). Black and Hispanic students, however, are more likely than White students to enroll at colleges and universities that are less selective, categorized by admissions competitiveness as defined by the *Barron's Profile of American Colleges*, and these institutions may have less money to spend on the enrichment programs that are a crucial part of STEMM education in particular (Barron's College Division Staff, 2019). Research has shown that students who attend a more selective college receive larger tuition subsidies, more generous college resources, and more attention from faculty (Hoxby, 2009; Hoxby and Avery, 2012). In addition, graduating from a selective college leads to higher average earnings, which is particularly true for minoritized students (Dale and Krueger, 2011).

Finally, while getting into college is an important milestone, graduating with a degree is the real goal. Studies have shown that Black students and Latine students are less likely to graduate from college than White students (Shapiro et al., 2017). One analysis found that Black students graduate from four-year institutions at a 40 percent completion rate, as compared to White students (65%; NCES, 2019).

HOUSING: THE LEGACY OF REDLINING

Where people live can have an effect on where they go to school, the colleges they attend, and ultimately, the careers they pursue (Emery, 2016). Indeed, housing segregation determines access to quality health, education, housing, food, and other factors which subsequently contribute to successful outcomes (Quick and Kalhenberg, 2019; Rothstein, 2018). The racist practice of redlining, a legacy of policies enacted during the Great Depression and in the aftermath of World War II, codified racial and ethnic segregation in ways that still affect racially and ethnically minoritized communities today. The term *redlining* refers to the red marks that were made on maps to indicate neighborhoods that were comprised of predominately or a significant proportion of African American individuals. This demarcation resulted in discriminatory practices in which housing resources would be restricted to African American neighborhoods (Swope et al., 2022).

In the winter of 1916, a small group of Black families left the repressive conditions in Selma, Alabama, for what they hoped would be a better life in Chicago. Historians consider this the start of what is known as the Great Migration—one of the largest movements of people in U.S. history (Tolnay, 2003). Over the next six decades, some six million Black Americans left the repressive conditions in the South for employment opportunities in northern and western cities. By the time the Great Migration ended in the 1970s, millions of Black Americans lived outside of the South (Tolnay, 2003; Wilkerson, 2020), and of those living outside of the South, 90 percent lived in urban areas (Farley and Allen, 1987).

The influx of Black laborers and sharecroppers into urban centers led to a variety of formal and informal rules and regulations that confined Black residents to specific neighborhoods. Though the Supreme Court struck down these ordinances in 1917, Black migrants continued to live primarily in these crowded, disadvantaged neighborhoods. Racial segregation was exacerbated by policies enacted during the Great Depression to help homeowners who were in danger of defaulting on their mortgages (Banaji et al., 2021) or those looking to purchase a home (Jackson, 2012). Under the terms of the Home Owners Loan Corporation (HOLC), lenders had to consider the riskiness of the neighborhoods in which properties were located based on color-coded “Residential Security Maps” that HOLC officials and local Realtors created. With few exceptions, Black neighborhoods, along with adjacent neighborhoods that were candidates for settlement by Black families, were colored red, designating that they were excessively risky and therefore ineligible for HOLC-backed loans (Rothstein, 2018).

Black families were disadvantaged further by the provisions of the newly created Federal Housing Authority (FHA) loan program, which relied on the color-coded Residential Security Maps, encouraged the use of racial covenants to protect FHA-insured homes, and included other provisions, such as guides for appraisers and loan officers, that favored home buyers purchasing single-family homes in nascent suburban areas and disincentivized investment in Black neighborhoods. The Veterans Administration adopted the same racialized practices when the GI Bill created a similar loan program (Katznelson, 2006). These two programs formally institutionalized redlining in real estate and banking, which had the effect of relegating Black Americans, as well as other systematically minoritized racial and ethnic people, to disadvantaged neighborhoods, which had the further effect of preventing them from owning homes and building generational wealth (Rothstein, 2018). As a result, by 1940, nearly 90 percent of Black Americans lived in redlined neighborhoods (Krimmel, 2018), and of the \$120 billion in FHA loans issued between 1934 and 1962, only two percent went to non-White families (Solomon et al., 2019). By 1970,

61 percent of Black Americans living in U.S. metropolitan areas resided in hyper-segregated neighborhoods (Massey and Tannen, 2018).

REDLINING AND UNEQUAL EDUCATIONAL OPPORTUNITIES

The negative effects of redlining went beyond denying minoritized families the opportunity to live in neighborhoods that were not overcrowded and beset with poverty. One of most significant adverse consequence of redlining was on the education that students living in redlined neighborhoods received and continue to receive today. Though *Brown v. Board of Education* outlawed racial segregation of public schools, it did not redress the underinvestment that had the de facto effect of creating a separate but unequal educational system, given that schools in neighborhoods with a predominantly non-White population still had fewer resources, fewer counselors, few experienced educators, and fewer educational opportunities than those found in predominantly White neighborhoods.

The main reason for this disparity was a lower level of funding for schools in non-White neighborhoods resulting from the fact that public school funding relied heavily—and still relies heavily—on local property taxes that are based largely on property values. As a result of these disparities, only 7.7 percent of Black students graduated from high school in 1940 compared to 26.1 percent of White students. Twenty years later, the percentage of Black students graduating from high school had reached 21.7 percent, while the percentage of White students graduating from high school has increased to 43.2 percent (NCES, 2020).

With parents who themselves had restricted educational opportunities and who might have had literacy challenges, disadvantaged students were likely read to less frequently and be exposed to less complex language at home (Ayoub et al., 2009; Brooks-Gunn, 2005; Hart and Risley, 2005). The effects of the laws creating and perpetuating residential segregation by race were to facilitate the active disinvestment of minoritized communities.

Today, more than 50 years after passage of the Fair Housing Act, neighborhood segregation persists for Black people, Indigenous people, Latine people, and Asian American people and imposes unfair burdens on people from those communities even when they have the same income or education levels as people from predominantly White neighborhoods (Frey, 2021).

Even now, housing and schooling continue to be linked intrinsically in the United States, both in terms of educational opportunity and property values. A 2021 study from the Annenberg Institute at Brown University found that districts and schools currently located in formerly redlined neighborhoods, regardless of where they are located in the nation, receive almost \$2,500 less per pupil in combined federal, state, and local funding, and report lower average math and reading test scores compared

with districts and schools located in neighborhoods that were not redlined (Lukes and Cleveland, 2021). Further, there is some evidence demonstrating that there are fewer courses related to STEM offered in schools with higher minoritized student enrollment (Office for Civil Rights, 2018). In addition, studies have found that schools with high percentages of Black students and Latine students are more likely than their peers to have teachers with one year or less experience, uncertified teachers, or higher annual teacher turnover, with the disparities largest for schools with high percentages of Black students (Mehrotra et al., 2021; Williams et al., 2021). Several studies have shown that high teacher turnover harms student achievement in both English language arts and math and makes it hard to establish coherent instruction and implement new initiatives (Balu et al., 2009; Ronfeldt et al., 2013).

The authors of the Annenberg report noted that while they documented positive trends for finance and diversity outcomes for both redlined and non-redlined neighborhoods, there were persistent and widening gaps between schools in historically redlined neighborhoods and those in non-redlined neighborhoods. At the same time, they found no statistically significant differences for average student learning and average student test score changes between redlined and non-redlined neighborhoods. “These results,” the authors concluded, “tell us that while learning rates and changes in educational opportunity are on average the same [between redlined and non-redlined neighborhoods], educational opportunity is not” (Lukes and Cleveland, 2021).

The inequities in educational opportunities resulting from redlining do not end when students graduate from high school. One housing-related reason for those inequities is the limited ability of those who live in historically redlined areas to accrue generational wealth because of lower property values and lower levels of homeownership. This racial wealth gap is reflected in the substantial disparity in net worth between White households and those of systematically minoritized racial and ethnic groups (Bhutta et al., 2020), which affects the ability of families to fund their students’ postsecondary education. According to a 2019 study, Black families rely more heavily on student debt, and on riskier forms of student debt, than do White families to gain postsecondary education (Kahn et al., 2019; Lucas, 2013). As the authors of this study conclude, “With lower family wealth and racial discrimination in the job market, Black students are far more likely than White students to experience negative financial events after graduating—including loan default, higher interest rate payments, and higher graduate school debt balances.”

According to an analysis by the Education Data Initiative, Black college graduates owe an average of \$25,000 more in student loan debt than White college graduates (Hanson, 2022). Moreover, 48 percent of Black

students owe an average of 12.5 percent more than they borrowed four years after graduation, while White students owe 12 percent less than they borrowed (Hanson, 2022). In addition, 29 percent of Black student borrowers make monthly payments of \$350 or more, and over 50 percent of Black borrowers report that their net worth is less than they owe in student loan debt. The same analysis found that American Indian and Alaska Native student borrowers have the highest monthly payments after graduation (Hanson, 2022).

A 2013 analysis conducted by the Center for STEM Education and Innovation found that White, Asian, and multi-racial graduate students had less debt than Hispanic graduate students, who in turn had less debt than Black students (Zeiser et al., 2013). In fact, 73 percent of White, Asian, and multi-racial STEM Ph.D. recipients reported having no graduate school debt at all, compared to 51 percent of Black and Latine students. Among STEM Ph.D. recipients, Black graduates were more than twice as likely as White, Asian, and multi-racial graduates to have debt exceeding \$30,000 (Zeiser et al., 2013).

RACISM AND EMPLOYMENT

As a 2019 report from the Center for American Progress noted, “Occupational segregation and the persistent devaluation of workers of color are a direct result of intentional government policy” (Solomon et al., 2019). The policies enacted as part of the New Deal, for example, reserved most of these benefits for White workers while restricting and excluding minoritized people by exempting many domestic, agricultural, and service occupations from the Fair Labor Standards Act of 1938, actions that helped institutionalize and validate racial disparities in economic wellbeing (The Fair Labor Standards Act of 1938, 2011; Linder, 1986). The Taft-Hartley Act of 1947 gave states permission to enact so-called right-to-work laws that have the effect of hampering the ability of unions to help employees bargain with their employers (National Labor Relations Board, n.d.). Today, eight of the 10 states with the highest percentage of Black residents have right-to-work laws, and not coincidentally, workers in right-to-work states earn 3.2 percent less on average and are less likely to have employer-sponsored health insurance and pension coverage than workers in non-right-to-work states (Gould and Kimball, 2015; Gould and Shierholz, 2011).

Even now, minoritized people remain overrepresented in the lowest-paid agricultural, domestic, and service vocations. Black or African American individuals, Asian individuals, and Latine individuals account for approximately 36 percent of the overall U.S. workforce. When examining representation by occupation, these groups of individuals are highly represented

within these lower-paid positions. For instance, collectively Latine individuals represent approximately 48 percent of maids and housekeeping cleaners; 20 percent of bellhops, concierges, and baggage porters; and about 46 percent of miscellaneous agricultural workers (USBLS, 2022a). Though Congress has modified the Fair Labor Standards Act to include some of these occupations, agricultural and domestic workers, many of whom are Latine or Asian American, remain some of the least protected employees in the nation (Lin, 2013). Live-in domestic service workers, babysitters, and companions for older persons—all occupations in which minoritized people are disproportionately represented—also remain excluded from many Fair Labor Standards Act protections (U.S. Department of Labor, 2022). Given that more Black and Latine women work in service industries than White women (Tucker and Lowell, 2016), this might be one reason why Black and Latine women earn less than both White women and Black men and Latine men (BLS, 2022b).

Employment and Systemic Racism in the Criminal Legal System

Approximately 77 million Americans have a criminal record, making it difficult, or even impossible, for an individual to work in a given field, particularly the one in four jobs that require a government-issued occupational license (CSG Justice Center, 2022; National Inventory of Collateral Consequences of Conviction, 2022). Research by the Department of Justice shows that minoritized individuals may face higher rates of incarceration (Carson, 2021). For instance, statistics from the U.S. Department of Justice found that as compared to White men, Black men were 5.7 times as likely to be imprisoned in 2020. When examining men within the ages of 18–19, Black men were 12.5 times as likely to be imprisoned, as compared to White men (Carson, 2021). While more than 25 percent of people arrested for drug law violations—the most frequent reason for incarceration—were Black people, drug use rates do not differ substantially by race and ethnicity (Edwards et al., 2020).

Criminal histories may disadvantage individuals when seeking future employment. Research has shown that job candidates with a criminal record are at best half as likely to get a call back than applicants who do not have one, with even fairly minor felony records having a largely negative effect on employer callbacks (Agan and Starr, 2017). One study of the intersectionality between race and gender, former incarceration, and unemployment found that the unemployment rates for formerly incarcerated Black men and Black women were 35 percent and 43 percent, respectively, compared to 18 percent and 23 percent for White men and White women, respectively (U.S. Council of Economic Advisors, 2008).

Employment and Health Disparities

The relationship between health and work is bidirectional. Health is a critical labor market determinant, given that healthy people are more likely to be employed, while people experiencing health issues are more likely to see their employment opportunities limited (Dooley et al., 1996; Olesen et al., 2013; van Rijn et al., 2014). Work, however, can also affect health. Unemployment or a bad job can harm one's health (Hergenrather et al., 2015), while moving from unemployment to a good job may improve health (Antonisse and Garfield, 2018).

The Centers for Disease Control and Prevention have determined that an abundance of literature demonstrates a clear pattern of racial disparities in health outcomes. Namely, individuals from racial and ethnic minoritized groups, as compared to White individuals, are significantly more likely to face higher rates of illness, and death related to a number of chronic health conditions, such as obesity, asthma, and hypertension (CDC, n.d.a). Research has shown that the social determinants of health play a major role in explaining health disparities. Social determinants of health are the conditions in which people are born, grow, live, work, and age, and they include a range of factors. These may include socio-economic status, education, neighborhood and physical environment, employment, and social support networks, as well as access to health care (CDC, n.d.b).

As with the inequities in education discussed above, this too can be seen as a consequence of historic redlining, with those living in majority White neighborhoods experiencing fewer of these factors. Historically redlined neighborhoods, for example, generally have poorer air quality than White neighborhoods (Woo et al., 2019). A study by the Kaiser Family Foundation found that minoritized people generally fare worse compared to White people across most examined measures of social determinants of health (Jack et al., 2012). In fact, residential racial segregation is a potent predictor of Black people's experience of health disparities, including increased rates of preterm and low-birth-rate births, asthma, cancer, tuberculosis, and material depression and other mental health issues (Bailey et al., 2017; Williams and Collins, 2001; Williams et al., 2019).

CONCLUSION 2-1: The history of systemic racism in the United States, including both written laws and policies and a culture of practices and beliefs, has harmed Black people, Indigenous people, Latine, Asian American, and other people from minoritized racial and ethnic groups that continue to this day. This history provides critical context for understanding the unequal representation of minoritized populations in science, technology, engineering, mathematics, and medicine higher education and workplaces.

MINORITY SERVING INSTITUTIONS

As mentioned above, in response to laws and practices that limited the opportunities for Black students to attend college, Black ministers and White philanthropists established institutions that came to be known as HBCUs. Over the years, institutions of higher education designed to honor and reflect Native Americans and Latine culture have also been established. The sections below find that even in the face of historical and current underfunding, these MSIs today are important venues for students from marginalized ethnic and racial communities to not only pursue a postsecondary education in a culturally supportive environment but go on to graduate school in STEMM fields.

The committee notes that a 2019 report from the National Academies of Sciences, Engineering, and Medicine, *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce*, presents a far more detailed examination of MSIs and the important role they play in bolstering the STEM workforce, as MSIs were central to the report's statement of task (the National Academies, 2019). The 2019 report presents findings, conclusions, and recommendations that "aim to support the expansion of effective practices, and the study of promising ones, such that both can be scaled and thus reach more institutions and their students." It also concludes that there is "very limited, rigorous research available on MSIs generally, but especially knowledge that sheds light on how these institutions organize, deliver, and support learning opportunities for students of color in STEM" (see Appendix A for further discussion of *Minority Serving Institutions* and other earlier related reports). Given some areas of content overlap in regard to MSIs, the committee of the current report decided to underscore the existence of the 2019 recommendations, as these are expansive and valuable extant resources. When forming recommendations, the committee was mindful to not recreate the same set of recommendations, but rather develop novel recommendations pertaining to MSIs.

Historically Black Colleges and Universities

The statistics reviewed in the upcoming section draw heavily from data within the National Center for Education Statistics (NCES). These data show that in the year 2020, there were a total of 101 HBCUs, located in 19 states, the District of Columbia, and the U.S. Virgin Islands, representing 2.5 percent of all public, private nonprofit, and for-profit colleges (NCES, n.d.a,b) Most of these institutions (59%) only offer undergraduate degrees, while 41 percent offer graduate degrees, including 28 percent that award doctoral degrees (NCES, 2022). Between the years 1976 and 2010, the number of students attending HBCUs increased 47 percent from 223,000

to 327,000 students, and decreased by 15 percent to 279,000 between 2010 and 2020 (Thurgood Marshall College Fund, n.d.). Between the years 1976 and 2010, the number of students in all degree-granting institutions increased 91 percent (from 11 to 21 million), and then between the years 2010 to 2020, it decreased 10 percent (NCES, 2021). Scholars note that HBCUs represent a small percentage (approximately 3%) of all four-year colleges. Even though they represent a small numeric minority, data have demonstrated that they are outperforming in regard to conferring bachelor's degrees (approximately 18%). Further, among African American individuals that earn STEM degrees, 25 percent received their degrees from HBCUs (Williams et al., 2019b).

As noted above, HBCUs have been chronically underfunded by both federal and state governments, despite the pivotal role they play in advancing representation of historically racialized and minoritized people in STEM. A 2019 report from the American Council on Education (ACE) found the following. Private HBCUs usually depend more on tuition than their non-HBCU counterparts. Compared to their non-HBCU counterparts, public HBCUs rely on sources of local, state, and federal funding more heavily. In addition, the ACE report notes specifically that between the years 2003–2015, both public and private HBCUs experienced the steepest declines in federal funding per full-time student. Private HBCUs in particular experienced a 42 percent reduction. At the same time, grants, contracts, and private gifts represent a smaller percentage of overall revenue for private HBCUs relative to non-HBCUs (American Council on Education, 2019).

There are also disparities between historically White land-grant institutions (HWLGUs) and historically Black land-grant institutions (HBLGUs) in endowments and campus resources (Allen and Esters, 2018). As of 2013, per full time student equivalent, public HBCUs had approximately 20 percent of the endowment funds as other public institutions (Lee and Keys, 2013). These disparities are a legacy of the two Morrill Acts of 1862 and 1890 that created HWLGUs and HBLGUs; such disparities dispel the notion that the 1890 Morrill Act created equal opportunities in higher education for Black Americans (Allen and Esters, 2018; Lee and Keys, 2013).

The authors of the 2019 ACE report noted that the huge gap in endowments jeopardizes an HBCU's ability to buffer ongoing decreases in state and federal funding and to continue offering high-quality education for a predominantly non-White student body. They also stated that “despite efforts to counter a historical legacy of inequitable funding and notable investments by the federal government and many state governments, resource inequities continue to plague HBCUs” (American Council on Education, 2019). In fact, federal funding per full-time student at non-HBCUs is greater than at HBCUs, particularly for private HBCUs compared to private

non-HBCUs; in this area, the gap has grown from less than \$400 per full-time student in 2003 to \$1,600 in 2015. Given the general divestment in higher education by the states over the past four decades, HBCUs are particularly vulnerable to underfunding. The authors of this study concluded that “because HBCUs are mission-driven to broaden college opportunities for Black students, many of whom have limited financial resources, these colleges and universities cannot increase costs to offset public divestments in higher education. Furthermore, they cannot grow their endowments overnight. As a result, federal, state, and local funding continue to play a critical role for HBCUs in their mission to support students that the country needs to earn college degrees” (American Council on Education, 2019).

In spite of these challenges, HBCUs continue to prepare high percentages of their graduates who go on to attain advanced degrees in STEMM. Approximately 20 percent of Black college graduates with a STEM degree earned it at an HBCU, as did one-third of the Black individuals with a STEM Ph.D. (Gewin and Payne, 2021). Given the projected shortfall of STEMM jobs that will need people to fill them, and increased interests in promoting diversity in STEMM, investing in HBCUs would be an important means of closing that gap while diversifying the STEMM workforce (Duker, 2021; Shuler et al., 2022).

Tribal Colleges and Universities (TCUs)

Currently, there are 32 Tribal Colleges and Universities (TCUs), each established and chartered by its own tribal government or the federal government, and they aim to “maintain, preserve, and restore Native languages and cultural traditions; offer high-quality college education; provide career and technical education, job training, and other career building programs; and often serve as anchors in some of the country’s poorest and most remote areas” (U.S. Department of Education, n.d.a). As of 2010, 8.7 percent of American Indian and Alaska Native students were enrolled at a TCU. Currently, TCUs serve approximately 30,000 students, including full- and part-time students. In addition, 23 TCUs offer several types of degrees, including associate’s, bachelor’s, and graduate degrees (U.S. Department of Education, n.d.a). Nelson and Frye noted that “despite the need and growing population, American Indians and Alaska Natives do not access higher education at the same rate as their non-Native peers” (Nelson and Frye, 2016).

The 2016 ACE report found that federal funding accounts for 71–74 percent of TCU revenues, compared to less than 25 percent for public non-TCUs. In contrast, state and local funding of public non-TCUs is higher than for TCUs, with state and local funding accounting for approximately 40 percent of public non-TCU revenues compared to approximately seven to 10 percent of TCU revenues. Similarly, tuition and fees account for between 27

and 38 percent of public non-TCU revenues compared to approximately nine percent for TCUs. The authors note that “the majority of states do not provide any financial support to TCUs, even as these institutions enroll significant numbers of non-Native state residents.”

The largest source of STEM-related funding for TCUs comes from the National Science Foundation (NSF), and specifically NSF’s Tribal Colleges and Universities Program (TCUP). TCUP was created after President Bill Clinton signed an executive order in 1996 directing all federal agencies to increase support to the tribal colleges. The NSF states TCUP “supports tribal colleges and universities, Alaska Native-serving institutions, and Native Hawaiian-serving institutions to promote STEM research and education to increase the number of Native Americans in STEM careers” (NSF, n.d.a). According to the Native Science Report, TCUP has “fundamentally transformed STEM education within [TCUs]” and enabled many TCUs to establish STEM programs and facilities comparable to public two- and four-year colleges (Native Science Report, 2022).

Hispanic Serving Institutions (HSIs)

The federal definition of a Hispanic Serving Institution (HSI) is a nonprofit, degree-granting institution with a full-time equivalent undergraduate Hispanic student enrollment of at least 25 percent (U.S. Department of Education, n.d.b). As of 2021, there were 559 HSIs in 29 states, the District of Columbia, and Puerto Rico achieving this designation (HACU, 2022b). In addition, there were 393 emerging HSIs. Emerging HSIs are defined as “non-profit, degree-granting institutions with a full-time equivalent undergraduate Hispanic student enrollment of at least 15 percent, but less than 25%” (HACU, 2022b). In 2020, over two million Hispanic students were enrolled at HSIs out of a total of 4.2 million students enrolled at HSIs (U.S. Department of Education, 2022). According to the Hispanic Association of Colleges and Universities, “HSIs comprise 17 percent of colleges and universities nationally yet educate more than two-thirds of the estimated 3.8 million Hispanic college students and 33 percent of all Pell recipients in the country. HSIs also enroll 41.3 percent of Asian, 35.6 percent of Native Hawaiian and Pacific Islander, 26.2 percent of multi-racial, 24.2 percent of Black, and 15 percent of White students” (HACU, 2022a).

Two federal programs provide the bulk of support for STEM programs at HSIs. The Department of Education’s Hispanic-Serving Institutions STEM and Articulation Program (HSI STEM) aims to increase the number of Hispanic students who graduate with STEM degrees and to develop model articulation agreements that would enable students to more easily transfer from a two-year college to a four-year college or university (U.S. Department of Education, n.d.c). This program provided an estimated

\$94.1 million to support STEM programs at HSIs in fiscal year 2021 (U.S. Department of Education, 2021). The NSF's Improving Undergraduate STEM Education: Hispanic-Serving Institutions Program awarded 48 grants to HSIs in fiscal year 2022 totaling approximately \$27 million (NSF, n.d.b). The goals of this program are to "enhance the quality of undergraduate science, technology, engineering, and mathematics (STEM) education and to increase the recruitment, retention and graduation rates of students pursuing an associate's or baccalaureate degrees in STEM" (NSF, n.d.b).

Asian American and Native American Pacific Islander-Serving Institutions

Asian American and Native American Pacific Islander-Serving Institutions (AANAPISI) are defined under the Higher Education Opportunity Act of 2008 as colleges or universities with an undergraduate enrollment that is at least 10 percent Asian American and Native American Pacific Islander and with at least 50 percent of the institution's degree-seeking students receiving federal financial aid (U.S. Department of Education, 2020a). The number of institutions eligible to receive AANAPISI grants has increased significantly between 2018–2022 from 110 to 199. Behind HSIs, they are the second largest number of MSIs in the United States (Herder, 2022). The committee identified that funding opportunities for AANAPISI programs exist to help improve and expand institutions of higher education's ability to serve students (U.S. Department of Education, 2020b).

CONCLUSION 2-2: The policies, programs, and practices of historically Black colleges and universities and TCUs are examples of providing intentional and culturally responsive student and faculty support. Predominantly White institutions of higher education and other science, technology, engineering, mathematics, and medicine organizations can look to these institutions as guides and adopt these systems to increase support for people from minoritized racial and ethnic groups.

RECOMMENDATION 2-1: Federal funding agencies, private philanthropies, and other grantmaking organizations should provide increased opportunities for grants, awards, and other forms of support to increase understanding of how the policies, programs, and practices of historically Black colleges and universities (HBCUs) and Tribal colleges and universities (TCUs) support students and faculty. Notably, one issue for further investigation is understanding the core principles of historically-based minority serving institution (MSI)-based programs and how to translate them to predominantly White institutions of higher education and other science, technology, engineering, mathematics, and medicine organizations. In addition, predominately White institutions should seek sustainable partnerships with all MSIs (HBCUs, TCUs, Hispanic serving institutions, and Asian American Native American Pacific Islander Serving Institutions).

STEMM: A REFLECTION AND REPRODUCTION OF BROADER BIASED STRUCTURES

The current chapter has reviewed the evidence demonstrating that structural, institutional, and systemic racism exists and has existed across multiple sectors of society, including education opportunities and housing, and that it continually reinforces a false hierarchy on the basis of race and ethnicity. Minoritized people face numerous systematic disadvantages across these sectors, with these disadvantages each acting as a barrier to entry and accessibility into the STEMM educational and workforce settings. STEMM organizations, and the educational and professional environments they provide, cannot be divorced from the larger history and contemporary sociopolitical contexts of the country.

The impacts of these disadvantages and barriers are wide-reaching, and the remainder of the report will articulate evidence demonstrating that these broader biased structures occurring in U.S. society can inform racial bias occurring within STEMM contexts. For instance, as a result of the educational disparities discussed above, people from marginalized racial and ethnic groups have had limited access to STEMM education, training, and career opportunities (see Chapter 3 for demographic disparities). With fewer Black people, Indigenous people, and other systematically minoritized racial and ethnic people able to enter STEMM in years past, there are fewer role models and smaller communities of support for entrants (see Chapters 4 and 5 for more about the experiences of minoritized people). Further, as the remainder of the report will demonstrate, racism is reproduced within STEMM settings. In fact, while traditionally marketed as a competitive and meritocratic field, research has shown that there is more bias in STEMM professions than their non-STEM counterparts (Borum and Walker, 2012; Leath and Chavous, 2018).

In general, while there are no legal or policy barriers explicitly preventing people from marginalized racial and ethnic groups from pursuing degrees and careers in STEMM today, the committee notes that there are parallels in STEMM to the ways that Black people, Indigenous people, and other systematically minoritized racial and ethnic people have faced discrimination in a broader national setting. For instance, gatekeepers of STEMM, who are often non-Hispanic White males, define the skills, identities, and values necessary for minoritized people to persist in STEMM (see Chapter 6 for further discussion of gatekeepers). They often exhibit bias on the basis of race and ethnicity, and cannot monitor their own bias and so, unwittingly perpetuate it. Individual and interpersonal racism as experienced by minoritized people yield adverse health outcomes, and racism informs working conditions in many STEMM contexts (see Chapter 7 on STEMM teams), all of which inform STEMM career outcomes. Across many STEMM disciplines, there is often a notion of the “survival of

the fittest” culture; this culture implies that student’s success arises exclusively from an individual’s intelligence, and also takes some of the emphasis off the role of structural racism and the importance of student’s multiple identities (McGee, 2020). White-centered culture in STEMM prizes meritocracy and establishes the criteria that perpetuate success based on similarity or likeness to the ingroup (see Chapter 8).

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Population Data and Demographics in the United States

The racial and ethnic composition of the U.S. population is changing rapidly. Today, minoritized individuals account for 50 percent of the population of those 18 years and younger, and if current trends continue, minoritized individuals will account for a majority of the U.S. population between 2042 and 2045 (Craig and Richeson, 2014; Frey, 2021). These demographic trends represent both an opportunity and a critical challenge to U.S. science, technology, engineering, mathematics, and medicine (STEMM): the opportunity to draw talent from groups that are currently minoritized in STEMM and the challenge for STEMM educators to attract and retain minoritized students and STEMM employers to attract and retain STEMM graduates in sufficient numbers to reflect the diversity in the population. Meeting this charge is critical to realize the full potential of talent in the United States as well as ensure equal education and professional opportunities for all. Although the representation of minoritized individuals in STEM undergraduate education and STEMM graduate education is increasing, the collective attainment of science and engineering degrees for Black, Indigenous, and Latine Americans lags behind that of the U.S. population as a whole, and these historically minoritized racial and ethnic groups remain minoritized in U.S. STEM and STEMM (Fry et al., 2021).¹

¹This chapter will use both STEM (to refer to science, technology, engineering, and mathematics) and STEMM (to refer to science, technology, engineering, mathematics, and medicine). In many references to undergraduate education, STEM will be used rather than STEMM, to indicate the lack of professional medical degrees in the data sets most often provided by the National Center for Science and Engineering Statistics. Many references used in this chapter refer to STEM (also referenced as S&E) or medicine, and the separation of STEM vs. STEMM should be seen as intentional to reflect the data.

Building on the previous chapter's examination of how racism works at the systemic level to create obstacles for individuals from historically minoritized racial and ethnic groups to join the STEMM workforce, the current chapter focuses on the end result of those obstacles—the national-level demographic and population data demonstrating the degree to which individuals from systematically minoritized racial and ethnic groups are minoritized in STEMM disciplines in the United States. This chapter focuses on two broad factors: (1) understanding racial and ethnic representation and trends over time in the United States; and (2) understanding who earns STEMM degrees and who enters the STEMM workforce. These factors go hand in hand, as demographic trends signal who is represented (or not) in STEMM broadly and within specific disciplines.

This chapter begins by demonstrating the ways in which race and ethnicity categories have changed over time in U.S. history. Such a history is meant to underscore that race and ethnicity are socially constructed categories that are dynamic and changing constantly as a result of sociopolitical forces (See Box 3-1). To this day, capturing racial and demographic data remains a complex issue. After covering the history of racial categories, the chapter addresses demographic trends that are occurring within the United States. This trend has implications for the future STEMM workforce, given that the present STEMM workforce does not currently feature representational diversity in terms of race and ethnicity.

Furthermore, the chapter examines data reflecting current trends within the STEMM educational spaces and the STEMM workforce. Though there have been increases in the numeric representation of individuals from systematically minoritized racial and ethnic groups, there are specific areas in the STEMM educational space and the STEMM workforce where significant disparities continue to exist today. This chapter also discusses other disparities, including pay inequities. The committee found that there are many important missing pieces in the data that would provide a better understanding of how certain racial and ethnic groups are minoritized in STEM and STEMM spaces. The chapter also provides conclusions that outline specific data to collect and areas to cover.

DEMOGRAPHIC DATA, RACIAL CATEGORIES, AND LIMITATIONS

One key way to understand the changing understanding of race in the United States is to review the ways that demographic information has been collected in the census. The practice of collecting demographic data through the U.S. Census Bureau goes back centuries. Understanding which groups exist and in what proportions in a population can

help governments make important policy decisions. For modern U.S. demographics, a main source of data is the decennial census conducted by the Census Bureau. In the 2020 census, the Census Bureau collected race and ethnicity data in accordance with the U.S. Office of Management and Budget (OMB) 1997 Standards for Maintaining, Collecting, and Presenting Federal Data on Race and Ethnicity (Office of Management and Budget, 1997). The OMB standards require two separate race and ethnicity questions for self-response. These standards require collecting answers to the ethnicity question before asking the race question, with the standards requiring two minimum categories for data on ethnicity—Hispanic or Latine and Not Hispanic or Latine—and five minimum categories for data on race—American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and White (U.S. Census Bureau, 2021a). According to the Census Bureau, “race and ethnicity categories generally reflect social definitions in the United States and are not an attempt to define race and ethnicity biologically,

BOX 3-1 What Is Race? What Is Ethnicity?

A variety of ways exist to describe race. Many researchers choose to recognize race as a social construction, “based on observed phenotypic manifestations of presumed, underlying genetic differences” (Brown et al., 1999). The committee, in its deliberations, also referenced the Smithsonian Institution definition of race: “a human-invented, shorthand term used to describe and categorize people into various social groups based on characteristics like skin color, physical features, and genetic heredity. Race, while not a valid biological concept, is a real social construction that gives or denies benefits and privileges” (Smithsonian, n.d.).

In contrast, ethnicity has a stronger relationship to place: “a grouping of persons according to a shared geographic, national, or cultural heritage” (Brown et al., 1999). The Smithsonian describes ethnicity as another human-invented term used to describe people from a similar national or regional background who share common cultural, historical, and social experiences. An ethnic group likely contains a subgroup of people who share distinct beliefs, values, and behaviors. Race, even though as mentioned above is not a valid biological construct, does contain reference to biological features, while ethnicity addresses social, cultural, and historical commonalities (Smithsonian, n.d.).

SOURCES: Brown et al., 1999; Smithsonian, n.d.

anthropologically, or genetically. We recognize that the race and ethnicity categories include racial, ethnic, and national origins and sociocultural groups” (U.S. Census Bureau, 2021a).

For demographic information related to STEMM, this report relies on several sources for data on race and ethnicity, including the National Center for Science and Engineering Statistics (NCSES), the National Center for Education Statistics (NCES), National Institutes of Health’s (NIH’s) Data-book (NDB), and the American Association of Medical Colleges (AAMC). NCSES, a federal statistical agency located within the National Science Foundation (NSF), is responsible for data on research and development; the science and engineering workforce; United States’ competitiveness in science, engineering, technology, and research and development; and the condition and progress of STEM education in the United States (National Center for Education Statistics, n.d.). NCES, located within the U.S. Department of Education, is “the primary federal entity for collecting and analyzing data related to education” (National Center for Education Statistics, n.d.). NDB “provides basic summary statistics on extramural grants and contract awards, grant applications, the organizations that NIH supports, the trainees and fellows supported through NIH programs, and the national biomedical workforce” (National Institutes of Health, n.d.). Finally, AAMC is a nonprofit, membership organization of over 170 academic medical institutions that makes select data on its institutions available to the public (AAMC, n.d.a).

The following NCSES definitions for race and ethnicity are according to OMB’s 1997 standards:

- *American Indian or Alaska Native*: A person having origins in any of the original peoples of North and South America (including Central America) and who maintains tribal affiliation or community attachment.
- *Asian [or Asian American]*: A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent; for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
- *Black or African American*: A person having origins in any of the Black racial groups of Africa.
- *Hispanic or Latine*: A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race.
- *Native Hawaiian or Other Pacific Islander*: A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific islands.

- *White*: A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.
- *More than one race*: Respondents who selected one or more racial designations (NCSES, 2021a,b).

These categories, while descriptive of major racial and ethnic groups and aligned generally with other data sources, have considerations attached to them. NCSES describes the challenges of reporting race and ethnicity data as follows:

The collection and reporting of race and ethnicity data pose several problems. First, both the naming of population subgroups and their definitions have changed over time. Second, many of the groups of particular interest are quite small, so it is difficult to measure them accurately without larger samples or surveys of the entire population of interest. In some instances, sample surveys may not have had sufficient sample size to permit the calculation of reliable racial or ethnic population estimates for all groups; consequently, data are not shown for some groups. The Census Bureau's Current Population Survey, for example, does not provide data on unemployment among American Indians. Third, data on race and ethnicity are often based on self-identification. Fourth, it is easy to overlook or minimize heterogeneity within racial or ethnic subgroups when only a single statistic is estimated for their entire population (NCSES, 2021b).

Pertaining to this last point about heterogeneity within racial and ethnic subgroups, one limitation of the NCSES categories is that they do not adequately capture the diversity of individuals included in a particular group. Every data set and accompanying definitions present advantages and disadvantages in terms of use, and while some methods are better than others, there is no ideal way to capture the full richness of racial and ethnic diversity to describe a population.

The Changing Nature of Racial Categories in the U.S. Census and Beyond

Since the first census in 1790, the U.S. government has included racial categories; however, the ways in which the government has measured race and ethnicity have changed from census to census as the politics and definitions of these categories have evolved (Parker et al., 2015). The history of racial and ethnic categories in the U.S. Census and the ways in which they have changed over time reflects the evolving nature of race in this country and the fact that race and ethnicity are socially constructed

categories (Figure 3-1). Along with the categories themselves, the data collection process has also changed. Prior to the 1960 Census, which introduced by-mail response, the majority of individuals self-identify race or ethnicity on their survey (U.S. Census Bureau, n.d.). Instead, federal census takers or enumerators—and not individual citizens being counted—determined a person’s race based on their direct observations.

Limitations imposed on racial identity by the basic structure of the U.S. Census Bureau go beyond self-identification. Prior to the 2000 Census, individuals could only choose one race to describe themselves (Brown, 2020). This is changing, however. In 2000, people who identify with more than one race were allowed to choose multiple races when responding to

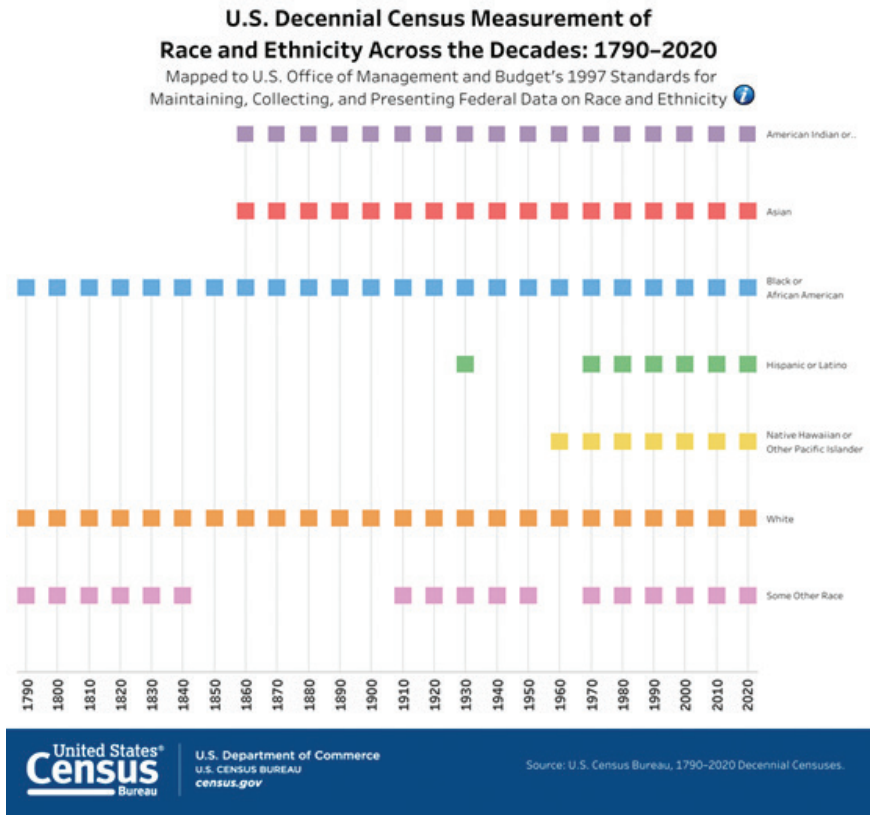


FIGURE 3-1 U.S. Census categories used throughout history.
SOURCE: U.S. Census Bureau, 2021b.

the race question (U.S. Census, 2021a,b). The 2020 Census offered a field to further describe national heritage for individuals who listed themselves as either White or Black, such as German, Lebanese, African American, or Somali (Brown, 2020). In addition, in 2020, people who identify with more than one race were allowed to choose multiple races when responding to the race question (U.S. Census Bureau, 2021a,b).

Categorizing Race and Ethnicity

The first census, in 1790, had only three racial categories: free Whites, all other free persons, and slaves. At that point, Indigenous people and Native Americans were not counted in the census. The 1860 census included American Indians living in the general population, and in 1900, for the first time, the census included American Indians on reservations and in the general population. The Census Bureau has acknowledged that American Indian and Alaska Native populations were significantly undercounted in censuses as recently as 2010 (U.S. Census Bureau, 2012, 2022a).

One challenge regarding STEM-related data is that the population of individuals identifying as American Indian or Alaska Native in STEM fields is small and often omitted from studies because the numbers are considered statistically insignificant (Shotton, 2013). As one group of scholars noted, this has led to a phenomenon referred to as the “American Indian research asterisk” that fails to include American Indian and Native Alaskan populations in research (Garland, 2007). In some of the tables in this chapter, data are shown separately for (i) American Indian or Alaska Native and (ii) Native Hawaiian or Other Pacific Islander (discussed below). In some of the graphs in this chapter, “Indigenous” is used to represent the sum contribution of these racial and ethnic groups.

Historically, Native Hawaiians and Pacific Islanders were lumped together with Asian American in an umbrella racial category (Asian Pacific Institute on Gender Based Violence, n.d.). Only in 2000 did the U.S. Census make the Native Hawaiian and Pacific Islander a racial category distinct from the Asian American category (Access, Equity and Belonging Committee, n.d.). However, even the category Native Hawaiian or Other Pacific Islander is broad and does not necessarily reflect the full diversity and cultures of these peoples. As with American Indian and Alaska Natives, Native Hawaiians and Pacific Islanders have been undercounted for decades (Georgetown Law, 2017).

Regarding Asian Americans, the census first included data in 1860 for individuals identified as Chinese, with Japanese added as a category in 1870, and Filipino, Hindu, and Korean added in 1910 (Holland and Palaniappan, 2012). Although the Census Bureau has collected demographic information

on Asian American subgroups for quite some time, the census reports typically have not provided disaggregated data and, instead, refer to Asian Americans as a seemingly monolithic group. Furthermore, and as noted above, the census lumped Asian Americans, Native Hawaiians, and Pacific Islanders into one category prior to 2000. It is likely that some of the more than 50 Asian American ethnicities (Chau and Chan, 2021) are underrepresented in STEMM, although the aggregated Asian American population is not (Iporac, 2020).

Even the category definition of White has changed over time. Initially, “white” referred only to Anglo-Saxon people. For example, Italians arriving in the United States in the decades of mass emigration from Europe between the late 1870s and the early 1920s were not regarded as fully “white” but were considered “our temporary negroes” or “not-yet-white ethnics” (Yang and Koshy, 2016). As the Pew Research Center noted in 2015, “In a society where whites had more legal rights and privileges than people of other races, detailed rules limited who was entitled to be called ‘white’ in the census. Until the middle of the 20th century, the general rule was that if someone was both white and any other non-white race (or ‘color,’ as it was called in some early censuses), that person could not be classified as white” (Parker et al., 2015).

In 2020, many media outlets and style guides shifted to the capitalization of the “b” in Black when referring to Black or African American people, prompting a conversation on whether the “w” in “White” when it refers to race should also be capitalized (Daniszewski, 2020; Darling-Hammond, 1998) This is a contentious issue, with some arguing that capitalizing the term “White” risks legitimizing White supremacy (Nguyễn and Pendleton, 2020). The committee has taken the position to capitalize White as a matter of consistency and that not capitalizing White when it refers to race could imply that White is the default race. The decision to capitalize “White” has been adopted by the National Academies Press (see Chapter 1 for more information).

Hispanic or Latine

Hispanic and Latine are both ethnicities. *Hispanic* refers to people from Spain or from Spanish-speaking countries in Latin America who can be of any race; it does not include individuals with Brazilian heritage. *Latine* refers to people from Latin America regardless of language (Lopez et al., 2022). The inclusion of Hispanic or Latine in the U.S. Census only dates to the 1980 Census (Parker et al., 2015). Since then, OMB developed standards for collecting data on Hispanic individuals in 1997 and revised them in 2016.

Given that Hispanic is an ethnicity and can be combined with any race, it has posed challenges as a data category, and the Census Bureau has acknowledged confusion on the part of many Hispanics over the way race

is categorized and how the census form asks about it (U.S. Census Bureau, 2021a,b). Civil rights advocates have expressed concern that an all-in-one race and Hispanic question could lead to a “possible loss of race data through a combined race and Hispanic origin question, the diminished accuracy of detailed Hispanic subgroup data, and the ability to compare data over time to monitor trends” (Parker et al., 2015).

Intersectionality and the Consideration of Other Demographic Groups

In addition to having data limited by an inadequate number of categories, another challenge in reviewing data by race and ethnicity alone is that it fails to capture trends or insights at the intersection of race, ethnicity, and other demographic characteristics such as sex, gender identity, age, religion, disability, economic status, education, and others. There are several important impacts to consider with intersectionality, particularly at the intersection between race, ethnicity, and gender, as two separate consensus study reports from the National Academies note:

Many employers, including those at educational institutions have adopted programs and the policies aimed at improving equity and diversity in STEMM without considering the complex, cumulative ways in which multiple intersecting identities influence outcomes of the interventions. For women of color in particular, multiple forms of discrimination, such as racism and sexism, intersect to shape their experiences (the National Academies of Sciences, Engineering, and Medicine, 2020).

For example, it is generally understood that women of color experience unique forms of gender and racial discrimination, but what is often lost in translation is the fact that women of color are not a monolithic group. . . . As a whole, women of color require distinct and unique supports, relative to the inequitable power and social systems they experiences; however these supports must be informed by the varying experiences and challenges face by different women of color (the National Academies, 2022).

Whenever possible, the committee looked to disaggregate data and review trends with an intersectional lens; however, given the presentation and limitations of publicly available data, this level of analysis was not always possible. In such instances, given the charge to focus on race and ethnicity, the committee prioritized understanding numerical representation primarily through that lens.

The changing nature of how race and ethnicity categories have been defined and assessed underscores the fact that race and ethnicity are socially constructed categories that are dynamic and changing constantly because of sociopolitical forces. The relevance of these category fluctuations to this

report is that they have created persistent knowledge gaps and challenges for how race and ethnicity data are monitored over time, as well as implications for understanding nuance within race and ethnicity groups. Given that there is no perfect way to capture the full richness of diversity in the U.S. population, collecting racial and demographic data in the United States is likely to remain a complex issue.

The following section presents data that articulates the demographic trends and shifts that have occurred in the United States. As the remainder of the chapter and report will demonstrate, understanding the demographic data and shifts that have occurred in the United States is critical for understanding who is (and who is not) earning STEMM degrees, and who is (and who is not) numerically represented in the STEMM workforce.

U.S. DEMOGRAPHIC TRENDS

For general demographic information regarding the U.S. population, the committee relied on data from the 2020 Census as reported by the Census Bureau. According to census data, nearly all racial and ethnic groups have seen population gains since 2010. Only the White population experienced both an absolute decline and a decline relative to other groups, falling 8.6 percent since 2010 as a percentage of the U.S. population. Relevant highlights from the 2020 Census (Figures 3-2 and 3-3) show:

- White remained the largest racial or ethnic group in the United States, with 204.3 million people identifying as White alone, and 235.4 million people identifying as White alone or in combination with another group. However, the proportion of White people alone has fallen by 8.6 percent since 2010 and continues to be in decline in comparison to all other groups. The decline in the number of White persons in the United States between 2010 and 2020 is unprecedented (Frey, 2020).
- The self-defined multiracial population grew substantially since 2010, increasing from nine million people in 2010 to 33.8 million people in 2020, a 276 percent increase; the “in combination” multiracial populations for all race groups accounted for most of the overall changes in each racial category.²
- The Black population grew 8.5 percent between 2010 and 2020, adding 1.7 million individuals to the nation’s total population; this

²As mentioned previously, before 2020, individuals could only select one race. The increase in multiracial may related to the ability to select two races, allowing individuals to select one race in addition to the U.S. census category “Two or More Races.”

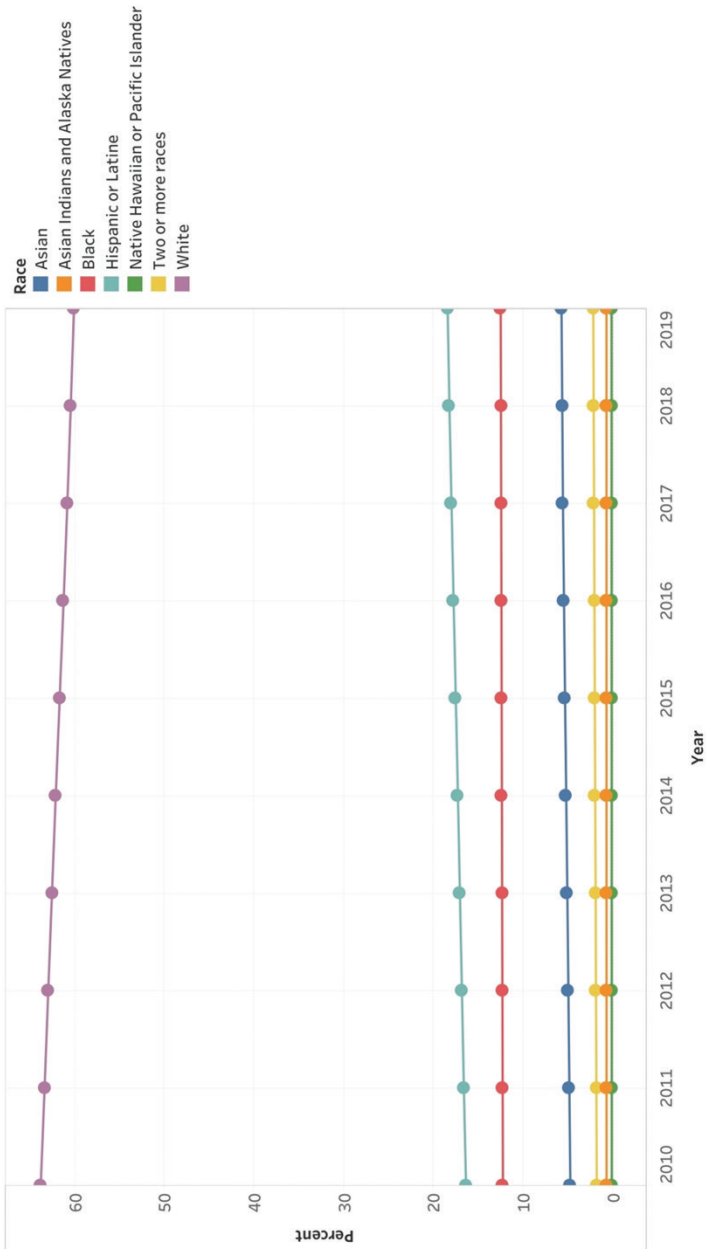


FIGURE 3-2 U.S. population trends by race and ethnicity, 2010–2019.
SOURCE: U.S. Census Bureau, 2021 d.

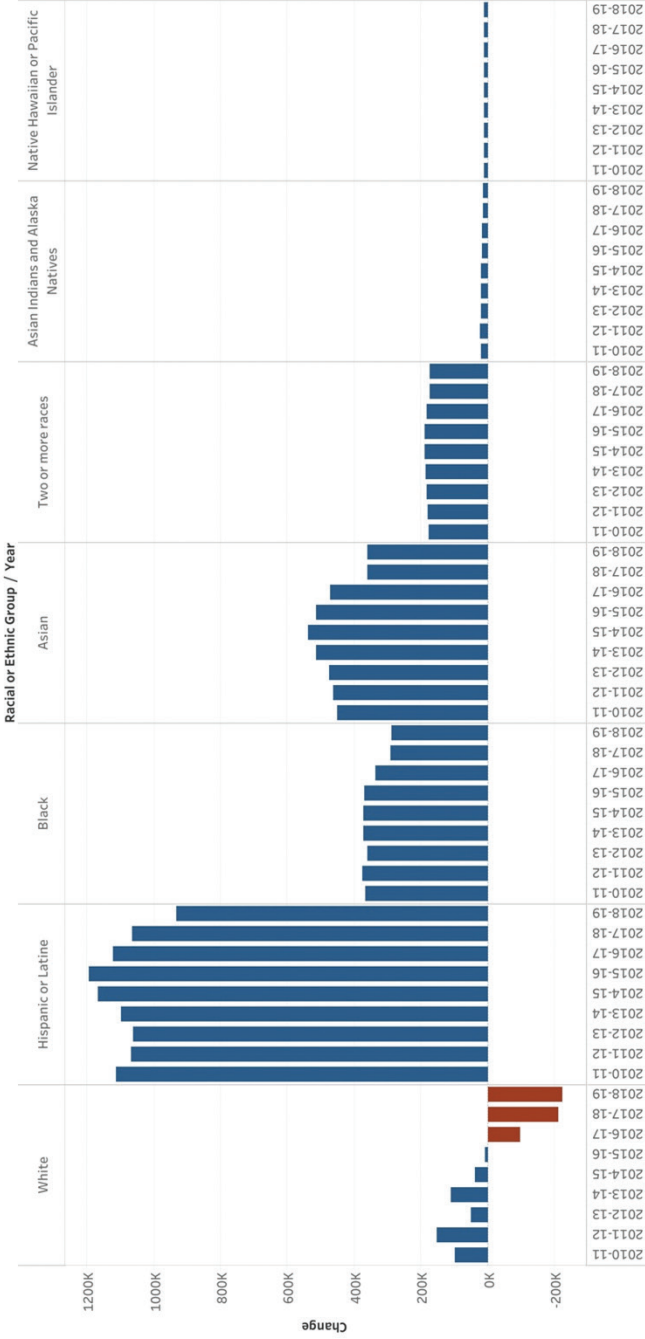


FIGURE 3-3 U.S. annual population changes by race and ethnicity per year, 2010–2019.³
 SOURCE: U.S. Census Bureau, 2021d, adapted from Frey, 2021.

³For categories other than Hispanic or Latine, these figures reflect the non-Hispanic population figures.

was the smallest growth in percentage and number among all races and ethnicities (Frey, 2020).

- The Hispanic or Latine population, which includes people of any race, grew by 23 percent between 2010 and 2020, totaling 62.1 million people in 2020. In comparison, the population that was not of Hispanic or Latine origin grew 4.3 percent since 2010 (Jones et al., 2021).
- The Asian racial or ethnic group alone grew 35.5 percent between 2010 and 2020 and totaled 19.9 million people, while Asian in combination with another race grew by 55.5 percent over the same period (Monte and Shin, 2022; U.S. Census Bureau, 2021c).
- The American Indian and Alaska Native alone population grew by 27.1 percent between 2010 and 2020 and totaled 3.7 million people. The American Indian and Alaska Native and another race population totaled 5.9 million individuals, an increase of 160 percent since 2010 (U.S. Census 2022b, 2021c).
- The Native Hawaiian and Other Pacific Islander population grew by 27.8 percent between 2010 and 2020 and totaled just under 690,000 individuals. The Native Hawaiian and Other Pacific Islander in combination population grew by 30.8 percent and included just over 890,000 people (Monte and Shin, 2022; U.S. Census, 2021c).

The Census Bureau urges users of census data to exercise caution when making data comparisons between the 2010 and 2020 census figures to account for changes the Census Bureau made to the Hispanic origin and race questions and the ways it codes how people self-report their race and ethnicity (Jones et al., 2021). The Census Bureau notes that people may change how they self-identify regarding their race given that racial categories are social constructs that have been fluid over time (Brown, 2020). The Census Bureau plans to continue to refine its demographic categories to reduce these ambiguities (U.S. Census Bureau, 2021a).

The proportion of the U.S. population that is non-White steadily increases with decreasing age groups; for instance, the group of persons 18 and younger is 50 percent non-White (NCSES, 2021a). Assuming these demographic trends continue, the NCSES estimated that the total population of individuals from historically minoritized racial and ethnic groups will comprise a numeric majority, accounting for more than 50 percent of the total U.S. population, before the year 2050 (Figure 3-4).

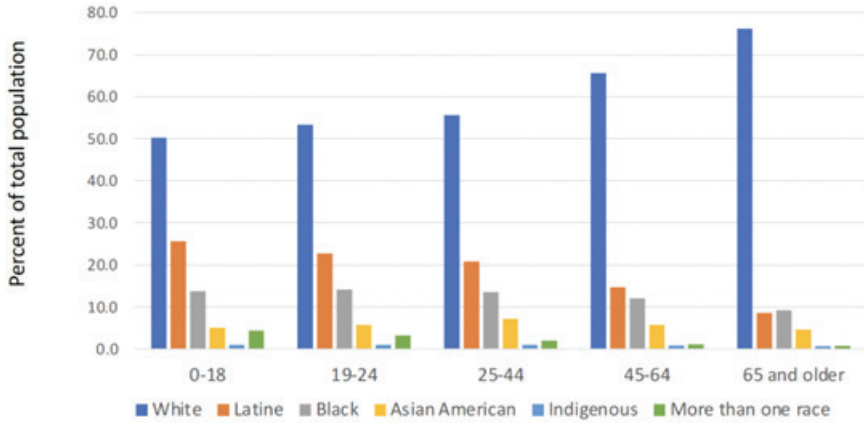


FIGURE 3-4 Racial and ethnic compositions of U.S. population by age.
SOURCE: NCSES, 2021a.

REPRESENTATION BY RACE AND ETHNICITY IN U.S. STEMM HIGHER EDUCATION

When it comes to demographic data and trends on enrollment and degree attainment, the focus of observations and research has been on the individuals who stay in the system, with less data available about the individuals who leave STEMM and higher education altogether. With that caveat, U.S. postsecondary education enrollment of individuals who identify as Asian American, Black, Latine, Pacific Islander, or as Two or More Races (in the official parlance of the Census Bureau) has increased in the 1980–2019 period according to NCES (Figure 3-5). The most significant increase occurred in the Latine population, growing from four percent in 1980 to 20.3 percent in 2019. Black enrollment peaked in 2010 at 15 percent before declining to 13.3 percent in 2019 (National Center for Education Statistics Institute of Education Sciences, 2021).

AAMC data for medical school attendees covering the years 2017–2022 (AAMC, 2022) show that total enrollment at U.S. medical schools increased by 20.8 percent, from 51,680 to 62,443 (AAMC, 2022). Enrollment of students who identify as Asian American, Black, Latine, or Native Hawaiian or Pacific Islander increased by 32.9 percent and accounted for 48.7 percent of medical school students in 2022, up from 44.3 percent of medical school students in 2017 (AAMC, 2022). Black student enrollment grew the most over that period, increasing by 47.6 percent, followed by Native Hawaiian or Other Pacific Islander, which increased

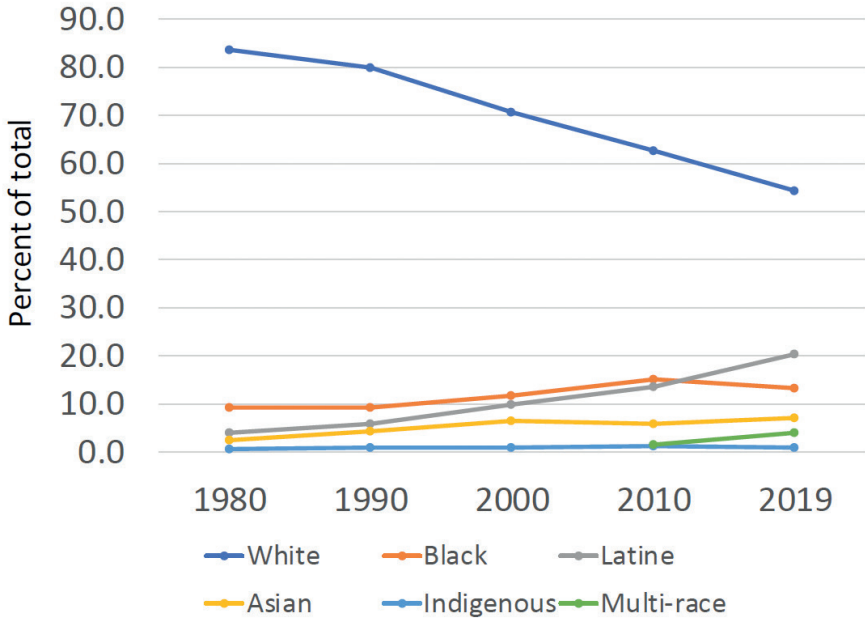


FIGURE 3-5 Total fall enrollment in degree-granting postsecondary institutions by race/ethnicity.
 SOURCE: National Center for Education Statistics Institute of Education Sciences, 2021.

by 39.1 percent, American Indian or Alaska Native by 35.0 percent, Hispanic or Latine by 31.1 percent, Asian by 29.1 percent, and White by 7.2 percent (AAMC, 2022).

In terms of medical school, the AAMC data for medical school attendees, and the data covering the years 2018–2019 to 2022–2023 show that total enrollment at U.S. medical schools increased by 5.8 percent, from 91,225 to 96,520 (AAMC, 2022). Enrollment of students who identify as Black, Latine, American Indian or Alaska Native, or Native Hawaiian or Pacific Islander increased by 22.3 percent from 12,113 in the 2018–2019 academic year to 14,818 in 2022–2023 (AAMC, 2022). Most racial and ethnic groups showed growth in enrollment: Black student enrollment increased by 26.0 percent; Native Hawaiian or Other Pacific Islander by 47.0 percent; American Indian or Alaska Native by 8.9 percent; Hispanic or Latine by 18.3 percent; and Asian by 13.6 percent. In that time period, White enrollment decreased by 6.4 percent (AAMC, 2022).

Representation by Race/Ethnicity Among S&E Degree Recipients

Data from NCSES for S&E degree recipients in 2018 reveal the following (Figure 3-6):

- White students earned an increasing share of total degrees in the progression from associate degrees to doctoral degrees, with the total combined percentage of students from all other racial and ethnic groups declining.
- Compared to the U.S. population 18–24 years of age, White people are overrepresented among bachelor’s, master’s and doctoral recipients, and underrepresented among associate degree recipients.
- Compared to the U.S. population 18–24 years of age, Latine people are overrepresented among associate degree recipients, and Asian Americans are overrepresented among all four postsecondary degree recipients.
- Compared to the U.S. population 18–24 years of age, Black individuals are underrepresented in all of the S&E degree recipients.
- Black students have a larger share of the total at the associate’s and master’s degree levels in comparison to their shares of bachelor’s and doctoral degrees.

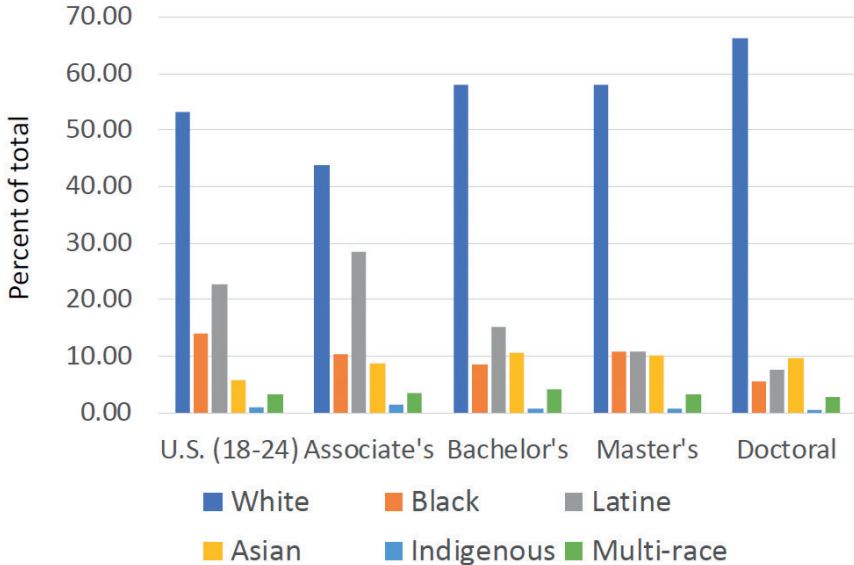


FIGURE 3-6 Representation of racial and ethnic groups in S&E degree recipients, 2018.

SOURCE: NCSES, 2021a.

- Persons identifying as belonging to groups indigenous to the United States and its territories—including American Indian, Alaska Native, Native Hawaiian, and Other Pacific Islander—are most represented at the associate degree level.
- Persons identifying as Black or Latine or Hispanic are underrepresented among medical school attendees compared to the percentage of 18–24 year olds who identify with those racial and ethnic identities. Persons who identify broadly as Asian are overrepresented numerically in medical schools (AAMC, n.d.b).

Changes in Racial and Ethnic Representation Among Degree Recipients, 2011–2019

The following tables and accompanying figures summarize NCSES data on the numbers of people who earned postsecondary S&E degrees in 2011 and 2019.⁴ (NCSES data report “S&E” degrees and do not include individuals in medicine and related degrees.) The degrees include associate’s, bachelor’s, master’s, and doctoral degrees, and these data are provided in two formats, Figure 3-7 below and in a series of tables in Appendix B. Figure 3-7 below illustrates the changes in the proportion of total degrees earned by race and ethnic group and by degree from 2011 to 2019. The exact attainment data can be referenced in Appendix B.

The data for the four postsecondary science and engineering degrees summarized in the tables and graphs above reveal the following trends:

- In all four levels of S&E degrees, the number of degree recipients increased from 2011 to 2019 for Asian American people, Black or African American people, Latine people, or Hispanic American people, and White People.
- The numbers of S&E degree recipients identifying as American Indian, Alaska Native, Native Hawaiian, and Pacific Islander were small relative to the other racial/ethnic groups, and there was little change in the numbers between 2011 and 2019.
- For all four degrees, the proportion of White degree recipients decreased between 2011 and 2019, with the largest decrease among associate’s degree recipients and the smallest decrease among doctoral degree recipients.
- In all four degrees, the proportion of Latine degree recipients significantly increased.

⁴NCSES data report “S&E” degrees and do not include individuals in medicine and related degrees.

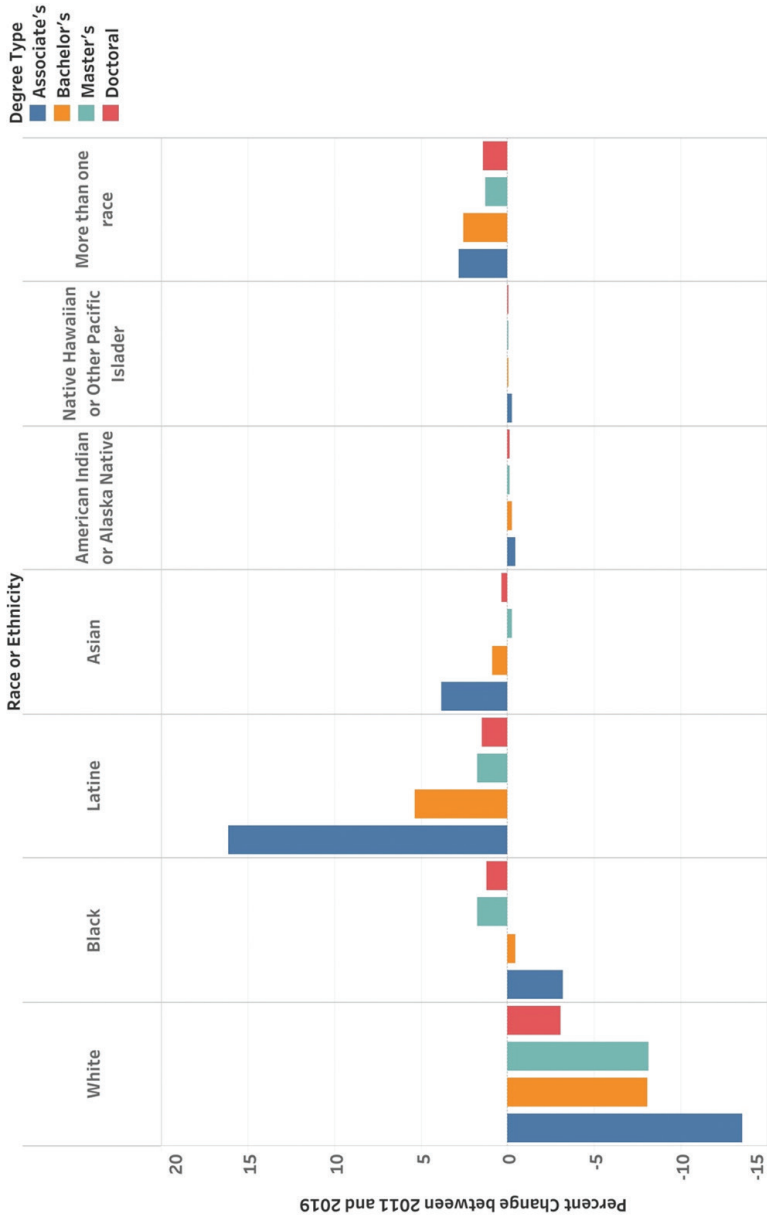


FIGURE 3-7 Change in percent of total of S&E degrees awarded by race or ethnicity by degree type between 2011 and 2019. SOURCE: NCSES, 2021a.

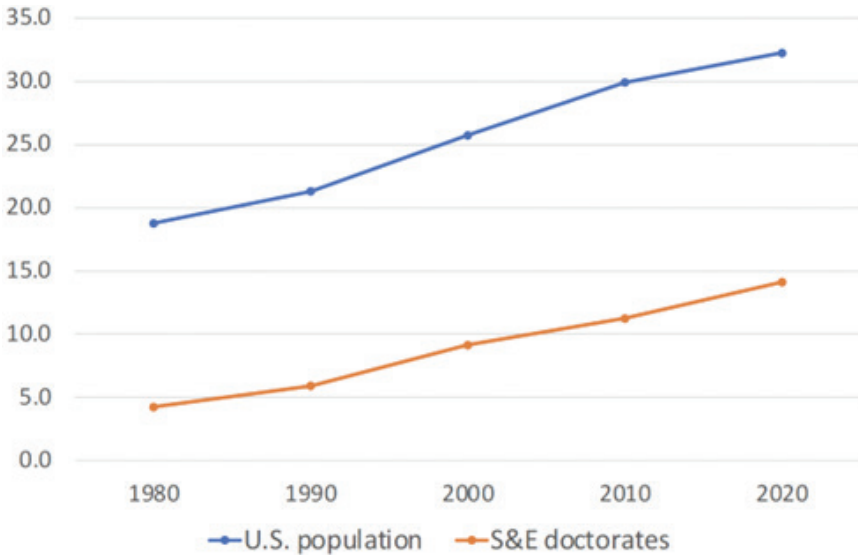


FIGURE 3-8 Proportion of U.S. population and S&E doctorates who identify as Black or African American, American Indian or Alaska Native, and Latine or Hispanic American.⁵

SOURCE: U.S. Census Bureau and NCSES Survey of Earned Doctorates, 2022.

- The proportion of Asian American degree recipients significantly increased among associate degree recipients, and more modestly among bachelor's and doctoral recipients.
- For all four degrees, the proportion of persons identifying as being of more than one race increased significantly.
- As the non-White portion of the U.S. population increases, so too does the proportion of non-White degree recipients. However, the increases for historically minoritized racial and ethnic groups do not appear to keep up with the change in U.S. population (see Figure 3-8 above).
- For all four degrees, the total number of females (all races/ethnicities combined) increased. Females were in the majority among bachelor's and doctoral degree recipients.
- For all four degrees, the proportion of females identifying as Asian American and Latina increased.
- The proportion of Black females increased among doctoral recipients, but decreased among associate's and bachelor's degree recipients.
- For all four degrees, the proportion of White females decreased.

⁵The sources do not include data for Native Hawaiian and Pacific Islander.

CONCLUSION 3-1: *Although the representation of minoritized persons in science, technology, engineering, and mathematics higher education is increasing, the collective attainment of science and engineering degrees for Black people, Indigenous people, and Latine people does not reflect their corresponding growth in the U.S. population.*

The data shown above from NCSES and NCES, along with data from NSF and the National Science Board (National Science Board, 2019; NCSES, 2021a), demonstrate that in recent history, minoritized individuals' numeric representation in STEM higher education has increased. Despite improvements, the collective attainment of S&E degrees for Black, Indigenous, and Latine Americans lags behind the U.S. population, and these racial/ethnic groups remain underrepresented throughout all sectors of the U.S. STEM enterprise. When looking into discipline-specific data within STEM from NCSES, Black, Indigenous, and Latine students are better represented in behavioral and social sciences than they are in engineering and natural sciences. Furthermore, some data suggest that minoritized individuals disproportionately leave STEMM (Estrada et al., 2016; Hatfield et al., 2022) and are underrepresented among bachelor's, master's, and doctoral degree recipients, though additional data are needed (more on exiting STEMM in Chapter 5).

STEM Higher Education Areas for Further Exploration

The committee identified three topics for further consideration:

- *Differences between STEM disciplines.* The tables and graphs above aggregate NCSES data for S&E degree recipients. What is not shown are degree attainment data for individual S&E disciplines, which include a broad swath of disciplines including engineering and computer sciences, the natural sciences, mathematics and statistics, and social and behavioral sciences. There are disciplinary differences in degree attainment by persons from different racial or ethnic groups. An examination of degree recipients who identify as Black, Indigenous, and Latine reveals a significant difference in representation between the behavioral and social sciences and the other STEM disciplines (Figure 3-9). As can be seen from Figure 3-9, within STEM, Black, Indigenous, and Latine Americans are more represented in the behavioral and social sciences than they are in engineering and natural sciences.
- *Measuring persistence in STEM.* A second area for further analysis is to understand the persistence of students in the STEM degrees.

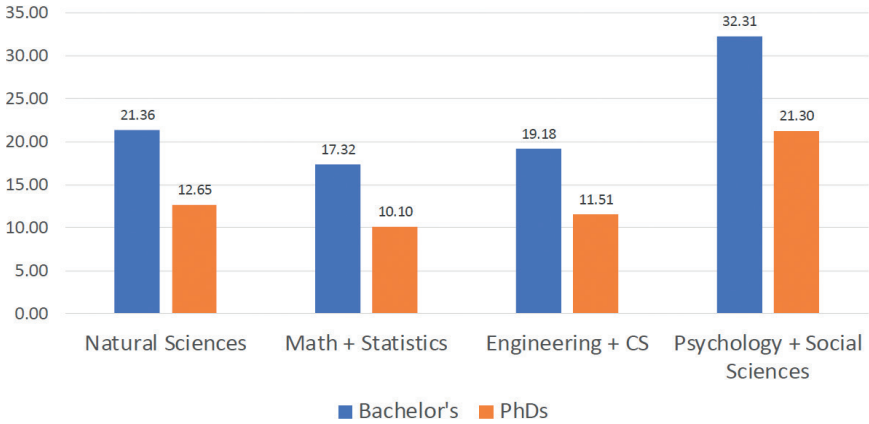


FIGURE 3-9 Degree attainment by persons from underrepresented racial and ethnic groups in different STEM disciplines.⁶
SOURCE: NCSES, 2021a.

This requires knowing the demographics of the students entering college intending to study STEM, and their educational outcomes—How many graduated with a STEM bachelor’s degree? How many switched to a non-STEM major? How many left college with no degree? Earlier reports suggest that the persistence rate of persons from excluded ethnic or racial groups—including Black, Indigenous, and Latine persons—is significantly less than that of whites and Asian Americans (e.g., Asai, 2020; Huang et al., 2000; the National Academies, 2011; Riegle-Crumb et al., 2019). The data required to measure persistence would include: (i) by race/ethnicity, who is entering college intending to major in STEM (separated by two- and four-year institutions), (ii) of these students, who completed the STEM bachelor’s degree, and (iii) who completed

⁶Underrepresented groups include Black or African American, persons from Indigenous groups—American Indian, Alaska Native, Native Hawaiian, Other Pacific Islander—and Latine or Hispanic American. NCSES defines “natural sciences” to include agricultural sciences; biological sciences; earth, atmospheric, and ocean sciences; mathematics and computer sciences; and physical sciences (astronomy, chemistry, physics). NCSES defines “social and behavioral sciences” to include psychology, anthropology, area and ethnic studies, economics, linguistics, political science and public administration, and sociology. Shown are the proportions of degree recipients who identify as persons from underrepresented ethnic or racial groups (NCSES, 2022).

master's and doctoral degrees in STEM. The committee was unable to assemble the necessary national data to measure persistence.

- *Effects of recent disruptions on enrollment and degree attainment.* The postsecondary degree data summarized above are from the years prior to the COVID-19 pandemic, which began in 2020 and significantly impacted student enrollment and retention. It appears that the disruption differentially affected students depending on several factors, including their race and ethnicity, first-generation status, and family financial resources. It will be important to revisit the enrollment and degree attainment data in several years (NCSES, 2022).

CONCLUSION 3-2: Currently-available data on students who intend to study science, technology, engineering, and mathematics in their undergraduate degrees leave out important information on educational outcomes, including persistence, completion, and transfer to other degree programs.

RECOMMENDATION 3-1: To understand the relative persistence of students in STEM higher education, data collection organizations, such as the National Center for Science and Engineering Statistics and the National Center for Education Statistics, should collect and share with the public information on the demographics of students entering college planning to study science, technology, engineering, and mathematics (STEM) and their subsequent educational outcomes, disaggregated by race and ethnicity, gender, and field of study, including:

- how many complete a STEM degree;
- how many switch to and complete a non-STEM degree; and
- how many leave college without a degree.

THE U.S. STEMM WORKFORCE

The committee also examined data to gain a deeper understanding of the numeric representation of minoritized individuals in the U.S. STEMM workforce. For the purposes of this report, the committee understood STEMM workplaces to include businesses, the pharmaceutical sector, nonprofit organizations, industry, consultants, hospitals, and institutions of higher education. The committee did not include the significant number of STEMM professionals who work for government, given the scope of the statement of task.

There are many ways to measure the STEMM workforce. According to NCSES, there has been a move for a more inclusive definition of the STEMM workforce that includes workers from all educational backgrounds and in middle-skilled and technical positions rather than the historic definition of people with a bachelor's degree or above in STEMM. Using this

broader definition, the STEMM workforce was approximately 29 million people of all educational backgrounds (National Center for Science and Engineering Statistics, 2021c), while the American Community Survey (ACS) puts the number of individuals working in S&E-specific, S&E-related, and middle-skill occupations at 36 million people of all educational backgrounds, representing 23 percent of the total workforce in 2019. NCSES measured individuals in S&E-specific occupations at nearly seven percent of the total workforce in 2019 (Figure 3-13; National Center for Science and Engineering Statistics, 2021c). ACS recorded a 2.3 percent increase in the STEM workforce from 2010 to 2019, exceeding the 1.4 percent increase for U.S. employment overall (National Center for Science and Engineering Statistics, 2021c). Individuals with bachelor's degrees and higher account for approximately 7.5 million S&E jobs, according to NCSES data, and NIH supported 46,371 individuals in the biomedical workforce in 2019. The number and proportion of persons employed in S&E-specific occupations have substantially increased over time (Figure 3-10).

The industry sectors that employed the largest number of S&E professionals in 2019 at all levels of education included professional, scientific, and technical services, at 2.4 million; manufacturing, at 1 million; education services, at 713,000; federal, state, and local government, at 672,000; and information, at 614,000. Other significant employers of S&E professionals included finance and insurance, at 414,000; management of companies and

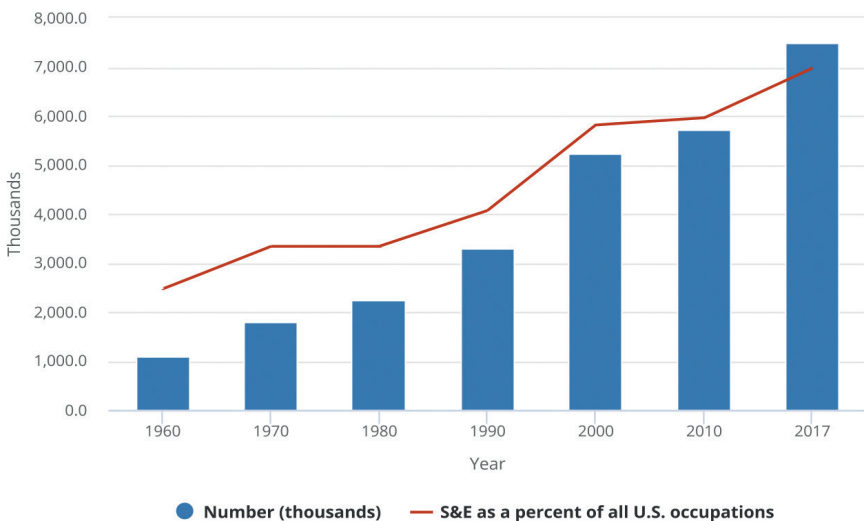


FIGURE 3-10 Individuals employed in S&E occupations in the United States, 1960–2019.

SOURCE: NCSES, 2021a.

TABLE 3-1 Persons Employed in Different S&E Professions by Race and Ethnicity and Discipline

	Total	White	Black	Latine	Asian	Indigenous
Computer and mathematical sciences	3,744 (100%)	2,259 (60%)	214 (5.7%)	238 (6.3%)	955 (25.3%)	6 (0.2%)
Biological and medical sciences	500 (100%)	300 (60%)	18 (3.6%)	40 (7.9%)	130 (26%)	s
Physical sciences	409 (100%)	300 (73.3%)	18 (4.4%)	27 (6.7%)	55 (13.5%)	1 (0.2%)
Behavioral and social sciences	663 (100%)	480 (72.4%)	47 (7.1%)	77 (11.6%)	44 (6.7%)	2 (0.3%)
Engineering	1,921 (100%)	1,305 (67.9%)	77 (4%)	159 (8.3%)	331 (17.2%)	5 (0.2%)
Health-related professions	5,728 (100%)	3,895 (68%)	399 (7%)	491 (8.6%)	754 (13.2%)	48 (0.8%)
S&E managers	999 (100%)	679 (68%)	70 (7%)	99 (9.9%)	135 (13.5%)	s
S&E precollege teachers	925 (100%)	719 (77.8%)	54 (5.8%)	95 (10.2%)	34 (3.7%)	2 (0.2%)
S&E technicians	973 (100%)	560 (57.6%)	84 (8.6%)	115 (11.8%)	189 (19.4%)	3 (0.3%)

SOURCE: NCSES, 2021a.

enterprises, at 360,000; administrative and support and waste management and remediation, at 285,000; and health care and social assistance, at 248,000. The U.S. Bureau of Labor Statistics projects that the number of jobs available in S&E occupations will grow by 12.7 percent between 2019 and 2029, compared to 3.7 percent for all occupations. The racial/ethnic representation in selected STEMM professions is shown in Table 3-1.

Although individuals from Black or African American, Hispanic or Latine, and American Indian or Alaska Native populations represent greater than 30 percent of the employed U.S. population, they account for only 23 percent of the STEM workforce with bachelor's degrees or higher (see Figure 3-11). White individuals constitute the largest group in the STEM workforce with bachelor's degrees or higher, followed by Asian Americans. In contrast, Black or African American individuals, who account for 11 percent of total jobs, constitute only nine percent of all STEM jobs and 5.1 percent of the S&E workforce with bachelor's degrees or higher. Hispanic and Latine people, who account for over 17 percent of the total jobs, constitute only eight percent of the STEM workforce (broadly) and 7.6 percent of the total S&E workforce. Native Hawaiian or Other Pacific Islander make up 0.2 percent of the total S&E workforce with bachelor's degrees or higher, while American Indian and Alaska Native figures are not reported because of insufficient numbers, as was noted above.

Of the 191,512 full-time faculty members at U.S. medical schools in 2021 (AAMC, 2021), 119,341 (62.3%) identified as White. In comparison, 40,148 faculty members (21.0%) identified as Asian; 7,231 (3.8%) identified as Black or African American; 6,585 (3.4%) identified as Hispanic or Latine; 4,709 (2.5%) identified as Hispanic and at least one other race or

ethnicity; 4,046 (2.1%) identified as non-Hispanic and at least one other race; 295 (0.15%) identified as American Indian or Alaska Native; and 161 (0.084%) identified as Native Hawaiian or Other Pacific Islander.

In terms of the total health care workforce, 60 percent of health care workers in 2019 were White, 16 percent were Black, 13 percent were Hispanic or Latine, and seven percent were Asian (Laughlin et al., 2021). Black and Hispanic health care workers made up relatively larger shares of aides and personal care workers and direct contact support workers and accounted for fewer health care providers (Figure 3-12). Of all active physicians in 2018 (AAMC, 2019), 56.2 percent identified as White, compared to 17.1 percent who identified as Asian, 5.8 percent who identified as Hispanic or Latine, five percent who identified as Black or African American, 0.3 percent who identified as American Indian or Alaska Native, and 0.1 percent who identified as Native Hawaiian or Pacific Islander; individuals whose race or ethnicity were not known accounted for 13.7 percent of active physicians. One recent study found that Black, Hispanic, and Native American people were underrepresented in ten different health care professions in 2019 (Salsberg et al., 2021).

According to the 2020 U.S. census, approximately seven million people worked in general medical, surgical, or specialty hospitals (Figure 3-13). By race and ethnicity, there was substantial variation across the health

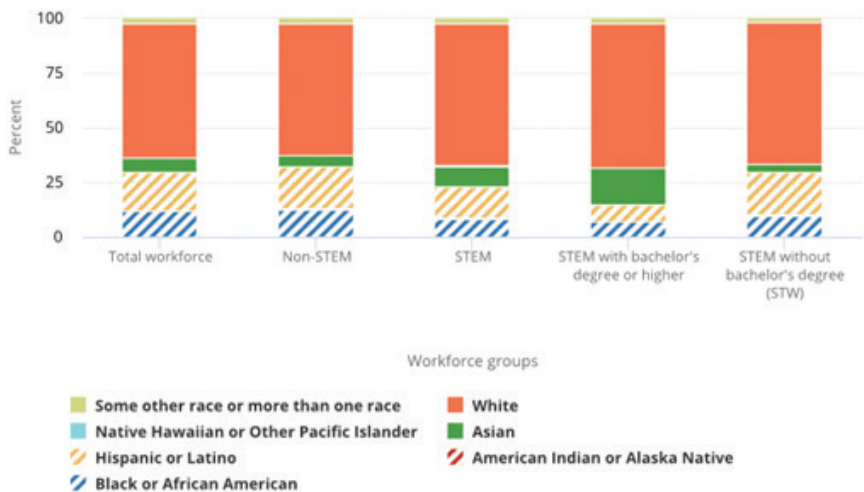
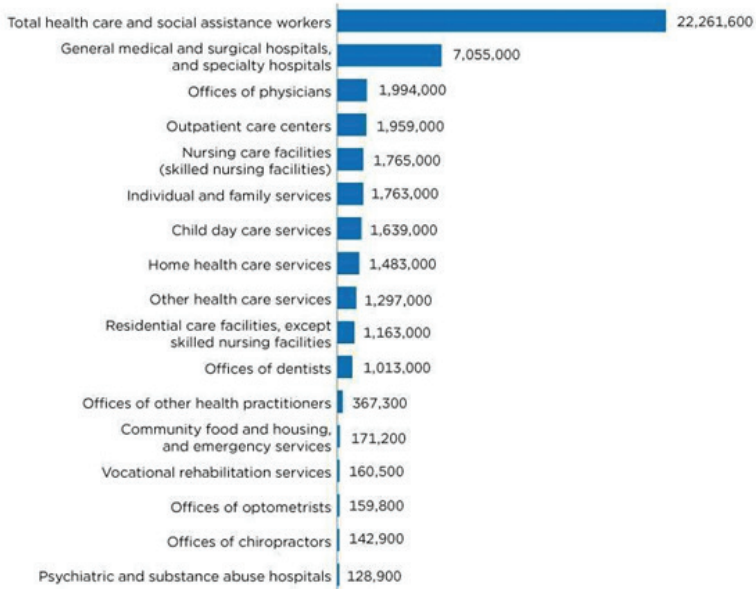


FIGURE 3-11 Employed adults, by workforce, educational attainment, and race or ethnicity, 2019.

SOURCE: NCSES, 2021c.



Note: Estimates include United States and Puerto Rico.
 For information on confidentiality protection, sampling error, nonsampling error, and definitions, visit <www.census.gov/programs-surveys/acs/technical-documentation/code-lists.html>.
 Source: U.S. Census Bureau, 2019 American Community Survey, 1-year estimates.

FIGURE 3-12 Health and social assistance workers by detailed industry, 2019.
 SOURCE: Laughlin et al., 2021.

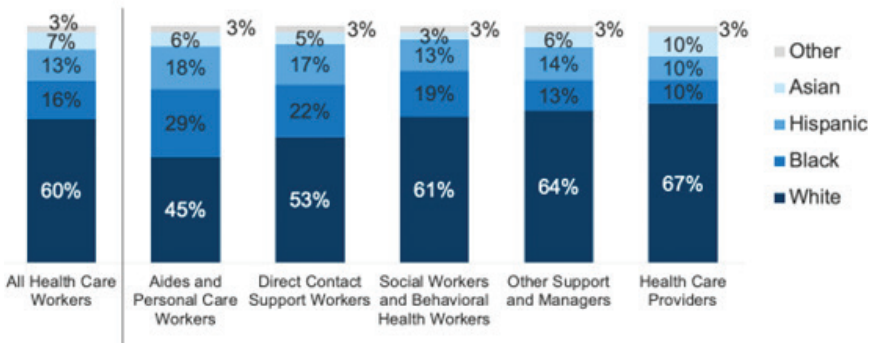


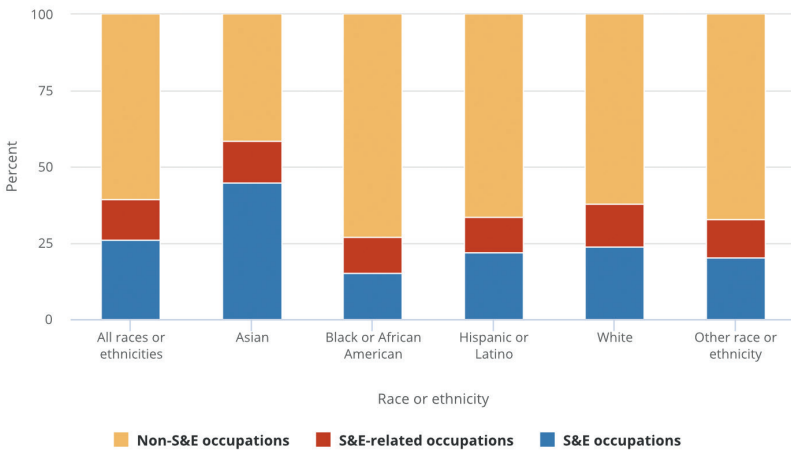
FIGURE 3-13 Racial and ethnic distribution of health care workers by occupation, 2019.
 SOURCE: Kaiser Family Foundation (Artiga et al., 2020).

worker categories. White individuals constituted the largest percentage of health care workers at 60 percent. Black individuals accounted for 16 percent of the health care workforce, Hispanic individuals accounted for 13 percent, and Asian individuals constituted seven percent.

Intersection of Race, Ethnicity, and Gender

Figure 3-14 highlights the disproportionately low representation of women from minoritized racial and ethnic groups in STEM fields. While over half of employed Asian American women work in S&E-related and S&E occupations, White, Hispanic, Black or African American women, and women of other race or ethnicity work predominantly in non-S&E-related occupations. Furthermore, regardless of the proportion of women in the STEM fields, women earn less than their men counterparts in all racial and ethnic groups (Figure 3-15), and Asian American women on average make more than Hispanic or Black men. The median salary for all S&E occupations in 2019 was \$96,000, compared to \$80,000 for all occupations. For women, the median salary for all S&E occupations was \$82,000 compared to \$100,000 for men.

In terms of promotion and advancement, men are more represented in supervisor ranks than women, and White individuals are more represented



STEM = science, technology, engineering, and mathematics.

FIGURE 3-14 Employed women with their highest degree in an S&E field by race or ethnicity and broad occupation, 2019.

SOURCE: NCSES, 2021a.

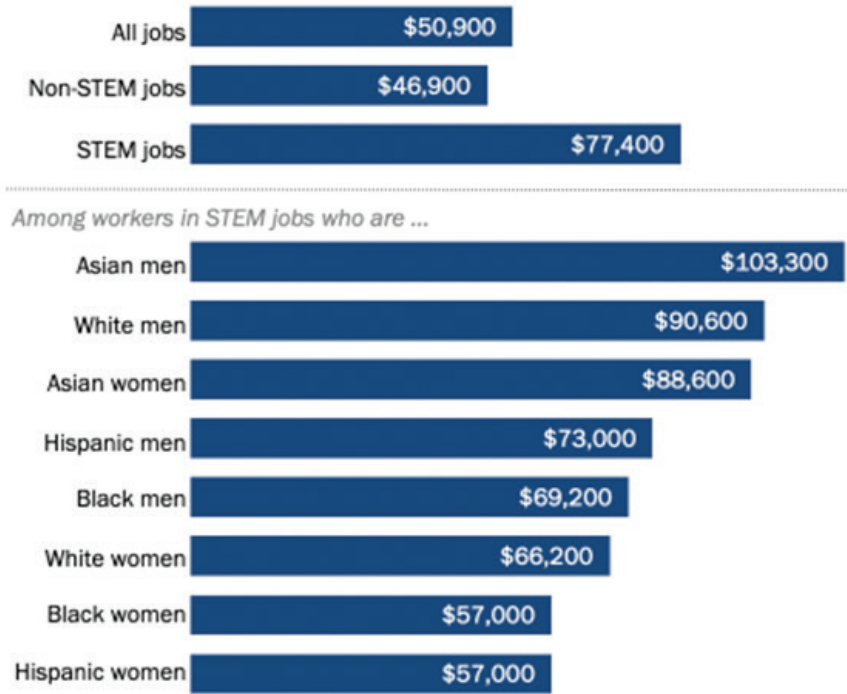


FIGURE 3-15 Salaries by gender, race, and ethnicity for workers in STEM occupations.

SOURCE: Pew Research Trusts (Fry et al., 2021).

than individuals from other racial and ethnic groups. While Asian men and women earn more on average, that does not necessarily translate into supervisory status.

STEM Employees in Industry

According to the U.S. Bureau of Labor Statistics, five industry groups—information; professional, scientific, and technical services; manufacturing; educational services; and government—employed nearly three-quarters of the total S&E workforce across all education levels. Those same five industrial groups accounted for one-third of total U.S. employment. Industries in which S&E jobs accounted for the highest proportion of their total employment included information, utilities, and management of companies and enterprises. Those with the lowest percentage of S&E jobs included health care and social assistance, retail trade, and accommodations and food services (NCSES, 2019).

STEM Employees in Academia

Over 2.3 million individuals whose highest degree was in an S&E field work in higher education, accounting for 15.3 percent of all employed individuals whose highest degree was in an S&E field. Of those individuals with STEM degrees working in higher education, 1.3 million work at four-year institutions, with the remaining 1.0 million working at two-year and precollege institutions. According to NCSSES's National Survey of Doctorate Recipients, which collects workforce data for individuals with science, engineering, or health research doctorates, some 350,000 individuals who received their doctorates in science, engineering, and health in the United States work in academia. While the majority of these individuals are full-time faculty, the percentage employed as full-time faculty has fallen from approximately 90 percent in the early 1970s to 70 percent in 2019 (National Science Board, 2021). Between 1997 and 2019, the percentage of individuals from unrepresented minority groups in science, engineering, and health doctoral degrees working in all academic positions and full-time faculty positions increased from six percent to nine percent (NCSSES, 2019).

CONCLUSION

The final sections of this chapter have examined demographic trends over time in the STEMM workforce. In sum, the data demonstrate that the STEMM workforce has been increasing over time, represents a sizable sector of the current U.S. workforce, and is projected to continue growing in the future. Individuals from historically minoritized racial and ethnic groups represent a numerical minority of the STEMM workforce with a bachelor's degree or higher, indicating a disparity in the positions that require higher education in STEMM. This may have implications on which jobs individuals from these groups can pursue, the salaries they earn, and their long-term job prospects. Data also show that regardless of the proportion of women in the STEMM fields, women earn less than their men counterparts in all racial and ethnic groups. Finally, the data demonstrate that among academic faculty and in all races/ethnicities, men are more likely to be tenured than women.

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PART II

Lived Experiences and Other Ways of Knowing in STEMM

The previous chapters presented evidence on a range of historical and present-day policies, practices, and data collection that have influenced the participation and success of systemically minoritized racial and ethnic groups in science, technology, engineering, mathematics, and medicine (STEMM) careers and organizations. Per the committee's statement of task, this chapter provides evidence from the lived experience and other crucial sources of information beyond traditional quantitative methods. The goal of the chapter is to provide a firsthand account of some of the challenges Black scholars encounter as they navigate in STEMM organizations. The interviews underscore the complex range of experiences, emotions, and situations that confront even the most successful Black scholars. This chapter also provides concrete examples of how the issues identified throughout this report are manifest on a personal level through the voices of successful Black scholars in STEMM. While the interviews were structured, they were not intended to qualify as a true qualitative study. As such, the committee does not provide specific conclusions or recommendations associated with this chapter beyond an acknowledgment of the value of soliciting more voices to deepen our understanding of the lived experience of Black people and other systematically marginalized groups in STEMM organizations.

There is growing recognition and an emerging evidence base that acknowledges the importance of documenting the lived experience in various fields and disciplines, including education (Orbe, 2008; San Miguel

and Kim, 2015), obesity (Farrell et al., 2021a,b), mental health (Kaite et al., 2015), and substance use (Alexandridis et al., 2020). One recent report on effective mentorship in STEMM points to a body of evidence that demonstrates how understanding students' lived experiences can improve the mentoring that faculty members provide (the National Academies of Sciences, Engineering, and Medicine, 2019). Another recent review highlights a range of federal agencies and initiatives that have incorporated the lived experience into their research, policies, and practices, and identifies emerging strategies that may be adopted more broadly (Office of the Assistant Secretary for Planning and Evaluation, 2021). Finally, the prioritization of personal knowledge and firsthand accounts that produce complementary evidence when the published research is lacking in such perspectives can be seen in numerous recent National Academies activities.¹

INTERVIEWS: LIVED EXPERIENCES OF BLACK STEMM PROFESSIONALS

To capture the lived experience and to provide a supplemental evidence base to the data presented elsewhere in this report, the committee conducted a series of structured interviews with Black individuals with careers in STEMM. The STEMM professionals who were interviewed have reached elite levels of contribution in their respective fields. The interview excerpts that follow are not intended as generalizable data; rather, they provide authentic and vivid examples of lived experience.

The committee's approach, approved by the Institutional Review Board (IRB) of the National Academies, is documented in Appendix C. It includes a detailed description of the methods used to conduct these interviews, as well as the interview script. Briefly, a total of 29 interviews were conducted with Black professionals, many of whom are members of the National Academies Roundtable on Black Men and Black Women in SEM, a group of individuals who have achieved outstanding records, proved themselves in the face of racial bias, are recognized by their colleagues, and are known for their success. Other interviewees included members of the National Academies who identify as Black or African American. As such, the interviews do not include the perspectives of professionals who have not yet reached "elite" status, people who left STEMM, people who are now beginning

¹Examples include The Lived Experience Innovation Collaborative; *Responding to the Current Youth Mental Health Crisis and Preventing the Next One*; *Communities, Climate Change, and Health Equity: A New Vision*; and *Review of Federal Policies that Contribute to Racial and Ethnic Health Inequities*.

their careers in STEMM, and STEMM professionals from other minoritized groups. As noted in Chapter 1, the committee elected to focus on the challenges facing Black Americans in STEMM, recognizing that while there may be some shared experiences, sociocultural factors differ for different minoritized groups and individuals, precluding a one-size-fits-all approach. As such, the committee believes that conducting similar interviews with members of other minoritized groups will yield different and valuable additional evidence. Thus, the structured interviews in this chapter also serve as a guide for future work and demonstrate the need for additional research that investigates the unique racialized issues facing other minoritized groups in the research agenda.

Really, the more and more we could share the stories of individuals and then the challenges that they have faced and then how they have overcome them. . . . Storytelling is very powerful. Because a lot of times individuals are just not aware of the challenges when it comes to diverse individuals, because they never had to think about it. [Interviewer O.A. 06-03-22 RT Interview p. 11]

Black people—I'm preaching to the choir in a lot of ways—Black people are not monolithic. There are so many pieces of us and whatever our experiences are; it's helpful to not measure them against the other . . . Everyone's experience is so valuable no matter . . . what the road they've traveled . . . I think intersections are so important in people of color and anyone really. I would say people of color, especially given . . . the challenges that we've consciously experienced and unconsciously experienced . . . the intersections I think are really important because we are multifaceted, and we can bring our subjugated selves: I could bring it as Black; I could bring it as gay; and all those things mount up. [Interviewer L.M. 06-14-22 RT Interview 2 p.12]

The rest of this section is organized by the subject matter of the interview comments.² These include experiences of belonging (or not), specific biased or racist incidents, sources of support from others (mentors, peers, family, community), and their own sources of resilience (determination, confidence). These lived experiences emerged as reported in particular contexts, in response to open-ended questions, but with full knowledge of their intended audience. They are a communication (Converse and Shuman,

²The quotations have been lightly edited to remove ordinary conversational disfluencies: repeated words, “you know,” “I mean,” and the like, retaining the original meaning. No words have been added. The initials in the brackets refer to the interviewer, not the person being interviewed.

1974) so they might aim to conform to conversational norms, to persuade, to self-promote, to self-deprecate, to promote a mentor, or to shock.

I think that capturing the lived experiences and the rich description of those experiences is critical, and that it should be evaluated or valued as much as some sort of nondescript, and impersonal literature that might be out there as well, that . . . this is just as important, if not more important, than the other elements of the report. [Interviewer O.A. 05-26-22 Pilot Interview p. 14]

Belonging

Interview participants were asked about the extent to which they felt that they belonged and supported in their respective field of study and expertise.³

And so was my first experience stepping into an environment where . . . students didn't necessarily all look like me and certainly not the faculty . . . there was no critical mass of scholars of color. And that was, I will admit, when I first arrived, it was a bit unnerving because I did not feel . . . the opportunity for any kind of sense of belonging or sense of someone else who could recognize my identity, someone who would be able to affirm my identity as a young Black woman. [Interviewer Y.A. 06-10-22 Pilot Interview p. 2]

And so my initial reaction was, . . . do I really belong here, but that really just lasted for a little while, until . . . I got the hang of it and realized that not only was I competing from an academic standpoint, but because of my personal experiences, I felt that I actually had an edge. [Interviewer J.N.B. 05-17-22 Pilot Interview p. 2]

There were very few moments when I didn't realize I was one of the few Black students in a majority White institution . . . This was . . . the early '70s. The civil rights movement was still going on. . . . You knew there were communities you just don't go in. That was a sense of the White students that I was in class with. They didn't get it. It was a sense of being separate from the majority of my classmates. [Interviewer L.M. 06-14-22 RT Interview pp. 3-4]

But certainly, [REDACTED] in particular is an extremely, not only male dominated, very conservative profession . . . so it was challenging because many of us were the first or the only in [REDACTED]. I think I was the second person ever to train at the [PWI 1]. And then I was the first person ever on the faculty there and so on. And, with that come a lot of challenges . . . you don't fit the mold that people are used to. [Interviewer L.M. 06-16-22 GM Interview p.1]

³Chapter 5 includes additional evidence related to the concept of belonging.

My experience as an African American in [FIELD REDACTED] has been often, I was the only one of many quite often, through grad school, postdoc, and even in industry. . . . I got used to being the only African American quite often. But overall, I did feel as part of the community. I never felt as if I was an outsider. I think I must have made good relationships with my majority colleagues that I still felt, as a [scientist], one of them. [Interviewer O.A. 06-03-22 RT Interview p. 2]

Now thinking back, back when I went to grad school, actually, I do remember the first semester. I did not feel as if “I belong”—just because when I reached out to some fellow colleagues, they really weren’t receptive to me, but then I realized, I just had to find individuals who had a passion outside of [REDACTED] science. And then I found that in basketball. So, I did find other grad students that love sports like I did; therefore they became my community. So, in that sense, . . . honestly, you have to maybe identify another way of connecting with individuals and therefore, you may not belong in one way, but you can find that commonality, and therefore you can build relationships that can then expand beyond your initial things that you had in common with them. [Interviewer O.A. 06-03-22 RT Interview p. 2]

Your colleagues didn’t really care about you or to show you what they are showing others, and you stumble through things. And I still remember my first mistake of doing something wrong. . . . And instead of telling me how to correct it, it was used as a more punitive approach to maybe we won’t allow you to do this anymore, to touch anything anymore. . . . I’m a PI [principal investigator], I have to place my own order. I had nobody else. My lab was new. So, I wrote my purchase items I needed to order, took it to the purchasing officer, and the lady looked at me and said, give it to your supervisor to sign. Automatically she assumed I wasn’t a PI, but in fairness to her, I was the first PI really, on the investigator track in that department. So, it was directly, she gave it back to me right away, asked me to give it to my PI to sign. I could have reacted violently. I could have really started screaming on top of my voice, but instead what I told her was where do you want my PI to sign? And she said, where you signed. And I took a pen on the desk, signed over my signature, left it for her and walked away. And that really transformed her even until the time I left for my institution. It was transformative for her. I don’t think she realized what she did until I signed over my signature. It was the first time she said, oh my God, he’s a PI. And . . . throughout my stay there, she was a different person; never looked at people the same way again, made sure that I got anything I wanted along the way. So that’s the way I dealt with that experience. . . . We are putting a big grant together, and I was asked to lead one of the development projects because I was a very young investigator, a junior investigator. Then I wrote my whole proposal, and he decided, let me tell you, grantsmanship is a little tricky. We will use

somebody's name as a PI for the development project so that when it gets funded, you'll still have the money, but we just want to make sure that this whole thing goes through without any hitch. And I said, wow, if you think I'm not good enough to be a PI on a development project, I don't need to be part of it. Right. And the irony is that that project scored one of the best scores ever in the whole program. . . . [Interviewer Y.A. 07-15-22 GM Interview pp. 4-5]

You are very good as long as you are not a threat to any other person's position. And so while those much higher than you would be happy because . . . they use all your work to praise themselves. Your colleagues that want similar positions or the next level position, really . . . lack collaboration with what you're doing. And I see that everywhere that even at my level right now, I expect a lot of resistance initially until I prove myself again. [Interviewer Y.A. 07-15-22 GM Interview p. 1]

Racism and Racial Microaggressions

Although interview participants were not specifically asked whether they experienced racism or racist incidences, general questions about belonging and support (and likely the overall subject of the committee's work) elicited a number of examples.

I always said that [grad] school was like A Tale of Two Cities: "It was the best of times. It was the worst of times." It depends on who you were. If you were White, it was the best of times all the time, and they just answer all my questions, and they invite me over to the house and go meet me at the bar, and for Black students, I can't get a professor to talk to me; when they [professors] talk to me they talk down to me. I don't belong here. I'm supposed to figure all this out and the White students are getting old tests from somewhere that I don't ever get to see. I'm supposed to perform at the same level as them. [Interviewer L.M. 05-24-22 RT Interview p. 1]

So, in that first academic position . . . some senior people made it clear to me that, well, maybe I don't really belong there . . . I worked very hard, but some of them actually went out of their ways to complain that I was publishing too many papers that it must be that the quality is not good. Even though it is the same places, the same journals that they too publish in . . . it was largely maybe out of jealousy that some of them did this, but . . . as the lone Black face there, sadly, you don't feel good when people are constantly trying to put you down even though you are externally getting some recognition. I saw that more as them trying to compete with me and then maybe also trying to show that maybe I'm not as good as it appears that I was. [Interviewer L.M. 06-30-22 GM Interview p. 5]

Not infrequently, White folks will say you're just being too sensitive. But when you have a Black colleague, you can share the experience and say I had the same thing or here's something you can try. It obviously led to a more supportive environment when you knew the person you were talking to about the obstacle you're dealing with, understood the role that race plays in our society. [Interviewer L.M. 6-14-22 RT Interview p. 9]

I was gone for eight months, and while I was over there: in an email, it comes across the book has been . . . accepted and the whole list of authors. And I tell you, it was every single person in our department, except me, [REDACTED] the people who are doing . . . , any kind of work in our department, every single person in the department, except me, had been included as an author. And when I saw that, . . . I felt like a horse had kicked me in the chest . . . that kind of exclusion. [Interviewer Y.A. 07-22-22 RT Interview p. 3]

. . . . But I didn't really understand what we were supposed to do. So, I went to the professor and instead of helping me, she says, well, I'm not going to do your homework for you. . . . I wasn't asking her to do that. And so that's where I understood that some professors would interpret my questions at a low level of sophistication, as opposed to a high level of sophistication, which is often a problem for Black and other racialized students. That's especially true in medical school, even now, when there's some students of color when you're on the rounds. And when you finally get in the clinical spaces, a lot of people are jockeying for the attention of the attending physician. And if you ask a question and then the attending treats it as if it was a stupid question, but then somebody else asks what really could be a stupid question, but then they can see, and it, oh, the brilliance of it. And they, they differentially respond to questions from different people. It could make people of color stop asking questions, which means they don't get their questions answered. And then they also don't look smarter, engaged or whatever. So, this whole thing of people who are judging you, responding to your questions at a low level of sophistication, as opposed to a high level of sophistication because of your so-called race is a real problem at all levels of education. [Interviewer Y.A. 07-22-22 RT Interview p. 10]

. . . racism, it's a tough thing, tough issue . . . even in this year—not directed to me personally, but even on our campus within science and engineering buildings, I mean, there have been a number of incidents where students who were legitimately supposed to be inside buildings and people called police on them. And these are students trying to do research and mind their own business . . . you see that and, wow this is still going on. Something that I thought yeah, I shouldn't have to see that again, and it's happening. [Interviewer L.M. 06-30-22 GM Interview p. 6]

Experiences at Historically Black Colleges and Universities and Predominantly White Institutions

Interviewees were asked questions about their experiences with training at the institutions they attended and in their fields of study over the course of their careers. Some of the interview participants described their experiences at Historically Black Colleges and Universities (HBCUs) while others described their experiences at Predominantly White Institutions (PWIs).⁴

So, at a [PWI 1] research team, it was great because we were all with a new professor. So we all were doing this science together. We were all learning. He was learning how to be a professor. We were learning how to be grad students. So it was that we had that commonality. So that was great. So then when I did my postdoc, it was a little different and I was, went to a senior like his PI in the field. I had a pretty large team actually. We think we had 50 individuals in one lab, probably 25 postdocs, 25 grad students. So that's where I really had to learn how to work with others. Although you're really not on the same team, but we had to share space, share ideas. You had to learn to work with people that thought they were smarter than you. So that's how it really got approached. Like, wow, okay. You were, you're pretty good at what you do, [NAME REDACTED] in [REDACTED], and you can still be yourself and still compete with people that are, you know, overly confident; I should say. [Interviewer O.A. 06-03-22 RT Interview p. 6]

When you come from a predominantly African American college undergraduate where you had just a lot of support, a lot of friendships . . . and then all of a sudden, I arrive on campus at [PWI] where you could go pretty much half a day/all day without seeing anyone who looked like you. I would describe at least initially my experience there as being a bit lonely because I was so used to people being warm and genuine and friendly. [Interviewer L.M. 05-12-22 Pilot Interview p. 4]

A lot of times I think Whites are reluctant to provide honest feedback to us either because they think they are going to hurt feelings or they don't know if there's going to be any kind of a backlash. I've come out of meetings where my presentation was okay but I didn't think it was great. I'll ask one of my White counterparts, how do you think it went. "That was great." I knew it wasn't great. We have to make sure that we're not getting lulled into everything is fine because people aren't being genuine and authentic with us. [Interviewer L.M. 05-12-22 Pilot Interview p. 13]

I was fortunate. I went to an HBCU. I didn't have the challenge of looking around and not seeing anyone like me. I saw so many beautiful, incredibly talented people who I was surrounded with. I had an amazing experience in undergrad in STEM. [Interviewer L.M. 05-12-22 Pilot Interview p. 4]

⁴Chapter 2 includes additional evidence related to HBCUs.

Well you know, at [HBCU 1], you know, was returning to [HBCU 1] was easy because it was like returning home. And so the challenges that one may experience as this person of color going to a PWI were different. [Interviewer Y.A. 06-10-22 Pilot Interview p. 5]

Yeah, I think a lot of that has to do with going to [grad] school at [HBCU1] and training at [HBCU1]. It instilled confidence in my abilities and having been around people who were supportive of abilities. I think it gives you a certain sense of confidence that you can certainly take elsewhere. And so that I would say is part of what would've built up. I would say that the characteristic of resilience came from starting off with a foundation of confidence. [Interviewer Y.A. 06-30-22 RT Interview 1 p. 2]

In some instances the whole HBCU versus a Big 10, and somehow the world has given weight to those, as one being more than the other. Again, I feel like that's mainstream that has defined that. [Interviewer L.M. 06-14-22 RT Interview 2 p. 12]

I went on to an HBCU. And largely because of the high school that I went to was, though diverse, it was largely White. And so I just wanted to experience something where we were the majority. And it was a great experience. And I learned a lot. I learned a lot of history that I don't necessarily think, in that time, I would've learned elsewhere. And so it was a pretty nurturing environment and affirming in a lot of ways. [Interviewer L.M. 06-14-22 RT Interview 2 p. 6]

Mentors, Ingroups, and Outgroups

Some interview participants underscored the importance of having knowledgeable guides during their education and professional pursuits. The committee revisits the subject of mentors in Chapters 5–8.

The advice I always give out is basically, you need to have mentors. You need to have as many mentors as you can possibly find. I have a lot of mentors. My mentors have been with me for a very long time . . . And it's just really important. You cannot do this work without mentors. It's just people - it's not really possible to do it alone. . . . And so having mentors is absolutely crucial. You need peer mentors, that is people in your same stage of life and doing what you're doing at that time. And you have people older than you. And subsequently I think as a teacher, I have, but some of my graduate students mentor me, they teach me things that I don't know. And so I do think that the key is really about mentoring. [Interviewer J.B. 06-08-22 RT Interview, pp. 9–10]

I've had the privilege of having Black people as mentors, advisors, sponsors throughout the course though, and it's been different at different

stages in my, but it has absolutely been seeing them in those leadership roles that has made me believe that, you know, that it is attainable. [Interviewer L.M. 06-14-22 RT Interview 2 p. 11]

Early in my career, of course, there weren't mentors who looked like me, but there were people who were willing to take me under their wing and mentor and support and advocate for me, that really took my career off, all older White men. So that was great. [Interviewer Y.A. 06-02-22 RT Interview p. 3]

And I had a few White male champions, one of whom became my main advisor, who I had met because I was in a summer program, the [REDACTED] summer research program for minorities and women . . . And he is still a mentor of mine. He will still call me up and see how I'm doing and see if he can help in any way with my career. So the importance for me, mentors were absolutely important for graduate school. [Interviewer J.B. 06-08-22 RT Interview, p. 6]

. . . . also mentors . . . , I had certain people I could reach out to and ask, 'Hey, this is what I'm experiencing, what do you think? How should I understand this experience? How do I make sense of this? To what should you attribute this?' And sometimes they called a spade, a spade: this is racism. . . . Or that I interpreted the situation wrong and perhaps there's a different strategy to approach it. [Interviewer O.A. 05-26-22 Pilot Interview p. 4]

So I had this community of Black men that I could rely on, including upperclassmen, who helped me navigate. I had a Black associate director of admissions, [NAME redacted], who was always there for me. My freshman advisor, [NAME redacted], who was a special assistant to the president was there. So I had these people to latch onto, and we had an Office of Minority Education that provided tutorial services, et cetera. So when you think about wraparound support, I had that at [PWI 1]. Even though the broader [PWI 1] seemed threatening to me, I effectively had a buffer. I experienced what Vincent Tinto called institutional integration, which is high quality interactions with administrators and having quality connections with peers. Tinto shows that those who have those two sets of relationships in schools are more likely to persist. I've observed that this principle applies to schools, colleges, and in the workplace. That's really what got me through. [Interviewer O.A. 05-26-22 Pilot Interview p. 6]

Peers, Ingroups, and Outgroups

Interview participants also emphasized the importance of having supportive peers and allies during their education and professional pursuits. The committee revisits this subject in Chapters 7, 8, and 9.

And we had a significant number of Black people. We have 25 in my class at my first year of class . . . What was our community like? Initially, it was a community that was—we were a tribe in this era of tribalism. We formed a tribe. We were there for each other, but at the same time, because of the lack of diversity amongst our tribe and the lack of resources for most of our tribe, we all struggled at about the same place. [Interviewer L.M. 05-24-22 RT Interview p. 2]

So at that point in time, I had to find somebody to study with. It was at that time that I decided to utilize the skills that I had learned in being the only Black in a predominantly White school starting from middle school to high school to college, and decided to start reaching out to my colleagues who are White and try to find folks, White or other, to try to find folks that would work with me. Eventually, I found a crew. And in my sophomore year in medical school, I actually rented a house with seven other medical students. There was a guy from Taiwan. There was a guy from Switzerland. There was a guy who was an Army brat. There was a guy who was of Native American heritage. There was another guy who was from Canada. And then there was a guy from Berkeley, which is its own country in itself. And we all lived in this one house with me, the one Black guy. We would study at night until 10 and 10:30 at night, and then we would have this big quiz bowl. If I stumped somebody, I had to teach them. If they stumped me, they had to teach me. And what that did was like a rise in tide. It lifted all of our boats. We did extremely well academically. [Interviewer L.M. 05-24-22 RT Interview pp. 2–3]

I went to [PWI] and, you know, all of my classmates, I found went to private schools and, and had better preparation than I did. [Interviewer J.N.B. 05-17-22 RT Interview p. 1]

In the program that I was in . . . there was another Asian woman who was in the class with me as well as an African American man. That was very encouraging because the rest of the program and all the faculty and all the other graduate students, the Ph.D. students because I was in a Ph.D. [program]. They were all White. Just showing up and being able to see that there were at least two people who were considered people of color. We developed a genuine friendship from the very beginning and became friends throughout my tenure there. [Interviewer L.M. 05-12-22 Pilot Interview p. 4]

There was a clear sense that [we] the Black faculty were different. It was a small group of us, and we began to meet with each other even though there were two of us in medicine. Others were in the social sciences, history. We would begin having meetings on a regular basis, in one of the more senior faculty members' homes, and have those discussions. We would talk about how we could get more students in, how we could support the students that we did have. That was a sense of support. [Interviewer L.M. 06-14-22 RT Interview p. 6]

Savvy

Mentors, peers, and allies may provide insights into norms, the unspoken rules that promote belonging and may help individuals avoid racialized aggressions and microaggressions. Interview participants described how this knowledge influenced their experiences.

It's very difficult to really know exactly what the steps are that should be taken. There's always a game being played that you're not privy to. So there's just a lot that you have to learn. [Interviewer J.N.B. 05-17-22 Pilot Interview p. 2]

I do think that there are unwritten rules in any organization. The values, the actions, the behaviors of people, the norms, the attitudes, all these things define a culture. And most of those elements are invisible to individuals when they walk into an organization. I'll give you an example. I showed up at [redacted] where I felt uncomfortable because of my socioeconomic background. I had never had my shirts laundered ever in my life. I only had two two-piece suits, and I discovered something on day three because I wore a sport jacket and a gray pair of pants; a blue sport jacket, and gray pair of pants. And someone pulled me aside and said, hey, [NAME REDACTED], I've never seen this. No one wears a separate sport jacket and slacks here; it's always a two-piece suit, shirt, and tie. And I think if I did not have somebody pull me aside and say that, I would've just gone ahead in this, and perhaps been evaluated in a way that says, "He doesn't believe in the culture" or something, because people will create their own story, right? [Interviewer O.A. 05-26-22 Pilot Interview p. 13]

It was very difficult at times, but that gets back to the resilience: the family and the confidence, and willing to work harder, you know, to get promoted at [primarily White institution]—once I knew what I had to do, you need this many publications . . . and if you have a NIH grant that helps a lot . . . And so, you tell me what I've got to do, and then I'm going to figure out how to do it. And so that approach seemed to serve me pretty well, is just trying to understand, what does it take and then figure out a strategy to do it, irrespective of all the noise. [Interviewer L.M. 06-16-22 GM Interview p. 8]

I think there were probably about 20 of us that identified as Black or African American. I sadly, during my first year of medical school, I lost my father . . . I plowed through and interestingly, I was in the library and one of my classmates, a White gentleman, expressed his condolences and he said, you're getting ready for the exam? I said, yeah, it's going to be a . . . [I'm a] little worried. He said, well, did you, did you study from the exam? And I said, what exam? And so apparently, they had some

of these older exams but we weren't privy to it. And then there was one woman, an African American woman, that I often studied with and I asked her, did you hear? She said, no, I had no idea. And so, you know, it's very interesting. Clearly there were some advantages that were just blatant, and you know, I essentially was oblivious to any of those things and, you know, we just, that was our thing. We just put our heads down, and we worked really hard. And we were fortunate to move past some of those difficult tests. [Interviewer L.M. 06-14-22 RT Interview 2 p. 7]

Money

In addition to social capital, several interviewees discussed the role that capital resources played in their experiences.

We don't have the same type of wealth because when we come out of [REDACTED] school, most of us are first generation [redacted] coming out. We don't have the wealth. We have income. But we don't have wealth. But with our income, comes the aspect of beholden. We are beholden to our church. We are beholden to our family. We are beholden to our extended family. We are beholden to our loans because nobody paid for our education to come to the school. [Interviewer L.M. 05-24-22 RT Interview p. 2]

I had a full-ride scholarship, as well a stipend. I think for me that made a huge difference. I didn't have the pressure that some of my other colleagues had to take on research assistance or teaching assistance in order to make additional money. The financial support took a huge burden off of my shoulders because it allowed me to focus on my work every day and my research as opposed to financials. And honestly, I probably wouldn't have been able to afford the program without that level of financial support. [Interviewer L.M. 05-12-22 Pilot Interview p. 5]

I think we have to find ways of helping take that financial burden off especially Black Americans, African Americans who are so often first generation and just do not have the support and don't want to necessarily be in debt the rest of their lives. [Interviewer L.M. 05-12-22 Pilot p. 12]

Sources of Resilience

Interview participants raised a range of sources of resilience including personal resources, such as family, faith, and self-reliance.

Faith, family, colleagues, who believed in me as classmates, faith from going to church, faith from the prayers of my mother and my grandmother and my grandfather, faith from understanding who I am and more importantly, whose I am. Resilience and understanding. It's not what they call

you but what you answer to. Resilience and understanding that don't give away your power. Keep your power as close to your chest and don't allow people to take it from you. And then humility. [Interviewer L.M. 05-24-22 RT Interview p. 5]

And what that [exclusion] did for me was quickly (and that's sad), it quickly made me to look inwards. I mean something you could have asked people easily get the answer to, you had to go on read it up, you have to find the literature, the relevant people publish something in order to do the same experiment you could have just asked somebody about. [Interviewer Y.A. 07-15-22 GM Interview p. 4]

NATURE OF EVIDENCE: MULTIPLE METHODS OF GATHERING KNOWLEDGE

There are a wide variety of ways to gather evidence—to learn and know in understanding pathways to professions in STEMM—that are worthy of attention and were used by the committee in its work. That diversity includes traditional quantitative methods as well as model-based inquiry, Indigenous approaches, oral and community traditions, and interviews to capture lived experience.

Model-based inquiry takes the premises of the standard scientific method and provides a different context and process for using them to build understanding:

. . . . “model-based inquiry” respects the precepts of the scientific method (that knowledge is testable, revisable, explanatory, conjectural, and generative). While the scientific method attempts to find patterns in natural phenomena, the model-based inquiry method attempts to develop defensible explanations. This new system sees models as tools for explanations and not explanations proper and allows going beyond data; thus, new hypotheses, new concepts, and new predictions can be generated at any point along the inquiry, something not allowed within the rigidity of the traditional scientific method (Castillo, 2013).

Another method derives from Indigenous approaches. One Tewa scholar (Cajete, 1999) defines Indigenous science as:

a broad category that includes everything from metaphysics to philosophy to various practical technologies practiced by Indigenous peoples past and present . . . [and, like western science] has models which are highly contextual to tribal experiences, representational and focused on higher order thinking and understanding (p. 81 as quoted in Snively and Corsiglia).

According to the Tewa scholar, Indigenous science includes “exploration of basic questions, such as the nature of language, thought and perception, the nature of time, human feeling, and knowing, interconnectedness, and proper relationships to the cosmos. It is a philosophy that gives rise to a diversity of technologies, such as hunting, fishing, plant cultivation, navigation, architecture, art, and healing” (pp. 90–91, as quoted in Snively and Corsiglia, 2001). “Coming to know,” a phrase that indicates a journey, is the process of “generating or learning Indigenous ways of living in nature” (Cajete, 2000; Peat, 1994). Indigenous coming to know is “a journey toward wisdom or a journey of wisdom in action, not a discovery of knowledge” (Aikenhead and Ogawa, 2007).

Another method is the use of oral and other community traditions to capture knowledge. Using methods that go beyond written records is especially important in capturing knowledge about groups that have not traditionally preserved information via writing or print.

Oral history provides a fuller, more accurate picture of the past by augmenting the information provided by public records, statistical data, photographs, maps, letters, diaries, and other historical materials. Eyewitnesses to events contribute various viewpoints and perspectives that fill in the gaps in documented history, sometimes correcting or even contradicting the written record. Interviewers are able to ask questions left out of other records and to interview people whose stories have been untold or forgotten (Baylor University Institute for Oral History, 2016).

Finally, there are methods for capturing lived experience, which are called for in the committee’s statement of task; the interviews conducted by the committee were designed to capture the lived experiences of Black STEMM professionals. The committee also recognized it is important to continue collecting lived experiences and to include voices that are not well represented in the research including those of Black, Indigenous, and other minoritized individuals.

In the context of the information gathered through the structured interviews with Black STEMM professionals and understanding the nature of evidence and multiple methods of gathering knowledge, the committee came to the following conclusion:

CONCLUSION 4-1: *Oral history and other means of exploring the lived experiences of scholars from historically and systemically minoritized groups in STEMM offer valuable insights that supplement findings from other kinds of research. These methods should be continued and expanded.*

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PART III

Minoritized Individuals in STEMM: Consequences and Responses to Racial Bias and How STEMM Professionals Can Help

The primary focus of the report so far has been on the experience of minoritized individuals in sciences, technology, engineering, mathematics, and medicine (STEMM) environments, situated within the larger sociopolitical context of the United States. As discussed in the first four chapters, the evidence has demonstrated that minoritized individuals have faced numerous *systemic* barriers, including macro-level policies and practices that have negatively impacted their opportunities, representation, and ability to thrive in STEMM careers. This chapter shifts the lens of analysis from an examination of racial bias at the systemic level to an examination of racial bias as it occurs at the individual and interpersonal levels. This chapter addresses the charge in the statement of task on reviewing the research and evidence on the ways in which racism at the individual level impedes STEMM careers for minoritized individuals. Furthermore, this chapter also addresses the charge to identify methods of improving recruitment, retention, and advancement of members of minoritized groups. To do so, the committee reviews literature covering Black individuals, but also Latine and Indigenous individuals.

The chapter begins by summarizing research describing how and why race and ethnicity are salient social categories. This research finds that as a result of several social cognitive processes, individuals create social categories, distinguish ingroups and outgroups, and assign personal meaning on the basis of race and ethnicity. All of these factors have implications for the ways in which individuals express and experience racial bias, and the consequences of racial bias are reviewed in detail in the second half of this section. These include a range of cognitive, emotional, and physiological outcomes associated with experiencing racism in STEMM

contexts: negative impacts of predominately White contexts, stereotype threat and social identity threat, imposter phenomenon, stigma and coping, attributional ambiguity, physical health impacts, and race-based rejection sensitivity. This section concludes with a major key finding: minoritized individuals experience a range of adverse cognitive, emotional, and physiological consequences as a result of facing racial bias.

The second part of the chapter summarizes the noteworthy ways in which these individuals respond to bias in STEMM environments, including other professional spaces. These responses can be categorized into three general groups: exiting the field, implementing strategies to fit in, and collectively mobilizing to transform the STEMM environment. Each response has different implications for the advancement, recruitment, and retention of minoritized individuals in STEMM.

The chapter concludes with a discussion of ways in which STEMM professionals can redesign local STEMM environments to support minoritized individuals. These strategies center on fostering connections, emphasizing communal values, affirming kindness cues, and increasing a sense of belonging.

Overall, the committee focuses on the experience of being in minoritized groups that deviate from White norms to the extent that individuals in those groups are often the target of racial biases and systemic racism in the United States—people who are Black, Indigenous, and Latine—and the impact on individuals in STEMM contexts specifically. Broadly speaking, these minoritized groups control fewer resources, have less access to STEMM professions and fields, and are more vulnerable to racism and exclusion. The material in this chapter dovetails with that in Chapter 6, which turns from people's experiences as the *targets* of racism to experiences of *gatekeepers* who possess power within STEMM and, whether consciously or unconsciously, perpetuate racism.

SOCIAL COGNITIVE PROCESSES AND CONSEQUENCES OF RACIAL BIAS

People carve the world into social categories or groups along many axes, including race and ethnicity, a tendency that can be seen in the social cognitive process of social categorization. The first part of this section details how creating such groups can lead to psychological experiences of “us” and “them.” This includes a consideration of how individuals may be members in particular social groups and subjectively identify with their groups to varying degrees (social identity), which has consequences for well-being when group esteem is threatened. The second part of the section demonstrates that there are a range of adverse cognitive, emotional, and physiological consequences that minoritized individuals experience as a result of facing bias against their racial or ethnic group.

SOCIAL CATEGORIZATION AND SOCIAL IDENTITY

The human mind simplifies information processing through *social categorization*, which is the process of categorizing people into groups based on perceived visual, functional, or role similarity and inferring that members of a group share these and other common attributes (Fiske, 2005; Hilton and von Hippel, 1996; Macrae and Bodenhausen, 2000). Such inferences allow humans to take mental shortcuts in processing information about *new* people; thus, when a person encounters an individual for the first time, they often categorize that individual into a social group, based on perceived salient characteristics. This grouping is often accompanied by the inference that members of a given group are more similar to others in that group as compared to members of other groups. This kind of inference is the essence of stereotyping, which is the overgeneralized attribution of characteristics to others based on their group membership (Fiske, 2005; see Chapter 6 for more on how social categorization underpins stereotyping, prejudice, and discrimination).

This process of social categorization is also reflexive, where individuals also think of themselves as belonging to groups. Groups to which an individual belongs are their “ingroup,” whereas other groups to which they do not belong are their “outgroup.” Thus, from the perspective of any given person, social categorization divides the world into “us” (ingroups) and “them” (outgroups). Ingroups may be based on ascribed characteristics (e.g., groups based on age, sex, race, or ethnicity) or chosen characteristics (e.g., groups based on professions, roles, religion, nationality; Brewer, 2007). Research using social identity theory (Tajfel, 1978; Tajfel and Turner, 1979) shows that a person’s identification with their various ingroups is a central component of that individual’s self-concept. Some ingroups may be more important to a person’s sense of self than others, in that people derive greater self-esteem from those identities (Brown, 2000). In addition, people exhibit a strong tendency to favor their ingroups relative to outgroups in social evaluations and resource allocations. This tendency has been used to explain intergroup prejudice as well as discriminatory behaviors (Böhm et al., 2020; Leaper, 2011; Wolfe and Spencer, 1996). These phenomena are not limited to racial groups in United States, but they occur with various types of groups, everywhere, throughout history.

When particular groups are of high status and power, whether historically or in the short term as the result of specific situations, other groups are often measured against the norms established by the high-status group (Fiske et al., 2016). In relation to race, research shows that the more a person deviates from the non-Hispanic White norms (hereafter referred to as White)—a high-status group—in terms of skin color, hair, accent, and physical features, the more racism a person is likely to experience (Blair et al., 2004; Dixon and Telles, 2017; Eberhardt et al., 2006; Maddox and

Perry, 2018; see Chapter 2 for more on historical context for race and status in the United States). Below, this chapter describes a range of cognitive, emotional, and physiological outcomes associated with experiencing racism in STEMM contexts. This includes sections on the negative impacts of predominantly White contexts, stereotype threat and social identity threat, imposter phenomenon, stigma and coping, attributional ambiguity, physical health impacts, and race-based rejection sensitivity.

Negative Impacts of Predominantly White Contexts

For minoritized individuals in STEMM, navigating classrooms and environments in which they are a clear numeric minority has measurable psychological, physiological, and behavioral effects (see Chapter 3 for a summary of issues that contribute to numeric representation). These predominantly White contexts threaten two fundamental human needs. The first is the human need to belong. Anthropologists, social psychologists, and sociologists show that all humans have a universal need for attachment affiliation (Bowlby, 1969, 1973; Casella and Fowler, 2005; Cosmides et al., 1992; Maslow, 1943, 1968; Sherif et al., 1988). From an evolutionary perspective, seeking belonging is necessary for survival across many species (De Waal, 1990, 2009). Affiliation needs lead humans to set aside personal desires for the sake of belonging to a group where roles, norms, and responsibilities promote the survival of all group-affiliated members (Cheney et al., 1986; Panter-Brick et al., 2001). Investigators have (Baumeister and Leary, 1995) concluded that “the desire for interpersonal attachments—the need to belong—is a fundamental human motivation.” People experience well-being and prosperity in the presence of social connection (Baumeister and Leary, 1995; Dunbar and Barrett, 2007) and stress and pain akin to physical pain in the presence of social exclusion (Eisenberger and Lieberman, 2005; Fiske, 2009).

The second fundamental need threatened by predominantly White contexts is the need to be valued and treated with dignity. Drawing on evolutionary, social, and developmental psychology, one scholar (Hicks, 2011) concluded that individuals feel their dignity is violated when some aspect of their identity is rejected. Dignity violation, which may include obvious acts of discrimination or subtle acts of ostracism, activates negative emotions that compromise decisionmaking, social judgments, and problem-solving (Isen, 2008; Keltner and Lerner, 2010). Dignity violations in the context of STEMM academic settings impact cognitive functioning related to academic success, motivation, and an array of other outcomes to be described in the upcoming paragraphs.

There are four features of predominantly White contexts that often make it difficult, if not impossible, for minoritized individuals to have these

needs of belonging and dignity met in a full or satisfactory way. The first is that in such environments, there are few, if any, people who share one's identity; this results in a lack of high-status role models (Dasgupta, 2011; Griffith and Dasgupta, 2018; Sekaquaptewa et al., 2007; Sekaquaptewa and Thompson, 2002; Stout et al., 2011). The second is a lack of support and opportunity for building relationships with peers from similar backgrounds, which results in a weaker network (Blake-Beard et al., 2011; Dasgupta, 2011; Dennehy and Dasgupta, 2017; Thiem and Dasgupta, 2022). The third is inadequate access to material and knowledge resources resulting, in part, due to resource-poor social networks and disconnection from central individuals with influence (Castilla et al., 2013a,b; Jack, 2016, 2019; Mishra, 2020; Simmons, 2011; Stephens et al., 2012; Thiem and Dasgupta, 2022). The final feature is that in such environments, one's contributions are not recognized or valued (Castilla, 2008; Griffith et al., 2022; Misra et al., 2017).

These four features are very much part of STEMM training and work environments, and as elsewhere, they have a profound impact on minoritized individuals who work in these types of local environments. They contribute to minoritized individuals feeling like solos or tokens, cut off from insider knowledge networks, and that their work and contribution is invisible (see Chapter 4 for descriptions of these phenomena from lived experience). As a result, individuals start to doubt their belonging, ability, and commitment to the endeavor, especially when alternative choices and paths are available (Dennehy et al., 2017; Thiem and Dasgupta, 2022). Threats to belonging that are driven by low numeric representation of similar others and absence of strong relationships or a social network are particularly potent in transition periods such as the transition to college, to graduate school, or to a new job (Dasgupta, 2011; Hurtado and Carter, 1997; Thiem and Dasgupta, 2022).

Stereotype Threat and Social Identity Threat

Stereotype threat is situation-induced worry that arises in achievement-oriented situations when individuals feel apprehensive that their performance will be judged in ways that confirm negative stereotypes targeting their ingroup (Steele, 1997, 1998, 2011). This worry acts as a stressor for the individual, taxing their working memory capacity and undermining their objective performance relative to non-stereotyped group members. However, when an achievement-oriented situation is redesigned to explicitly disavow the negative stereotype (and be identity safe), the same individuals perform as well as non-stereotyped peers (for reviews, see Aronson and Steele, 2005; Crocker et al., 1998; Schmader et al., 2008; Steele et al., 2002).

A concept closely related to stereotype threat is social identity threat, which focuses on situations where individuals feel their valued identities are marginalized or ignored, which in turn affects much more than performance—their sense of belonging, motivation, interests, persistence, and aspirations to persist. By activating negative stereotypes and undermining belonging, stereotype threat and social identity threat reduce self-confidence in one's ability (or self-efficacy) and leads individuals to withdraw from the domain. This is the experience of many minoritized students at predominantly White universities, women (of multiple racial and ethnic identities) in science and engineering, and professionals on upward career trajectories in professions where they (minoritized individuals, and women of multiple racial/ethnic identities) are often tokens (e.g., STEMM; Blascovich et al., 2001; Emerson and Murphy, 2014; Fischer, 2010; Lewis and Sekaquaptewa, 2016; Sekaquaptewa et al., 2007; Spencer et al., 2016; Steele et al., 2002). Consequently, many of these individuals tend to leave their academic or professional path (Ceci and Williams, 2010; Ceci et al., 2009; McArdle, 2008).

Imposter Phenomenon

Social identity threat sometimes leads individuals to lose confidence in their abilities, consequently, they remove themselves from achievement-oriented environments even when their performance is equal to that of their peers. In other words, high performance and high confidence are not always strongly correlated (Dasgupta, 2011; Stout et al., 2011). Thus, social identity threat is closely related to the imposter phenomenon, a term coined more than three decades ago (Clance and Imes, 1978). Research on the imposter phenomenon (also known as imposter syndrome) shows that sometimes individuals privately believe they are faking talent (Clance and Imes, 1978; McGregory et al., 2008); in these cases, they are more likely to attribute their strong performance to luck, effort, or personal charm (Chae et al., 1995; Clance, 1985; Thompson et al., 1998) instead of personal ability (Topping and Kimmel, 1985). They are dissatisfied with their performance even when it is at par with peers and colleagues, feel unsure of their ability, and have low expectations of repeated future success (Chrisman et al., 1995; Cozzarelli and Major, 1990; Kumar and Jagacinski, 2006; Thompson et al., 1998). Members of minoritized groups who are solos or tokens in high-achieving, predominately White contexts are particularly vulnerable to imposter phenomenon (Bravata et al., 2020). For example, African American graduate students at predominantly White universities experience imposter fear, which is associated with lower academic confidence or self-efficacy (Ewing et al., 1996). Likewise, for women who are a small numeric minority in engineering, academic failures are associated

with a sharp decrease in self-esteem, and academic successes do not result in an increase in self-esteem (Crocker et al., 2003). Taken together, research demonstrates that the experience of being a numeric minority in high stakes achievement environments—like those of STEMM—shakes individuals' confidence in their own ability, especially in the face of difficulty. This remains true even if their actual performance is objectively equivalent to individuals of the majority group.

Stigma and Coping

Social identity threat is related to another body of research on stigma. A stigma is an attribute of a person that is associated with devalued stereotypes and is deeply discrediting in society (Goffman, 1963, p. 3). A discredited attribute could be visible, such as one's skin color or body size, or could be hidden but discreditable if revealed, such as one's criminal record, struggles with mental illness, or poverty. Carrying a stigma complicates everyday interactions—stigmatized individuals may be wary of engaging with people who do not share their stigma; meanwhile, those without a certain stigma may disparage, overcompensate, or attempt to ignore stigmatized individuals. Research demonstrates the negative impacts of stigma on self-esteem, achievement, mental health, and physical well-being (for a review, see Major and O'Brien, 2005; also see Bryant-Davis and Ocampo, 2005). Sometimes, societal stigmas are internalized by minoritized individuals, leading them to experience a lack of deservingness, self-directed racism, and self-devaluation (Frost, 2011; Wester et al., 2011).

In the face of stigma, individuals may engage in multiple forms of coping to regulate their emotion, cognition, and behavior (Sanchez et al., 2018). Some coping strategies help individuals buffer against the stressful event (Aspinwall, 2004), while others may exacerbate the stress. One review highlighted commonly used strategies for coping in the face of discrimination, such as attributing negative events to experiences of discrimination as opposed to internalizing the event and blaming oneself; disengaging self-esteem and effort from identity-threatening situations; and increasing one's personal identification with the stigmatized group (Major and O'Brien, 2005).

Attributional Ambiguity

Even when situations do not activate social identity threat specifically, they often create a feeling of uncertainty in minoritized individuals about the cause of someone else's behavior toward them, be it positive or negative (Major et al., 1994; Mendes et al., 2008; Smith and Wout, 2019). This feeling of uncertainty is called attributional ambiguity, and it happens in many

contexts, including STEMM environments (Bandyopadhyay et al., 2022; O'Brien et al., 2016). Experiences of attributional ambiguity arise in interactions between people of different status groups, where the lower-status interaction partner feels uncertain about whether the cause of the higher-status person's behavior toward them is based on personal deservingness (e.g., their actual ability or qualifications) or the result of racial bias. In the context of race, this ambiguity occurs when minoritized individuals interact with White individuals; in such interactions, the minoritized individual may wonder whether positive feedback from the White individual is genuine or the result of overcompensating, and if negative feedback is deserved or the result of stereotyping or prejudice (Major et al., 2002).

Evidence demonstrates that in interracial interactions (i.e., interactions between individuals of different races), Black individuals trust feedback more (both positive and negative) if their identity is masked than if their identity is revealed (Crocker et al., 1991). When their identity is revealed, they attribute negative feedback to the evaluator's prejudice, which protects their self-esteem, but they are unable to trust positive feedback as genuine, which undermines self-esteem. Individuals who belong to multiple minoritized groups, such as Black women, may face additional obstacles of determining whether another person's behavior toward them is a result of one of several types of bias (e.g., racism, sexism), a unique intersectional form of bias, or personal deservingness. Such intersectional forms of attributional ambiguity are under-researched (Remedios and Snyder, 2015).

Attributional ambiguity can yield both positive and negative outcomes for the minoritized individual (Aronson and Inzlicht, 2004; Hoyt et al., 2007; King, 2003; Major and Crocker, 1993). Attributing an ambiguous event to prejudice or discrimination may protect minoritized individuals' self-esteem by preventing them from attributing the event to their personal characteristics (e.g., Crocker et al., 1991; Hoyt et al., 2007; Mendes et al., 2008). However, attributing events to discrimination may yield adverse outcomes as well, such as distress, reduced well-being, and threats to identity and belongingness (Albuja et al., 2019; Chae et al., 2011; Miles et al., 2020). For instance, one study analyzed the perceptions of racial microaggressions—subtle or indirect form of racial discrimination (see Chapter 6 for more on microaggressions)—among Black doctoral students in STEMM and found that participants' sense of belonging and identity as scientists were negatively impacted (Miles et al., 2020). Mixed signals wherein minoritized individuals receive university communications that affirm commitment to diversity while simultaneously experiencing microaggressions in classroom settings may also contribute to attributional ambiguity in STEMM educational contexts (Estrada et al., 2018).

PHYSICAL HEALTH IMPACTS OF BEING THE TARGET OF RACISM

Over the past several years, there has been a substantial growth in research on the association between racism and health outcomes. This work shows that racism experienced at every level (e.g., institutional, interpersonal) undermines psychological health (Araújo and Borrell, 2006; Jones and Neblett, 2019; Pieterse et al., 2012) and physical health (Paradies et al., 2015; Solomon et al., 2022; Williams et al., 2019a,b). In fact, the director of the Centers for Disease Control and Prevention (CDC) and leading medical societies, including the American Medical Association (AMA), declared racism to be a serious public health threat (Centers for Disease Control and Prevention, 2021; O'Reilly, 2020). In terms of psychological health, racism faced by minoritized individuals is associated with increased anxiety (Stein et al., 2019), depressive symptoms (English et al., 2014), major depressive disorder (Russell et al., 2018), distress (Nguyen et al., 2021), and suicidal ideation (Madubata et al., 2022). Some scholars note that negative psychological consequences associated with racism share features associated with trauma (Pieterse et al., 2012).

In terms of physical or physiological health, experiences of racism are significantly associated with poor cardiovascular health (Javed et al., 2022), hazardous drinking behavior (Gilbert and Zemore, 2016), poor sleep (Slopen et al., 2016), and cancer-related risks (Black et al., 2015; Plascak et al., 2022). A number of studies suggest that stress-induced “weathering” among older Black individuals, defined as the cumulative health impact of repeated experiences of social, economic, or political exclusion and effortful coping, induces morbidity both directly and indirectly through unhealthy behaviors (Geronimus, 2001; Geronimus et al., 2006). Weathering is thought to be partially responsible for race disparities in metabolic illnesses such as diabetes and cardiovascular disease. Multiple studies connect extended psychosocial stress to inflammation (McDade et al., 2006; Melamed et al., 2006; Weinstein et al., 2007). Inflammation, in turn, plays a causal role in cardiovascular problems and poor blood sugar control resulting from insulin resistance (Grundy et al., 2004; Yudkin, 2003). Chronic low-grade inflammation is linked to cardiovascular disease (Danesh et al., 2000), type 2 diabetes (Pradhan et al., 2001) and metabolic syndrome (McDade and Hayward, 2009; Ridker et al., 2003). Using a nationally representative probability sample from the 2005–2006 U.S. National Social Life, Health, and Aging Project, one study found that inflammation was most consistently associated with older Black men’s greater metabolic problems, less control over blood sugar levels, and negative cardiovascular outcomes (Das, 2013). Moreover, inflammation significantly mediated men’s race disparities in metabolic states. The authors of that

study argued that inflammation is an underexamined “biological gateway” through which stressors in social environments affect older Black men’s diabetic and cardiovascular outcomes. In sum, the scientific literature shows that racism creates a substantial and disproportionate burden of illness on minoritized individuals.

RACE-BASED REJECTION SENSITIVITY

Research shows not all minoritized individuals experience the same context in the same way. For example, individual differences in expectations shape how minoritized individuals interpret their environment, which in turn influences their adjustment to academia and other STEMM contexts. Some people are more sensitive to rejection based on their race, which influences their interpersonal experiences in predominantly White contexts. Research has found that college students’ expectations of race-based rejection can strain their social relationships and undermine their sense of confidence in the academic institution they are enrolled in. This has been found to result in reduced motivation to pursue personal goals among rejection-sensitive students, compared to less rejection-sensitive students who continued to persist (Mendoza-Denton et al., 2002). A later study showed that ethnic identification and race-based rejection sensitivity predicted decreased intention to persist in school among African Americans but did not predict lower grade point average (Mendoza-Denton et al., 2008). These findings demonstrate that individuals who belong to a given minoritized racial or ethnic group do not represent a monolith. There are important individual-level differences within members of a given group, and these differences can inform experiences and outcomes. Therefore, some minoritized individuals may thrive in predominately White contexts while others struggle. Additional research studying these individual-level differences is necessary and important for better understanding the discussed range of adverse cognitive, emotional, and physiological consequences.

Summary

The committee wishes to highlight a key finding that emerged from the information summarized in the above sections: Minoritized individuals experience a range of adverse cognitive, emotional, and physiological consequences as a result of facing racial bias. Moreover, individuals who occupy multiple minoritized identities may face added complexities and consequences navigating STEMM spaces as a result of facing multiple sources of bias. There is a paucity of research on the experience of such individuals, and the committee noted that more is needed. The committee also felt it important to emphasize that minoritized individuals in STEMM

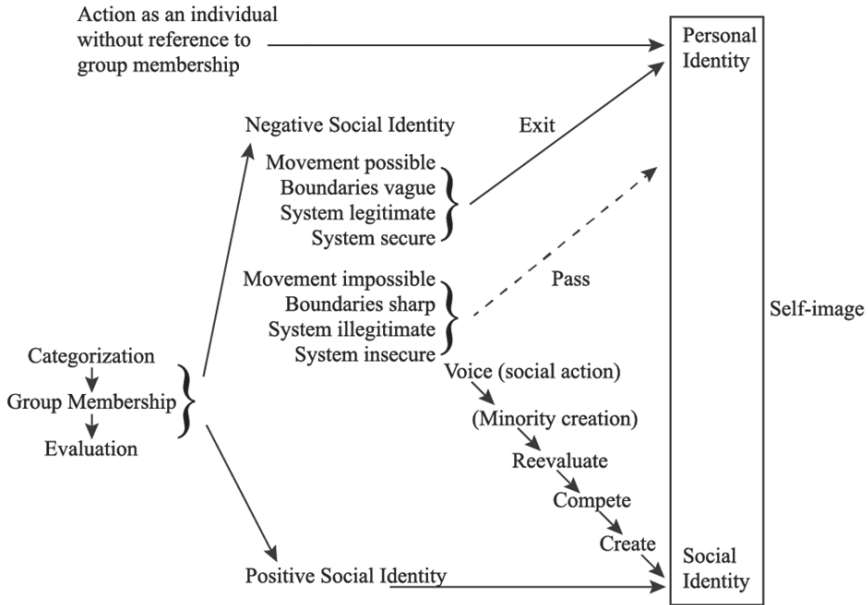


FIGURE 5-1 Minoritized individuals’ responses to facing racial bias.
SOURCE: Brown, 1986.

are not a monolith, both within a given group and between groups. As such, the experiences and consequences of racial bias may vary at the individual level. Additional research and expanded sampling to include larger and more representative samples of all minoritized racial and ethnic groups is necessary to better understand these potential similarities and differences.

Minoritized Individuals’ Responses to Racial Bias

The following section reviews three noteworthy ways in which minoritized individuals respond to experiences of racism. These responses can be grouped loosely into three groups: exiting the field, implementing strategies to fit in, and collectively mobilizing to transform the environment (see Figure 5-1; Brown, 1986).

STRATEGIES FOR EXITING: DISIDENTIFICATION AND PASSING

Exiting is a common response for minoritized individuals experiencing racism in STEMM environments. Exiting generally encompasses two

patterns: moving away from and often leaving the field (disidentification) and moving away from one's ingroup (passing; Woodcock et al., 2012). National data of more than 200,000 students who started college in fall 2004 at 326 four-year institutions across the United States show that Black, Latine, and Native American students enter college with aspirations to major in STEM at levels similar to their White and Asian peers. However, their paths diverge in college. Four-year (2008) and five-year (2009) college graduation rates reveal that Black, Latine, and Native American students complete college with STEM majors at lower rates (15.9, 13.2, and 14.0% respectively) compared to their White and Asian American peers (24.5 and 32.4% respectively). These differences become more pronounced when comparing the five-year graduation rate (Higher Education Research Institute, 2010; see Chapter 3 on related data).

In an attempt to identify specific barriers responsible for persistence gaps, other research identified a few key characteristics that differentiated students who earned bachelor's degrees in STEM fields from those who did not (American Council on Education, 2005; the National Academies of Sciences, Engineering, and Medicine, 2011). This research found that students who successfully completed bachelor's degrees in STEM were more likely to: (i) enter college with rigorous high school preparation; (ii) have access to high-quality information and support related to higher education and career pathways that influenced their choice of college and navigation while in college; and (iii) have financial support that allowed them to focus on academic work without juggling long hours of paid work. In other words, high school preparation, social support, and financial capital strengthened students' skills and persistence in STEM. Furthermore, there is evidence demonstrating that even after statistically accounting for students' socioeconomic status and academic preparation, cultural experiences in college influenced STEM students' performance, engagement, and persistence (Chang et al., 2011). Therefore, the nature of the context is another critical factor, and environments that fail to affirm inclusion may result in individuals implementing exiting strategies. These strategies are discussed next.

Disidentification is one exiting strategy that minoritized individuals may use to deal with persistent social identity threat and belonging uncertainty. Disidentification is the process of becoming less invested in, or the long-term abandoning of, a formerly valued activity, interest, or social identity. Consequently, individuals may disidentify from their STEMM degree or profession, which places minoritized individuals at risk of leaving the field of STEMM (Woodcock et al., 2012).

Ironically, the more a person's sense of self is contingent upon doing well in a particular domain, the more vulnerable they are to social identity threat because of the worry that their underperformance or failure may prove the stereotype true in others' eyes. Disidentification creates distance

between the self and a domain that includes sets of specific stereotypes (e.g., STEMM), and thus is one way that minoritized individuals can mitigate the effects of social identity threat (Major and Schmader, 1998). While disidentifying from the field is an individual-level strategy implemented by minoritized individuals in the face of racism, larger racist systemic-level barriers can continue to remain in place even after the person exits, if no top-down changes are made (see Chapter 8). Research shows that disidentification is more likely to happen in early stages of academic or professional development, such as when individuals in transition (e.g., college to a job), or among individuals who are new to the environment (Callagher et al., 2021).

Consider Black, Indigenous, and Latine students at predominantly White universities or girls and women in science and engineering, where their ingroup is numerically underrepresented. Research has found there is a substantial number of high-performing individuals who are exiting their field or taking a different academic or professional path (Ceci and Williams, 2010; Ceci et al., 2009; McArdle, 2008; Pinker, 2008; Rosenbloom et al., 2008). While it may appear that the choice to leave or opt for a different path appears to be made freely, there is a body of research demonstrating that these critical decisions are in fact shaped by stereotypes. These stereotypes inform ideas about who is likely to succeed or fail and who belongs in a given environment (Cheryan et al., 2009; Logel et al., 2009; Settles, 2004; Spencer et al., 1999; Steele et al., 2002; Stout et al., 2011; von Hippel et al., 2011; Walton and Cohen, 2007, 2011; Woodcock et al., 2012). For example, a three-year longitudinal study of African American and Hispanic/Latine undergraduate students in STEM majors showed that experiences of stereotype threat were associated with scientific disidentification, which in turn predicted a significant decline in the intention to pursue a scientific career (Woodcock et al., 2012). This effect was stronger for Hispanic/Latine students than African American students. Other research found that African Americans experiencing stereotype threat disengaged from academics in response to negative performance feedback (Nussbaum and Steele, 2007).

Passing—psychologically distancing oneself from one’s ascribed social ingroup—is another type of exiting. Passing is only possible if a person can conceal their disadvantaged group membership, which may be the case for individuals from poor or working-class origins, individuals who are lesbian, gay, bisexual, or transgender, and Black, Indigenous, and Latine people with light skin color who can pass as White. This is a form of exiting as well, wherein an individual “exits” their own social identity and no longer thinks of themselves as a member of the racial or ethnic group (Brown, 1986). There is a small set of contemporary research on passing among minoritized individuals, particularly in the context of STEMM (McGee, 2016; Ong, 2005). Additional research is necessary to better understand this phenomenon.

STRATEGIES FOR FITTING IN AND SURVIVING: GRIT, RESILIENCE, AND CODESWITCHING

Grit and resilience are related concepts that describe how minoritized individuals might try to fit in and survive in achievement-oriented environments, such as STEMM. Grit is an individual trait that reflects a single-minded pursuit of long-term goals regardless of setbacks (Duckworth et al., 2007). Studies show that grit is significantly associated with improved academic performance (Christopoulou et al., 2018).

Resilience is defined as a healthy and adaptive functioning following adverse events (Southwick et al., 2014). It is an individual's ability to bounce back or overcome difficult stressors and adversity (Masten and Narayan, 2012). Resilience is sometimes conceptualized as an individual-level trait (Debb et al., 2018) and at other times as a process of adaptation or having a better-than-expected outcome (Southwick et al., 2014). Research shows that increased trait resilience is associated with higher levels of subjective well-being and increased optimism and life satisfaction among African Americans college students (Utsey et al., 2008). Other research, viewing resilience as an ongoing process, identified several predictors associated with the process of becoming more resilient (Johnson, 2011). These include: (i) participating in learning communities with peers who share one's racial or ethnic identity (Leyva, 2021); (ii) participating in STEMM pipeline programs (e.g., Lane and Id-Deen, 2020); (iii) connecting with social support structures, community, and family (e.g., Fernández et al., 2021; Pumacahua and Rogers, 2022; Rincón et al., 2020); (iv) having opportunities to giving back to communities (Page-Reeves et al., 2019; Rincón and Rodriguez, 2021); (v) affirming one's racial identity (e.g., Morton and Parsons, 2018; Sparks et al., 2021) including language heritage (Stevenson et al., 2019); (vi) engaging in self-renewal activities and religiosity (e.g., meditation; Gazley and Campbell, 2020); and (vii) integrating multiple identities (Ross et al., 2021).

There is critical literature examining resilience in STEMM among minoritized individuals (Gonzalez et al., 2021). For example, one recent study explored the factors that allow Black women to be successful and thrive in engineering professions. Interviews with a sample of Black women engineers who had at least 10 years of work experience in industry showed that the integration of race, gender, and role identities fostered resilient engineering identities (Ross et al., 2021). Similarly, longitudinal research shows that Native scholars who have STEMM mentors with knowledge of Native culture are more likely to endorse STEMM values and persist in STEMM (Estrada et al., 2022).

Like exiting, grit and resilience are individual-level forms of coping where individuals carve out their own path despite the existence of

structural barriers. An overreliance on individuals' resilience to "make it" in STEMM ignores the need for a critical examination of structural barriers in STEMM institutions (McGee and Bentley, 2017; Morton and Nkrumah, 2021) that contribute to the persistence of underrepresentation and exclusion of minoritized individuals, as well as the need to change them. Structural changes in STEMM cultures to promote antiracism, diversity, equity, and inclusion will require more than the advocacy and actions of minoritized individuals with grit or resilience (see Chapter 8 for more).

Codeswitching is another way that people from minoritized groups adapt to a predominantly White context and culture temporarily. Codeswitching is a context-dependent impression management strategy where minoritized individuals adjust their self-presentation in predominantly White contexts to fit in and be accepted by mirroring the White majority (McCluney et al., 2021). This occurs through mirroring norms, attributes, and behaviors. Recent codeswitching research shows how minoritized employees may navigate predominately White contexts by dressing differently, changing their speaking style, adopting specific hobbies, and adopting specific topics of conversation (Boulton, 2016; Koch et al., 2001; McCluney et al., 2021). Through codeswitching, a person acculturates to a predominantly White culture while in the company of White people and switches back to a different, more authentic, self-presentation in non-White environments. For instance, a Black emergency medical doctor from California indicated having to become more familiar with ice hockey and the National Hockey League games because that was a popular topic of conversation among his mostly White work colleagues; however, when interacting with another minoritized surgeon, that individual felt freer to discuss "making it" and facing discrimination in medicine as a person with dreadlocks (Brown, 2021).

One form of codeswitching among Black individuals involves changing hairstyles or chemically altering one's natural hair to fit into the White norms and rules that define professional appearance in predominately White contexts, including STEMM (Bryant, 2013; Dawson et al., 2019; Donahoo, 2022; Ferguson and Dougherty, 2021; Johnson and Bankhead, 2014; Opie and Phillips, 2015). Codeswitching may be a double-edged sword. On the one hand, there is evidence demonstrating it is associated with increased perceptions of professionalism (McCluney et al., 2021). On the other hand, it reaffirms the expectation that White norms and appearances are the default (McCluney et al., 2019; Opie and Phillips, 2015; Ray, 2019; Rabelo et al., 2021), and it may undermine feelings of authenticity (McCluney et al., 2019). Moreover, minoritized individuals may feel pressured to codeswitch because of psychological penalties for not doing so (Brown, 2021; Dickens and Chavez, 2018; McCluney et al., 2021; Morales et al., 2021).

COLLECTIVELY MOBILIZING TO TRANSFORM THE DOMINANT STEMM CULTURE

Historically, programs to address the numeric underrepresentation of systemically minoritized groups in STEMM have focused on “fixing” individuals—e.g., improving scholastic performance, increasing interest, providing research experiences (Asai, 2020). However, solely relying on this “deficit-based framework” may lead to the assumption that the cause of the problem is the character of minoritized individuals rather than the persistence of structural barriers (e.g., Coleman and Davis, 2020; Rocha et al., 2022). It also creates the false impression that minoritized individuals are passive. Shifting to an “asset-based” framework (Denton et al., 2020) identifies the strengths, social, and cultural capital among minoritized individuals and returns power to these individuals to counter structural racism; thus, such a shift may prove beneficial (Yosso, 2005). Research on validation theory has demonstrated positive effects on student persistence when educators take an asset-based approach by valuing students’ strengths and celebrating inclusion (Barnett, 2011; Linares and Muñoz, 2011).

Despite being numerically underrepresented, minoritized students and faculty in STEMM have been active in building welcoming, affinity-based professional communities, both virtual and in-person, to strengthen their sense of belonging, provide support, expand networks, and grow the next generation in STEMM. For example, the Society for Chicanos, Hispanics, and Native Americans in Science (established in 1973; SACNAS, n.d.), the National Society for Black Engineers (established in 1975; NSBE, n.d.), and the American Indian Science and Engineering Society (established in 1977; AISES, 2021) are some of the first professional societies to address the paucity of people from minoritized groups in various STEMM disciplines. These pioneer organizations—which typically work as membership societies, with dues, student chapters, and annual in-person conferences—provide refuge, support, mentorship, professional development, and ingroup role models for emerging scholars (Martin et al., 2016; Ondrechen, 2014; Ross and McGrade, 2016). Qualitative research showed that after attending a SACNAS research conference, students reported increased motivation and networking (Perez and Robnett, 2014). Other research on the impact of SACNAS local chapters showed that Iowa State University students in STEM advanced their careers through attending regular chapter meetings, workshops, seminars on campus, frequently communicating opportunities from the national SACNAS office, and attending the annual national conference (Flores et al., 2018).

Recently, affinity-based communities have sought to use the internet, social media, and social networking platforms to connect minoritized people across geographical distances and surmount the isolation often faced in STEMM. For example, the nonprofit Ciencia Puerto Rico (CienciaPR) was launched in 2006 through a social networking website with the goal

of creating a critical mass of scientists from the Puerto Rican community (Guerrero-Medina et al., 2013). In addition to promoting access to information about scientific training pathways and careers, CienciaPR uses its website and social media platforms to counter the negative effects of minoritization in STEMM, challenge the mainstream White-centric narrative by celebrating and affirming Puerto Rican cultural identity in science, and create opportunities for engagement of Puerto Rican members of the STEMM community. Through collaborations with various media outlets, the organization promotes culturally relevant science communication in both Spanish and English that highlights the contributions of Puerto Rican scientists and scientists affiliated with Puerto Rican community and locates scientific advances and information in the context of the lives of Puerto Ricans (Guerrero-Medina et al., 2013). Many of CienciaPR's programs are designed to enable its community of more than 15,000 scientists to influence their environments through knowledge and leadership (Colón, 2015; González-Espada et al., 2015). These programs resulted in an engaged community that mobilized following the 2017 Hurricanes Irma and María, as well as during the COVID-19 pandemic (Forman, 2020; Lynn, 2018; MacArthur et al., 2020; Nirmal, 2021).

The number of identity-based organizations and movements has increased in recent years thanks to social media and as a result of large-scale conversations on racism in society (see Box 5-1). Other organizations, such as LatinXinBME, have leveraged new platforms and tools such as Slack and Twitter to overcome geographical divides and isolation in predominantly White contexts. Using Slack has allowed LatinXinBME to create

BOX 5-1

Finding Community on Social Media

The purpose of this box is to highlight that spaces on social media have been a place where minoritized individuals in STEMM can find community and start mobilizing.

As an example, *Nature* recently published a piece focusing on the emergence of a movement on social media that came about in response to racially motivated incidents (Gewin, 2021). In response to the murder of George Floyd, and the false accusation against the Black birdwatcher Christian Cooper in New York City, the hashtag #BlackBirders was created and ignited the #BlackBirders week. Black researchers and scientists from a range of STEMM disciplines then developed a #BlackinSTEM week series. Each field, for instance physics, received its own week of social media events with the intention of helping diversify and create more inclusion in these environments, generate institutional change, and build community. The *Nature* article includes the interviews of five researchers who took part in #BlackinSTEM week (Gewin, 2021).

conversation channels centered around specific topics, centralize information relevant to the community, initiate private messages between members, and engage members across time zones. Among the most popular topics are making career connections, mentoring, mental health, and issues of particular concern to Latine communities, such as immigration (Aguado and Porras, 2020).

Minoritized scientists and health professionals have also recently started mobilizing to examine how the nation teaches STEMM disciplines and to call for the incorporation of antiracism, diversity, equity, and inclusion into the curriculum.¹ For example, an effort to transform STEMM emerged among Indigenous scholars who noted that there was a disconnect between Western practices of STEMM education and Indigenous ways of knowing and that this dissonance prevented their matriculation into these majors (e.g., Chow-Garcia, 2016; Lee Bitsoi and Lowe, 2018; Smith et al., 2014; see Chapter 4 for more on Indigenous ways of knowing). Instead of advising students to change and comply with Western practices, Indigenous scholars advocate to create more integrated approaches to STEMM that emphasize the central premise of Indigenous knowledge, which is that all things are connected (Deloria, 1992). Specifically, some scholars have worked to “find a pedagogy of holism combining the best of both” to assist in building capacity (Marker, 2015, p. 3). One group, for example, describe how Indigenous knowledge regarding medicine, technology, math, and anatomy, passing orally across hundreds or even thousands of years, can advance STEMM knowledge pursued by the West (Lee Bitsoi and Lowe, 2018). The process of combining involves assessing assumptions, structures, and practices of STEMM. The broadening of STEMM to involve Indigenous students, employees, and local tribal members in the development of these processes is critical to shifting the historical paradigms of these fields, resulting in STEMM fields that broaden to incorporate culturally diverse learners.

Furthermore, there have been other recent efforts to transform academic institutions. For instance, minoritized scientists, medical students, and professionals have advocated for change in the form of returning ancestral remains to Indigenous communities (Gulliford, 1996). Others have worked to acknowledge unethical research with Black and Indigenous people. Some individuals have focused on teaching about the history of discrimination against many different peoples in the history of science and medicine in the United States. This has taken many forms, including organizing town halls, teach-ins, op-eds, reading groups, and other initiatives to help STEMM faculty and other members of the scientific community broaden their understanding of the causes and consequences of racism in

¹This section draws on an expert review commissioned by the committee (Smith, n.d.).

their respective disciplines (Adelekun et al., 2019; Braun and Saunders, 2017; Hagopian et al., 2018).

CONCLUSION 5-1: There are a few noteworthy ways to describe how people from historically and systemically minoritized groups respond to racism in science, technology, engineering, mathematics, and medicine (STEMM) environments, including other professional spaces. These responses can be loosely grouped as follows: exiting the field, implementing strategies to fit in, and collectively mobilizing to transform the STEMM environment.

HOW STEMM PROFESSIONALS CAN HELP

In this final section of the chapter, the committee explores specific steps that individuals might take to help promote inclusion through the design of STEMM environments. These steps are grouped into three broad categories: signal inclusion through numeric representation and spatial design of local environments; build peer relationships and community for minoritized groups; and create access to high-status relationships.

This section and the recommended actions center around Stereotype Inoculation Model, which holds that “social vaccines” can protect one’s mind against noxious stereotypes, analogous to biomedical vaccines that protect and inoculate one’s physical body against noxious bacteria and viruses (Dasgupta, 2011; Stout et al., 2011; Thiem and Dasgupta, 2022). The committee’s approach is motivated by a growing body of research that demonstrates that when local STEMM cultures are redesigned to foster social connections among minoritized individuals, increase exposure to experts from minoritized groups, and link STEMM with communal values, these cultural cues act as social vaccines. Specifically, they increase minoritized individuals’ sense of belonging in STEMM, protect against negative stereotypes, and preserve their self-efficacy, motivation, and persistence in STEMM (Dasgupta, 2011; Dennehy and Dasgupta, 2017; Estrada et al., 2021; Thiem and Dasgupta, 2022; Wu et al., 2022). This section relies on research on minoritized individuals’ experiences in early training and career stages. However, research on minoritized individuals in middle- and late-stage of their careers is still scarce, and more is needed (see Chapter 9 for the research agenda).

SIGNAL INCLUSION THROUGH NUMERIC REPRESENTATION AND SPATIAL DESIGN OF LOCAL ENVIRONMENTS

Provide a Diverse Representation of STEMM Role Models

It is common for academic organizations and workplaces to elevate some individuals as exemplars of success by raising their portraits on the wall and celebrating their accomplishments through media stories and awards.

These exemplars communicate what “great” looks like within that organization. It is easy to draw the inference that others who look like these success exemplars have potential to be great as well. Conversely, it is easy to infer that people who look different have less greatness potential.

Research shows that when young people who are numerically underrepresented in STEMM (e.g., women students in engineering) are exposed to images and success stories of a racially diverse array of successful women engineers, they express more positive outcomes (Wu et al., 2022). These include positive implicit attitudes toward STEMM, reporting more confidence in their own engineering ability, and identifying more strongly with these exemplars, compared to other women students who are exposed to success stories of men engineers or engineering innovations with no mention of the engineer’s gender. In a way, these diverse exemplars of success act as important role models. In fact, women students’ subjective identification with success stories of women engineers predicts greater self-confidence in their own ability, which in turn predicts stronger intentions to pursue careers in engineering (Stout et al., 2011).

Other research has found that successful individuals are likely to become role models themselves if three key conditions are met. First, there are others that are able to identify with them, second they believe their success is something that can be attained, and third they have overlapping similarities with others (Asgari et al., 2010, 2012; Aspinwall, 1997; Blanton, 2001; Davies et al., 2005; Haines and Kray, 2005; Hoyt and Blascovich, 2007; Lockwood, 2006; Lockwood and Kunda, 1997, 1999; Lockwood et al., 2002; Marx and Roman, 2002; Marx et al., 2005). The dimension of similarity may be similar life history, shared group membership, common academic or professional interests, and so on. For example, research shows that encountering professional women who were framed as similar to the self in terms of background (collegiate or gender) bolsters young women’s implicit beliefs about their own leadership ability. However, when the professional women were framed as different from the self, there was no effect on women’s implicit self-beliefs about leadership, and in fact, this even backfired on occasion (Asgari et al., 2012; for additional reading see Parks-Stamm et al., 2008; Rudman and Phelan, 2010). This latter finding may be explained by the possibility that successful ingroup members who are perceived as different from oneself may increase feelings of threat. These feelings of threat may signal leadership potential is not possible (Mendes et al., 2001).

One longitudinal study found that both quality and quantity of contact with similar exemplars of success jointly enhance young women’s implicit leadership self-concept and increase ambitious career goals (Asgari et al., 2010). Even though personal contact and mentoring relationships (discussed more below) are powerful ways to find role models, role models

may include more indirect contacts, such as with successful individuals with whom one has had only brief contact with or were connected through social media exposure (for a partial review, see Gibson, 2004).

Role models are particularly important to minoritized individuals in high-achievement domains (Blanton et al., 2000; Stout et al., 2011). For example, research has demonstrated that after hearing about a high-performing Black peer in a stereotyped field, Black students demonstrated positive outcomes including increased performance and self-efficacy. After hearing about a low-performing Black peer, Black students showed opposite outcomes (Blanton et al., 2000). Moreover, encountering a high-performing Black person is associated with increases in Black students' confidence even more so than what encountering a high-performing White person does for White students.

Build a Critical Mass of Minoritized Individuals

Building a critical mass of minoritized individuals in a local context reduces feelings of evaluation apprehension and elevates performance and full participation. Research shows that Black women's academic performance is enhanced when they are in a group of same-race peers compared to when asked to perform in the context of being the only Black person in an all-White environment (Inzlicht and Ben-Zeev, 2003; Sekaquaptewa and Thompson, 2002). In the presence of other Black peers, negative stereotypes about the group become less prominent in the minds of Black students, feelings of performance apprehension are reduced, and performance is elevated (Sekaquaptewa et al., 2007). Similarly, other research examined women's behavior after they were randomly assigned to engineering teams that vary in gender composition (Dasgupta et al., 2015). Women in engineering teams with a critical mass of same-sex peers expressed less worry and anxiety and were more verbally engaged in the team task compared to women who are the only woman in their team. Even though negative gender stereotypes were present in their minds, women's self-confidence was inoculated against such stereotypes if they were in teams with a critical mass of other women (Dasgupta et al., 2015; see Chapter 7 for more on teams).

Create Congruency Between Expressed Diversity Values and the Reality of the Environment

Organizations signal their endorsement of diversity and inclusion values in many ways. One of the most common strategies includes the increased use of diversity and inclusion statements. However, research has found that what minoritized individuals trusted more than diversity and inclusion statements is actually seeing minoritized employees in the workplace

(Purdie-Vaughns et al., 2008). For example, pictures showing a diverse group of employees in an organization's informational materials increased prospective applicants' trust in the company. When the demographic diversity of people was prominent, diversity statements became less important. However, if diversity signals did not match the reality within the company, such measures backfired; new recruits saw the diversity signals as disingenuous and lost trust in the organization (Cheryan et al., 2009).

Another feature of local environments that signals diversity values includes the physical design. One study found that the aesthetics of workspaces conveyed clues about its culture, values, and norms (Cheryan et al., 2009). Imagine walking into a workspace where you see vibrant nature posters on the wall and a bookshelf with a variety of books, puzzles, and stacks of water bottles in the corner. Alternatively, imagine that the workspace had Star War posters on the wall, science fiction books in the bookshelf, videogames, and a stack of soda cans in the corner. A room with science fiction paraphernalia and videogames signaled a masculine geeky culture, while a room with nature posters and puzzles signaled that all genders are welcome. Women felt more welcome and, in turn, expressed more interest in computer science classes and majors if they were in the room with nature posters than the one with Star Wars posters. Additional research should be conducted to examine which specific features of a physical environment are most inclusive to promoting antiracism, diversity, equity, and inclusion in STEMM.

BUILD PEER RELATIONSHIPS AND COMMUNITY FOR MINORITIZED GROUPS

Broker Ingroup Peer Relationships by Developing “Near Peer” Mentors

Peer mentorship programs that broker relationships between new students from minoritized groups with other students who share their identity is another feature of local environments that enhance belonging and thriving (Dennehy and Dasgupta, 2017; Herrmann et al., 2016). These “near peers,” who are only slightly more senior, mentor early career colleagues, a form of mentorship that has been found to be effective, including for minoritized individuals in STEMM environments (Dennehy and Dasgupta, 2017; the National Academies, 2020; Rockinson-Szapkiw and Wendt, 2020; Thiem and Dasgupta, 2022; Wu et al., 2022). Authentic relationships with successful ingroup peers safeguard individuals from the impacts of negative ingroup stereotypes. For example, a one-year mentoring relationship with a same-sex peer mentor during the first year of college was enormously effective for female engineering students at protecting them against academic anxiety. Same-sex peer mentoring also protected the female students' well-being, enabled them to have increased success in obtaining experiential

learning opportunities (e.g., engineering internships), and increased their retention in engineering and other STEM majors (Dennehy and Dasgupta, 2017; Wu et al., 2022). These benefits achieved by having same-sex mentors were not only present in the first year of college when mentoring was active, but also endured through graduation and one-year post-graduation (Dennehy and Dasgupta, 2017; Wu et al., 2022). Having male peer mentors in the first year of college produced results statistically no different from having no mentors (Dennehy and Dasgupta, 2017; Wu et al., 2022). In short, a low-cost, light-touch, near-peer mentorship experience in a critical transition period in life yielded dividends through the college years and one year after graduation, long after mentorship had ended.

One benefit of ingroup peer mentors and other peer role models derives from their relatability and shared experiences. For example, a national sample of African American undergraduates majoring in STEM disciplines found that from these students' perspectives, perceived similarity of values rather than demographic similarity was the most important factor associated with protégé perceptions of high-quality mentorship, which in turn was associated with stronger personal commitment to pursue STEM careers (Hernandez et al., 2017).

Normalize Struggles and Strengths of Minoritized Groups

Hearing that adversity and struggle is a normal experience and part of the journey bolsters persistence and performance. For example, Black students who learned from a slightly more senior peer that all students encounter challenges and that the challenges are usually temporary experienced positive outcomes. Specifically, they were not concerned about whether they belonged in college, but instead attributed their challenges to the broader college environment. Consequently, these students with the senior peer were more likely than Black students in a control condition to achieve higher grades and improved well-being (Walton and Cohen, 2011).

As a corollary, emphasizing the strengths that come from the culture, history, and knowledge of historically and systemically minoritized groups can also empower numerically underrepresented students in higher education, such as first-generation working-class students (Stephens et al., 2014; Townsend et al., 2019). For example, first-generation students learning from senior first-generation peers about the positive and negative effects of their working-class status on their overall college experience reduced both anxiety and bolstered college adjustment (Stephens et al., 2014). Research with 670 STEM minority undergraduates (Black and African American and Latine) and non-minority (White and Asian students) found that an intervention that raised students' awareness about stereotype threat and encouraged them to use their lived experiences to generate coping strategies that

work for them protected their abstract reasoning, increased course grades, and decreased worries about confirming racial and ethnic stereotypes (Ben-Zeev et al., 2017).

Create Affinity-Based Peer Programs

When young people transition from high school to college, they are often in new environments and unmoored from prior social supports, and so, often experience uncertainty about belonging and self-doubt. This is especially likely for students from minoritized groups who are also numerically underrepresented in higher education. Affinity-based programs that gather a cohort of similarly situated students in the transition to college have been found to be very effective.

For example, summer bridge programs that take place during the summer before college starts help first-generation students, low-income students, and students from minoritized racial and ethnic groups make a smoother transition to college (Ramirez et al., 2021; Strayhorn, 2011). Such programs enhance college-related social capital through an immersive on-campus experience, spanning several weeks, that strengthens socioemotional ties among peers, builds relationships with faculty and staff, and familiarizes students with campus resources (Ashley et al., 2017; Bradford et al., 2021; Suzuki et al., 2012). A systematic review of STEM-specific summer bridge programs found that students leave these programs with increased feelings of preparedness and belonging more in college, and they get better grades post-program (Ashley et al., 2017). A recent meta-analysis examining STEM-specific summer bridge programs found similar positive outcomes (Bradford et al., 2021). Summer bridge program participants, including minoritized, and first-generation students are also more likely to graduate within six years of college matriculation than a matched comparison group (Douglas and Attewell, 2014).

Another study on summer bridge programs showed that including a component that has new students from minoritized groups hearing from senior peers from similar identity groups plays a key role in their success. One study, for example, looked at outcomes from a sample of summer bridge program participants in which most participants were from minoritized racial and ethnic groups, first-generation students, and/or low-income students (Ramirez et al., 2021). All participants received information about academic resources available to them on campus, but only half of the participants also heard from senior first-generation college students. These senior students told stories about encountering and overcoming identity related obstacles. Program participants who heard from these senior peers reported greater interest in using campus resources compared to program participants who did not hear from them. Given the demonstrated benefits

of summer bridge programs, additional research is needed to identify which specific elements of these programs drive each outcome.

Living-learning student communities are another affinity-based peer program. These communities foster socioemotional and academic relationships among a cohort of students transitioning into college who have common academic interests or a shared identity. Students live together in the same residence hall, attend at least one class together, and interact together in structured activities (Brower and Inkelas, 2010). Consistent with the Stereotype Inoculation Model, immersion in a community of ingroup peers increases psychological fit within the local environment. This is especially important for students who are in a small numeric minority in the context of their larger university environment. The local community, in this case, is a space in which students are protected from tokenization and doubts about their belonging, bolstering their confidence and persistence (Thiem and Dasgupta, 2022).

Research shows that as compared to those who are not participants, those in living-learning communities have more frequent academic interactions with their peers, and they experience a stronger sense of belonging within their university and living-learning community (Dahl et al., 2020; Schussler and Fierros, 2008; Wawrzynski et al., 2009; Wu et al., accepted in principle). Studies demonstrate that the social support from the community peers also increases academic persistence (Inkelas et al., 2007; Soldner et al., 2012) and reduces academic anxiety. These factors have been found to help students earn higher grades (Wu et al., accepted in principle).

As with summer bridge programs, research suggests that living-learning communities are particularly beneficial for orienting students to campus resources. Compared to students living in traditional residential campus communities, students participating in living-learning communities are more likely to use campus resources such as computer labs, academic advisors, and peer counselors, and they are more invested in participating in research, studying abroad, and conducting a thesis project (Brower and Inkelas, 2010; Dahl et al., 2020; Inkelas et al., 2007). This pattern of findings may occur as a result of increased knowledge of these opportunities and increased confidence they may experience. They are also more likely to maintain higher academic confidence or self-efficacy up to three years later after a program is over (Brower and Inkelas, 2010). Importantly, research has identified value of living-learning communities for women of color in STEM (Johnson, 2011).

In addition, communal aspects of college are also emphasized through living-learning communities. These communities show that learning is not something that only occurs in classrooms. Rather, learning can happen in informal spaces with peers, through activities, and within residence halls outside of class (Brower and Inkelas, 2010; Shapiro and Levine, 1999).

Furthermore, these communities may help students connect with faculty through informal low stakes one-on-one interactions (Eidum et al., 2020). Programs that create more opportunities for faculty-student interactions are likely to attract faculty members who are more communally oriented, and research shows that students who prioritize communal values may have a preference to interact with faculty who share similar values (Fuesting and Diekman, 2017). Therefore, minoritized students, who may be more likely to prioritize communal values, may appreciate this particular aspect of living-learning communities.

Curriculum Change Initiatives

Curriculum change initiatives also contribute to increased performance and persistence for minoritized students. One significant intervention to increase inclusion has occurred with the adoption of course-based undergraduate research experiences, sometimes called Freshman Research Initiatives. During the research experiences, faculty provide students with opportunities to engage in discovery as part of a course, as opposed to a more traditional instructional model. Students work in collaborative teams and take part in each element of the research process, including developing research questions, collecting data, analyzing data, and drawing conclusions (Alkahr and Dolan, 2014; Auchincloss et al., 2014; Bangera and Brownell, 2014; Weaver et al., 2008). Studies on these research experiences show that this shift in the curriculum toward doing “authentic” research results in a range of positive outcomes that include greater knowledge acquisition, increased self-efficacy and shifts in psychosocial outcomes, a greater sense of belonging in the scientific community, increased retention, increased persistence for all students, and an increased science identity (Alkahr and Dolan, 2014; Brownell et al., 2013; Drew and Triplett, 2008; Hanauer et al., 2012; Jordan et al., 2014; Lopatto et al., 2008; Rodenbusch et al., 2016; Shaffer et al., 2010, 2014). Increases in science efficacy, identity, and values have been shown to predict persistence for minoritized STEM students one year and four years after graduation (Estrada et al., 2011, 2018). Moreover, these courses equalize retention rates for minoritized students compared to non-minoritized students (Rodenbusch et al., 2016), which is significant, given that first-year courses contribute toward large numbers of minoritized students with an expressed interest in STEMM leaving their STEMM career pathways. Despite critiques (Linn et al., 2015), several national reports have recommended course-based undergraduate research experiences as an important mechanism for increasing persistence and retention of students (the National Academies, 2017; President’s Council of Advisors on Science and Technology, 2012). The measured psychosocial shifts indicate that in addition to affecting learning outcomes, course curriculum changes

potentially provide increased affiliation cues and affirm student dignity and inclusion for minoritized students.

CREATE ACCESS TO HIGH-STATUS RELATIONSHIPS

Because of long-standing barriers, students from minoritized groups may be unable to cultivate meaningful relationships with people in higher-status roles, such as managers, professors, and other organizational leaders. These relationships are critical for opening doors to important opportunities for students, such as internship positions, career advice, and future letters of recommendation (e.g., Castilla et al., 2013a,b). For example, many working-class students who are the first in their families to attend college and do not have parents helping them navigate college life may not recognize the importance of forming these relationships or may not know how to cultivate them (Collier and Morgan, 2008; Jack, 2016). Even students who do understand the importance of faculty relationships may feel uncomfortable and self-conscious approaching high-status people they do not know out of a fear that doing so will make them be perceived as a “suck-up” (Collier and Morgan, 2008; Jack, 2016). Consequently, students, including minoritized students, often avoid approaching faculty members.

Enable Access to High-Status Mentors

Mentorship plays an essential role in the development and career trajectories of emerging STEMM professionals. Much of science professional development is based on an apprenticeship or mentorship model in which junior trainees work directly with other STEMM professionals and develop through their guidance. Mentorship is “a reciprocal, dynamic relationship between mentor (or mentoring team) and mentee that promotes the satisfaction and development of both” (McGee, 2016; p. 232). Mentoring relationships are complex and have a substantial impact on the professional and personal lives of the mentees (the National Academies, 2020).

Mentees are not passive recipients of their mentors’ guidance. Ideally, they and their mentors collaborate in reciprocal ways as they plan, act, reflect, question, and problem-solve (Pfund et al., 2016). While mentees acquire research skills they need to be scientifically productive and build professional knowledge to advance their careers, mentors acquire skills that enable them to nurture the academic and professional growth of the next generation more effectively. Mentors are successful if they can support their mentee in attaining transferable skills, knowledge, and confidence necessary to meet the latter’s individual goals. This requires mentors to understand their mentees’ unique needs and desires, as well as the flexibility and humility to adjust their approach to support the mentees’ success. In addition to disciplinary

training, successful mentees also must acquire the tacit “know how,” or social capital, to navigate political and disciplinary minefields, maintain personal and professional integrity, and learn the values of their professional fields (Csikszentmihalyi, 2009; Yosso, 2005; Zambrana et al., 2015).

The positive impacts of mentoring on student mentees are clear. Mentors contribute to students’ science identity by recognizing their mentees’ talent, teaching them what to do, validating their aspirations, and providing opportunities for mentees to take on more responsibility (Chemers et al., 2011; Hurtado et al., 2009). More generally, strong mentorship is associated with mentees’ self-efficacy (Laursen et al., 2010). Mentorship also benefits the mentor by fostering a sense of fulfillment, sharpening mentors’ leadership skills, and increasing their self-awareness (Dolan and Johnson, 2009; Laursen et al., 2010). Increased productivity among research mentees is associated with increased productivity for research mentors (Dolan and Johnson, 2009). For minoritized students in STEM, mentorship enhances pursuit of research-related career pathways (Hathaway et al., 2002; Nagda et al., 1998).

One study examined factors that predicted the integration of minoritized individuals in the STEM environment from students’ junior year through the postbaccalaureate year (Estrada et al., 2018). Researchers assessed mentees’ perceptions of the extent to which their mentor provided quality psychosocial, networking, and instrumental support. Results showed longitudinal support demonstrating that quality mentorship experiences were significantly associated with the integration of minoritized individuals in STEM (Estrada et al., 2018). Despite these promising findings, research demonstrates that Black, Latine, and Indigenous individuals typically receive less mentoring than their non-minoritized peers (Ginther et al., 2011; Morzinski and Fisher, 2002; Thomas, 2001).

Mentoring relationships are influenced by the mentor and mentee’s perceptions of the other (Byars-Winston et al., 2020) and are culturally informed in ways that vary by race and ethnicity (Byars-Winston et al., 2015, 2020; Prunuske et al., 2013). For example, research has shown that minoritized women in STEM are more interested in having discussions pertaining to issues of race and ethnicity with their mentors, as compared to their White counterparts (Muller et al., 2012).² Differences in priorities between mentors and mentees regarding race and ethnicity can create a disconnect and can potentially hurt minoritized mentees (Byars-Winston et al., 2015, 2020).

One qualitative study examined perspectives on mentoring minoritized students that were held by a sample of White faculty who did not often

²Differences in priorities between mentors and mentees regarding race and ethnicity can create a disconnect, and can potentially hurt minoritized mentees (Byars-Winston et al., 2015, 2020).

mentor minoritized individuals (McCoy et al., 2015). In the interviews, their use of race-neutral, “colorblind” language (avoiding racial terms but implying them) allowed these White faculty members to describe their students as inferior, both academically and across a range of perceptions, while potentially ignoring issues related to structural racism. The faculty stated they utilized colorblind methods to “treat everyone equal;” however, the findings showed that their colorblind approach had negative implications for their perception of the mentees, including the assertion of their mentees as being inadequately prepared.

Misalignment of diversity related beliefs and expectations between mentors and mentees can complicate mentoring relationships (Carlone and Johnson, 2007; Chang et al., 2011; Hurtado et al., 2009; Johnson et al., 2011). Some programs, such as the National Institutes of Health-funded National Research Mentorship Network aims to strengthen alignment between mentees and mentors by teaching faculty five clusters of skills (McGee; 2016; Pfund et al., 2016). These include (i) teaching and evaluating research skills, (ii) building honest and trusting mentor-mentee relationships; (iii) providing psychosocial support (motivation, coping strategies, belonging); (iv) being culturally responsive (being self-aware of bias, reducing impacts of stereotype threat); and (v) being an active sponsor (helping mentees network, advocating for them, promoting their professional development).

Students from minoritized groups may be most comfortable forming working relationships with faculty of similar identities (Blake-Beard et al., 2011). However, as demonstrated in earlier chapters (see Chapter 3), few faculty are members of minoritized groups. This limits the chances that minoritized students have to interact with them. As an added barrier, the few minoritized faculty members tend to be over-extended. In part, this results from the fact that they are highly sought out by students with similar identities (Hirshfield and Joseph, 2012; Mondisa, 2018; Padilla, 1994; Stanley, 2006; Zambrana et al., 2015). Which is to say, numeric underrepresentation of minoritized faculty can contribute to the limited professional networks of students from minoritized groups. It is important, therefore, for academic STEMM departments to form relationships with STEMM organizations dedicated to nurturing diverse talent, such as SACNAS, NSBE, and the Annual Biomedical Conference for Minoritized Scientists. In addition, it is important for STEMM departments to create and support local chapters of these organizations and create annual opportunities for cohorts of students to travel to their conferences to build a network of peers and professionals from similar identity groups. These in-person connections can be supplemented with participation in virtual groups for minoritized scholars in STEMM (e.g., @LatinXinBME). Additional research is needed to examine the potential impact of other high-status individuals, including sponsors and champions, in other STEMM organizational environments beyond higher education.

ORGANIZATION OF THE RECOMMENDATIONS

This concluding section offers recommendations aligned with the core areas of empirical research discussed in the chapter. Specifically, Recommendation 5-1 corresponds to signaling inclusion through numeric representation and spatial design of local environments. Recommendation 5-2 corresponds to building peer relationships and community for minoritized groups. Recommendation 5-3 corresponds to creating access to high-status relationships. Recommendation 5-4 corresponds to additional strategies that are centered on fostering connections, emphasizing communal values, affirming kindness cues, and increasing an overall sense of belonging. The final, Recommendation 5-5, is centered on continuing research experience curriculum-based initiatives.

RECOMMENDATION 5-1: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Improve numerical diversity through the admission, hire, and inclusion of minoritized individuals at all levels of an organization:
 - a. Establish information systems across institutions using common metrics for comparison purposes to collect data, track success, and identify areas of numeric disparities. Results should be transparent, up-to-date, and accurate.
 - b. Hire more minoritized individuals, especially in positions where minoritized role models are often missing (e.g., leadership, mentorship), with the aim of building a critical mass.
 - c. Determine whether the institutional diversity statement reflects the reality of the institutional environment, and directly address discrepancies.
 - d. Adapt curriculum, physical environment, media stories, and other content to incorporate more examples of minoritized role models.

RECOMMENDATION 5-2: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Create and provide continued investment in evidence-based programs that connect minoritized individuals to ingroup peers, institutional resources, and professional networks. These investments require significant expertise in their designs and execution,

and they may not yield immediate results; however, they can increase a sense of welcome and belonging through the ability to connect with individuals from similar racial and ethnic backgrounds. Types of programs may include the following types of resources:

- a. Summer bridge programs.
- b. Living-learning communities.
- c. Peer and near-peer mentorship programs.
- d. Actively work to form relationships with national-level affinity societies (e.g., SACNAS, NSBE, AISES), create local chapters, and provide opportunities for minoritized individuals to connect with them.

RECOMMENDATION 5-3: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Create and provide continued investment in programs that facilitate working relationships between minoritized individuals to high-status professionals:
 - a. Create and invest in mentorship programs, while also hiring more minoritized faculty.
 - b. Conduct additional research examining the roles of other high-status individuals such as champions and sponsors on fostering STEMM careers for minoritized individuals.

RECOMMENDATION 5-4: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people's individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Develop interpersonal environments and institutional norms that promote inclusion, dignity, belonging, and affirmations of kindness:
 - a. Actively recognize minoritized individuals' contributions to STEMM across multiple mediums such as portraits, media stories, awards.
 - b. De-center White professional norms in culture, dress, and appearance.
 - c. Conduct additional research examining which features of the physical environment are most likely to promote sustainable antiracism, diversity, equity, and inclusion in STEMM.

- d. Emphasize and recognize the importance of communal values in STEMM work.
- e. Redesign STEMM curriculum to incorporate Indigenous ways of knowing, and actively involve Indigenous communities in the development of this process.
- f. Create cultural norms that communicate the strengths and struggles of minoritized groups.
- g. Provide access to culturally responsive mental health providers or resources with experience in addressing racial stress, trauma, and aggressions for minoritized individuals who have experienced distress and would like to pursue these options.
- h. Conduct bi-annual “cultural audits” to determine if the institution is fostering an environment of inclusion.

RECOMMENDATION 5-5: Leaders and gatekeepers of science, technology, engineering, mathematics, and medicine (STEMM) organizations, higher education, and human resource offices can improve minoritized people’s individual and interpersonal experiences in STEMM educational and professional environments through the following practices:

1. Use evidence-based design and implementation practices to build curriculum initiatives that increase access to discovery, including, for example, course-based research experiences.

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The Gatekeepers of STEM: How Individual Bias and Inequality Persist and How STEM Professionals Can Help

The previous chapter focused on minoritized individuals who aspire to be in science, technology, engineering, mathematics, and medicine (STEMM). It included data examining experiences of racism, consequences of racism, and how minoritized individuals may respond to racism. It also covered strategies on how to improve minoritized individuals' experiences in STEMM. The current chapter builds on this work by continuing to focus on individual and interpersonal bias but flipping the attention from the perspective of minoritized individuals to what the committee refers to as the gatekeepers of STEMM. There is a substantial body of research in each of these areas, and this chapter can stand alone from the previous one. However, Chapters 5 and 6 are meant to be read and understood together as they are not mutually exclusive phenomena, but rather two sides of the same coin. Like the previous chapter, the current chapter addresses the charge in the statement of task on reviewing the research and evidence on the ways in which racism at the individual level impedes STEMM careers for minoritized individuals. Here, the committee also addresses the charge to identify methods of improving recruitment, retention, and advancement.

This chapter comprises three sections, beginning with a definition of who the gatekeepers are in STEMM. The second section describes different types of racial bias gatekeepers exhibit and discusses the unique function of each type. The third section describes several social motives gatekeepers have and how larger demographic shifts in the nation can inform individual-level decisions of gatekeepers.

Overall, this chapter shows that gatekeepers possess power and can determine who is and who is not included in STEMM fields. The chapter

centers on the research, which describes that most often in STEMM, non-Hispanic White males occupy the gatekeeper role, and that these individuals define the skills, identities, and values necessary for minoritized individuals to persist in STEMM. Furthermore, as discussed in detail below, gatekeepers can perpetuate racism at the individual and interpersonal levels. Racial bias is not only more automatic, but also more ambivalent and ambiguous than most people think, which means that individuals, including gatekeepers, cannot monitor their own bias and will unwittingly perpetuate it. Finally, gatekeepers hold social motives that keep the White status quo of gatekeeping intact. These factors are at odds with promoting antiracism, diversity, equity, and inclusion in STEMM and make gatekeepers unlikely to be change agents. Given these factors, fully explored below, STEMM professionals who want to help advance antiracism, diversity, equity, and inclusion in STEMM should seek to develop accountability structures at the level of the organization to help identify potential patterns of racial bias among gatekeepers.

The literature on individual and interpersonal racism covered in this chapter focuses largely on White-on-Black racism. Clearly, racism targets Latine, Indigenous, and Asian individuals as well, but in comparison, these groups have not been studied as much. Therefore, as noted in the beginning of this report, the committee urges creating similar reports on the distinctive forms of racism where sufficient research exists. In addition, the committee urges that more research be conducted on the experiences of each racial and ethnic group, including additional research on understanding the impact of those experiences in STEMM.

The committee urges this for several reasons. First, each of these groups has a distinct history and a distinct set of experiences with White gatekeepers, and each group faces its own unique set of stereotypes, prejudices, and discriminatory behaviors. Thus, forms of racism can differ across groups (Fiske, 1998). For instance, Latine immigrants have varied origins, but White discrimination targets them in a categorical way, almost as much as Black individuals (e.g., Fernández et al., 2021). Latine individuals are often viewed as foreign, criminal, and low-skilled (Harris et al., 2020), hardly conducive to STEMM recruitment. White individuals tend to view Native Americans through varied lenses also: the noble, wise, nature-loving elder Indian stereotype versus the ignoble, disreputable alcoholic stereotype (Burkeley et al., 2017); the former stereotype touches on ways of knowing. Other dimensions of racism find White, anti-Asian bias as judging Asians more competent than White people but less socially skilled, so less suited to leadership positions (Lin et al., 2005). In this chapter, the committee does not presume to directly compare experiences across groups. Rather, the committee's intention is to address some general principles of gatekeepers that tend to cut across their aggregate reactions to various minoritized individuals.

DEFINING AND EXAMINING GATEKEEPERS

The following section begins by defining gatekeepers and providing several examples of which individuals in STEM can occupy the role of gatekeeper. This discussion demonstrates how power is central to defining and identifying gatekeepers and how gatekeepers' decisions can directly shape antiracism, diversity, equity, and inclusion outcomes in STEM environments. Subsequently, the chapter reviews the literature examining gatekeepers through the lens of race and ethnicity and demonstrates that in STEM contexts, like many other contexts in American society, credentialed non-Hispanic White men are most likely to occupy the role of gatekeepers.

Defining Gatekeepers

The term gatekeeper is defined simply as any individual who possesses power in a given STEM context or situation, where power includes the control over valued outcomes and resources (DiTomaso et al., 2007; Torelli et al., 2020; Yu and Zhao, 2019). Gatekeepers in STEM can exert their power across a range of everyday behaviors. For example, they can define boundaries, decide who does or does not get tenure, decide who should be hired, decide who gets recognition and praise, and direct the flow of and use of resources. Individuals such as managers, supervisors, admissions officers, principal investigators, heads of laboratories and research groups, deans, university presidents, and chief executive officers represent some of the most common gatekeepers in STEM.

In the context of STEM, gatekeepers can exert their individual power as a single actor (e.g., a boss promoting an employee) or as an actor within a larger group of other gatekeepers (e.g., a committee). Understanding gatekeepers as a source of power and influence has important implications for antiracism, diversity, equity, and inclusion-related outcomes in STEM environments. They can directly shape minoritized individuals' ability to access, be included, and thrive in STEM, as they define the skills, identities, and values necessary for minoritized individuals to persist (Estrada et al., 2011). Therefore, gatekeepers are the central focus of this chapter.

Even though power and status are often correlated, status is not a necessary feature of the gatekeeper role. Status is defined broadly as the social prestige that comes with an individual's position within a group (DiTomaso et al., 2007; Torelli et al., 2020; Yu and Zhao, 2019). For example, a graduate student in physics may be tasked with directly informing who is admitted to a Ph.D. program. While the graduate student does not necessarily possess status in an academic STEM context, in this situation they do possess power to inform admissions. Therefore, individuals who do not

always have status but possess power on a more situational basis can also occupy the role of gatekeeper.

Conversely, some individuals possess both power and status, and their gatekeeping role may persist over time and incorporate power over decisions that have large-scale or organizational-level impact. For example, a university president whose term spans several years will likely make decisions that affect the entire student body.

White Gatekeepers in STEMM

Chapter 2 covers an extensive history of how a racial hierarchy was created and reinforced in the United States to systematically advantage White individuals (structural racism), and Chapter 3 provides detailed figures on racial disparities in STEMM contexts. The section below is meant to complement these chapters by providing additional analysis of White advantage in STEMM from the perspective of the psychological literature at the individual and interpersonal levels (gatekeepers).

Due to differences in structural power and status, some groups occupy the gatekeeper role in STEMM more often than others. A century of psychological research shows that in the United States, specific salient characteristics—including being White, male, English-speaking, middle-aged, and credentialed—individually and together confer higher power and status, and with them, respect, and influence. Thus, research shows that non-Hispanic, White, male, credentialed individuals, as the racial group with higher power and status, are the most frequent gatekeepers in STEMM and elsewhere (for reviews, see Bobo and Charles, 2009; Fiske, 1998, 2010; Richeson, in press). Though not all gatekeepers are White and not all White individuals are gatekeepers, the two are correlated.

Some areas within STEMM, such as anthropology, sociology, geoscience, biology, and psychology, are more diverse than others, including engineering, chemistry, math, physics, economics, computer science, and political science (Langbert, 2018). However, as a whole, STEMM has a particular lack of diversity compared with other fields (see Chapter 3 on the recent demographic data of STEMM). For example, 80 percent of university and college faculty are White, but in STEM, 91 percent are White and 96 percent are White at more selective schools (Li and Koedel, 2017; Nelson et al., 2010).

While power and status are disproportionately located within this group, there is research demonstrating that many White individuals express discomfort identifying as White because of the association with White supremacy (Grzanka et al., 2019; Thomann and Suyemoto, 2018). However, ignoring one's race does not make its privileges, power, and status vanish (Helms, 1990). Salient characteristics convey status without the individual choosing to, so certain immediately apparent features anchor interpersonal

interactions in any human's situation, including STEMM environments (Berger et al., 1972; Carter et al., 2019; Ridgeway, 2019). Whether or not it is acknowledged, in the West generally and the United States specifically, White individuals carry higher status in countless ways (Fiske, 2010). For example, "White" is the default assumption for citizens (Devos and Banaji, 2005), just as "male" is the default for "scientist" (Cheryan and Markus, 2020). The linguistic standard dialect comes from White speech (Labov, 1972), and research has found that White individuals widely favor other White individuals and have anti-non-White prejudices (Charlesworth and Banaji, 2019; Dovidio and Gaertner, 2010).

Importantly, from this structural position of power follows the risk of enacting racism (also sexism, heterosexism, etc.; Fiske, 1993). In U.S. society, White individuals have largely controlled social constructions of race and have historically defined it as essential, even biological. Furthermore, to maintain these beliefs, they tend to favor more neighborhood segregation and limit discretionary contact (e.g., Charles, 2000). Most White individuals are not routinely interdependent with (i.e., on teams with) minoritized individuals. As other chapters elaborate, these factors underlie structural racism (see Chapters 2 and 3).

These practices may find their way into STEMM contexts, and racism may also be enacted at the individual and interpersonal levels via gatekeepers. For example, White gatekeepers may frame local cultural "fit" in terms such as "requires brilliance" or "innate/fixed talent" that alienate, discourage, and undermine minoritized individuals who aspire to that career (Chestnut et al., 2018; Muradoglu et al., 2022; Storage et al., 2016). On the other hand, the use of other, more welcoming terms such as "learnable skills" and "can grow" implies support, encouragement, and growth (Burnette et al., 2020). Even though this welcoming interpersonal approach is possible, the later sections in this chapter will show that on average, White individuals hold beliefs that maintain their power and privilege, scoring higher on social dominance, conservatism, and system justification. Thus, gatekeepers tend to favor power, status, homogeneity, similarity, and familiarity. That is, on average White individuals are prone to keeping their surroundings White (Charles, 2000). The next section examines in detail how gatekeepers manifest and perpetuate racism at the individual.

EXAMINING RACISM PERPETUATED BY GATEKEEPERS

Gatekeepers (as well as other individuals) possess three kinds of psychological bias: cognitive stereotyping, emotional prejudice, and behavioral discrimination, all of which perpetuate racism at an individual level and undermine antiracism, diversity, equity, and inclusion. Each of these is explained below. Following that, the section explores several different clusters

by which racism can take form, including old-fashioned or blatant racism; more modern or aversive racism; and cognitive biases that can perpetuate racism but occur automatically.

Stereotypes, Prejudice, and Discrimination

Cognitive stereotyping, emotional prejudice, and behavioral discrimination are forms of psychological bias that tend to correlate but operate differentially (Bodenhausen et al., in press). Additionally, all three forms of bias tend to target members of an outgroup (e.g., another racial group or “others”) as a category, more than the individuals’ own ingroup, whom they tend to individuate or personalize.

Stereotyping is where an individual overgeneralizes a set of characteristics, such as being untrustworthy, unfriendly, incompetent, pushy, unattractive, or contagious, to outgroup members as a whole (Nicolas et al., 2021). This cognitive bias occurs as the result of social categorization, where individuals put people into different groups based on perceived similarity (see Chapter 5 for more on social categorization and its relation to stereotyping; Leonardelli and Toh, 2015). This categorization occurs for all people across time in order to quickly determine which social environments are safe and which are threatening.

Prejudice is an evaluative bias, where individuals attach affective values to groups that might range from simple negative-positive attitudes to complex emotions, such as envy, resentment, scorn, pity, and fear (Cottrell and Neuberg, 2005; Fiske et al., 2002; Smith et al., 2007). Positive prejudices include admiration and pride (Cuddy et al., 2007). Emotional prejudices predict discriminatory behavior twice as well as cognitive stereotypes do (Talaska et al., 2008).

Discrimination is behaving distinctly toward an outgroup member, based on stereotypic assumptions or emotional prejudices. Discrimination includes both active harm (attack) and passive harm (neglect), as well as active help (protect) and passive help (tolerate; Cuddy et al., 2007). As other chapters show, discrimination occurs in everyday interactions, including within STEMM organizations. For example, common discriminatory behaviors include not being hired or promoted, qualifications judged as supposedly insufficient, being unfairly fired, unfairly denied services, and being unfairly stopped, searched, and treated by the police (Williams et al., 1997, 2008).

Explicit Bias, Old-fashioned Racism, and Dehumanization

White Americans, as the dominant racial group and most frequent gatekeepers in STEMM, can sometimes be explicitly biased (Bobo and Charles,

2009; Fiske, 1998, 2010; Richeson, in press). Explicit bias is also referred to as overt or “old-fashioned” racism. Overt racism, forged in years of slavery and oppression, inaccurately views Black individuals as inferior to White individuals, even as subhuman, dating back to pseudo-logic justifying slavery (Oh, 2020).

No group of individuals are immune from expressing bias; even educators show some racial biases (Turetsky et al., 2021). However, over time, overt or “old-fashioned” expressions of bias have been on the decline. Multiple factors, such as systemic-level shifts in policies (see Chapter 2) have, in part, helped reduce the occurrence of blatant bias, even at the individual level. Examples of this trend include integrated housing (Jahoda and West, 1951) and integrated neighborhoods leading to less racial bias (Oliver and Wong, 2003). Systemic change also includes implementation of Title VII of the Civil Rights Act of 1964 (42 U.S.C. § 2000e - 2000e17), which prohibits employment discrimination on the basis of a number of protected “classes,” including race (National Archives, n.d.; U.S. Code, n.d.). Research demonstrates that racial attitudes changed significantly for most White Americans over the 20th century, in part because of these systemic-level policy changes (Schuman et al., 1985; Smelser et al., 2001).

Although overt biases have on average become less common as measured on surveys, they have not become extinct. A hardcore resistant 10–20 percent of the population (depending on the measure; see Figure 6-1; National Research Council, 2001), almost all White, still express overt biases by openly endorsing segregation, White supremacy, and Black inferiority. Research focused on bias toward Black Americans has shown that forms of overt bias include, expressed outward hostility and degradation, beliefs that minoritized individuals are unintelligent and criminal, a general overall negative “feeling thermometer” about Black individuals, and support for formal forms of racial discrimination (Henry and Sears, 2002). Demographic groups scoring high on these scales are often White individuals, who dominate gatekeeper roles, and less educated people whose own status is precarious, except for their perceived White superiority (e.g., Henry and Sears, 2002). Research also shows that Black individuals on average still experience and perceive more discrimination than White individuals do (Earle and Hodson, 2020). In fact, White individuals on average are more likely to deny Black individual’s reports of discrimination. Instead, White individuals on average view their own group as losing ground, as Black individuals gain civil rights. Conversely, research demonstrates Black individuals less often view civil rights as a zero-sum game over time (Peacock and Biernat, 2021).

Besides endorsing salient stereotypes of being criminal, lazy, and unintelligent, extreme racists have been found to rate Black individuals as being less than human (Kteily et al., 2015). Using the graphic of silhouettes showing the “Ascent of Man (sic)” from quadrupedal apes to our modern upright form,

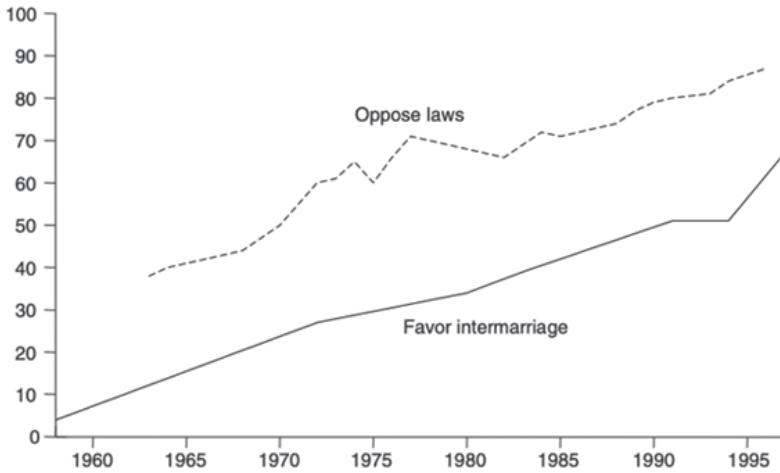


FIGURE 6-1 Trends in White's attitudes about racial intermarriage. Oppose Laws: Do you think there should be laws against marriages between Blacks and Whites? Favor Intermarriage: Do you approve or disapprove of marriage between Whites and Non-Whites? (Adapted from Shuman et al., 1997).
SOURCE: National Research Council, 2001.

42 percent of a representative sample of Americans rate African Americans as being less than fully human (Jardina and Piston, 2022). Although most participants (57%) rated African Americans and White individuals the same, the study demonstrated that African Americans were not always perceived as fully human by everyone as a result of the variation in this perception among participants. Furthermore, these ratings predict consequential behavior, such as presidential voting. In addition, these ratings correlate with denying that Black people as a group have typically human attributes, such as being warm and good-natured (Haslam and Loughnan, 2014). Studies have demonstrated that overt, subhuman racist epithets and metaphors that liken Black individuals to primates are also found in police dispatch tapes and newspaper crime reports (Goff et al., 2008), and early visual processing links them to criminality (Eberhardt et al., 2004).

Most White individual do not subscribe to these overtly racist and inaccurate views, but there are certain attributes that are predictive of such biases. One such difference is by political party; there is data demonstrating that White Republicans believe that anti-White discrimination outweighs anti-Black discrimination (Earle and Hodson, 2020; Peacock and Biernat, 2021). Another difference is by personality; certain personalities among White individuals are predictive of tendencies toward exhibiting biases more than others. For example, a cluster of three conceptually related

traits that are usually self-serving and are socially adverse—narcissism, Machiavellianism, and psychopathy (Furnham et al., 2013; Paulhus and Williams, 2002)—significantly correlate with increased outgroup prejudice (Hodson et al., 2009; Koehn et al., 2019), racism, (Jonason et al., 2020), and social dominance orientation, which is a tendency toward maintaining social inequalities (Ho et al., 2015; Hodson et al., 2009).

Narcissism, a strong or inflated sense of the self and entitlement, also devalues others and lacks empathy (Rauthmann and Kolar, 2012). Machiavellianism focuses on deceit and exploiting others, often manipulatively, working in logical yet immoral ways to gain power, while psychopathy entails a substantial lack of empathy and regard for others, often accompanied by antisocial behavior, and irresponsibility (Hodson et al., 2009). While there is as yet no research linking these personality types to STEMM settings, there is no reason to expect individuals with these personality types to be absent from such settings (Logan et al., 2019). That said, although certain personalities may be more inclined to hold racist prejudices and to discriminate overtly, these explicit biases can be and are held by others as well.

Despite the variability in White individuals' expressions of racial biases, overt bias continues to be the rarest form. As the next section will show, more indirect or covert forms of racism are even more common and pervasive, including in academic environments, among White individuals despite their better intentions. This makes covert biases difficult to control.

Aversive, Symbolic, and Modern Racism

Because most well-socialized individuals believe old-fashioned, overt racism to be unacceptable, verbalized racial attitudes became less direct, enabling “modern” racism to often fly under the radar (Dovidio and Gaertner, 1986). Various forms of less obvious contemporary racism uphold current systems of racial inequality (Gaertner and Dovidio, 1986; McConahay, 1986; Sears et al., 2000). Aversive racism is where individuals who hold and may express outwardly egalitarian attitudes nevertheless have an aversion to members of their outgroups (e.g., White individuals having an aversion to Black individuals, Indigenous individuals, Latine individuals). Aversive racism describes a subtler racism than old-fashioned racism that is not recognized by White individuals as inappropriate, based on contemporary standards, but this aversion shows they still harbor negatively prejudiced attitudes (Dovidio and Gaertner, 2004). These prejudices leak out in non-verbal responses, described below.

Symbolic racism, a related form of modern racism, occurs when members of the dominant racial group hold what seem like cohesive beliefs, but their beliefs are actually informed by underlying bias. Empirically, their attitudes stem from anti-Black sentiment such as Black individuals are

intrinsically lacking, being lazy, and too demanding; that they are no longer victims of discrimination; and that Black individuals are allegedly getting more than they deserve (Henry and Sears, 2002). As such, individuals who are likely to endorse symbolic racism, tend to disfavor race-based policy related to minoritized racial groups (e.g., affirmative action; Brandt and Reyna, 2012). These modern forms of racism are generally not recognized as discriminatory and do not necessarily violate the law, but may still reinforce racial inequalities.

Two related forms of indirectly racist behaviors include microaggressions and incivility (Andersson and Pearson, 1999; Sue, 2010; Torino et al., 2019). Incivility is defined as low-intensity types of conduct that may not be obvious to others in their intent to harm, unlike overt discrimination (Cortina et al., 2013; Kabat-Farr et al., 2020). While microaggressions can be similar to incivilities, some scholars have noted that microaggressions are usually targeted toward groups that face marginalization (Patterson, 2017). Some examples of these behaviors may include disrespectful verbal behaviors, such as premature use of a person's first name, and distant non-verbal behaviors, such as not making eye contact and being distracted. At work, this may include behaviors such as exclusion (Martin and Hine, 2005). Microaggressions and incivilities appear in STEMM contexts, with some evidence suggesting they can be targeted against minoritized individuals; research has looked specifically at the experiences of Latine engineering students (Smith et al., 2022) and minoritized students in STEMM programs in colleges (Dortch and Patel, 2017; Lee et al., 2020; Miles et al., 2020). A study of college students found that microaggressions and incivilities may not occur as isolated incidents, but are ingrained within the larger campus culture, so minoritized individuals may frequently encounter them from multiple sources on campus (Lee et al., 2020). Furthermore, these experiences of microaggressions act as a major barrier because they reduce minoritized individuals' sense of belonging within STEMM contexts (Miles et al., 2020; Smith et al., 2022).

To summarize, gatekeepers are likely to hold racial attitudes that are covert, hidden from self and others, but still imply White superiority, support the status quo, and prefer racial hierarchy. These forms of bias are pervasive. For example, across most occupations, hiring managers favor a White over Black candidate (Bertrand and Mullainathan, 2004).

Unexamined Cognitive Bias: The Privilege of Not Thinking

Regardless of changing norms, individual racism has cognitive underpinnings that remain unchanged. Racial cognitive bias is thus harder to detect than overt racism. The following research will show that ordinary individual racial bias is not only more automatic, but also more ambivalent

and ambiguous than most people think—and often too much so for gatekeepers to notice at all. Because of their position as holders of disproportionate power, gatekeepers have the privilege of not thinking about their own stereotyping, making them vulnerable to doing more of it (Fiske, 1993). This means that individuals cannot easily monitor their own bias, and they will unwittingly perpetuate it. To counter racism in STEM, systemic accountability at the organizational level will be essential.

Automatic Category Detection and Implicit Associations

The following research will show that ordinary individual racial bias is more automatic than most people think. As discussed in Chapter 5, social categorization is the process by which people categorize others into groups based on perceived similarities (Allport, 1954; Bodenhausen et al., in press), and research finds that the racial categorization effect is robust (Kubota and Ito, 2017; Pietraszewski, 2018).

As social beings, people categorize each other automatically by dimensions that are universal (gender, age) and those salient in a given culture (in the United States, race/ethnicity; Allport, 1954; Bodenhausen et al., in press). With defined racial categories come culturally associated stereotypes and prejudices. Even White introductory psychology students who do not endorse stereotypes and prejudices explicitly have been found to still carry those associations from the environment (Devine, 1989). For these individuals, their automatic racist associations will contrast with their more controlled, deliberate egalitarian responses. For those who explicitly endorse the stereotypes and prejudices, the two responses are the same.

Relatively automatic and controlled responses emerge in implicit biases versus explicit biases. Explicit bias includes the already-discussed overt expressions of prejudice and explicit endorsement of stereotypes. On the other hand, implicit bias refers to stereotypic beliefs and negative evaluations, about social groups that pop into mind quickly, often with little awareness or intention (Blair et al., 2015; Greenwald and Banaji, 1995). Implicit attitudes (prejudice) and beliefs (stereotypes) are conceptualized as strong mental associations connecting social groups with positive or negative evaluations in the case of implicit prejudice, or with specific attributes (brilliant vs. mediocre), in the case of implicit stereotypes. The stronger the mental association, the faster they get activated in a given situation.

The Implicit Association Test (IAT) measures implicit biases (stereotypes and prejudices) that would otherwise not be captured on standard or more explicit psychological measures. The IAT is a categorization test that measures the strengths of associations between a concept (such as a racial group; e.g., “Black” and “White”) and a series of attributes (e.g., “good” and “bad”). For example, participants taking the IAT may be

asked to categorize on the same side of the screen, one specific racial group (White) with one specific set of attributes (good), and on the other side a different racial group (Black) and a different set of attributes (bad). Then they do the opposite pairings (e.g., pairing Black and “good”). The faster they pair the ingroup/good and outgroup/bad than the reverse, the more implicit bias they are showing (Fazio and Olson, 2003; Greenwald et al., 1998). Research using a variety of racial outgroups, including Latines (Pérez, 2010) and probably Native Americans (Poitra and Norder, 2019), show similar patterns. White individuals, as the historical majority, are seen as “owning” the nation to the degree that “White” is more rapidly paired with “American” than are other racial and ethnic groups (Devos and Anderson, 2019).

Decades of research using the IAT have demonstrated a substantial prevalence of implicit bias against Black individuals, such that White individuals on average associate their own group labels (White, European-American) with positive attributes and the outgroup (Black, African Americans) with negative attributes (Banaji et al., 2021; Kurdi et al., 2019). The IAT website attracts millions of participants over the age 18, so results generalize to populations besides students, a common pool of research participants.¹ In specific studies, participants include STEMM professionals who act as gatekeepers and who commonly show implicit bias against minoritized groups (Jost et al., 2009). Implicit bias correlates with social exclusion by race (Rudman and Ashmore, 2007), as well as employment decisions for a variety of protected groups, including race and ethnicity (Jost et al., 2009). In a meta-analysis of 217 studies, implicit associations reliably predicted intergroup behavior (Kurdi and Fiske, 2019).

Implicit bias is relatively automatic and unintentional but is still informed by intergroup motivation and context such as affiliation, where social networks, both small and large, shape implicit racial attitudes. Motives to affiliate with other people, to create a shared reality, can meaningfully influence the expression of automatic bias (Sinclair et al., 2005). For example, White Americans express less implicit racial bias in the presence of Black experimenters compared with White experimenters. For good or ill, these social tuning effects operate through affiliation networks, leading people to adopt the attitudes and perspectives of other network members (Jacoby-Senghor et al., 2015). These processes may be implicated in the persistence of societal racial disparities, despite reductions in individual levels of racial bias. People working in racially homogenous STEMM departments and organizations may be particularly susceptible to perpetuating racial biases, given they are not being challenged to question their existing worldviews.

¹<https://implicit.harvard.edu/implicit/takeatest.html>

Increased numeric diversity may be essential to interrupting existing social cognitive processes for White individuals.

Reviewing studies of real-world implicit bias in millions of online participants reveals its link to systemic discrimination in particular regions (Charlesworth and Banaji, in press). For example, anti-Black/pro-White IAT scores in a county's teachers predicted racial gaps in children's achievement tests and racial disparities in school discipline (Chin et al., 2020; Riddle and Sinclair, 2019). Regional implicit racial bias has also been found to be predictive of upward mobility from one generation to the next. Specifically, among low-poverty neighborhoods, a significant factor that was predictive of smaller Black-White intergenerational gaps included Black men growing up in tracts that have less racial bias among White individuals (Chetty et al., 2020). The point here is that implicit biases predict discriminatory behavior, whether between individuals or "in the air," i.e., systemic.

Both implicit and explicit biases are measurably decreasing, thanks to the millennial generation. In the nearly two million online respondents, race and skin-tone implicit biases have markedly improved over the past decade, faster than age and disability biases, but not as fast as sexuality biases (see Figure 6-2; Charlesworth and Banaji, 2019). The same holds for explicit biases (see Figure 6-2). These trends match nationally representative survey samples, as noted earlier. But individual change does not immediately or automatically change systemic factors. Even without individual-to-individual bias, structural disparities (housing segregation, wealth gaps, underfunded schools, over-policing—and more) persist (see Chapter 2 for a fuller history of structural racism in the United States). Still, automatic biases complicate the issue because individuals may perpetuate biases without even knowing they are carriers of contagion (Charlesworth and Banaji, in press), and this is true for STEMM educators and professionals.

Ambivalent, Plausibly Deniable Biases

Research shows that ordinary individual racial bias is more ambivalent than most people think. Most forms of bias have both positive and negative components, allowing individuals to claim and to feel unbiased. For example, a person might claim that Black individuals cannot do science, but they can do music and sports; this same individual can then claim to respect Black people, just not in STEMM. The two key dimensions of stereotypes enable this (Abele et al., 2021; Fiske et al., 2002). One dimension is the group's perceived competence and status in society. Americans report in representative sample surveys (Cuddy et al., 2007) that our society views some racial and ethnic groups as more capable (Asians, Whites, Jews, British, Germans) than others (Italians, Turks, immigrants from Africa or

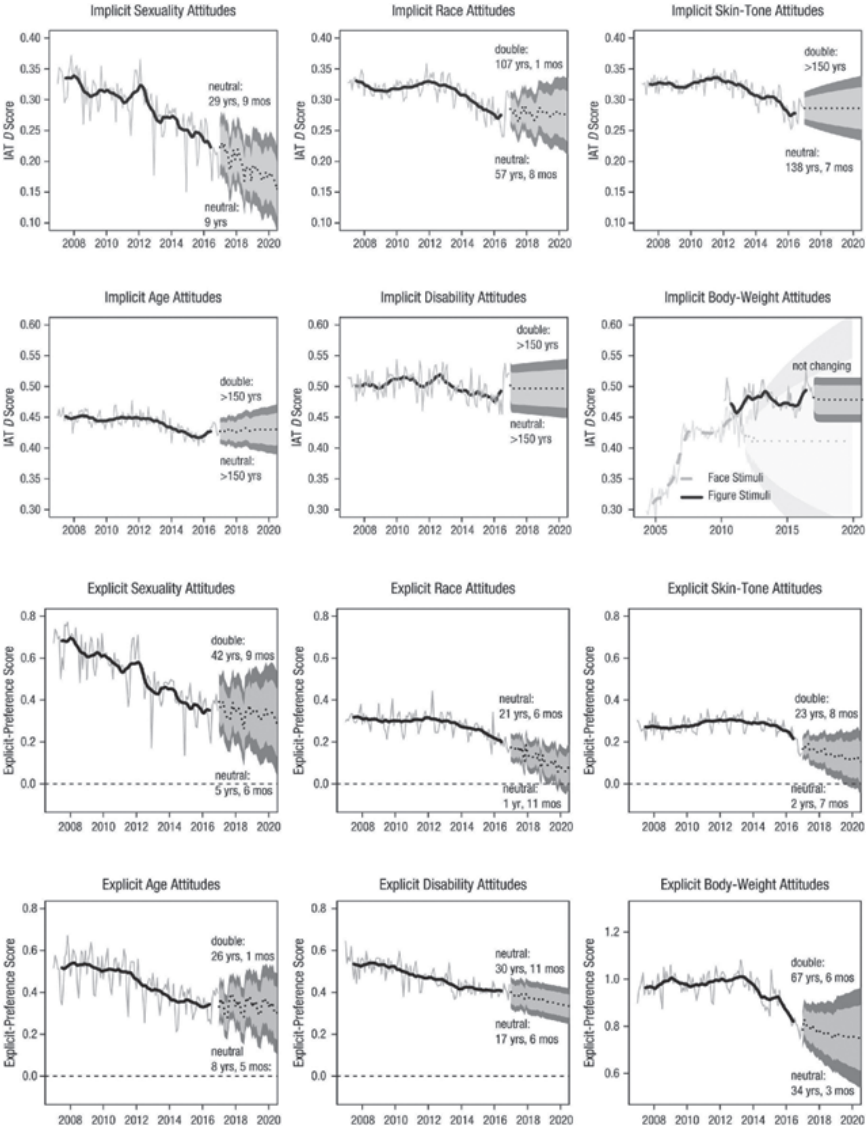


FIGURE 6-2 Change and predicted change in implicit and explicit attitudes from 2007 to 2020: observed monthly weighted averages (2007–2016) of implicit association test (IAT) D scores (implicit attitudes; top two rows) and explicit-preference scores (explicit attitudes; bottom two rows), as well as forecasts of the autoregressive-integrated-moving-average (ARIMA) model (2017–2020). Solid black lines indicate decomposed trends of observed data (removing seasonality and noise), solid light-gray lines indicate the weighted monthly means from observed data, dotted black lines within the light-gray areas indicate the means of the ARIMA forecasts, light-gray areas indicate 80 percent confidence intervals (CIs), and dark-gray areas indicate 95% CIs of the ARIMA forecasts. SOURCE: Charlesworth and Banaji, 2019.

Latin America). The other dimension is warmth (trustworthy, friendly). People believe that others like themselves are trustworthy.

Racial stereotypes about people viewed as Black depend on whom you ask about whom and in what context. Elite student samples (Princeton, from 1933 to 2003) report that Black Americans are stereotypically warm but incompetent, suggesting a patronizing bias, or liking without respecting (Bergsieker et al., 2012; Katz and Braly, 1933). If supported widely, this would reflect on Black STEM students' experiences with peers and colleagues. Perceived subtypes of Black people² provide more differentiated but still stereotypic images. Native Americans are also viewed in terms of subtypes, including noble and ignoble, though the aggregate, overall generic image might seem neutral (Burkley et al., 2017). Immigrants, too, are subtyped into racialized groups: respected and liked Canadians and Western Europeans; threatening Asian and Jewish competitors; contemptible Mexican, Central American, and African migrants (note that "race" dominates the subtyping patterns; Lee and Fiske, 2006).

These nuances are important to the experiences of STEM trainees, graduates, and professionals. To the extent a peer views a minoritized peer ambivalently (e.g., as nice but dumb) this is a deniable prejudice suggesting a condescending pity. Indeed, in online and laboratory studies, well-meaning liberal White respondents talk down to Black peers, dumbing down their vocabulary and topic choices (Dupree and Fiske, 2019). High-status people who want to "get-along" do the same competence downshift when interacting with a lower-status person (Swencionis and Fiske, 2016). If these results characterize STEM interactions, it is possible that White individuals are unintentionally patronizing their Black colleagues, while feeling friendly in the attempt. Ambivalence is hard to detect because on a superficial level it seems pleasant. Again, a cognitive feature of individual racism makes individuals unaware or able to deny their prejudices. The larger context can monitor them better than they can monitor themselves.

²More of a puzzle is an adult sample's report that Black Americans are viewed neutrally on warmth and competence, likely a deliberately careful response, given other measures of racial attitudes and the sensitive nature of expressing opinions on racism (Kervyn et al., 2015). Alternately, this may mask a combination of common subgroups that cancel out to neutral: low-income people (race unspecified) are stereotypically neither competent nor warm (representative sample; Cuddy et al., 2007). Black professionals are however stereotypically competent, and only moderately warm (nationally representative sample; Cuddy et al., 2007). Combining across low and high status would add up to neutral. Consistent with the idea that race and class combine to produce most non-Black adults' stereotypes of Black people because of subgroups, a sample of online Black adults rated Black subgroups such as Black students did, with competence largely a function of social class (Fiske et al., 2009).

Ambiguous Attributions Maintain Flexibility

The following research summarized here show that ordinary individual racial bias is more ambiguous than most people think. When gatekeepers are ambiguous about the reasons behind their decisions, they gain flexibility; that is, they can later plausibly deny that the choice was racist. To illustrate this, the committee has gathered examples that reveal this process of ambiguous attributions about feedback, performance, and discomfort. For example, was that person treated in a certain way because of their race or because of a bad interview? The implication of this ambiguity is that organizational-level accountability must rely on examining the gatekeeper's aggregate patterns and choices, not on any single choice that may have ambiguous origins.

Minoritized individuals can experience attributional ambiguity (discussed in Chapter 5): Is this negative feedback a result of my performance or my race? (Major and O'Brien, 2003). Gatekeepers must also attribute minoritized individuals' outcomes to either race or individual factors. How they introduce a new staff member, in terms of causal attributions, indicates the opposing views that can make or break a career: "This is Henry, hired under our new diversity plan" versus "This is Henry, whose excellence for this job made him our top choice." Attributions to category, as in affirmative action, are stigmatizing (Heilman et al., 1992), but subtle and indirect. When the reason for the evaluator's decision is ambiguous (either target's individual factors or target's category, such as race), it maintains flexibility and thus, deniability. Being accountable for a decision assumes that observers can pin it down.

Another attributional dilemma comes from distinguishing whether a gatekeeper's decision mainly favored the ingroup or disfavored the outgroup (Tajfel and Turner, 1982). When White gatekeepers opt to choose others similar to self, they are not necessarily displaying hostility to minoritized individuals, but perhaps comfort with other ingroup White individuals. In a zero-sum game, the outcome for the excluded minoritized person is the same, but the cause differs. Responding to overt hostility, such as not being chosen because of being a minoritized individual, differs from responding to passive exclusion, such as not being chosen because the gatekeeper favors White individuals. When managers describe choices as a matter of fit (the ingroup "fits;" Heilman, 1983), they create attributional ambiguity and plausible deniability.

When gatekeepers fail to put their response into words, they again obscure the decision. Gatekeepers maintain flexibility by communicating nonverbally, whether intentionally or not. In social interactions, nonverbal distance cues, such as sitting farther away or not facing the other, signal the gatekeeper's lack of engagement, as well as an interaction not going well for

the more engaged, lower status person; this signal affects the minoritized person's performance. For example, Black and White highschool students—trained to behave according to the same script—interviewed with White college students for a STEMM research assistant job (Fiske, 2010). White interviewers talking to Black interviewees displayed nonverbal discomfort, at a minimum, and possibly antipathy, given that they ended the interview sooner, oriented away, and conveyed disfluencies. In a second study, White interviewers were trained to display the same nonverbal cues directed toward the White or Black applicants in the first study. White interviewees, treated as if they were Black, performed worse and judged the interviewer as less competent, compared with White interviewees treated as White (Word et al., 1974).

Nonverbal behavior expresses gatekeepers' racial category-based responses that are made outside of full consciousness or awareness. This has self-fulfilling effects on minoritized individuals (Rosenthal and Jacobson, 1968). In general, cognitive racial expectations come across in spoken words, while affective prejudices come across as nonverbal impressions (Dovidio et al., 2002). Gatekeepers are not called to account for their nonverbal behavior because the signal is often too ambiguous or noisy in any given instance.

While the previous chapter covered the psychological impacts of experiencing racism from the perspective of the minoritized individual, the committee was not able to incorporate a similar section in the current chapter—namely, the psychological impacts of perpetuating racism from the perspective of the gatekeeper in STEMM. This is a result of the dearth of research in this area; more is clearly needed.

A critic might argue, specifically with regard to STEMM gatekeepers and bias, that STEMM professionals are trained to observe, analyze, and interpret objectively, so they would not be vulnerable to errors and biases in judging others. Unfortunately, graduate training does not guarantee accuracy on the types of reasoning implicated in judging other people: statistics, confounds, or logic (Lehman et al., 1988). No research at this time demonstrates that STEMM gatekeepers are immune from perpetrating racial bias. The perpetual minoritization of Black, Indigenous, and Latine students, faculty, professionals implies that something is amiss.

GATEKEEPERS' SOCIAL MOTIVES TO PRESERVE THE STATUS QUO

This section reviews literature demonstrating that gatekeepers tend to possess several social motives that enable the preservation the status quo of gatekeeping (i.e., that most gatekeepers tend to be White). The role of

gatekeeper selects for people with status-quo-perpetuating attitudes and encourages those attitudes because they preserve the position's advantages. The same is true for the gatekeeper's motives, which are self-serving because they can be. Gatekeepers see opportunities and rewards everywhere (Keltner et al., 2003). Gatekeepers can attend to their goals because they are not contingent or as dependent on other people (Guinote, 2017). Gatekeepers are prone to stereotyping outgroup others because powerholders by definition do not depend on their subordinates (Fiske, 1993). Likewise, White individuals tend to endorse beliefs that favor their continuing power and status (Fiske, 2010). All these self-serving tendencies appear in the core social motives that drive gatekeepers. These are loosely grouped into the following categories: (i) belonging; (ii) understanding and controlling, and (iii) esteeming and trusting. Comprehending these motives can suggest how to intervene in systemic structures that routinely advantage White individuals. Belonging works as the overarching social motive, while understanding and controlling are considered the more motivated cognitions, and esteeming and trusting are motivated affects. Each of these are discussed below.

Belonging as a Moral Credential

As discussed, minoritized individuals desire and often work toward a sense of belonging in STEMM, but are usually denied (see Chapter 5). On the other hand, it would seem that White gatekeepers automatically feel they belong in STEMM contexts, given U.S. history and given that they are most likely to occupy those positions. Thus, belonging for gatekeepers is not necessarily a recognition of their competence and achievement, as belonging would be to minoritized individuals (Dupree and Fiske, 2019; Swencionis and Fiske, 2016). Furthermore, gatekeepers have power to determine who belongs and who does not belong in STEMM.

Organizations make tradeoffs between instrumental (practical) and moral (justice) reasons for policy, including policy pertaining to advancing diversity. Institutional justifications for antiracism, diversity, equity and inclusion, if they focus on profit or benefits to White individuals, are generally pleasing to White respondents (Starck et al., 2021), but they are instrumental justifications and not justice oriented. For example, this sentiment may reflect the belief that “diversity helps increase profit.” For Black respondents, the justification for belonging is often social justice, which communicates shared morality. For example, this sentiment may include the belief that “advancing diversity is the right thing to do.”

Instrumental justification correlates with academic settings that show greater racial disparities. Instrumentality sends the message to minoritized individuals that now they are welcome only because they are useful—not because equitable belonging is the right way to treat another human.

From the perspective of minoritized individuals, being useful for instrumental purposes, but not being part of the moral circle, is dehumanizing. Gatekeepers generally seek to be accepted as a good and unprejudiced person, and as such use diversity instrumentally and make belonging a moral credential (Dupree and Fiske, 2019; Swencionis and Fiske, 2016). For example, having chosen one minoritized individual for the shortlist demonstrates, in the mind of the gatekeeper, a lack of prejudice, while hiring a White person from the shortlist feels justified (Merritt et al., 2012; Monin and Miller, 2001).

Understanding and Controlling Resources

Gatekeepers are more likely to understand the social world as full of groups that will not change and that exist in dominance hierarchies. In that regard, gatekeepers tend to favor power, status, homogeneity, similarity, and familiarity, and altogether preserve the status quo, which they usually control. Several cognitive belief systems support these biased understandings, including essentialism, dominance, authoritarianism, system justification, and a need for closure. All of these create obstacles for antiracism, diversity, equity, and inclusion-related change, maintain White gatekeeper control over resources, and make gatekeepers unlikely to be change agents.

Essentialism is the belief that specific social categories, such as racial groups, are natural, and individuals who belong to specific social categories have essences, or underlying natures that are associated with that category (Medin and Ortony, 1989). These essences that relate to category membership are believed to be naturally occurring, inborn, and immutable characteristics. Consequently, essentialist beliefs are associated with more rigid and categorical thinking, and subsequently a greater stereotyping, prejudice, racism, and greater support for boundary enhancing policies (Keller, 2005; Mahalingam, 2003; Mandalaywala et al., 2018; Roberts et al., 2017). This cognitive bias is analogous to endorsing the belief that race is a biological and not a social construct (Schudson and Gelman, 2022). STEM faculty who view ability as fixed, for example, have bigger racial disparities regarding student motivation and achievement (Canning et al., 2019). More generally, a growth mindset, instead of a fixed mindset, facilitates student engagement and performance (Muenks et al., 2019).

Social dominance orientation is another belief system that tends to underpin support for the status quo. It is an individual-level difference in the preference for group-based hierarchy and inequality, and individuals who have higher levels of social dominance orientation tend to make decisions and judgments that serve to protect the status quo (Ho et al., 2020; Pratto et al., 1994). For example, this effect has been examined within the racial categorization of multiracial individuals (Ho et al., 2013, 2017).

One study found that White individuals who were strong endorsers of social dominance orientation, as compared to those White individuals who were not, were more likely to categorize a multiracial (Black-White) individual as being Black as compared to White. This was especially true when these White participants believed that their high status was threatened. This pattern of categorization—exclusion from a higher status racial group membership—is consistent with racial status boundaries that are reinforced by excluding multiracial people from the White racial group (Ho et al., 2013).

Greater endorsement of maintaining socially based inequalities is also a significant predictor of policy preference. One study found that the more that individuals held strong motivations to endorse hierarchy between groups, the less they perceive inequality between “higher status” and “lower status” groups. Furthermore, perceiving less inequality was significantly associated with rejecting egalitarian social policies (Kteily et al., 2017). Individual differences in social dominance orientation therefore predicts which STEMM gatekeepers will be open to leveling the playing field and which will favor hierarchies.

Another example of a belief system that often endorses and maintains the status quo is right-wing authoritarianism, which is a politically oriented motivation to submit to authority, acting aggressively with the purpose of supporting authority, and often displaying hostility toward outgroup members (Altemeyer, 1998). Research has defined two primary facets of right-wing authoritarianism that tend to drive behaviors. First, individuals who score high in right-wing authoritarianism tend to perceive individuals as being a part of either their ingroup or an outgroup. Furthermore, those who are deemed to belong in the outgroup are perceived as threatening authoritarianism values. Second, individuals who score high in right-wing authoritarianism tend to perceive themselves as possessing a greater sense of morals, and subsequently feel justified to behave in ways that uphold systems and figures of authority (Whitley, 1999). Increased endorsement of right-wing authoritarianism is associated with more negative attitudes and more prejudice toward outgroup members (Duckitt et al., 2002; Sibley and Duckitt, 2008).

Individuals with system justification beliefs tend to find society to be generally fair, that most policies serve the greater good, and that people generally get what they deserve. According to system justification theory (Jost and Banaji, 1994; Jost et al., 2004), people vary in their motivation to defend and uphold existing systems. That gatekeepers would be especially likely to favor stability is aligned with preserving the status quo, and indeed advantaged groups’ system-justifying beliefs correlate with higher self-esteem, well-being, and ingroup favoritism (Jost and Hunyady, 2003). The opposite holds for disadvantaged groups whose system-justification

beliefs correlate with lower self-esteem, lower well-being, and less ingroup favoritism, as well as self-stereotyping. When even low-power groups subscribe to system justification, it might not seem to serve their self-interest or group interest, but apparently many low-power group members prioritize predictability over their own interests, at least sometimes. Gatekeepers can exploit this, because justifying the system entails endorsing positive stereotypes about their own group. Indeed, system justification works better for White individuals than for Black individuals (Rankin et al., 2009).

Need for closure relates to an individual's preference (or a situation's demand) to arrive at an answer quickly rather than having persisting ambiguity (Kruglanski, 1990; Kruglanski and Webster, 1996; Webster and Kruglanski, 1994). As compared to individuals with a lower need for closure, individuals with a greater need for closure generally have a need to arrive at a decision quickly, and they have a need to create and maintain simple structures (Neuberg et al., 1997; Roets and van Hiel, 2007). As such, these individuals may tend to be more rigid in their thinking and are likely to endorse essentialist categorizations, rely on stereotypes, and support authoritarian ideologies. Consequently, the need for closure predicts bias (Roets and van Hiel, 2011; Theodorou and Kovic, 2021), with a higher need for closure significantly associated with prejudice against a range of outgroup members (e.g., Bianco et al., 2022; Burke et al., 2017; Shah et al., 1998).

Esteeming and Trusting as Meta-Perceptions

Besides motivated cognition that reflects understanding and control in favor of the status quo, gatekeepers seek esteem in the form of respect and appreciation. Because their higher status and power predicts that others will see them as competent, gatekeepers seek recognition of the other main social cognitive dimension, esteem for their warmth in terms of morality and friendliness. This occurs in high-status bosses interacting with subordinates (Swencionis and Fiske, 2016), and liberal White individuals prioritize conveying warmth in their interactions with Black interaction partners. However, because of a perceived warm-competence trade-off—if you are too smart, you must be cold—these well-intentioned White adults in online experiments downshift their competence to seem folksy and down with the people (see section above on ambivalent, plausibly deniable biases). White Democratic candidates for President do the same thing for Black and Latine audiences (Dupree and Fiske, 2019). Therefore, well-meaning STEM mentors may be at risk of similarly patronizing behavior; in their attempts to make friends with their mentees, they could be too warm and not respectful enough.

Interracial meta-perceptions, or how each person thinks the other sees them and wanting others to see oneself positively, arise in interracial

interactions in dozens of laboratory studies (Shelton et al., 2006). Meta-perceptions are distinct from general perceptions because they are relational; they are one's beliefs about how the interaction partner perceives the self (Shelton and Richeson, 2006). In other words, meta-perceptions are perceptions of the self, through the lens of the other. Much of the research has focused on interracial interactions between a White individual and a minoritized individual (Shelton and Richeson, 2005). On the one hand, researchers have focused on the perspective of the White individual, including experiences of anxiety (Plant and Devine, 2003) about how they are viewed. For example, in an interracial interaction between a Black individual and a White individual, the White individual's meta-perceptions could include the extent to which their Black interaction partner would like them. White individuals express concern about their meta-perceptions in the context of interracial interactions, particularly, concerns about being perceived as prejudiced by the other individual (Shelton and Richeson, 2006). In contrast, Black individuals may care more about whether their White interaction partner respects them.

Taking these perceptions together, White individuals and minoritized individuals during interracial interactions may have different impression management goals stemming from their meta-perceptions (Fiske et al., 2015). White individuals want to be perceived as moral, fair, and unbiased (Bergsieker et al., 2010). Minoritized individuals want to be respected and perceived as competent. In a STEMM context, respect for one's ability is more relevant than reassurance that one is not a racist.

As a foundational study has demonstrated, there are two primary motivations for White individuals not wanting to be perceived by their minoritized interaction partner as prejudiced (Plant and Devine, 1998). First, some White individuals are externally motivated to respond and be perceived as not prejudiced. This motivation is driven out of fear of facing negative social consequences. On the other hand, some individuals may be internally motivated to respond and be perceived as not prejudiced. This internal motivation is rooted in a set of personal values. Furthermore, individuals who are more internally motivated to respond without prejudice, as compared to individuals who are externally motivated, navigate interracial interactions in very different ways. Across a series of studies, White individuals who were internally motivated to respond without prejudice were more likely to engage in partner-focused behaviors toward their Black interaction partner. For example, they were more likely to show them the respect they wanted and remember more details about what they said and did. Conversely, individuals who were externally motivated were more likely to focus on the self by avoiding engaging in behaviors their partner may find as biased and were not as sensitive to their partner's desire for respect (LaCosse and Plant, 2020).

For gatekeepers to build trust between themselves and minoritized individuals, this means getting past a challenge for many White liberals—contemplating their race’s role in oppressing minoritized individuals, especially Black individuals. Although anti-social traits predict racism, individuals who mean well and are not necessarily anti-social can still perpetuate racism. Specifically, White individuals facing racial stress may be vulnerable to a range of emotions (e.g., fear, guilt; Grzanka et al., 2019). These emotions inform the display of behaviors that work to restore a sense of racial comfort as well as White superiority (DiAngelo et al., 2011). When affirmed, White individuals no longer feel threatened by Black people’s progress (Wilkins and Kaiser, 2014). Consistent with these ideas, White individuals scoring higher on a White “fragility” scale also endorsed modern racism, social inequalities, and allegedly colorblind racial attitudes (Langrehr et al., 2021).

THREATS TO GATEKEEPERS FROM DEMOGRAPHIC SHIFTS IN THE UNITED STATES: THREAT, ANXIETY, AND SYSTEM-REINFORCING BEHAVIORS

As discussed in the previous section, gatekeepers tend to possess several social motives that encourage the preservation of the status quo. The present section looks at how attempts to preserve the status quo, enacted at the individual and interpersonal levels by gatekeepers, might be informed by larger demographic shifts. The research reviewed below shows that specific societal-level demographic shifts occurring in the United States may be perceived as a potential threat to the preservation of the status quo and a source of anxiety around this possible loss of power and status. As such, cues signaling these demographic shifts can inform individual- and interpersonal-level outcomes among gatekeepers.

Even while minoritized individuals remain severely underrepresented across multiple STEM contexts, the United States is experiencing a massive demographic shift (see Chapter 3 for more on this). Specifically, the population of minoritized individuals has been growing faster than White individuals, and minoritized individuals could attain majority-minority status by 2050 (Richeson and Sommers, 2016). While the percentage of non-Hispanic White individuals is decreasing over the years, scholars have noted that the changes regarding how race and ethnicity are measured and categorized through the U.S. Census over the years also increases the complexity of understanding the demographic shift. Nevertheless, the perception and framing of majority-minority has become more mainstream in recent political events and in the media (Craig et al., 2018).

Some researchers have focused on examining perceptions of this shift by White individuals. A body of research demonstrates that some

non-Hispanic White individuals may perceive the majority-minority shift as a threat to their power and status as a member of a dominant group. Furthermore, this perceived shift is associated with greater reported feelings of anxiety, and often greater support of policies that serve to promote White dominance (i.e., maintain their position in society; see Craig et al., 2018 for review).

Non-Hispanic White individuals' perceptions of and outcomes associated with majority-minority shifts taking place in the United States (Perkins et al., 2022) have been captured in a series of experiments manipulating the salience of this shift. Research has found that cues signaling a majority-minority shift were associated with perceptions of threat, and subsequently a greater tendency to perceive mixed-race faces as belonging more so to minoritized racial groups, thus demonstrating an increased tendency to uphold racial boundaries and restrict who counts as White. This phenomenon increases the number of individuals who may be targeted with discrimination, as a greater number of individuals, including those of mixed race, may be perceived as minoritized individuals (Krosch et al., 2022). Similarly, perceptions of a decreasing White demographic group were associated with feelings of existential threat, and, subsequently, support of far-right extremism as displayed by more positive feelings toward the Ku Klux Klan (KKK) and other alt-right and neo-Nazi groups (Bai and Frederico, 2021) and support for White supremacy (Fortunato et al., 2022). In a related series of experiments, researchers found that exposure to cues about majority-minority shifts was associated with non-Hispanic Whites' concerns about facing anti-White discrimination (Craig and Richeson, 2017). In short, they fear experiencing the discrimination currently faced by minoritized individuals now.

CONCLUSIONS

As the previous sections have shown, many gatekeepers tend to possess several social motives that enable the preservation of the status quo. As discussed above, these social motives include belonging, understanding and controlling resources, and esteeming and trusting. These factors contribute to advantage gatekeepers and disadvantage minoritized individuals, their position challenges the gatekeepers' proclivity to notice, let alone remedy racism in STEMM. Furthermore, additional research demonstrated demographic shifts occurring in the United States, specifically perceptions of the "majority-minority" shift, may be perceived as a potential threat to the preservation of the status quo, and a source of anxiety around this possible loss in power and status. These perceptions can further invoke support for far-right extremism and maintenance of the White status quo. Taken all together, though not impossible, these numerous factors and cognitive biases make gatekeepers unlikely to be change agents.

CONCLUSION 6-1: Like other people, gatekeepers often have attitudinal biases, cognitive mechanisms, and social motives that keep the White status quo intact. Racial bias is not only more automatic, but also more ambivalent and ambiguous than most people think. That means that individuals, including gatekeepers, may not be able to monitor their own bias impartially, and may unwittingly perpetuate it.

CONCLUSION 6-2: Additional research is needed to examine the psychological impacts of perpetuating racism from the perspective of the gatekeeper in science, technology, engineering, mathematics, and medicine.

ORGANIZATION OF THE RECOMMENDATION

As discussed in the chapter and the conclusions, gatekeepers may not be able to monitor their own bias, are unlikely to become change agents themselves, and yet they are still a source of power and influence over antiracism, diversity, equity, and inclusion-related outcomes in STEM contexts. Therefore, the recommendation in the current chapter is aimed at intentionally creating links between two levels; the level of the organization and the level of the individual gatekeeper. The essence of the recommendation for this chapter involves generating systems of accountability at the organizational level, above gatekeepers, that can help identify behavioral patterns of individual gatekeepers. In turn, understanding and identifying behavioral patterns may shed light on potential patterns of bias, which can be helpful for initiating top-down change to improve conditions for minoritized individuals.

RECOMMENDATION 6-1: Leaders of science, technology, engineering, mathematics, and medicine (STEMM) organizations and directors of human resource offices can improve minoritized people's individual and interpersonal experiences in STEM educational and professional environments through the following practices:

- Create organizational-level or unit-level information systems to collect data on the decisions of gatekeepers. Data collected may include, but not be limited to hiring, admissions, promotion, tenure, advancement, and awards. Data should be examined in the aggregate to identify patterns of bias exhibited by gatekeepers based on race and ethnicity.
- Include responsibilities related to advancing antiracism, diversity, equity, and inclusion in leadership role descriptions and requirements for advancement into management.
- Develop systems with more widely shared, inclusive decisionmaking processes and shared authority over the allocation of resources, which should limit the negative consequences that occur when gatekeeping is concentrated in a select few individuals.

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Diverse Work Teams: Understanding the Challenges and How STEM Professionals Can Leverage the Strengths

In the previous two chapters, we examined individual and interpersonal racism from two distinct perspectives, namely the minoritized individual and the gatekeeper. This chapter examines situations where these individuals are brought together, in a team. The way that much science is done today relies on individual scientists training or working together in this way, and in light of teamwork's central role in science, technology, engineering, mathematics, and medicine (STEMM), the committee here explores the dynamics of numerically diverse teams, describes the challenges that can arise within them, and discusses how STEMM professionals can leverage the potential strengths of diverse teams.

The chapter begins by defining teams as a small number of individuals with different roles and responsibilities who interact independently to perform tasks and accomplish shared goals. The research shows that teams are part and parcel of STEMM in educational and professional settings. As recent calls to increase "team science" continue, many STEMM organizations and professionals may be motivated to improve the conditions of effective diverse teams.

After, the chapter examines the research on how racial and ethnic diversity in teams impacts team performance. A common narrative is that diverse teams perform better. As the research shows, the evidence around the impact of team diversity on team performance is not straightforward, and in some cases even contradictory. This is driven, in part, by a key finding demonstrating that numeric diversity alone is necessary but insufficient to help produce positive team performance. Numerous challenges can threaten performance, including anxiety about working with people from other race and ethnicity groups and prevalent mistreatment targeting minoritized individuals.

The chapter then reviews literature finding that under ideal conditions, diverse teams can be leveraged to produce positive performance outcomes. Some conditions include promoting inclusion and a positive team climate and working under conditions of psychological safety. Further, a body of research finds that attending to teamwork contexts may also help facilitate prejudice reduction among individuals. We end by concluding that STEMM professionals who want to help advance antiracism, diversity, equity, and inclusion (A DEI) need to take an active approach to diverse team management. To leverage the potential strengths of diverse teams, several ideal conditions should be actively fostered, and careful and conscious management of diverse teams is needed. These are specified.

TEAMS WITHIN STEMM

STEMM culture has historically been characterized by and centered on individualism and competition with others (Gilliam et al., 2017; Morton et al., 2019). In academia, in particular, reward structures, including grades and promotions, are all allocated at the individual level. Yet the way most science is done today in practice relies on individual scientists training or working together in teams of varying sizes. In addition, in recent years there have been calls to increase “team science,” or the formation of collaborative groups with experts from various disciplines leveraging their strengths to solve increasingly complex problems of social and scientific importance (National Research Council, 2015). Innovative curricula have also been developed for introductory courses that center teamwork and innovation (Full et al., 2021; Handelsman et al., 2022), which have been linked to increased retention of minoritized students (Handelsman et al., 2022). Thus, improving the conditions of diverse teams to yield effective teamwork is often a priority for STEMM training, organizations today, and nations as they tackle the problems of tomorrow (Phillips et al., 2014).

A *team* is defined as a small number of individuals with different roles and responsibilities that interact together and interdependently to perform tasks and accomplish goals that are shared (Katzenbach and Smith, 1993; National Research Council, 2015). In STEMM, teams are typically made up of two to ten individuals (National Research Council, 2015), and this is also the scale of most of the research on teams presented in this chapter. In STEMM, teams may take several forms. These may include working together in laboratory spaces, mentorship, online or asynchronous collaborative work, and other work models (Robotham et al., 2021). As individuals continue to come together to form teams, they bring with them not only their individual differences in knowledge and education (Shemla and Wegge, 2019), but also their entire selves, including their individual racial and ethnic identities (Osseo-Asare et al., 2018). However, the numeric underrepresentation of

minoritized individuals in STEMM has made studying the impacts of racially and ethnically diverse teams limited, if one omits international students and international employees. Therefore, the current literature discussed is inclusive of studies across several contexts. There is opportunity within STEMM for the formation of diverse teams along racial and ethnic backgrounds if numeric diversity increases, but as will be explored through this chapter, the formation and maintenance of effective diverse teams depends on a number of factors that go beyond numeric representation alone.

RACIAL AND ETHNIC DIVERSITY WITHIN TEAMS: IMPACT ON TEAM PERFORMANCE

It has been long theorized that racially and ethnically diverse teams may yield more positive performances on outcomes like innovation and creativity, as compared to racially and ethnically homogenous teams. This is because individuals from various race and ethnicity groups may contribute more varied experiences, perspectives, information, and ideas to help improve overall performance (Richard et al., 2021; Timmerman, 2000). However, the evidence around the impact of team diversity on team outcomes is not entirely straightforward, and in some places contradictory—with some research demonstrating associations with positive outcomes and others with negative outcomes (e.g., positive or negative performance; Bell et al., 2011; Ely et al., 2012; Horwitz and Horwitz, 2007; Joshi and Roh, 2009; Kirkman et al., 2004; Schneid, 2015; Smith-Doerr et al., 2017; Stahl et al., 2010; van Knippenberg and Schippers, 2007; Wang et al., 2019; Webber and Donahue, 2001). Consequently, the research on demographic diversity of teams and performance is inherently unclear and limited (Avery et al., 2022; Smith-Doerr et al., 2017; Williams and O'Reilly, 1998).

A closer look at the literature suggests why these conflicting findings arise. First, not all the research investigating team diversity is focused on race and ethnicity as the primary lens of diversity. Some studies have focused on other demographic factors, such as age or gender. Some research may even define “diversity” in terms of other factors like education, values (Wang et al., 2019), different skill sets, fields of study, or other non-identity characteristics. Beyond conceptualization differences, some studies may vary in how they measure diversity (Shemla et al., 2016), which can inform inconsistencies in the results.

Second, simply having a numerically diverse team does not automatically result in positive performance outcomes. In fact, many negative emotions and experiences related to interracial anxiety may impede the interpersonal process of team dynamics, and subsequent performance. As described in depth in Chapter 2, historical systems of racial segregation have divided the United States into neighborhoods and subsequently schools that

were stratified by race. The historical legacy of policies, systems, and practices that uphold racial segregation continues today. Therefore, most friendships, relationships, and interpersonal interactions remain largely stratified by race, and interracial interactions (interactions of people from various racial and ethnic backgrounds) remain infrequent, especially for White individuals (Banaji et al., 2021; Fahle et al., 2020). Since interracial interactions remain infrequent, they may provoke anxiety and negative emotions for those involved when they do happen (Avery et al., 2009; Mallet et al., 2008; Richeson and Shelton, 2007, 2012; Shelton et al., 2010). For example, a White individual may have anxiety about appearing prejudiced in the interaction, while a minoritized individual may have anxiety and concerns about being stereotyped or facing discrimination during the interaction (see also Chapter 5 and Chapter 6; Dunton and Fazio, 1997; Plant et al., 2008; Shelton, et al., 2005, 2010). These anxieties, negative emotions, and expectations may impede the cohesion, functioning, and subsequently the performance of a team, generally yielding negative performance outcomes (Richeson and Shelton, 2007; Richeson and Sommers, 2016).

Third, a numerically diverse team does not ensure that the team will also be antiracist, equitable, and inclusive of minoritized individuals. A significant body of research has focused on the range of negative experiences and outcomes of prejudice, stereotyping, discrimination, stigmatization, and tokenization for minoritized individuals in spaces that are predominantly White (see Chapter 5 for more information about minoritized individuals; and see Chapter 6 for more about the perpetration of prejudice, stereotyping, and discrimination; Richeson and Sommers, 2016). These dynamics also play out in team settings (Smith-Doerr et al., 2017). Specifically, while the incorporation of a few minoritized individuals may make a team more numerically diverse, these individuals may represent solos or “tokens” of their racial or ethnic group and face feelings of alienation and isolation. (Allaire, 2019; Basile and Black, 2019; Dickens et al., 2020; Wilkins-Yel et al., 2022). Further, individuals who are tokens may face the added pressure of becoming the symbolic representation of their entire identity group. Asymmetrical power dynamics and an unwelcoming climate may sideline minoritized individuals from full participation, thus reducing the overall potential of the team’s performance (Smith-Doerr et al., 2017). In teams that require contributions from everyone, formation of numerically diverse teams may be achievable, depending on the context; however, moving into norming inclusion may be more intense and take longer. Therefore, numerically diverse teams are not automatically inclusive and may actually perpetuate racial disparities if conditions that foster inclusion are not actively pursued.

What are those conditions, and how to effectively pursue them? To better understand positive performance outcomes, recent research has

suggested that it may not be a question of whether diverse teams perform better than non-diverse teams; rather it is a question of which conditions can realize this potential (Galinsky et al., 2015; Joshi and Roh, 2009). Under ideal conditions, there is evidence suggesting that team diversity can be leveraged to produce positive performance outcomes (Ellemer and Rink, 2016; Galinsky et al., 2015). One major condition is having a team that promotes an *inclusive positive climate*, which requires positive interpersonal working conditions for minoritized individuals on the team (Ely and Thomas, 2001; Ely et al., 2012; West, 2002). In short, the quality of interpersonal interactions matter. For instance, one study examined two years of data on racial composition, employee attitudes, and their impact on team performance. The researchers found that when White and minoritized team members perceived the team environment as supportive, there was a positive association between team diversity and bottom-line performance (Ely et al., 2012). Relatedly, research focused on gender diversity of teams has found that having a *critical mass* of women in science is an important antecedent of promoting greater inclusion and a positive climate (Griffith and Dasgupta, 2018; Ong et al., 2018; Smith-Doerr et al., 2017). While the benefits of building a critical mass for gender minorities in STEMM are known, additional research examining building a critical mass for racial and ethnic minoritized individuals on STEMM teams is needed.

Other important factors pertain to the structure and context of the team. A recently published study demonstrated that the specific structure of the team roles may help leverage the promising effects of a diverse team on positive performance. The researchers found that more racially and ethnically diverse teams were associated with greater team performance when there was *greater participation diversity* (i.e., individuals with a diverse range of temporal involvement, including core and peripheral performers). The authors suggest that having clarity around different team member's participation roles provides a behavioral script for team members and eases interracial anxiety. This was supported by additional findings showing that *cooperation* contributes toward this pathway (Avery et al., 2022). Likewise, Bresman and Edmondson (2022) also found that diverse pharmaceutical teams underperformed relative to homogenous team due to their avoidance of interpersonal risk. However, when diverse teams worked under conditions of *psychological safety*, there was a positive relationship between diversity and performance.

Further, research has identified some additional conditions that may promote a positive association of team diversity and performance include the following. These may include having *diversity across all levels* of management teams (Richard et al., 2021), having organizational leaders with greater *visionary* behaviors who do not categorize their team into subgroups (Greer et al., 2012), designing teams with *clear objectives* to

maximize knowledge management systems (Guillaume et al., 2017), and having greater *congruence between team diversity and the diversity in the local community* (Richard et al., 2017).

In general, most research summarized here suggests that attending to the conditions under which a diverse team works maximizes the likelihood of more positive performance outcomes. Because STEMM work frequently occurs in teams, team leaders may be interested in actively monitoring and managing for these teamwork conditions to help facilitate positive outcomes. In the following sections, we move beyond the outcome of team performance to explore how attending to teamwork conditions may also reduce the inclination for individuals to be prejudiced, which may have important implications for fostering antiracism, diversity, equity, and inclusion on STEMM teams.

THE CONTACT HYPOTHESIS: REDUCING PREJUDICE THROUGH INTERRACIAL INTERGROUP CONTACTS

In addition to considering how team diversity may impact performance, a related body of research has examined another outcome, namely prejudice reduction. This substantial body of research has investigated whether contact between individuals from multiple racial and ethnic groups may help reduce bias.

Against the backdrop of a racially stratified society, negative prejudices, stereotypes, and discriminatory behaviors toward minoritized individuals continue, in part due to the lack of exposure to minoritized individuals (Pettigrew et al., 2007). White individuals who have limited exposure to, or “contact” with, minoritized individuals are generally more likely to hold racial biases, and conversely, those with greater exposure may be generally less likely to hold those biases (Pettigrew, 1998). The contact hypothesis (Allport, 1954) posits that under the right conditions, interracial intergroup contact can be positive, and it can help reduce prejudice. Increasing contact with individuals of multiple racial and ethnic groups may be a key factor in challenging and mitigating racist prejudices, stereotypes, and discriminatory behaviors in society. For the contact to be positive and yield the intended impact of helping reduce bias, original theorists proposed that individuals must meet under four specific conditions (Allport, 1954; Pettigrew, 1998). Each of these are described below.

The Conditions of the Contact Hypothesis

- *Equal Status*: individuals of different racial and ethnic groups must perceive and have equal standing within the situation, without asymmetrical power differences, when the individuals meet.

- *Having Common Goals*: the individuals during the interaction must share and work toward the same planned or intended outcomes.
- *Interpersonal Cooperation*: the individuals in the interaction should be working toward the common goal without competition. The individuals in the interaction should be working cooperatively toward the common goal without competition.
- *Support of Authorities, Law, and Custom*: leaders must formally accept and actively support the intergroup contact, reinforcing the norms, laws, and customs of this contact.

While achieving these four conditions were proposed as necessary, a meta-analysis of 713 independent samples from a total of 515 studies found that all four of these conditions do not necessarily have to be met in order for prejudice reduction to occur (Pettigrew and Tropp, 2006). In addition to generally achieving these said conditions, the perception of the nature of the interaction is likely a critical factor in promoting prejudice reduction. Specifically, intergroup interactions that are perceived as positive have been found to be associated with greater prejudice reduction (Hewstone, 2015; Laurence et al., 2018).

Empirical Evidence Supporting the Contact Hypothesis

A substantial body of research supports the contact hypothesis as a mechanism of reducing bias (Pettigrew and Tropp, 2006). For instance, one recent study incorporated 16 different samples of participants from five countries. Using a variety of research methods, the study team sought to examine the effect of intergroup contact on two distinct outcomes. These included the rates of blatant *dehumanization* of outgroup individuals and *meta-dehumanization* (i.e., perception that ingroup members will be dehumanized by the outgroup). The results demonstrated that intergroup contact was associated with a reduction in dehumanization and meta-dehumanization. While the quantity of intergroup contact was correlated with the reduction of both dehumanization and meta-dehumanization, it was found that the quality of that contact was more strongly associated with both of those outcomes (Bruneau et al., 2021). Whether this translates for reducing racial bias, as opposed to national stereotypes, is uncertain. In the age of online communication, intergroup contact through online spaces is more common. One recent meta-analysis examining 23 studies found a significant effect of online intergroup contact in reducing race-based and other forms of prejudice. The authors concluded that our new virtual contexts may be leveraged to promote prejudice reduction through intergroup interactions (Imperato et al., 2021). Some support for the contact hypothesis was also found in another recent meta-analysis (Paluck et al., 2019); however, the authors caution that while intergroup contact generally

reduces prejudice, the contact effects vary, and more research is needed to help understand which factors can promote a stronger “contact” effect.

The research on leadership provides evidence that providing support in a way that leads to the benefits of intergroup contact is also a complex issue. Several recent studies unpack the ways in which diversity rhetoric may intend to be supportive and positive yet negatively impact organizations’ diversity goals, such as the attraction, retention, and performance of minoritized groups (for more on this, see Chapter 6). Therefore, diversity rhetoric that explicitly articulates why multiple groups are brought together may yield differential impacts.

These conditions of the contact hypothesis help to shed light on why STEMM continues to lack representation. In academic and professional STEMM contexts, at the organizational level, the attributes of contact that decrease prejudice are not common. Minoritized people are more likely to be in lower status roles (see Chapter 3), and thus equal status is not present and this may carry over into teams. Further, minoritized people may come to STEMM with different values and goals, focusing more on community benefits than individual personal triumphs (see Chapter 5). For some minoritized groups, their cultures emphasize cooperation, and they may have variable experience of receiving this from White individuals. In some cases, the lack of shared culture with White individuals may result in a mismatch of expectations to guide the team’s work. Finally, there is no strong evidence that STEMM leadership, which is primarily drawn from the dominant White racial group, formally accepts and actively supports intergroup contact that includes equity and acknowledgement of multicultural values and norms. Instead, there is evidence that gatekeepers are often working to preserve the White status quo (Chapter 6) and may be reinforcing the norms, laws, and customs of their own culture. In the next section, we report on contact research that occurred in the context of STEMM organizations and other workplaces. Further, we examine what interventions have been investigated to facilitate intergroup contact. To do so, we consider evidence from multiple fields.

Contact Hypothesis Tested in Workplaces and STEMM Contexts

Some empirical evidence from organizational science demonstrates that the contact hypothesis is applicable in STEMM workplaces and educational settings, although additional research in this area is needed. Many workplaces in the United States are equal opportunity employers, which makes discrimination based on race illegal (Estlund, 2003). These structures encourage a more numerically diverse workforce, and in theory the formation of diverse work teams, although data show that certain minoritized racial and ethnic groups continue to be highly underrepresented (see previous chapters). While teams are often spaces in which individuals are working

cooperatively toward a common goal (Allport, 1954; Pettigrew, 1998), the research on teams and contact hypothesis have primarily focused on how White individuals are influenced by contact with people different from them along factors like race or ethnicity. Additional research examining intergroup contact in STEMM, from the perspective of minoritized individuals is also needed.

One recent study sought to examine whether interracial intergroup contact at work was associated with reductions in racial bias. The research team utilized 12 years of data from a nationally representative survey and focused exclusively on 3,359 Non-Hispanic White working adults. After statistically adjusting for the presence of other confounding variables, the study found that consistent with the contact hypothesis, White workers with a Black coworker had significantly less pro-White bias (Darling-Hammond et al., 2021). Further, using propensity score matching, the researchers found evidence of a *causal* association between contact and a reduction of pro-White bias. The impact on the Black coworker was not measured. Another study sought to examine the contact hypothesis in the context of medicine. The researchers focused on the interpersonal patterns of majority-group hospital workers across several hospitals. The study demonstrated that more frequent and positive interactions with outgroup immigrant patients were significantly associated with lower levels of prejudice toward outgroup immigrants in general. These findings remained significant after the researchers controlled for other forms of contact (including contact outside work and contact via media), suggesting that workplace contact is a meaningful and independent predictor of prejudice reduction (Pagotto et al., 2010).

Intervention and Exercise Development

Grounded in the contact hypothesis, some scholars have developed and tested interventions that build cooperation in non-STEMM team settings with the goal of reducing prejudice. Some evidence indicates that intergroup contact interventions may be promising, although a more robust and rigorous empirical investigation is needed (Paluck and Green, 2009), including those in STEMM contexts. For instance, the “Jigsaw Classroom” exercise was implemented as a cooperative teaching technique to help reduce racial bias among K–12 students in a school that had become desegregated (Aronson, 1978). The Jigsaw method requires that students work collaboratively and depend on each other to learn the course content. Each student is assigned to a small diverse team. Each team (about 4–6 teams) is of equal status and is assigned to learn a specific content area or a single “puzzle piece” of the larger topic. At the end, each team presents their “puzzle piece” of information to the larger class, and all the information of the lesson is finally incorporated. Importantly, throughout this activity, individual students do not suppress their individual racial

and ethnic identities. They recognize their individual differences, while recognizing their superordinate identity of being part of the shared class (Williams, 2004). The researchers found that this activity helped significantly reduce racial bias (Aronson, 1978; Walker and Corgan, 1998). In higher education, similar course designs have been developed, whereby students drawn from different fields of interest first engage in individual design efforts and build the confidence to interact in teams. Team-building curriculum helps students experience the advantages of a diverse set of minds as they conduct, develop, and implement a project design (Full et al., 2021). While this course does not measure prejudice reduction, it does aim to increase innovation and creativity by building diverse teams.

Despite these optimistic findings, several factors (e.g., differences in classroom spaces, ages of participants) might limit or vary the effectiveness of the Jigsaw Classroom exercise in reducing prejudice and contributing to more innovative outcomes. Therefore, the generalizability of the Jigsaw Classroom exercise might be limited (Bratt, 2008). Even in contexts in which the Jigsaw Classroom exercise is effective, scholars have cautioned against an overreliance on this and other similar mechanisms to reduce bias (Bratt, 2008) and suggested it should not be used as a replacement of larger policy changes that work to dismantle systemic racism (Williams, 2004).

Intergroup Contact Contributions to Individuation

Intergroup contact may result in reductions in prejudice toward outgroup members because it provides greater opportunity for *individuation* to occur among diverse team members as they get to know each other and form relationships. Generally, when individuals encounter another person, they tend to rapidly categorize them based on previous encounters or assumptions, and consequently stereotype them (see the previous chapter for more on this). This immediate and rapid categorization has been recognized as a common element of social cognition. Humans tend to be “cognitive misers,” utilizing as few cognitive resources as possible, and by categorizing individuals rapidly, limited cognitive resources are used in more streamlined ways to help expedite the impressions (social categorization, one example of this, is discussed in Chapter 5). In contrast to categorization, *individuation* is a process whereby a person consciously considers the unique factors of a given individual. They may consider their unique beliefs, perspectives, and intentions of the other (Swencionis and Fiske, 2013). Some research has demonstrated that this process may reduce bias by focusing attention on the individual’s specific and unique traits rather than any larger stereotyped category (Wilder, 1978). Research suggests that increased exposure to individuals from other racial and ethnic minority groups via contact may facilitate this process of individuation (Fiske and Neuberg, 1990; Swencionis and Fiske, 2013).

Individuation has the potential to be facilitated in STEMM teams. For instance, individuals who have more frequent and personal contact with individuals from outgroups may engage in more individuation because they see more individual variation (unique factors) among individuals who are part of their outgroup (Heyman and Yazdi, 2019). Frequent contact with individuals from other race and ethnicity groups can happen on numerically diverse teams. Further, individuation often occurs when people depend on each other (Fiske, 2000), as they do on STEMM teams. When a person needs to rely on a teammate, they may seek individual-level information to form more nuanced impressions (Swencionis and Fiske, 2013). In particular, when people's outcomes depend on someone else, they seek specifically stereotype-inconsistent information (because it is more informative); they make dispositional inferences (individuated, not stereotypic impressions); and they activate brain regions associated with considering the other person's mind (Ames and Fiske, 2013). Taken together, when people individuate, they are less inclined to rely on generalizing (often negative) stereotypes (Fiske, 2000) and may perceive members of an outgroup on an individual basis (thus less homogenous; Dovidio et al., 2017).

Some research has demonstrated that individuating may help people rehumanize members of outgroups (Swencionis and Fiske, 2013). In fact, some experimental work has examined whether training people to recognize the faces of outgroup members as specific individuals, also termed perceptual individuation, may reduce bias (Lebrecht et al., 2009). There is some evidence that individuation may help reduce implicit racial bias including in samples of children (Qian et al., 2017; Xiao et al., 2015). Leaders and heads of teams might be interested in establishing practices and environments that promote individuation, particularly of groups that have been historically and systemically minoritized. Putting people on interdependent teams, as in lab or project teams, may help people to overcome group differences because everyone contributes a "piece of the puzzle" (cf. Jigsaw Classrooms; Aronson and Gonzales, 1988). As stated above, cooperation is one of Allport's (1954) conditions for successful intergroup contact. Further, interdependent structures—cooperation rather than individualistic competition—may be a better cultural fit for some minoritized groups (see Chapter 5; Nickerson, 2021).

INGROUP FAVORITISM AS A BARRIER TO THE DIVERSIFICATION OF STEMM TEAMS

Although there is evidence that diverse teams can yield positive outcomes, diverse teams also require energy from members to communicate through differences and wrestle with conflicts in values and perceptions of norms. Teams of ingroup members may be easier for both gatekeepers and minoritized individuals. In some cases, resegregation can occur and

can challenge the formation of diverse teams and the maintenance of positive team conditions. The phenomenon and process of resegregation has been demonstrated across several studies (Wharton and Baron, 1987), and literature exists showing evidence of institutional segregation occurring at multiple levels, including at the “micro-level” (individual and interpersonal level; see Kauff et al., 2021) and the team level (discussed below).

Resegregation is a barrier that may also have major implications for understanding prejudice reduction in the context of STEMM teams. Resegregation by race can occur within larger organizations. This has the potential to act as a major point of structural racism because interracial intergroup interactions can then never occur, or would remain rare (McKeown and Dixon, 2017; Ramiah et al., 2015). Although segregation was outlawed in the United States, self-segregation among White individuals has been found to persist and be reproduced in multiple spaces (Anicich et al., 2021). Bettencourt and colleagues note the following:

Indeed, a growing body of research suggests that the formal policies of desegregation are typically offset by informal ‘micro-ecological’ (Dixon, Tredoux, Durrheim, Finchilescu and Clack, 2008) practices of (re)segregation, enacted across a range of everyday and institutional settings (e.g., Dixon and Durrheim, 2003; Swyngedouw, 2013; Tredoux and Dixon, 2009) (Bettencourt et al., 2019).

Consequently, organizations can remain largely White, and racially homogenous White teams may persist. Resegregation, especially in the highest tiers of occupational groups, contributes to the reproduction of racial stratification within an organization (Petsko and Rosette, 2022; Ray, 2019). Most often, Non-Hispanic White men have disproportionality greater power over STEMM team resources and power in determining the composition of teams, but routinely reproduce predominately homogenous teams (Ahmad et al., 2019; Greider et al., 2019; Rodriguez et al., 2021; see Chapter 6 for more on gatekeepers). Leadership at academic institutions, particularly research-intensive universities, show a similar demographic tendency to place a disproportionate number of White males in leadership positions (see other chapters).

Resegregation may also happen within and impact teams. For instance, one study investigated the impact of social distance on diversity preferences in group formations. The researchers found that at an abstract level, participants indicated that diversity in groups was desirable. They did, however, indicate concerns about feasibility. However, when it came to making decisions, participant’s choices were aligned with segregation. Namely, participants often selected a collaboration partner who was “dissimilar” for another person but picked someone similar for themselves. When making

decisions about forming work groups, participants exhibited the same pattern. When establishing a work group for others, the composition of the group they selected was more diverse; however, when forming a work group for themselves, the group was less diverse (Jaffé et al., 2019).

Another study examined how racial diversity of local contexts impacted White participants' attempts to resegregate local groups to preserve White majority status. Across five studies, using a mix of methodologies, the researchers found that in the face of increased racial diversity, White individuals worked to racially segregate themselves from outgroup members by exclusions both geographic and institutional (policies, norms, customs). These resegregation patterns and preferences of White majority spaces happened across multiple local environments, including the workplace (Anicich et al., 2021). Expanding on this phenomenon, biased White individuals are less likely to have White friends who are known to affiliate with Black individuals. Therefore, this work suggests that White individuals' networks can become increasingly segregated because some individuals may limit even indirect contact with minoritized individuals (Jacoby-Senghor, 2015).

Ironically, interventions to increase diversity in STEMM fields have included providing space for minoritized individuals to form affinity groups (as described in Chapter 5) in which they can experience STEMM research and training among other minoritized people. Co-curricular activities that provide STEMM training and professional development in small teams of other minoritized scholars have been found to be particularly important to increasing persistence of minoritized higher education and early faculty scholars (Estrada, 2011). Research examining the advantages and disadvantages of having ingroup spaces is not straightforward and deserves increased research. On the one hand, these spaces can be perceived as racist and exclusionary when gatekeepers are not sharing resources and professional benefits with minoritized individuals. Conversely, minoritized individuals who are experiencing exclusion and lack of equity find ingroup spaces to be restorative and important for their own ability to persist in STEMM environments to which they do not generally experience belonging (the National Academies of Sciences, Engineering, and Medicine, 2016).

MYTHS ABOUT RACIAL PROGRESS

In this chapter, we have summarized the research showing that when gatekeepers and minoritized individuals come together to form diverse teams, they encounter both challenges and opportunities. Under ideal conditions, there is opportunity for innovation and creativity that benefits from team members who have diverse perspectives and experiences. We described how several conditions of teamwork influence how well these teams function and produce desired outcomes. Positive intergroup contact between team

members can also be an opportunity to help reduce bias. Further, we find that there are strong cognitive and behavioral tendencies to retreat to in-group-only spaces that may further perpetuate racial inequities in STEMM.

To help move toward greater inclusion, especially for teams, we must critically examine the commonly held narrative that racial progress is rapidly, naturally, and automatically moving in the direction of greater racial equity. Although widely held, this narrative is not representative of the actual racial progress landscape (Onyeador et al., 2021). When gatekeepers adhere to the narrative that inclusion will occur automatically simply by having a diverse team, a significant barrier toward promoting ADEI remains in place. This is because if racial progress is believed to be rapid, automatic, and natural, active and deliberate efforts that work to improve ADEI do not occur (Kraus et al., 2022). Thus, gatekeepers who want to make change need to recognize this myth and actively make efforts to diversify their teams, and create and manage the ideal conditions that foster inclusion on teams since numeric diversity alone is insufficient (Smith-Doerr et al., 2017). Passivity in terms of managing diverse teams will not be adequate.

The Connection of Levels: Gatekeepers, Teams, and Organizations

Here, the committee makes explicit connections between various levels of analysis covered in the chapters (e.g., teams, individuals, organizations, society), as they relate to the recommendations. As discussed in the previous chapter, gatekeepers are unlikely to become change agents themselves, but they are still a source of power over ADEI related outcomes in STEMM. Therefore, the recommendations in the previous chapter were aimed at establishing systems at the level above individual gatekeepers to help generate systems of accountability and identify patterns of bias. The recommendation presented in the current chapter, which is oriented toward gatekeepers, is meant to follow that of Chapter 6, and is supposed to exist with the implementation of organizational-level recommendations made in the upcoming chapter. Which is to say, recommendations covering individual and organizational level change are not mutually exclusive. Rather they exist together, within a multi-level approach, eschews the notion that individual actors should be the *only* point of intervention. Importantly, if individual gatekeepers are intentional about initiating change within their team, or space, the recommendations provide guidance for implementation.

CONCLUSION 7-1: For teams in science, technology, engineering, mathematics, and medicine organizations, increased numeric representation of minoritized individuals is critical; however, numeric diversity alone is an insufficient condition to produce positive team performance. Conditions that foster inclusion are also essential.

RECOMMENDATION 7-1: Gatekeepers who manage teams, including but not limited to principal investigators and heads of laboratories and research groups, should be intentional about creating the following conditions. These can help support positive team performance outcomes and help reduce instances of interpersonal bias.

- Increase the numeric representation of minoritized individuals on teams by working toward building a critical mass, a necessary but not sufficient attribute of building an inclusive environment.
- Create team norms that centralize a positive climate, in which it is known that all team members, including minoritized individuals, are supported, heard, and respected.
- Develop interdependent teams in which everyone is cooperating and working toward an established common goal.
- Ensure that team members feel psychologically safe on the team, and if not identify the specific factors that are preventing psychological safety and work to address them.
- Work to promote equal status among team members. Remove asymmetric power differentials among team members, especially between White team members and minoritized team members.
- Incorporate greater diversity in developing team roles, and make sure all team members have clear roles and expectations, including access to professional development and pathways to advancement.

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Understanding Organizations and the Role of Leadership in Developing a Culture of Antiracism, Diversity, Equity, and Inclusion

Previous chapters have emphasized the importance of individual behavior and group dynamics. This chapter considers the broader context of the science, technology, engineering, mathematics, and medicine (STEMM) organizations in which individual and group interactions and behaviors occur.¹ STEMM organizations exist in many sizes, containing groups and individual people working together to achieve common goals. Here, the committee examines the structural and systemic issues that have contributed to inequalities; organizational antiracism, diversity, equity, and inclusion efforts; and ways to enact change at this level.

The committee relies on several key concepts throughout the chapter. An organization's *culture* can be defined as the historically and collectively evolving mix of norms, values, practices, and policies that guides action (Groysberg et al., 2018). Related to organizational culture, the *climate* of an organization is participants' perceptions and experience of their immediate context within the organization's culture. An organization's culture creates conditions for its *structures* as well as its climate; in this chapter, the structures of a particular institution come into focus as systems that can shape and guide how individuals and groups behave based on the culture (i.e., norms, values, policies, and practices) that informs decisions. Together, the culture, climate, and structures affect how people gain access to and experience educational and professional STEMM settings (Alvesson, 2002; the National Academies of Sciences, Engineering, and Medicine, 2018).

¹For the purposes of this report, STEMM organizations include universities, nonprofit organizations, private funders, professional societies, hospitals, and industry.

Those experiences are consequential for performance, persistence, belonging, and well-being, all of which can have direct effects on how teams operate and individual people perform.

One important goal of this chapter is to provide a guide for leaders who want to accelerate progress in advancing antiracism, diversity, equity, and inclusion in STEMM organizations and fostering cultures and climates where all participants can succeed. As discussed in more detail below, this focus on leadership is in response to evidence showing that culture change is an essential ingredient for systemic and transformational change, and that such change begins at the top of an organization and permeates multiple levels. Leaders, notably those at the very top of the organization such as presidents and chief executive officers, have the unique opportunity to shape the culture and climate of an organization by (re)shaping the norms, values, policies, and practices that comprise that culture and climate. Without the leadership changing organizational structures, culture change may not be sustained or may only advance unevenly in the organization.

The material in the present chapter intersects with and builds on points of discussion from previous chapters in the report. As discussed in Chapter 3, there are fewer people from minoritized racial and ethnic groups in positions of leadership in STEMM organizations. More STEMM organizations are led by non-Hispanic, White men than people from other races, ethnicities, and genders (see Chapter 6 for more on gatekeepers). Such racialized disparities in an organization's leadership, ones that often reflect the values present in academia and research settings, can cause inequities in the distribution of resources and other foundational aspects of the organization and thus perpetuate racial bias (see Chapter 3 for additional data; Ray, 2019). As discussed in Chapter 5, additional support systems and removal of barriers at the individual level can allow more people from minoritized groups to advance in STEMM organizations to diversify leadership ranks (Allen-Ramdiel and Campbell, 2014).

However, as noted in Chapter 6, leaders also have a greater ability to address racial bias and contribute to change in an organization through addressing norms, values, policies, and practices. Such changes can be mutually reinforcing, reflecting the systemic nature of change work. For example, making substantive changes to hiring, promotion, tenure, and advancement policies may also shift norms for recruitment, drawing a more diverse set of participants, which is a condition for the realization of more equitable outcomes. Reviewing policies and updating practices through an antiracist lens can create more equitable and inclusive environments. Furthermore, such structural changes at the institutional level can have an impact on individual behavior; equally importantly, the collective

behavior of individuals can change organizational culture (Society for Human Resource Management, 2016). While organizations, groups, and individuals have their own patterns of behavior, these different levels are interconnected. Changes at one level can transfer up, down, or across to others.

To make large-scale change, leaders need to set forth an agenda that addresses the organization at multiple levels, including gatekeepers, leaders, mid-level management, and administration, with the appropriate resources in terms of person hours and funds. Antiracism, diversity, equity, and inclusion do not serve as compliance metrics, but rather act as goals or concepts that require sustained effort and learning to maintain. Often, these changes come with dedicated action from all levels and a sense of collective responsibility across the organization to uphold the values of antiracism, diversity, equity, and inclusion.

As discussed below, changes related to antiracism, diversity, equity, and inclusion also come with distinct challenges. Leadership can expect resistance, both explicit and implicit, to cultural change centered around antiracism, diversity, equity, and inclusion, and this chapter provides frameworks for addressing resistance and supporting the individuals who engage in the emotional labor of the work (see Chapter 6 for more on implicit bias). Although the analysis presented here is rooted in the science behind organizational change, not all of the research has been carried out in STEM organizations specifically.

The first section of this chapter elaborates on these key concepts in an overview of organizations, culture, and climate. The racialization of organizational structures through specific policies and practices and how that can impact culture and climate is the focus of the second part of this chapter. In the third part of the chapter, the committee discusses paths to change organizational culture and climate to center antiracism, diversity, equity, and inclusion and reviews research on change at individual organizations as well as collective change effected by organizations across a single sector. The fourth part of the chapter discusses barriers to and challenges of culture change. The fifth part provides some frameworks for organizational change, setting out key findings and recommendations on how change can—and must—be brought about at the organizational level.

AN OVERVIEW OF ORGANIZATIONS, CULTURE, AND CLIMATE

Typically, within an organization, there are structures that define individual roles and responsibilities, as well as divide people into separate groups based on function, content area, or level of responsibility. Box 8-1 provides definitions for key terms used throughout this chapter.

BOX 8-1 Key Terms and Definitions

- *Values*: “Organizational values can be defined as beliefs about socially or personally desirable end states or actions that are explicitly or implicitly shared by members of an organization” (Society for Human Resource Management, 2016). Values signal and determine organizational priorities.
- *Culture*: While there are many ways to define culture, an organization’s culture can be broadly defined as “the historically, collectively evolving use of tools, practices, and norms.” Organizational culture is dynamic: “Culture is not best understood as a homogeneous, cohesive and causal force, but as something that people do; it is emergent, dynamic, situationally adaptive and co-created in dialogue” (Alvesson, 2002).
- *Climate*: In contrast to culture, climate refers to the participants’ *perception* of and experiences with the organization, leadership, and actions, including the policies, practices, and procedures that comprise its culture (the National Academies of Sciences, Engineering, and Medicine, 2018). Climate can help identify particular issues in an organization, notably when gaps exist between values and actions.
- *Norms*: Critical to shaping culture, norms are a set of behavioral expectations within an organization or group. “Often unspoken, these norms offer social standards of appropriate and inappropriate behavior, governing what is (and is not) acceptable and coordinating our interactions with others” (World Health Organization, 2009).
- *Structures*: Systems that can shape and guide how individuals and groups behave based on the culture (i.e., norms, values, policies, and practices) that informs decisions (Ray, 2019).

SOURCE: Committee generated.

Using Schein’s Iceberg to Understand Organizational Culture

Schein’s iceberg model of culture (Schein, 1992) suggests that there are different layers to organizational cultures—artifacts, espoused values, and tacit underlying beliefs—with some visible and others hidden and difficult for newcomers to an organization or those outside of it to understand and interpret. Artifacts, such as branding strategy, logos, organizational structure, job titles, and even décor, are visible indicators of an organization’s culture. Espoused values are the behaviors, methods for accomplishing the mission, and other policies and procedures that an organization states publicly but may not follow on a daily basis. Basic assumptions are tacit underlying beliefs—the unwritten rules, status, relationships, attitudes and feelings, people’s fundamental needs, values, and norms—that manifest themselves in the way an organization actually functions. These assumptions are important sources of influence on activities and behaviors that produce organizational success or failure.

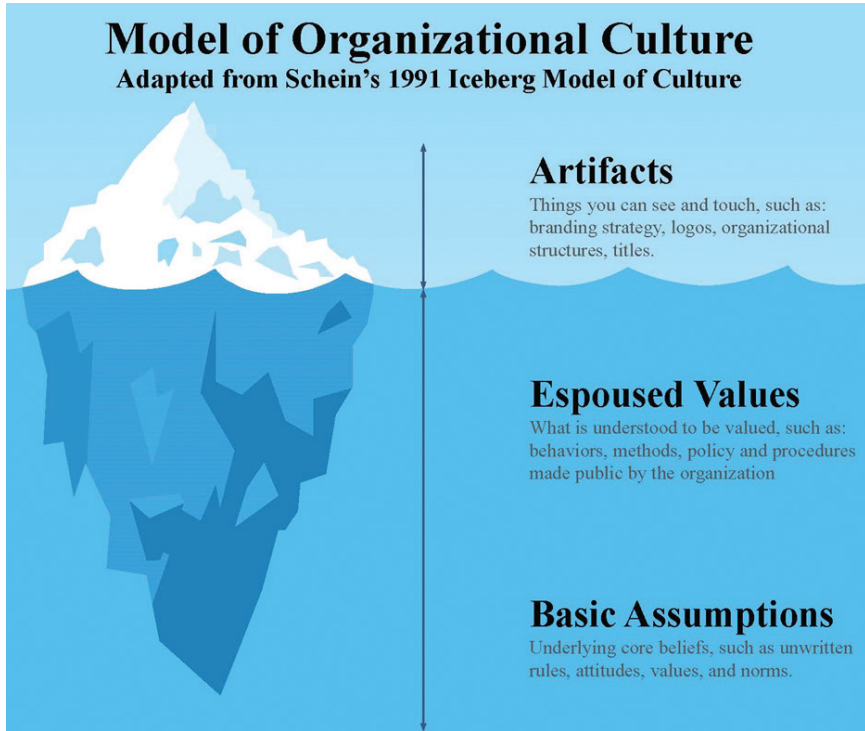


FIGURE 8-1 Model of organizational culture.
SOURCE: Adapted from Schein, 1991.

Applied to the advancement of antiracism, diversity, equity, and inclusion in STEM organizations, this model proposes that changing culture requires addressing the tacit underlying beliefs, because that is where racism originates. Tacit underlying beliefs about racial hierarchy can be institutionalized in public policies (as discussed in Chapter 2 and Chapter 6) and processes, and they affect the opportunities and experiences that minoritized groups, in particular, have within an organization. Any efforts or recommendations to bring about systemic change, increase the participation of minoritized individuals, and also improve the quality of experience of minoritized groups in STEM disciplines must therefore address the invisible, underlying beliefs that exist in both academic and non-academic STEM organizations. While such values and beliefs are abstract, they are critical to address because members of an organization defer to them as justifications for standard practices and for defining possible responses to organizational challenges (Schein, 2010). Such beliefs and values effectively operate as boundaries on what changes and solutions to problems are possible within that particular culture.

Organizations communicate their values to their participants through both formal and informal policies, practices, and norms (Society for Human Resource Management, 2016). *Values* can help determine importance or priority amid multiple interests; they vary based on individual judgment, biases, and prejudices; and they shape personal behavior (Society for Human Resource Management, 2016). *Norms* are accepted behaviors or conduct within a social group, such as an organization, and they serve as the unwritten guidelines and expectations for individuals while participating in that group (World Health Organization, 2009). *Policies* provide documented structure and guidance for decisionmaking, while *practices* are the formal and informal means of completing tasks. Facially race-neutral policies and norms can end up reinforcing racially unequal outcomes (Ray, 2019). Values and beliefs that have bearing on antiracism, diversity, equity, and inclusion are made visible in ways that include, but are not limited to, practices such as how an organization defines and applies its goals, what criteria it prioritizes in making decisions, how it evaluates and socializes new members, and what expectations it places on its leaders, including how resources are allocated.

STEMM organizations also express and transmit their cultures through processes such as hiring, admissions, tenure and promotion, and other activities that identify new members and promote those within. Conceptions of merit and excellence in doctoral admissions, for example, are not given or objective, but rather culturally constructed over time within disciplinary communities that have been mostly non-Hispanic White and mostly male; thus, the metrics of merit and excellence that institutions privilege in admissions reproduce cohorts of students who resemble what came before (Posselt, 2016). Faculty hiring and tenure committees make decisions using inherited norms of legitimate scholarship and scholarly behavior for one's field, which are often themselves biased toward qualities that purport to be race neutral (Gonzales and Rincones, 2012; Posselt, 2018). These norms can mask biases that affect "objective" processes, which, in fact, are socially and culturally constructed over time within disciplinary communities that have been homogeneous in terms of race and gender.

To affect antiracism, diversity, equity, and inclusion, it is necessary to understand and change organization-level structures and cultures. Organization-level analyses can address the problematic environmental factors that impede individual success as defined by both organizations and its participants and actors. Leaders who remove organization-level barriers in the system can allow people to succeed and thrive, for example, rather than simply struggle and persist.

THE RACIALIZATION OF ORGANIZATIONAL STRUCTURES

Organizations striving to advance antiracism, diversity, equity, and inclusion need to address not only the racial bias and behaviors of individuals,

but also the institutionalized forms of racism that are embedded in organizational policies, practices, norms, and values, which are structures upheld by organizational culture. Understanding how structures of an organization can produce and reproduce inequality is a foundation for understanding the changes in its culture needed to advance diversity, equity, inclusion, and antiracism, particularly given that most organizations do not operate in a “neutral” or unbiased way. Each institution reflects values through a combination of its mission; expenditures of time and money; membership and stakeholders; how it describes itself on social media platforms and literature; the behaviors it promotes in its students or employees; and other factors. How an organization chooses to distribute resources; hire, advance, retain, promote, and reward individuals; and enforce policies related to race and ethnicity reveal the depth of its commitment to antiracism, diversity, equity, and inclusion (Ray, 2019).

For example, a medical school’s hiring process or admissions criteria may appear to be race-neutral or colorblind (Tiako et al., 2022). However, without taking existing inequities into account or analyzing disparate impacts, selection processes or criteria may produce racially disparate outcomes (Obermeyer et al., 2019). These differential outcomes reflect—and can reinforce—the broader race-related history of access and barriers, wealth accumulation, and discrimination in the United States (see Chapter 2). A neutral policy or standard cannot erase this history, and ignoring the impacts of race can perpetuate cumulative and inequitable outcomes (Small and Pager, 2020).

Affirmative action is a class of policies and programs that considers race among the multiple criteria that are used to assess applicants for educational and professional opportunities (Cornell Law School, n.d.). It is intended to promote the inclusion and representation of historically minoritized groups, including both women and people of color. Race-conscious policies may take the form of targeted recruitment and hiring, grants and scholarships for students from disadvantaged backgrounds, and the formal consideration of an applicant’s race and ethnicity within processes of holistic review (Posselt, 2020). Introduced by President Lyndon Johnson in 1965, and extended into federal agencies in 1969 by Richard Nixon, before diffusing throughout higher education institutions, the parameters by which colleges and universities can consider race have been narrowing since the 1978 *Regents of the University of California vs. Bakke* case decided by the U.S. Supreme Court (U.S. Supreme Court, 1978). At the time this report was written, two additional U.S. Supreme Court cases are under review that will have an impact on the future of affirmative action, *Students for Fair Admissions Inc. v. President & Fellows of Harvard College* and *Students for Fair Admissions, Inc. v. University of North Carolina* (U.S. Supreme Court, 2021a,b). The goals of affirmative action may vary and

have included compensating for histories of discrimination and inequality, realizing the educational benefits of diverse learning environments, and correcting for the ways that conventional processes often produce racialized outcomes (Jayakumar, et al., 2018).

How STEMM and other types of organizations produce racialized outcomes is a quickly growing area of theory and research (Jayakumar et al., 2018; Ray, 2019). Leaders in organizations are a key part of both perpetuation and change in that they define and manage the environments in which individuals and groups operate. One of the most important ways that do this is through their power to determine the distribution of resources (e.g., entry and membership, monetary, opportunities and advancement); financial and monetary rewards in an organization (Ray, 2019). Decisions about resource distribution that have implications for racial inclusion and equality take place across multiple areas in an organization, including:

- *Recruitment*: where you search for talent
- *Hiring*: whom you select and through what methods
- *Evaluation criteria*: how people and their performance are assessed
- *Rewards*: who gets key assignments, recommendations, leadership positions, promotions, and higher compensation
- *Resources*: who gets access to career development, funding, mentorship and sponsorship, support systems, and peer and professional networks

The sections below examine how racialized selection criteria, standards, and processes can impact the composition of an organization. Selection processes used for admissions as well as those used for hiring, the typical evaluation criteria used, the biases of decisionmakers, and other processes all directly institutionalize racial inequality (Ray, 2019). How STEMM organizations determine who merits access is a powerful reflection of organizational culture and has been a topic of considerable research.

Standardized Tests in Undergraduate, Graduate, and Medical School Admissions

The alarming numeric underrepresentation of persons of color in STEMM (see Chapter 3) is a powerful indicator of a culture that permits the differential exclusion of persons along lines of ethnicity and race. Admissions processes are important both as a reflection of that culture and as a reinforcer of it—they determine access to credentials that affect participation in STEMM professions. While colleges and universities strive for fairness in their admissions processes, many rely on criteria and credentials that are unevenly distributed by race, and therefore produce racialized outcomes.

Among the criteria that have received the most research attention, standardized admissions tests, such as the ACT and SAT (for undergraduate programs), Graduate Record Examination or GRE (graduate programs), and Medical College Admissions Test or MCAT (medical programs) have been associated with inequalities in results related to the race and ethnicity of students (Camara and Schmidt, 1999). There is also a growing body of research about holistic admissions as an alternative approach that, when thoughtfully designed and implemented, can better align organizational action with values of ADEI (Posselt, 2020).

SAT

While the SAT was originally designed to open access to more students to test into higher education, present-day results show Black and Latine students score lower, on average, than White and Asian students on both sections of the exam (Reading/Writing and Math):

The average [math] scores for Black (454) and Latino or Hispanic students (478) are significantly lower than those of white (547) and Asian students (632). The proportion of students reaching college-readiness benchmarks also differs by race. Over half (59%) of white and four-fifths of Asian test takers met the college readiness math benchmark, compared to less than a quarter of Black students and under a third of Hispanic or Latino students. [. . .]

Despite a wide range of efforts to reduce inequality, the racial gap in SAT scores has scarcely narrowed during the lifetimes of the class of 2020. In 2002, the average white student's SAT math score was 106 points higher than the average Black student's (533 compared to 427); by 2020, the gap narrowed to 93 points. Still, nearly a third (31%) of white test takers scored above 600 on the math portion of the SAT, compared to just 7% of Black test takers (Smith, 2020).

Disparities in college preparedness and readiness manifest in test scores, and they trace back to unequal access to high-quality pre-K–12 education: Black and Latine students are more likely to attend schools that do not offer college preparatory courses, such as Advanced Placement courses, and less than 50 percent of American Indian and Alaska Native students have access to a full range of math and science courses in high school (United Negro College Fund; U.S. Department of Education Office for Civil Rights, 2014).² In addition, research shows the effect of stereotype threat (see more details in Chapter 5), which “refers to a psychological phenomenon

²Full range of math and science courses defined as Algebra I, geometry, Algebra II, calculus, biology, chemistry, physics.

in which a member of a negatively stereotyped group underperforms on an activity because of increased anxiety that they may confirm the negative stereotype” (U.S. Department of Education Office for Civil Rights, 2014). The observed effect sizes in one meta-analysis suggest that the SAT Math and Reading/Writing tests underestimate the intellectual ability of Black and Hispanic Americans by 39 to 41 points for each group. This underestimation of latent ability is a substantial portion of the overall Black-White and Hispanic-White test gaps typically observed on SATs—199 and 148 points, respectively (Smith, 2020). These results suggest that the psychological context of common testing environments significantly undermines real-world performance (Walton and Spencer, 2009).³

The SAT has significant effects on college admissions for students beyond acceptance letters, contributing also to university decisions about which students to actively recruit and offer financial aid (Sackett et al., 2009). As Black and Latine students are less likely to come from households with generational wealth, the effect of lower SAT scores on financial aid packages can further exacerbate challenges in funding higher education (Hernández Kent and Ricketts, 2021). The challenges on the academic and affordability side can persist into other educational and financial outcomes:

But significant gaps in graduation rates and test scores remain; representation is increasing, but success rates have yet to catch up. Half of Asian students and 45% of white students graduate college in 4 years compared to 21% of Black students, and 32% of Latino or Hispanic students. Default rates on student loans tell a similar story; Black and Latino or Hispanic students are much more likely to default within 12 years of graduation (Smith, 2020).

This suggests that colleges and universities may be creating barriers to their services and to financial aid due to the racialized results produced by standardized tests. As undergraduate education is a major prerequisite for advanced study and many STEMM careers, the inequities produced by the SAT are noteworthy. Some colleges and universities have in recent years decided to drop the SAT as well as the ACT (another standardized test) from their admissions process. Many did so in response to the COVID-19 pandemic (Nietzel, 2021). For example, the University of California system decided to remove the standardized tests in 2020 and launched an investigation to determine whether to reintroduce the exams; it decided to continue with the test suspension until fall 2024 (Nietzel, 2021). In the years after the standardized test suspension, the University of California system has

³In 2009, each section of the SAT was worth 800 points or 1600 for the combined score.

seen an increased number of applications from students from minoritized racial and ethnic groups (Nietzel, 2021).

GRE

The GRE has been a significant part of graduate admissions since its establishment in 1936 (Boykin, 2022). According to the Educational Testing Service (ETS), which administers the GRE, women and people from minoritized racial and ethnic groups score lower, on average, than White men and Asian men (Langin, 2019). The disparities have a direct effect on racial equity in terms of access to STEM doctoral programs: “A 2014 analysis found that a GRE cutoff of 700 eliminated 94.8 [percent] of Black applicants from the admissions pool in the physical sciences versus 18 [percent] of white and Asian applicants” (Roberts, 2021). While ETS discourages the use of cutoff scores in admissions decisions, research from a variety of sources suggests that an emphasis on GRE scores play a significant role in the admissions process and strongly shapes professors’ judgments of admissibility (Petersen et al., 2021; Posselt, 2016). One study found that with only undergraduate GPA and physics GRE score, the likelihood of a person’s admission to physics Ph.D. programs could be predicted with 75 percent accuracy (Young and Caballero, 2021).

Research evidence is mixed concerning the predictive validity of the GRE across different outcomes, disciplinary and institutional contexts from which samples are drawn, research methods, and versions of the test. Studies show GRE scores are associated with first-year grades, but current research does not demonstrate whether GRE scores correspond to longer term outcomes (Moneta-Koehler et al., 2017). According to one recent study:

Although we did not examine any other indices of success in STEM Ph.D. programs related to GRE scores, Hall et al. [20] found that neither GRE V nor GRE Q scores predict the number of first author publications. Moneta-Koehler et al. [21] found that GRE V scores were moderate predictors of first semester grades, graduate GPAs and of better subjective faculty evaluations of some aspects of students’ performance. However, these predictions did not translate to differences in time to degree, passing qualifying exams, numbers of conference presentations, or numbers of individual fellowships or grants (Petersen, 2018).

Since 2018, many STEM graduate programs have dropped the test as an admissions requirement. These decisions began during the COVID-19 pandemic as graduate programs in most STEM fields decided to suspend the requirement at least during the public health emergency (Langin, 2022). Overall, movement away from GRE requirements varies by discipline. Up to 50 percent of programs in the life sciences had already eliminated GRE

requirements before COVID-19 (Langin, 2019). Most graduate schools have delegated to individual programs the decision about whether to require scores, but some, such as University of Michigan and Montana State University, have stopped collecting GRE scores altogether in admissions processes for all graduate programs (Nietzel, 2022).

MCAT

Introduced in 1947, the MCAT has been assessed for its ability to predict success in medical education coursework, licensing exams, and graduation within four to five years (AAMC, 2019; Searcy et al., 2015). An individual application to medical school includes MCAT scores, in addition to undergraduate GPA, academic achievements, and personal essays. While many medical schools have moved to a holistic approach to admissions that balance these components, lower scores on the MCAT, even those within the predictive range of success, are associated with lower rates of acceptance to medical schools (Lucey and Saguil, 2020). In a study of 2009 MCAT scores, White applicants had a higher mean score (26.3) than Black (20.0) or Latine (21.6) students (Davis et al., 2013).

While there have been differences in mean scores, a comprehensive study of the MCAT and racial bias found that “Factors other than bias in the exam might explain differences in performance [on the exam], such as family, neighborhood, and school conditions, which relate to academic achievement and differ by group” (Davis, 2013). This study also found evidence that many admissions committees accept students at similar rates regardless of race, and they are looking beyond MCAT data to select students with a wide range of experiences and characteristics (Davis, 2013).

Yet, in a review of data from the American Association of Medical Colleges, admission rates for Black and Latine students have not yet reached parity with their broader representation in the U.S. population: “Of accepted applicants, nearly half (49.8 [percent]) were White, 22.0 [percent] were Asian, 7.1 [percent] were Black or African American, and 6.2 [percent] were Hispanic, Latino, or of Spanish Origin” (AAMC, 2019).

Here, a tension exists between the available data showing that on one hand, similar acceptance rates across different racial and ethnic groups, and on the other hand, that rates have not yet reached parity. Looking at the data on applicants in the 2021–2022 class, only seven percent of applicants self-identified as Black, suggesting that while the admissions rates are similar, the number of total applications has not yet reached parity (AAMC, 2021).

The U.S. scientific enterprise has long recognized this minoritization, which exists also in Ph.D. admissions. Over the past several decades, STEMM writ large has implemented interventions supported by federal funding agencies and private philanthropies to increase the representation of people from minoritized racial and ethnic groups in doctoral and medical education (National Science and Technology Council, 2021). Efforts to support STEMM departments in redesigning their selection and recruitment processes are one exception to a general tendency in antiracism, diversity, equity, and inclusion interventions to reflect a “fix the person” mindset. That is, rather than changing the organizations and systems that students and early career scientists must navigate, most interventions provide students or early career faculty with experiences, support, mentoring, community, and coaching to better guide them for survival and eventual assimilation in a STEMM environment that some individuals may find hostile (Posselt, 2021). In contrast, relatively few programs have focused on changing the structure of access to STEMM organizations or their learning and working environments itself, although there are important and promising exceptions. Thus, despite the work of local champions who lead these student-centered programs, progress on a national level has been slow.

CONCLUSION 8-1: Although standardized tests, such as the SAT, GRE, and MCAT, may not be biased as instruments, they often replicate the educational inequities endured by students from historically minoritized racial and ethnic groups, and they are not consistent predictors of academic and professional success. Reliance on standardized test scores can exacerbate racial inequities in admissions and financial aid decisions for undergraduate, graduate, and medical programs.

Holistic Admissions

In undergraduate, graduate, and medical education, the movement away from reliance on standardized tests has been coupled with a movement toward holistic review, which is defined as an assessment of “academic ability coupled with a flexible assessment of applicants’ talents, experiences, and potential to contribute to the learning of those around them” by evaluating “all of the information available in their file” (U.S. Supreme Court, 2003). There is a growing body of evidence about holistic admissions in undergraduate, graduate, and medical admissions and the conditions under which the practice of holistic admissions can serve as a means of improving diversity and reducing inequalities. Research shows that this approach reflects a cultural shift for organizational admissions practices to look beyond metrics that reinforce racial and other social inequalities; align standards of quality with expressed commitments to antiracism, diversity, equity, and inclusion; and formally assess professional skills and socio-emotional

qualities that affect professional success and organizational health (Bastedo, 2016; Garces and Jayakumar, 2014; Roca-Barcelo, 2021). Such skills and qualities include distance traveled, teamwork or leadership, contributions to the diversity goals of an organization, and prior experience with navigating challenging situations with regard to antiracism, diversity, equity, and inclusion (Roca-Barcelo, 2021; Wilson, 1981).

Research on holistic admissions across higher education sectors also shows that in addition to broadening the criteria that are assessed, changes must be made to how organizational decisionmakers interpret information in applications if the goals are to increase diversity and create more equitable selection processes (Posselt, 2020). Like test scores, other information in applications for admissions, such as extracurricular involvement and research experience, may reflect existing inequities; therefore, organizational evaluations should contextualize information in the application instead of taking credentials information at face value (Bastedo, 2016; Posselt, 2021; Rosinger, Meyer, and Wang, 2021). Strategies for contextualization include considering the error on metrics such as grades and test scores and considering an applicant's achievements considering the opportunities they had or did not have access to (Posselt, 2016).

In addition to conducting more comprehensive and contextualized review, research shows the importance of being systematic and equity-minded in admissions, particularly in graduate admissions, which is especially subject to bias because it is decentralized and often lacking in formal policy (Klitgaard, 1985). There is evidence that utilizing evaluation protocols or rubrics can support holistic review implementation. When thoughtfully designed, such protocols or rubrics create more consistent evaluations across applications and among multiple reviewers. They can also make holistic review of applications more efficient and accountable and result in selection of more underrepresented racial minority applicants (Roca-Barcelo, 2021). Research on rubrics in K–12 education indicates that they also reduce implicit bias (Quinn, 2020).

Hiring and Wage Setting

In contrast to research on admissions, which looks mainly at selection criteria and processes with disparate impacts, there has been a strong focus on direct racial discrimination in the research on selection for hiring (Liera and Hernandez, 2021). Major audit studies have demonstrated that racial discrimination exists in hiring processes across organizations (Eaton et al., 2020). While not STEMM specific, one meta-analysis covering research from 1980 to 2015 found that White applicants received 36 percent more callbacks from employers than African American candidates and 24 percent more than Latines with equal qualifications (Quillian et al., 2017).

This research suggests that there has been no change since 1972 in terms of racial discrimination in hiring for African American people, and while there is a possible decline for Latine people, that decline was not considered significant.

What does the discrimination look like? One non-STEMM specific study looking at credentials created identical applications for 350 employers posting for entry-level jobs, except some noted that applicants had a criminal record and others did not. Here, the criminal record is meant to be a negative credential, as it is often correlated with less desirable outcomes in the labor market. For the White applicants, the impact of a criminal record was a 50 percent reduction in the likelihood of receiving a callback. Adding race as a factor, the study showed that an application for a White individual with a criminal record had a nearly 2.5-fold higher likelihood of receiving a callback than an application for a Black candidate with no criminal record (Pager, 2009). Returning to the theory of racialized organizations, Whiteness here serves as a credential for employment without any indication of additional skill or education. If Black individuals have a lower likelihood of receiving a callback, they will likely spend more time securing employment.

This has impacts beyond the application process. When Black individuals do find a job, it is likely that they will spend more time commuting to their place of employment, reducing their leisure and rest hours (Ray, 2019). Earnings are also negatively impacted. The Bureau of Labor Statistics notes that once people are hired, there are racialized and gendered wage gap discrepancies, possibly reflecting that Black and Latine people may also be in lower-wage positions. According to the U.S. Bureau of Labor Statistics, in the first quarter of 2022, the median weekly earnings of Black people (\$840) and Latine people (\$799) working full-time jobs for all employment sectors were lower than those of White (\$1,064) and Asian (\$1,362) employees. Median weekly earnings for both Black and Hispanic men were just over 75 percent of the median weekly earnings for White men, while the median weekly earnings for Black and Latine women were 85 percent and 77 percent, respectively, less than the median weekly wage for White women. Earnings of Asian men (\$1,452) and women (\$1,237) were higher than those of their White counterparts (U.S. Bureau of Labor Statistics, 2022). Specifically for faculty jobs, the salaries that Asians and Asian-Americans earn are often higher than for White people and people from other minoritized groups; however, while they may earn more money, they often are appointed to leadership positions at a lower rate (Lee, 2002).

As with many phenomena in academia, these patterns and the causes for them may vary by discipline. A recent study in chemistry found, for example, that discrimination is responsible for wage differentials between chemists who identify as White and those who are Asian and Black, whereas most of the wage differential between White and Hispanic chemists was

that result of differences in human capital, such as educational attainment and experiences (Broyles and Fenner, 2010).

CONCLUSION 8-2: Racial discrimination continues to be a significant factor in hiring processes and wages. In terms of hiring, Black people are less likely to receive callbacks than less-credentialed White people. In terms of wages, across occupations Black people and Latine people have lower median weekly earnings than their White and Asian counterparts. Analyses of salary levels and start-up packages by race/ethnicity for science, technology, engineering, mathematics, and medicine faculty are limited but recent data suggest that White men receive higher salaries and larger start-up packages than scientists who are women or who are not White.

Academic Positions, Advancement, Retention, and Tenure

While many of the major audit studies focus on the labor market broadly, there has been less research on what happens to individuals once they have gained employment in terms of promotion and advancement, especially in non-academic STEMM organizations.

There are well-documented barriers in academia to the advancement and tenure of individuals from historically minoritized groups in STEMM, as mentioned previously in Chapter 5. One such area is the long-lasting and amplifying effect of publication record. For example, one study shows that a less productive first-author predoctoral publication record, along with other qualifications, correlates with lower likelihood of obtaining a faculty position (Tregellas, 2018). Early success in publications can aid an early scientist's long-term efforts in a self-reinforcing situation known as the Matthew effect:

This happens [compounding benefits to early success] because the winner enjoys resource and status advantages over the nonwinner. These advantages cause differences in future success to further grow, setting in motion a cumulative advantage process of increasing distinction. To the extent that luck plays a role in early academic success, the Matthew effect may undermine meritocracy by allowing an initially fortunate scientist's recognition to self-perpetuate, while an equally talented but initially less fortunate counterpart remains underappreciated (Bol et al., 2018).

This phenomenon suggests that so called "early winners" may continue to enjoy the cumulative benefits into the future. Because of disparity along racial lines related to early career outcomes, White people may enjoy amplified benefits if there are compound effects, while people from minoritized groups do not meet success at the same level. This disparity is also evident

in the proportion of individuals from each group who are able to obtain tenure track positions, with nearly 50 percent of White doctoral scientists and engineers employed at four-year colleges having a tenured position as opposed to 40 percent of Asian employees and 42 percent of employees from minoritized racial and ethnic groups (National Center for Science and Engineering Statistics, 2021).

A study of medical faculty found that medical schools promoted non-White assistant professors at lower rates than their White counterparts. The promotion gap was largest for minoritized faculty, smaller for Asian and Pacific Islander faculty, and not statistically significant for Hispanic faculty. This study also found lower promotion rates for systemically minoritized associate professors compared to White peers, although the difference was not statistically significant. There was no evidence that these gaps in promotion rates had narrowed over time. Medical schools have also been noted as sites of discrimination, with racialized processes shaping admissions, learning climate, and career trajectory (Xierali et al., 2021).

One review of the literature on barriers for African American individuals in academia (not STEM-specific fields) identified the following factors: microaggressions from White colleagues, no acknowledgment of Black faculty as credible researchers, Eurocentric work environments, and higher workload responsibilities compared to White faculty. Studies have also shown that African American faculty are less satisfied with their jobs compared to White faculty (Frazier, 2021). It may be that these differences in job satisfaction and workload distribution result from Black faculty having less opportunity to select committees, administrative appointments, or the courses they teach.

In terms of antiracism, diversity, equity, and inclusion, organizational climate and culture can have a profound impact on the experience of participating individuals. One term that describes the issues that faculty of color face is cultural taxation, or, the unique burden placed on them to fit into the academy, often at the expense of their own cultural identity (Padilla, 2002). One scholar described cultural taxation as the

. . . obligation to show good citizenship towards the institution by serving its needs for ethnic representation on committees, or to demonstrate knowledge and commitment to a cultural group, which, though it may bring accolades to the institution, is not usually rewarded by the institution on whose behalf the service was performed (Padilla, 2002).

There is growing evidence that for White women and people of color, both of whom face pressures and expectations outside of their academic responsibilities, the preset time-clock and vague but high expectations for promotion may lead to decisions not to progress up the academic ladder.

One report referred to this as “bias avoidance” and suggested that many academics, particularly those who are parents, make choices about their careers that may be counterproductive to career advancement (Drago et al., 2006). Current research and campus demographic realities suggest that women, for example, do not progress in their careers as faculty or in their progression to leadership positions at the same rate as their male colleagues (Ceci et al., 2014; Mason et al., 2013; Ward and Wolf-Wendel, 2012). While the ideal-worker framework, often characterized by a culture where workers center their profession as the primary obligation and have additional support to attend to their domestic needs (Zhanhour and Sumpter, 2022) is most often used in relation to White women and work and family concerns, looking at faculty from minoritized racial and ethnic groups through this lens is also important. This is because they too are impacted by these systemic norms, not only as a result of personal concerns, but also because of the demands of cultural taxation. For women of color, the cultural tax related to race and ethnicity combined with ideal-worker norms associated with gender represent a double set of pressures (Kachchaf et al., 2015).

Faculty of color can bear quite high professional, psychological, and emotional costs as a result of experiencing common barriers, including tokenism, marginalization as scholars, racial microaggressions, devaluation of their scholarship, and a disconnect between their racial/ethnic culture and the culture within academia (Settles et al., 2021). Research has found this is particularly true for STEMM faculty of color leading scholarship in the diversity, equity, and inclusion space (Clauzet et al., 2015; Payton et al., 2018). These penalties adversely affect faculty advancement, which is closely tied to psychological well-being. Studies have found that faculty who have high levels of social support or mentoring, enhanced sense of belonging within their department, and satisfactory work-life balance are the most successful in the academy (Bean et al., 2014; Freel et al., 2017; Stupnisky et al., 2014). In contrast, faculty penalized because of their race and ethnicity experience a variety of psychosocial and professional consequences, ranging from loneliness, race-related stress, decreased job satisfaction, to imposter syndrome (Allen et al., 2004; Dancy and Jean-Marie, 2014; Niemann, 2011; Payton et al., 2018).

Particularly for Black women, a welcoming environment may change over time. In a phenomenon called Pet-to-Threat, which is not limited to STEMM, Black women, especially those early in their career, may initially receive support from managers and supervisors, who most often are White men (Thomas et al., 2013). While at first the mentorship may go smoothly, as the women grow in their roles and begin to assert themselves, the attitudes of the managers and supervisors shift as they perceive this increased agency as a threat to the status quo in a culture typically dominated by White males. These women, who once received guidance, can

BOX 8-2
Black Women, Natural Hair, and Discrimination

Workplace policies and norms that monitor dress, wardrobe, and overall appearance have a tendency to center the habits of White, Eurocentric styles. (Rabelo et al., 2020). These policies can contribute to an unwelcoming environment for the people affected, overall creating a climate that is hostile to a part of their identity. For example, policies and norms that restrict natural hair have a disproportionate impact on Black men and women. This norm reflects anti-Black hair sentiment dating back to slavery through the Civil Rights movement, and generally impacts Black women the most (Griffin, 2019). At present, there are no federal laws that protect against race-based discrimination related to natural hair as courts cite that it is a characteristic that a person can change.

In educational and professional settings, these policies and norms signal to Black women that the White-dominant culture expects them to assimilate to White-centered standards of care to be accepted and that their natural hair, often connected to Black culture and community, is not welcome. This choice to go against the standard Eurocentric values may be thought of as an act of agency or dominance that threatens White-dominant culture, when in actuality a Black woman who chooses to wear an Afrocentric hairstyle is displaying a part of herself that is unique, fulfilling her need to feel distinct (Bell, Nkomo, and Stella, 2003).

One study provides a theory connecting racial identity, belonging, and perceived dominance in the workplace that suggests that individuals with minoritized identity traits may suppress those traits, and hence their unique identity, to feel that they belong in the dominant culture and fulfill a need for belongingness. One result from this study is that Black participants did not demonstrate ingroup favoritism about Afrocentric hair, suggesting that, "When Black women don Afrocentric hair, Black perceivers may have heightened concerns that the Black women's dominance display will negatively reflect on all Blacks." Individuals may feel alienated and experience increased emotional and cognitive burdens as they consider how to manage how others perceive them. This may result in the individual becoming less committed to their organization (Opie and Phillips, 2015; Rosette and Dumas, 2007), while organizations may lose the richness that diversity provides. In addition, organizations with perceived requirements to suppress identity traits may have to deal with lawsuits.

While removing explicit policies that discriminate against natural hair and other hairstyles might be a first step, there are broader cultural factors that can continue to contribute to stigma. Building an organization with an inclusive and welcoming culture that embraces individual authenticity may increase the well-being and function of the individual and decrease stress and anxiety related to identity suppression.

find those resources retracted and their career trajectories undermined by their previous supporters. This phenomenon underscores that belonging is not a binary state, but rather is a continuum that can vary over time and where one's place in that spectrum depends on the treatment from others (Thomas, 2013). (For more on group and team dynamics, see Chapter 7.)

Within academia, one model proposes a dual process for creating epistemic exclusion, which occurs when certain areas of scholarship are seen as outside of a discipline's dominant discourse. First, it reflects a racial prejudice that faculty of color do not have the capability or credibility to be scholars based on stereotypes related to Black, Latine, and Native Americans as lacking intelligence, being lazy, and willing to game the system for their advantage. Asian Americans often suffer from stereotypes of being foreign. Second, while many disciplines have strong norms for research topics and methods, faculty of color are more likely to adopt alternative approaches and conduct studies on topics and groups that fall outside of the established expectations. This can be seen in the devaluation of scholarship led by faculty of color that does not appear to fall within the mainstream of their discipline's research activities. Those scholars who choose research outside of the norms are more likely to face delegitimization. At the same time, faculty of color who chose to study mainstream topics may not necessarily benefit from conforming to the mainstream, as racial prejudice will negatively impact how their colleagues regard their research. Taken together, epistemic exclusion serves as a gatekeeper in which bias regarding certain scholars and specific types of research prevents faculty of color from being valued as legitimate and credible knowers and scholars. This devaluation has negative consequences for the hiring, retention, and advancement of faculty of color (Griffin et al., 2013; Patton, 2017; Settles et al., 2021).

Non-tenure-track positions have implications for racial and ethnic bias as well. These positions are important for understanding the professoriate, as 70 percent of faculty across all academic departments are non-tenure-track or contingent (American Association of University Professors, 2018). While departments often promote prestigious tenure-track positions as synonymous with research and development and the opportunity to contribute to their disciplines, non-tenure-track positions are more strongly associated with service and teaching. Non-tenure-track positions, lacking the security of tenure, are therefore seen as less acclaimed and often come with fewer support than their tenure-track peers. Hiring for these positions may follow a different path than tenure-track positions, opening the door for bias to creep in. In addition, many non-tenure-track positions are hired outside of traditional processes, which often excludes them from affirmative-action oversight. Department chairs often do much of the non-tenure-track hiring, and they are often White men who may unconsciously hire from their own peer groups and networks (AAUP, 2018). (For more on gatekeepers see Chapter 6.)

In terms of part-time positions, there has been an increase in the proportion of scholars of color, from nine percent in 1993 to 14 percent in 2013 (Finkelstein et al., 2016; Flaherty, 2016). Faculty of color are less likely to be at large, research-intensive universities as well, although the reasons behind this could be multifaceted and result from bias in hiring at four-year schools or because faculty of color are opting to be at diverse institutions in order to mentor and support students of color (Bavishi et al., 2010). Some qualitative data suggest that faculty sometimes chose to help their communities and return to particular types of institutions (Baez, 2000; Stanley, 2006).

In addition to facing discrimination in tenure and promotion, Black and Asian professors across all academic disciplines face different kinds of treatment in student evaluations. One study found that students judged their Black professors to be significantly less competent and legitimate than their White and Asian counterparts (Bavishi et al., 2010). Students also judged both Black and Asian professors to have significantly fewer interpersonal skills than White professors (Kreitzer and Sweet-Kushman, 2022).

CONCLUSION 8-3: People from minoritized racial and ethnic groups encounter significant race-related barriers in academia that affect their career advancement and retention, including but not limited to bias in tenure and promotion, challenges to align with the dominant culture, and everyday discrimination from colleagues and students including microaggressions and tokenism.

Career Development, Mentorship, and Professional Networks

In addition to the research demonstrating that Black individuals are paid less for the same level of employment as their White counterparts, White individuals are also shown to be more likely to receive other non-monetary resources, such as formal and informal mentoring, access to professional networks, sponsorship from institutional or other STEMM leaders, and opportunities for professional development. As a result, despite having similar credentials and working in equivalent positions, it will take a Black person more time to accumulate wealth, which will affect decisions related to housing, education, and health (Ray, 2019).

For example, given the low numbers of Black researchers in computer science and engineering, there are limited opportunities for the Black students in those departments to find mentors and advisors who understand and can advocate against anti-Blackness (the National Academies, 2019). As a result, Black students in those fields may turn to an unsupportive advisor who believes the narrative that STEM is colorblind and a meritocracy (McGee, 2020). It is not the case that all Black students, Indigenous students, and other students from historically minoritized backgrounds

require a mentor of the same racial or ethnic background, and it would be problematic to assume that faculty of color have to be responsible for mentoring all students of color.

However, professors of all races and ethnicities do need to have cultural competence to serve as effective mentors to students of color (Chrobot-Mason, 2003). Emerging literatures on cultural humility and racial literacy build on the evidence about cultural competence to highlight the importance of mentors and faculty, as representatives of disciplinary cultures, engaging with students' cultures of origin. The same is true for research advisors, who serve a different role than mentors and who may not otherwise appreciate a student's interest in pursuing research topics that come out of their unique minority experiences. Some advisors may not believe that antiracism, diversity, equity, and inclusion issues are legitimate topics for scholarly study, while others may feel they are protecting their minority student protégés from the negative judgements of future colleagues who do not consider such research to be important. In either case, faculty advisors may steer their graduate students away from diversity research and only support them if they pursue more mainstream research that future colleagues will find credible, advice that limits academic freedom relative to White graduate students.

CONCLUSION 8-4: Lack of diversity within organizations can limit access to career resources for people from minoritized racial and ethnic groups, such as mentorship, sponsorship, and professional networks, that could support their development.

RECOMMENDATION 8-1: Organizational leaders should take action to redress both individual bias and discrimination as well as organizational processes that reproduce harm and negative outcomes for people from minoritized racial and ethnic groups at critical points of access and advancement. This action should include a review of evaluation criteria and decisionmaking practices (i.e., in admissions, hiring and wage and start-up resource-setting, promotion, advancement) to understand whether and to what degree existing standards perpetuate underlying racial and ethnic inequities.

- Admissions offices at colleges and universities, as well as admissions decisionmakers in graduate programs, should assess the alignment or divergence between their current admissions policies and criteria and values of antiracism, diversity, equity, and inclusion and develop holistic admissions strategies that offer a systematic, contextualized evaluation of applicants on multiple dimensions.
- Hiring managers, directors of human resources, and supervisors should measure and review the application, offer, and acceptance

rates in their organization, as well as the salaries, resource packages, and academic tracks and titles of new hires, for instances of racial and ethnic discrimination in the hiring process. As a result, these leaders should, as appropriate, implement proactive outreach and recruitment to increase applications from people from minoritized racial and ethnic groups, trainings and resources to eliminate bias in the hiring process for managers, and updated policies to reduce bias and discrimination in setting wages.

- Directors of human resources and supervisors should measure, evaluate, and address the presence of bias and discrimination in rewards and promotion; the proportion of people from historically minoritized backgrounds leaving their positions; and their reasons for doing so, as well as in and the access to culturally relevant mentorship for students and employees.

CHANGING ORGANIZATIONAL CULTURE AND CLIMATE TO CENTER ANTIRACISM, DIVERSITY, EQUITY, AND INCLUSION

How Leaders Change Organizations

As stated at the beginning of the chapter, individuals leading hierarchical organizations have the power and responsibility to make decisions about values and determine priorities on behalf of others in the organization. This can be demonstrated through the distribution and allotment of resources such as financial, material, mentorship, level of comfort, and prestige (Ray, 2019). These individuals can also shape the application of rules and bureaucratic procedures in ways that reinforce, or at least do not undermine, their power. Racism can thus be framed as a differential power dynamic, in which policies, practices, norms, and values explicitly or implicitly provide one group additional privilege based on race or ethnicity rather than other factors. Even in organizations that have diverse numerical representation overall, it matters where individuals are located within the hierarchical structure. Inequities can arise in organizations where people from minoritized racial and ethnic groups are limited to entry-level or administrative positions (Wilkie, 2018).

For STEM organizations today, increasing demographic diversity and increasing sensitivity to equity, inclusion, and antiracism across society are motivating changes that many institutions had previously resisted (Foster, 2016). This trend is consistent with the established open-systems view of organizations today, a perspective that argues that organizations' internal activities by necessity evolve with political, economic, and social forces in the environment (Scott and Davis, 2015). Like other forms of organizational change, efforts to make changes that advance antiracism,

diversity, equity, and inclusion may come from outside the organization (i.e., exogenous) or from within the organization (i.e., endogenous) factors. Internal drivers of change might be reflected in low recruitment and high attrition rates for STEMM professionals from minoritized racial and ethnic backgrounds. Member demands for greater transparency and equity in treatment can also reflect internal drivers for change.

There are a number of exogenous factors that can create incentives for change. A potent example of exogenous change was provided in 2020 during the COVID-19 pandemic, when universities' very financial survival depended upon their ability to quickly pivot to online instruction. Funding agencies and organizations can motivate change by creating new criteria and can shift norms through policy changes. International and national events can change the overall environment in which research takes place. For example, the 2020 murders of George Floyd, Ahmaud Arbery, and Breonna Taylor by law enforcement spurred a broader national movement and conversation around racism in the United States. Boards, trustees, and investors can demand greater transparency in antiracism, diversity, equity, and inclusion; track results; and request meaningful progress over time. In addition, as organizations compete for talented minoritized students and scientists, this can provide a powerful motivation for change in order to attract and retain diverse talent.

Organizations in a Sector Collectively Change

Research and theory have documented how organizations in a field or a sector may collectively trend toward new, shared forms and values, including changes that advance antiracism, diversity, equity, and inclusion (DiMaggio and Powell, 1983; Posselt, 2020). Organizational theorists call this institutional isomorphism, and three mechanisms of institutional isomorphism have been identified: mimetic, normative, and coercive isomorphism (DiMaggio and Powell, 1983).

Mimetic Isomorphism

In some circumstances, notably if an overarching strategy has not been formed or the organization is at a decision point, organizations may take actions that imitate or align with those of the most powerful in their field, sometimes referred to as mimetic isomorphism (DiMaggio and Powell, 1983). Therefore, organizing influential organizations in some sector or field around changes that support antiracism, diversity, equity, and inclusion can be a powerful lever for field-wide change. In such situations, diffusion of some new practice or policy can reach a tipping point, wherein what was once a minority viewpoint overturns established consensus

(Centola et al., 2018). An example of this is the elimination of GRE requirements in many U.S. astronomy Ph.D. programs. Through a combination of equity-minded advocacy from the American Astronomical Society's president and board of directors in 2015, and the coordinated action of several top-ranked Ph.D. programs in the field, a sea change occurred in the field in a relatively short time (American Physical Society, 2020). As of summer 2022, across 50 top-ranked universities in the United States, only three percent of programs required the GRE in psychology, computer science, physics, geology, chemistry, ecology, neuroscience, and molecular biology (Langin, 2022). Mimetic influences are widespread and can be leveraged in support of antiracism, diversity, equity, and inclusion values when influential organizations use their privileged position within status hierarchies to lead their field in challenging the status quo.

Normative Isomorphism

Systems of professionalization and socialization, including advanced training in STEM disciplines, are another important potential source of sector-level changes because it is through professionalization experiences that students are socialized to community standards. Graduate and professional education may be an important site for such change. As students are trained into professional norms, there is an opportunity for changing the expectations that we associate with the work and performance of scholars, doctors, engineers, and others relative to the last generation regarding what it means to uphold their roles with excellence. For example, to the extent that racial literacy, mentoring, equitable project management, or more inclusive approaches to teaching are promulgated in graduate and professional training programs, STEM organizations can begin to reshape the culture of whole fields. Disciplinary and professional societies have an important role in this regard as conveners who shape the collective conversation and priorities in fields (Greenwood et al., 2002).

Coercive Isomorphism

Coercive isomorphism results from both formal and informal pressures exerted on organizations by other organizations upon which they are dependent and by cultural expectations in the society (DiMaggio and Powell, 1983). Given the dependence of many STEM organizations on federal agency funding, for example, changes in the requirements for federal grants and contracts can reshape what everyone judges and tries to produce as a meritorious proposal. When universities change their tenure and promotion requirements to include effective teaching, mentoring, and contributions to departmental change efforts, faculty are more likely to dedicate time and

energy to this work (Mbuagbaw et al., 2020). Calls to change incentive structures are effectively calls to leverage the influence of coercive isomorphism on professional behavior. However, as evidence from studies of the Athena SWAN Charter in the United Kingdom have found, institutions that adopt policies and practices supportive of antiracism, diversity, equity, and inclusion to align with external standards, without strong internal commitment or mission alignment, may engage in “box-ticking,” performative, and other contradictory behaviors that can undermine long-term equity, diversity, and inclusion efforts (Tzanakou and Pearce, 2019).

BARRIERS TO AND CHALLENGES OF CULTURE CHANGE

Although a growing number of organizations are working to create positive cultural change toward realizing values of antiracism, diversity, equity, and inclusion, there is also evidence of several common contradictions and barriers that may emerge as organizations begin working on these issues.

Contradictions in Cultural Change

STEMM organizations that formally espouse values of antiracism, diversity, equity, and inclusion might still signal or create hostile or chilly climates for racial minority groups. There are several reasons this may occur: (i) a failure to interrogate the outcomes of prior practices and the messages sent during recruitment; (ii) how people are experiencing the ways that an organization is operationalizing its commitment to antiracism, diversity, equity, and inclusion; and (iii) the racialized equity labor that an organization often requires of minoritized members as it evolves its organizational culture toward antiracism, diversity, equity, and inclusion (Lerma et al., 2020; Wynn and Correll, 2018). Rather than attracting Black students, Indigenous students, and other students of color, the STEMM organizations that publicly embrace antiracism, diversity, equity, and inclusion values but struggle with participation, low stay rates, and limited leadership of color may send messages that they do not prioritize diversity, and that Black students, Indigenous students, and other students of color may risk isolation, alienation, harassment, and discrimination.

Another challenge is that even the STEMM scholars and organizations that elevate messages of inclusive excellence may perpetuate scientific norms that marginalize, exclude, or devalue minoritized individuals or groups. This gatekeeping reality (see Chapter 6) creates a disconnect between the diversity rhetoric and the realities of diverse scientists who continue to experience exclusion and fewer opportunities for funding, advancement, and tenured academic positions. (Fini et al., 2022; Ginther et al., 2011;

Hofstra et al., 2020). This unevenness has several origins. As noted above, culture is unlikely to be uniform across an organization and fragmentation is a common feature in processes of cultural change (Martin, 2001). In addition, STEMM organizations often operate within incentive structures whose values are at odds with antiracism, diversity, equity, and inclusion. While significant strides are possible with investment and sustained effort, no organization can instantaneously undo the entire scope of its inherited racialized practices, beliefs, norms, and policies.

Emotional Dimensions of Organizational Change Theory Related to Antiracism, Diversity, Equity, and Inclusion

For organizations broadly, change related to antiracism, diversity, equity, and inclusion⁴ may be experienced as qualitatively different from many other types of organizational change because it is bound up with members' social identities and the emotional and political dimensions of those identities. Discussions and other activities centered around race and inequity are often accompanied by feelings such as anger, fear, and pain (Ahmed, 2004; Zembylas, 2011, 2012). A growing body of research documents the importance of recognizing and managing racialized emotions, which tend to differ significantly between White individuals, who enjoy racial privilege, and people of color, who have experienced racism (Joseph et al., 2015).

For leaders and those within an organization, change management can feel personal: "Change begins by recognizing the fields of influence in a situation and identifying the points at which there are 'gatekeepers' that impede the flow of change in a system" (Estrada et al., 2016).⁵ Disrupting the status quo, for any reason, calls into question the often-overlooked assumptions buried in the values and practices of an organization (Southern, 2022). This can cause cognitive dissonance for White members. It is not uncommon for professionals to feel and believe that they hold values supportive of antiracism, diversity, equity, and inclusion while the organizations they work for may not fully uphold them. This dissonance can prompt individuals to confront parts of themselves and biases that may be uncomfortable or troubling.

It is here that processes happening at the organizational and individual levels can reinforce one another. While individuals may uphold the principles

⁴Research on antiracism as a component of organizational change is newer to the field, and the findings in this section may not have the evidence on antiracist efforts in the same depth as diversity, equity, and inclusion.

⁵Change management is personal, for both those leading change and those within organizations.

of antiracism, diversity, equity, and inclusion in theory, the practice of change may require naming realities of racism in the organization, which can provoke “White guilt.” It may also require redistributions of power and resources, which can elicit an emotions-based resistance to change efforts. At a minimum, White individuals may resist confronting uncomfortable racialized emotions because they reap frequently unexamined privilege from systems that prioritize Whiteness. They may therefore resist the personal transformation that accompanies a journey of antiracism, a reaction that leaders may reinforce by prioritizing colleagues and their comfort when setting the pace for their organization’s antiracism, diversity, equity, and inclusion transformation efforts (Patton and Haynes, 2018; Southern, 2022)

Finally, reiterating issues highlighted earlier in Chapter 5 in relation to organizational fit and comfort, White members of an organization often experience a greater level of comfort in the status quo than people from systemically minoritized groups. In particular, if leadership is predominantly White, the culture, climate, and norms will likely center Whiteness and give the privilege of comfort to White individuals (Hauge, 2019). In contrast, cultural change also compels attention to the comfort—or lack thereof—experienced by Black people, Indigenous people, and other people of color in work environments that were not designed with their needs in mind, that may be downright hostile, and that can lead them to be less committed to and satisfied with the organization (Cady and Valentine, 1999; Greenhaus et al., 1990; Tsui et al., 1992, 1997).

Additionally, organizational policies and standard practices may differentially affect Black scientists, Indigenous scientists, and other scientists of color. For example, as mentioned earlier in this chapter, policies that limit or ban natural hairstyles have a disproportionate impact on Black women in the workplace. The policing of Black women’s appearance sends the signal that they do not belong in the workplace or educational setting. Racialized identities are a filter through which people experience racialized organizations and change processes around antiracism, diversity, equity, and inclusion. Therefore, how leaders manage both the implementation of new policies and practices and the experience of the change process and the emotions that accompany it can be the difference between a change effort succeeding or failing (Southern, 2022).

Resistance to Change

In thinking about cultural change, particularly in regard to antiracism, diversity, equity, and inclusion, it is important for organizations to anticipate and identify resistance among its members. One definition of diversity resistance is “a range of practices and behaviors within and by organizations that interfere, intentionally or unintentionally, with the use

of diversity as an opportunity for learning and effectiveness” (Plaut et al., 2014). For STEMM, this can also manifest in arguments that seek to rationalize inequalities or use logic to delegitimize diversity efforts, in addition to the emotional dimension to resistance briefly discussed above. Often these arguments rest upon misperceptions, myths, or otherwise false claims, such as the claims that people from historically minoritized groups are not interested in STEMM, that they have not received adequate preparation to participate in STEMM, that science is a meritocracy so it does not matter who is conducting the research, that discrimination no longer exists, a lack of supportive resources for diversity programs, and the argument that there is not a strong business case for diversity (Plaut et al., 2014).

The widespread presence of such myths in STEMM organizations, which are ostensibly dedicated to data and truth, makes it clear that learning must be a critical element of organizational change (Smith, 2020). While many organizations will offer diversity or implicit bias training for employees, the literature indicates limited efficacy of mandating participation.

Efforts to moderate managerial bias through diversity training and diversity evaluations are least effective at increasing the share of white women, black women, and black men in management. Efforts to attack social isolation through mentoring and networking show modest effects. Efforts to establish responsibility for diversity lead to the broadest increases in managerial diversity (Kalev et al., 2006).

Research suggests five reasons why mandating participation may not necessarily yield the intended results. First, short-term trainings do not generally have a strong enough effect to change behavior in and of themselves (Dobbin and Kalev, 2018). Second, diversity training may activate thoughts of racial stereotypes, which may be counterproductive (Dobbin and Kalev, 2018). Third, the training may inspire an unrealistic expectation that the program eliminated bias when it, in fact, merely raised attention to its existence (Dobbin and Kalev, 2018). Fourth, efforts to promote multiculturalism in training may result in White participants feeling left out or resistant to change (see Chapter 6 on gatekeepers; Dobbin and Kalev, 2018). Finally, research from organizational sciences suggest that people react negatively when they think that others are attempting to control them. “Self-determination research shows that when organizations frame motivation for pursuing a goal as originating internally, commitment rises, but when they frame motivation as originating externally, rebellion increases” (Dobbin and Kalev, 2018).

As discussed above and in Chapter 6, resistance to change related to diversity often arises because it can provoke emotional responses related to power, privilege, and comfort, as well as fears about an uncertain future

and losing status and influence. Resistance to change to address antiracism, diversity, equity, and inclusion issues can manifest itself in emotions such as anger, fear, anxiety, and mourning perceived loss of power and prestige (Plaut et al., 2014).

The discussion of race and racism in the United States remains fraught with tension, making it a challenging issue to discuss freely for fear of being called a racist or associated with racism. The conversation begs for a deeper analysis of value and belief systems that rarely get aired, in part a result of Americans' strong individualistic value systems (Plaut et al., 2014). The focus on the individual in the broader U.S. value system overlaps with an emphasis on individual merit in STEMM. In both instances, the dominant group has been White men, who may feel that disruption to the status quo poses a serious risk to their historic access to power and will leave them being outnumbered by presumably unqualified women and minorities (Plaut et al., 2014). This belief demonstrates a devotion to the current system as a true meritocracy, in that those with the most potential and skills will rise to the top rather than a biased, racialized system that offers opportunities inequitably.

In practice, organizations may experience diversity resistance in blatant instances of discrimination or harassment, such as the appearance of a hangman's noose or Klu Klux Klan attire, which appear in approximately 5.8 percent of all hostile work environment claims with the Federal Equal Employment Opportunity Commission (Godhart, 2017). While a member may use this image as a mark of aggression against a peer, the response to the action can indicate resistance from the organization as a whole if the action or similar behavior is not held accountable through policy and practice. Unintentional actions, such as microaggressions, may also demonstrate the presence of diversity resistance, which can be especially pernicious as those who inflict damage may rely on their good intentions to rationalize their behavior (Plaut et al., 2014).

There are also more subtle ways that individuals can demonstrate their diversity resistance. Silence or passive reactions when discrimination, harassment, and mistreatment occur or failing to object to the overt behavior can be viewed as tacit agreement with it. Other methods include exclusion, avoidance, and social distancing that create social barriers and can foster a hostile environment in which Black people, Indigenous people, and people of color do not feel a sense of belonging (Plaut et al., 2014).

Access and legitimacy issues are a similar form of resistance, and these are apparent in limited efforts that can, in effect, marginalize people from minoritized groups into certain roles, divisions, or initiatives without fully integrating their perspectives into the core and strategic functions of the organization. Organizations often allow people from minoritized groups to lead work to advance antiracism, diversity, equity, and inclusion without providing the appropriate resources or recognition. This disparity in responsibility, and lack of reward, is also known as the "minority tax" or

“cultural tax” (Rodriguez et al., 2015). The failure to include efforts to advance antiracism, diversity, equity, and inclusion in an organization can be a way that organizations delegitimize these efforts (Rodriguez et al., 2015). Finally, organizations can cause secondary victimization when they fail to provide opportunities for recourse against discriminatory behavior: “This experience can eventually lead the victimized to accept (and in some cases rationalize the prejudice directed to them)” (Plaut et al., 2014).

Second-order conflict is one way to describe the more covert and subtle forms of discrimination that can undermine efforts to address the blatant acts of “old-fashioned” racism, or first-order conflicts. Second-order conflict may represent conflict about how to address workplace discrimination and harassment, how diversity is defined, and which diversity strategies to pursue (Plaut et al., 2014). For example, individuals may have different views of affirmative action as a strategy but they may not voice these opinions for fear of conflict (Plaut et al., 2014). This can create an organizational climate that restricts open and honest conversation about key issues:

What prevents organizations from enacting these efforts? Two explanations include: (1) organizations rarely engage in reflective (double-loop) learning, and (2) organizations adopt defensive routines when events occur . . . when these [harassment and discriminatory] events occur, they deny claims, defend the organization (and at times justify the organization), and use the mere existence of EEO [equal employee opportunity] as a rationale for why discrimination could not possibly occur (Plaut et al., 2014).

There are ways that organizations can counter resistance and that are most effective when pursued at multiple levels and approaches:

But large corporations and big universities are developing multipronged diversity initiatives that tackle not only implicit biases, but structural discrimination. The trick is to couple diversity training with the right complementary measures. Our research shows that companies most often couple it with the wrong complementary measures. The antidiscrimination measures that work best are those that engage decision makers in solving the problem themselves (Plaut et al., 2014).

Additionally, it is important to think of the issues as linked together: We find that special college recruitment programs to identify women and minorities—sending existing corporate managers out to find new recruits—increase managerial diversity markedly. So do formal mentoring programs, which pair existing managers with people a couple of rungs below them, in different departments, who seek mentoring and sponsorship. So do diversity task forces that bring together higher-ups in different departments to look at the data on hiring, retention, pay and promotion;

identify problems; brainstorm for solutions and bring those back to their departments. So do management training programs that use existing managers to train aspiring managers. All of these programs put existing higher-ups in touch with people from different race/ethnicity/gender groups who hope to move up. All of them help existing managers to understand the contours of the problem. And all of them seem to turn existing managers into champions of diversity (Dobbin and Kalev, 2018).

One counter-resistance measure is through communication that enables employees to feel involved in the change process and that provides honest and straightforward communication about the change, as opposed to hearing about it via rumor and innuendo (Plaut et al., 2014). This approach can take place in tandem with another strategy, which is the demonstration and justification of change based on how the status quo does a disservice to the organization and its members (Plaut et al., 2014). Another measure, centered more on the implementation of change, includes policies and practices that hold members accountable for learning and adapting. There is evidence that employee and member perceptions can shift. In a series of randomized controlled trials, researchers found that brief interventions that educate individuals about historical acts of discrimination can lead to greater understandings of the presence of discrimination in modern society (Bonam et al., 2019; Nelson et al., 2012). Those with deep resistance may choose to leave the organization entirely (Plaut et al., 2014).

CONCLUSION 8-5: The process of cultural change toward antiracism, diversity, equity, and inclusion in science, technology, engineering, mathematics, and medicine organizations can be complex, multi-layered, and uneven in its progress due to the significant demands from leadership and participants. Cultural change around antiracism, diversity equity, and inclusion can involve personal reflection, emotional labor, and challenges to individual beliefs, all of which cause discomfort.

RECOMMENDATION 8-2: Leaders, managers, and human resource departments in science, technology, engineering, mathematics, and medicine organizations should anticipate resistance to antiracism, diversity, equity, and inclusion efforts and investigate with rigorous empirical tools, the impacts of training on different types of antiracism, diversity, equity, and inclusion outcomes (hiring, climate, promotion, retention, leadership roles, resource allocation).

INTERROGATING STEMM VALUES AND BARRIERS TO CHANGE

While this chapter has drawn on some research, theory, and evidence beyond the STEMM realms, this section will dissect instances specific to STEMM environments. The committee understands the term “STEMM

environments” to include a variety of settings in which STEM education, training, and work take place: classrooms, labs, administrative settings, universities, corporations, hospitals, and nonprofit organizations. They help make up the scientific enterprise, and they all require support in advancing antiracism, diversity, equity, and inclusion.

Dominant beliefs about science and the process of research contribute to the framing of diversity in STEM. There may be pushback on the value of antiracism, diversity, equity, and inclusion; the ways that lived experience and other ways of knowing can contribute to understanding; and the superiority of quantitative, experimental research. A prominent theme in STEM culture includes an image of a researcher with singular devotion to the lab or theory, who has the support to put in hours well beyond a nine-to-five workday, and whose “passion” operates sometimes to the deficit of other parts of their life (Blair-Loy and Cech, 2022). This norm precludes the kind of people who cannot see themselves fitting into that role, as many individuals with family and community responsibilities, broader interests, and the need for greater work-life balance do not identify with this image or feel less belonging because of their divergence from it.

Many STEM environments also lack an accountability and incentive structure for antiracism, diversity, equity, and inclusion work. While individuals may feel drawn to the work out of personal interest and dedication, the extra time and energy devoted to improving antiracism, diversity, equity, and inclusion may be less sustainable if leadership does not provide structures to integrate the work into process and practice. On the other hand, it is rare to find organizations with accountability measures that ensure that members attend to antiracism, diversity, equity, and inclusion goals and priorities (Bersin, 2021).

Many organizations, including those focused on STEM, often fail to put into place learning systems for continuous improvement and reinforcement of key priorities. There are two important terms that can help describe patterns of behavior. The first is single-loop learning, “When the process enables the organization to carry on its present policies or achieve its objectives” (Argyris, 1977). This kind of change around the edges, also known as first-order change, is often limited to direct adjustment of existing processes, and can be seen as correcting the outcomes or the symptoms of an issue (Argyris, 1977).

In contrast, double-loop learning is a more comprehensive process that interrogates both existing policies and practices and the underlying assumptions, structures, norms, and objectives that have motivated current processes. This kind of learning, one that seeks to understand and address the root causes of an issue, requires an organizational culture with the safety to identify and talk about core beliefs or structures that are problematic. Research on a group of STEM Ph.D. programs that all became more diverse by race and ethnicity over time found that only some were able to sustain

that diversity, and that the major difference among those that did and did not sustain diversity was the presence of double-loop learning and active questioning of longstanding cultural norms and practices (Posselt, 2020). Cultural change, one that reaches to affect norms, values, and rules, is an example of double loop learning that brings in second-order change, the kind of transformative shift that impacts the system and the way things are done.

FRAMEWORKS FOR ORGANIZATIONAL CHANGE

As stated at the beginning of this chapter, the goal here has been to provide a guide for leaders who want to accelerate progress in advancing antiracism, diversity, equity, and inclusion in STEMM organizations. The evidence shows that culture change is an essential ingredient for systemic and transformational change, which begins at the top of an organization and permeates multiple levels. There are a variety of published frameworks designed to guide leaders and organizations that are committed to advancing antiracism, diversity, equity, and inclusion and creating systemic and impactful change. Highlighted in Table 8-1 below are 10 recently published change frameworks focused on antiracism, diversity, equity, and inclusion in industry and academic settings. The frameworks encompass multiple levels in an organization and are aimed at creating ongoing learning and achieving systemic and sustainable results. While each framework is unique, there are common themes which can serve as helpful guideposts for leaders looking to advance antiracism, diversity, equity, and inclusion diversity, equity, and inclusion in STEMM organizations.

Many of the frameworks in Table 8-1 highlight the importance of recognizing and acknowledging the problems at the highest level of an organization and doing the necessary analytics to uncover the root cause of the problems and why inequities continue to exist. Most frameworks have an explicit focus on race and racial inequalities. While diversity representation is key, a critical emphasis is placed on the experiences of those from minoritized groups who are facing deeply embedded inequities. The frameworks emphasize the importance of listening to those individuals and learning from their lived experiences and about valuing cultural differences. These frameworks also emphasize an orientation toward action vs. rhetoric. This includes: (i) articulating an anti-racism, diversity, equity, and inclusion vision of the future; (ii) establishing a clear set of measurable goals and outcomes; (iii) ensuing ongoing assessment and evaluation; (iv) engaging individuals at multiple levels to be a part of the desired change; and (v) ensuring leaders are held accountable for results.

Finally, several frameworks highlight the value of engaging human resources or others responsible for implementing policies and practices associated with the professional growth and development of the students, faculty or members of nonacademic STEMM organizations, especially for those who have experienced inequities in the past.

TABLE 8-1 Summaries of Culture Change Frameworks for Organizations

The Antiracist Organization: Dismantling Systemic Racisms in the Workplace
Daniels, S. (2022)

Four-Factor RACE Model:

1. Recognize the Problem: Do you understand the people most impacted by racism?
2. Analyze the Impact: Organizational analyses should include both quantitative and qualitative data
3. Commit to Action: Address leaders who are resistant to change
4. Empower for Change: Assist people in feeling a part of the change

How to Promote Racial Equity in the Workplace

Livingston, R. (2020)

Five-Step Plan:

1. Problem Awareness: Do I understand what the problem is?
2. Root-Cause Analysis: Where does the problem come from?
3. Empathy: Do I care about the problem and the people who are impacted?
4. Strategy: Do I know how to correct the problem?
5. Sacrifice: Am I willing to do so?

Elevating Equity: The Real Story of Diversity and Inclusion

Bersin, J. (2020)

Five Essential Strategies for DEI Excellence:

1. Listen, hear and act (listening to employees is a top driver of excellence)
2. Strengthen HR Capabilities in all roles (DEI must permeate the talent supply chain from hiring, to promoting and helping people grow)
3. Engage senior leader commitment (diversity training has limited value, but leadership commitment can make a big difference)
4. Set goals and measure success
5. Create accountability for results (drive DE&I across the entire ecosystem)

Advancing Black Leaders

Roberts, L.M. et al. (2019)

1. Move away from the business case and towards a moral one
2. Encourage open conversations about race
3. Revamp DEI programs—promote sustained focus on racial equity
4. Manage career development across all life stages (from early in one’s career and throughout)

Getting Serious About Diversity: Enough Already with the Business Case

Ely, R.J. and Thomas, D.A. (2020)

1. Promote the Learning and Effectiveness Paradigm
 2. Build talent
 3. Actively work against discrimination and subordination
 4. Embrace a wide range of styles and voices
 5. Make culture differences a resource for learning
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continued

TABLE 8-1 Continued

Organizational Transformation Is an Emotional Journey
White, A., Smets, M., and Canwell, A. (2022)

1. Address the unsustainable status quo
 2. Detach from the status quo
 3. Develop a purposeful vision
 4. Lead emotional transformation
 5. Include both the rational and emotional
 6. Align KPIs, funding, resources and people
 7. Make transformation the new normal
-

AAC&U's Committing to Equity and Inclusive Excellence: Campus Guide for Self-Study and Planning
AAC&U (2015)

Action steps:

1. Know who your students are and will be
 2. Commit to frank, hard dialogues about the climate for minoritized students on your campus, with the goal of affecting a paradigm shift in language and actions
 3. Invest in culturally responsive practices that lead to the success of minoritized students
 4. Set and monitor equity goals and devote aligned resources to achieve them
 5. Develop and actively pursue a clear vision and goals for achieving high-quality learning
 6. Expect and prepare all students to produce culminating or signature work
 7. Provide support to help students develop guided plans to achieve essential learning outcomes, prepare for and complete signature work, and connect college with careers
 8. Identify high-impact practices best suited to your students and your institution's quality framework
 9. Ensure that essential learning outcomes are addressed and high-impact practices are incorporated across all programs.
 10. Make student achievement—specifically, minoritized student achievement—visible and valued
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From Equity Talk to Equity Walk: Expanding Practitioner Knowledge for Racial Justice in Higher Education
McNair, TB. et al. (2020)

1. Start asking about why these inequities exist
 2. Start to question privilege and biases in the systems and structures that perpetuate inequities, specifically racial inequities
 3. Stop using language that masks who the students really are.
 4. Stop believing that the accepted norm should be from the dominant culture's viewpoint
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continued

TABLE 8-1 Continued

Equity in Science: Representation, Culture, and the Dynamics of Change in Graduate Education

Posselt, J.R. (2020)

Moving Scientific Institutions Toward Equity:

1. Acknowledging the racialized and gendered beliefs, standard practices, and power dynamics that are root causes of inequities
2. Coordinating systemic actions in the multiple contexts and levels at which equity is created or impeded
3. Leveraging bottom-up, top-down, and inside-out forces for change
4. Equity-minded learning and retooling for individuals and organizations, facilitated by cultural translators who span social, professional, and/or disciplinary boundaries
5. Cultivating, expecting, and rewarding knowledge, skills, and labor that support equity as new generations are trained and enter the labor market

How Colleges Change: Understanding, Leading, and Enacting Change

Kezar, A. (2013)

Systemic institutional change is best achieved by converging bottom-up (“grass roots” initiatives) and top-down (individuals in positions of power) efforts. Three phases of culture change:

1. Mobilize – develop initial awareness of the need for change (data); create vision; galvanize support for change through discussion; mobilize leadership and collective action
2. Implement – choose strategies; pilot; change policies; process and structures; professional development; evaluate results and reorient; celebrate successes; scale-up or down
3. Institutionalize – disseminate results; review; commit; persist

SOURCE: Excerpts from Daniels, 2022; Livingston, 2020; Berson, 2020; Roberts et al., 2019; Ely and Thomas, 2020; White, Smets, and Canwell, 2022; AAC&U, 2015; McNair et al., 2020; Posselt, 2020; Kezar, 2013.

RECOMMENDATION 8-3: Presidents, chief executive officers, and leaders of science, technology, engineering, mathematics, and medicine organizations, including those in higher education and the private sector, should use a framework (such as those listed below) to evaluate the institution’s values and norms and identify specific ways to address norms that impede diversity and promote a culture that is genuinely accessible and supportive to all. These top-level leaders should work with managers, supervisors, and other mid-level leaders who influence the local culture within organizations and can be a critical part of implementation. The evaluation should include review of:

- institutional policies and practices for instances of bias with regard to race and ethnicity;
- policies and practices for entrance into the organization (admissions, hiring, or nomination), advancement (promotion and tenure), and other rewards;

- analysis of resource allocation by race and ethnicity such as wages and bonuses, mentorship, professional development opportunities, physical materials or assets, and other items or forms of support;
- mentorship, training, and professional development opportunities to build skills specific to supporting Black students, Indigenous students, and students from historically minoritized racial and ethnic groups;
- culturally-aware mentorship and management training for supervisors, administrators, and other leaders; and
- the results of regular climate surveys to evaluate the working conditions and environment.

The ability to change an organization begins with evaluation of the institution's existing norms, values, policies, and practices. Through an investigation of the organization's current culture and climate, the leadership can identify the different areas needed for growth related to antiracism, diversity, equity, and inclusion. These issues may begin at the entrance point, such as with recruitment, admissions, or hiring. Many STEMM practices in these areas disproportionately disadvantage people from minoritized racial and ethnic groups. Other areas for review may include wages, curriculum, promotion, tenure, and advancement, which affect the participants' experience, sense of inclusion and belonging, and persistence within an organization. Reviewing the underlying criteria for entrance into an organization and the advancement within an organization can surface biases based on race and ethnicity in those practices.

Organizational change requires motivation, strategic alignment of mission and values, leadership commitment, and an understanding of the current culture and climate. To avoid a compliance-based mentality, leaders can use antiracism, diversity, equity, and inclusion as guiding principles to shape decisionmaking rather than goals in and of themselves. The process of culture change around antiracism, diversity, equity, and inclusion can challenge organizations, as the work itself can encourage individuals to interrogate their own values and behavior. In addition to the intense nature of the work, culture change can also come with a redistribution of resources, which can create feelings of loss for individuals who previously held privilege. These tensions can contribute to resistance to antiracism, diversity, equity, and inclusion efforts in organizations, which can slow change efforts if not sufficiently addressed by leadership and management. To encourage this work, this chapter has offered a series of frameworks that provide multiple perspectives on creating a vision and strategic plan for culture change centered on antiracism, diversity, equity, and inclusion.

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Research Agenda

The preceding chapters have covered many areas of existing research spanning various levels from the systemic level to individuals, teams, and organizations. The current chapter pivots from examining extant evidence to identifying the evidence that is missing. Thus, this chapter sets forth a research agenda, as directed by the committee’s Statement of Task, which states that the committee’s final consensus report will “define a research agenda to address gaps in knowledge in the evidence base to advance anti-racism, diversity, equity, and inclusion.”

The committee developed this research agenda over the course of the study process. For each of the report’s chapters, the committee reviewed relevant areas of empirical research across multiple disciplines. Even though there is existing and ongoing research in this field, the committee identified numerous critical gaps. We found there is great need for more evidence-based research to better understand what produces sustainable antiracism, diversity, equity, and inclusion change in science, technology, engineering, mathematics, and medicine (STEMM). In addition to filling the gaps, the committee envisioned an agenda that could help facilitate a future line of transformational and groundbreaking work. Taken together, the committee sought to develop an aspirational research agenda that pushes the field forward in ways it identified as innovative, necessary, and challenging.

The research agenda includes priority areas for further examination. The order in which they are presented in this chapter corresponds to the organizational framework in Figure 9-1. The research agenda is organized first by the multiple levels that were discussed in previous chapters of the report, beginning with items that address the historical and contemporary

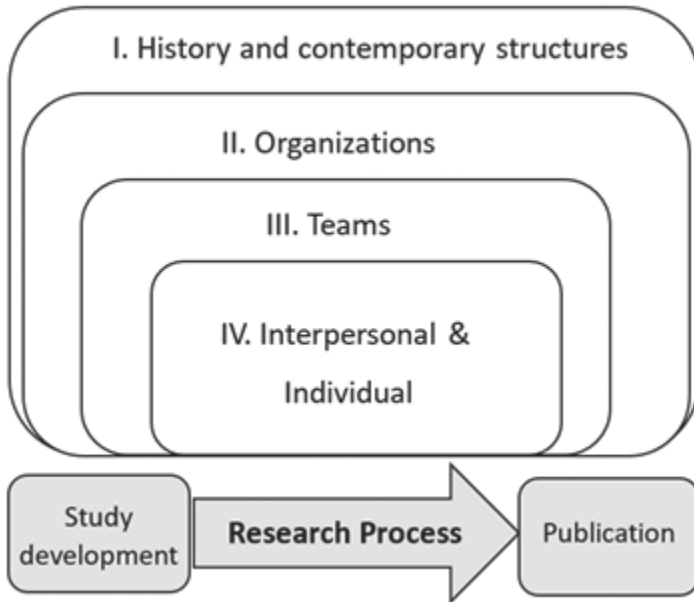


FIGURE 9-1 A summarized model of the organization of the research agenda. This includes the various levels of analysis (I-IV) and the inclusion of the research process from start to finish.

SOURCE: Committee generated.

societal structures of the United States. Subsequently, the research agenda covers items that address the organization level; questions around teams; and finally, the interpersonal and individual levels. There are several instances in which research agenda items may be located within a specific level, but actually span multiple levels due to the complexity of how these levels are overlapping. Therefore, the overall organizational structure of the research agenda by level is meant to help guide the reader; it is not meant to enforce strict ideological boundaries between the levels. The second half of the research agenda addresses the research process. The committee found that knowledge gaps persist for two primary reasons. First, the gaps exist because there is a need to expand on what is being studied. Second, the gaps exist because methodological research practices that are implemented inform how the research is conducted. Taken together, the types of research questions asked and the ways in which science is conducted can inform, create, and sustain the evidence gaps in the scientific literature. The committee believed that to address the knowledge gaps and develop an innovative agenda, each part of the research process starting

from study development through publication needed to be taken into consideration. The items discussed in the research process are meant to apply to all levels of analysis from historical structures to the individual level. By addressing these factors, the body of empirical science would continue to become a more authentic representation of the human experience and help to meaningfully advance antiracism, diversity, equity, and inclusion in STEMM.

Overall, this chapter has implications for many STEMM stakeholders who take part in research, including but not limited to students, trainees, faculty, staff, statistical analysts, ethicists, scientists, administrators, and leaders. The committee believes that many stakeholders in STEMM may consider prioritizing the entire agenda as these numerous and multi-level gaps can be addressed simultaneously.

HISTORY AND CONTEMPORARY STRUCTURES

Based on its examination of the historical context, the committee found that there needs to be a more complete and comprehensive national and international investigation of reparations from national governments to groups of people who have been harmed by historic policies and practices (Darity and Mullen, 2020; U.S. Congress, 2021). Part of the investigations could include how a system could be implemented, and ultimately test what kind of impact reparations may have on minoritized individuals and their ability to enter into and thrive in STEMM, as well as the impact on the White majority group. There needs to be greater examinations of the following (Darity and Mullen, 2020; U.S. Congress, 2021):

1. Historical forms of reparations in the United States and internationally, and determining their impact on aiding minoritized individuals in entering spaces in which they remain underrepresented, including STEMM.
2. The range of outcomes associated with the implementation of reparations. Outcomes include, but are not limited to, reducing disparities and systemic racism across multiple sectors that underlie entry into STEMM:
 - a. Health outcomes and other metrics of quality of life
 - b. Educational outcomes in STEMM
 - c. Wealth—current and generational
 - d. Career opportunities in STEMM
3. Identification of the multiple institutions, including those in STEMM education and industry, that worked to support slavery, genocide, and continued White supremacy. The goal is to determine the institution(s) that are responsible for making reparations.

4. Identification of the full population of recipients. Identifying the complete population of individuals in the United States who have been harmed by slavery, genocide, and continued White supremacy.
 - a. Examinations of additional and significant damages accrued from post-slavery forms of systemic racism. For instance, this may include considering the impacts of legalized segregation (Coates, 2014).
5. Identifying what form reparations may take, and quantifying what could be given directly to those impacted, including those in STEMM contexts.

There needs to be a greater examination of the impact of structural financial investments in communities of minoritized individuals in the United States. As these sectors underlie entry into STEMM, it is important to examine whether financial investments in areas in which minoritized individuals have faced systemic disinvestment and disadvantage would ultimately help improve wether presentation and their ability to thrive in STEMM for generations to come. There needs to be greater examinations of the following:

1. Novel or emerging investments to understand their scalability and impact on minoritized individuals.
2. Historical investments to understand their impact on minoritized individuals.
3. Structural investments that serve to address various inequalities that directly map onto the empirically supported historical and current legacies of structural racism. These are inclusive of, but not limited to the following:
 - a. Community health investments: in both mental health and physical health resources.
 - b. Neighborhood investments: in housing and living conditions of minoritized individuals' neighborhoods.
 - c. Educational investments: in schools, colleges, and universities that may still face inequities in funding.
 - d. Climate change investments: in minoritized individuals' neighborhoods and regions that may face a disproportionate burden of suffering from the consequences of climate change.
 - e. Industry investments: in STEMM businesses that are owned and run by minoritized individuals. Investments may include entrepreneurial resources, and other financial mechanisms that support ownership and longevity of these STEMM businesses (McGee, 2020).

Similar to the previous point, there needs to be a greater examination of the impact of novel, emerging, existing, and historical policies that are

developed with the purpose of helping reduce racial hierarchy and remove structural barriers for minoritized individuals (e.g., Bailey et al., 2021). As these sectors listed below underlie entry into STEMM, it is important to examine whether policies that aim to help reduce inequality would ultimately help improve representation and ability to thrive in STEMM for generations to come. There needs to be greater examination of the following:

1. Policies that directly map on to the empirically supported historical and current legacies of structural racism. These are inclusive of, but not limited to the following:
 - a. Policies that reform incarceration
 - b. Policies that reform policing
 - c. Policies that reform healthcare
 - d. Policies that reform housing
 - e. Policies that reform education
 - f. Policies that reform wealth accumulation and distribution

As stated previously in the report, Title VII of the Civil Rights Act of 1964 was a milestone in helping promote antiracism, diversity, equity, and inclusion in STEMM organizations. It made discrimination on the basis of race, along with other protected “classes,” unlawful. The committee encountered literature suggesting there may remain an exemption for small businesses, such that specific subsets (U.S. Equal Employment Opportunity Commission, n.d.) of small businesses may be exempt from following Title VII, and this may include small businesses in STEMM (Carlson, 2006; Chay, 1998; Lewallen, 2014; Roberson, 2019). There needs to be a greater empirical examination of the following:

1. What fraction of the STEMM workforce is in small businesses, and what is the fraction of minoritized individuals in these spaces?
2. Are there patterns of racial and ethnic discrimination over time in small exempt STEMM businesses?
3. What are the workplace conditions like in small exempt STEMM businesses?
4. Are there gaps between different levels and forms of discrimination protection? For example, federal-level, state-level, and other potential mechanisms?

ORGANIZATIONS

There needs to be a greater examination of how federal agencies, such as but not limited to the National Science Foundation and National Institutes of Health, could use their convening and grant-making powers to support fundamental change in STEMM organizations that use and depend

on their resources. There needs to be a greater empirical examination of the following:

1. Tying federal financial resources to antiracism, diversity, equity, and inclusion goals to help increase institutional transparency and incentivize change.
2. Assessment of the impact and sustained effect of prior and current programs aimed at increasing antiracism, diversity, equity, and inclusion in STEMM.
3. Making funding requirements and terms of receiving research funding contingent on STEMM organizations and principal investigators achieving specified antiracism, diversity, equity, and inclusion goals.
 - a. This may include rewards over penalty focus.
 - b. This may also include penalties for non-compliance with limitations on acquiring future funding.
 - c. Funding requirements may include expectations on continuous reporting and tracking of antiracism, diversity, equity, and inclusion efforts and outcomes.

As discussed in Chapter 2, the committee found that while minority serving institutions (MSIs) have faced significant underfunding, they have advanced representation by helping minoritized students obtain STEMM degrees. Since MSIs are a critical asset, there needs to be a continued and more robust empirical investigation that helps better understand the ways in which the strengths of MSIs can be advanced and leveraged. There needs to be a greater empirical examination of the following:

1. Development and testing of interventions that help bring MSI-based programs and practices that are successfully helping minoritized individuals achieve STEMM degrees to predominantly White institutions.
2. If continued or increasing financial investments to support MSIs help further increase the percentage of minoritized individuals who persist in acquiring a STEMM education.

There needs to be a greater assessment of persistence of students in the STEMM degrees, across all STEMM disciplines. This includes a strong focus on minoritized individuals. To accomplish this, it will be essential to know the demographics of the students entering college intending to study STEMM and their educational outcomes. There needs to be a greater empirical examination of the following questions:

1. How many graduated with a STEMM bachelor's degree?
2. How many switched to a non-STEMM major?
3. How many left college with no degree?

Minoritized individuals with STEMM training who have left STEMM at various points may represent an unused and yet valuable workforce (Rahman et al., 2020). However, there is not much research focused on how to reintegrate these individuals back into the STEMM workforce. There needs to be a greater examination of these minoritized individuals who have left with the goal of facilitating their reentry and retaining the pool of lost talent. There needs to be a greater empirical examination of the following:

1. What are the factors, programs, policies, and practices that may help promote the reinclusion and reincorporation of minoritized individuals who have left?
2. Development and empirical testing of interventions that may help promote reinclusion and reincorporation of minoritized individuals. Interventions could potentially be designed to target groups of individuals who left at different points (e.g., undergraduates who left, Ph.D.'s who left).
3. What are the strengths, skills, resources, and perspectives that minoritized individuals bring back with them into the STEMM workforce?

Additional organizational psychology research is needed to examine the organizational systems, dynamics, and incentives that inform advancements in antiracism, diversity, equity, and inclusion across several STEMM contexts, including STEMM departments within universities and various business units within industry settings. There also needs to be greater investigation on the role of community accountability in helping advance and sustain antiracism, diversity, equity, and inclusion.

The committee encountered some scholarship that has supported the greater or more systematic use of positionality statements in research-based spaces (e.g., Roberts et al., 2020). Positionality is defined broadly as a reflexive practice, during which an individual conducts an internal self-examination to critically consider how their unique “position” informs the way they conduct science, research, and other STEMM activities. This may include a complete examination of an individual’s own identities (e.g., demographic identities), political leaning, worldviews, experiences, and relations to systemic privilege as well as their relations to marginalization (Secules et al., 2021).

Scholars have noted that during the practice of determining an individual’s positionality, the person is considering their unique social location and their unique perspective, as it informs the entire process of science, from developing research questions, to selecting and interacting with participants, to interpreting and analyzing the results (Hampton et al., 2021). While emerging as a potential tool of helping fostering antiracism, diversity, equity, and inclusion, it remains an empirical question whether these

statements have a measurable impact in improving antiracism, diversity, equity, and inclusion in STEMM. There needs to be a greater empirical examination of the following:

1. Are positionality statements effective in helping gatekeepers reflect on, address, and ultimately reduce bias at the individual level?
2. Are positionality statements effective as a teaching tool in helping promote structural racism awareness, increase knowledge of racism in STEMM, and foster ongoing antiracism, diversity, equity, and inclusion learning?
3. Are positionality statements effective in promoting structural racism awareness at the leadership level, and a tool in helping initiate larger organizational culture change?

There needs to be a continued investigation focused on identifying which organization-level interventions, including policies, practices, procedures, opportunity structures, trainings, and interventions, work in producing measurable and sustainable change in advancing antiracism, diversity, equity, and inclusion in STEMM organizations. There needs to be a greater empirical examination of the following:

1. Which novel interventions are effective in producing meaningful change in the short term? In the long term? And for whom?
2. Under what conditions can diversity training be effective and for whom?
3. How might different interventions target different groups of minoritized individuals over the course of their career trajectory to maximize antiracism, diversity, equity, and inclusion in STEMM?
4. How personnel who hold power in these organizations can help advance antiracism, diversity, equity, and inclusion in STEMM.
 - a. There needs to be increased research examining different models of leadership that work to de-center White individuals in power and help increase antiracism, diversity, equity, and inclusion in the highest ranks of STEMM. For instance, research could examine whether leadership term limits increase representation at the highest levels of STEMM (Beeler et al., 2019).
 - b. Understanding how leadership roles are defined in different STEMM organizations may inform accountability for advancing antiracism, diversity, equity, and inclusion.
 - c. What are the conditions and resources that DEI officers need to help promote measurable antiracism, diversity, equity, and inclusion change in a given organization?

- d. What are the conditions and resources that human resource departments need to help promote measurable antiracism, diversity, equity, and inclusion change in a given organization?
- e. How can leadership of organizations examine incentive structures at different levels of power? Along with research, teaching, and service, adding antiracism, diversity, equity, and inclusion to regular faculty responsibilities, with salaries dependent on quality of results, may potentially incentivize antiracism, diversity, equity, and inclusion efforts. This includes understanding how upper-level administrators could also be incentivized by adding antiracism, diversity, equity, and inclusion to their accountability.

There needs to be a more comprehensive examination of the organization-level White-centered “professionalism” standards that impact minoritized individuals. For instance, as discussed in Chapter 5, research has demonstrated that many minoritized individuals codeswitch in predominantly White contexts. However, further investigation into STEMM contexts is needed. There needs to be a greater empirical examination of the following:

1. What are the conditions like in STEMM contexts that strongly adhere to White-centered “professionalism” standards?
2. How minoritized individuals codeswitch and navigate within White-centered STEMM workplaces, and what impact this has on them.
3. Examining hair (e.g., Powell, 2018) and hair covering discrimination as a mechanism of upholding White-centered professionalism standards in STEMM.
 - a. Researchers could conduct a robust examination of this form of discrimination occurring within STEMM contexts to develop a broader understanding of the prevalence.
 - b. How do hair and hair covering discrimination vary by states, STEMM institutions, and STEMM companies across the United States with differing levels of protection for minoritized individuals?

TEAMS

More robust investigations are needed to focus on identifying which team-based interventions—including policies, practices, procedures, opportunity structures, trainings, and interventions—are most effective in producing measurable and sustainable change that advances antiracism, diversity, equity, and inclusion in STEMM teams. Specifically, there needs to be a

greater examination of the contact hypothesis in STEMM organizations. Namely, researchers should continue to identify the team-based factors that help facilitate bias reduction and increase experiences of inclusion within STEMM teams.

Additional research is needed from the perspective of minoritized individuals. Furthermore, there needs to be an examination of what it means to build a critical mass of minoritized individuals on STEMM teams, and the impact that has on team performance and minoritized individuals.

INTERPERSONAL AND INDIVIDUAL DYNAMICS

Chapters 5 and 6 articulated how racism is experienced or perpetuated at an individual level. However, there are likely conditions under which a given individual may experience racism and *also* perpetuate it. There needs to be a greater examination of this phenomenon.

1. What are the conditions under which individuals may perpetuate racism, and the conditions under which individuals may actively engage in antiracist behaviors?

The phenomenon of racism denial, while not a central focus of the report, needs a more robust examination as this may inform how interventions and strategies toward promoting antiracism, diversity, equity, and inclusion in STEMM are formed. There needs to be a greater empirical examination of the following:

1. The incidence and impact of racism denial across various STEMM sectors.
2. Racism denial among a range of STEMM leaders and stakeholders including those in universities, colleges, communities, industries, and funding agencies.
3. The predictors and mechanisms that give rise to racism denial and how it resembles or differs from existing research and theory on aversive racism and modern racism.
4. How racism denial beliefs at the individual level may inform interpersonal interactions, again relative to what is known.

In addition, there needs to be a continued, more robust, and more in-depth understanding of minoritized individuals' sense of belonging and inclusion, beyond what is already known.

The committee determined that a continued examination of the factors, conditions, and mechanisms that predict a greater sense of belonging and inclusion across multiple STEMM contexts. Furthermore, there needs to

be a more robust body of qualitative and mixed-methods research capturing the lived experiences of minoritized individuals. This research should prioritize individuals that are not only minoritized in STEMM, but also minoritized in the empirical literature. These more in-depth data collection efforts may help provide a better understanding of the unique sets of barriers, opportunities, and points of interventions for specific individuals who remain at the furthest margins in STEMM.

Finally, there needs to be a more robust body of research examining both White identity and the emotions of White individuals. There needs to be a greater empirical examination of the following:

1. How identity and various emotions are associated.
2. How emotions inform intergroup contact, mentorship in STEMM, team cohesion and performance, developing and fostering ally ship in STEMM, and leadership quality.
3. Do White identity and emotions operate to uphold systemic racism in STEMM?

The committee notes that additional research is needed to examine the potential impact of other high-status individuals beyond senior mentors, including sponsors and champions, in helping promote greater representation and inclusion of minoritized individuals in STEMM contexts. This includes research that examines which specific features of a physical environment are most inclusive for minoritized individuals. Furthermore, additional research is needed to identify the specific components of summer bridge programs that may be significant factors in producing specific positive outcomes for minoritized individuals.

The committee found that additional research is needed to examine the psychological impacts of perpetuating racism from the perspective of the gatekeeper in STEMM. In addition, additional research is needed to identify ways to reduce the negative impacts of racialized trauma.

The body of research on Indigenous individuals' experiences in STEMM education spaces and the workforce is scarce. A much more robust program of research is needed.¹ Specific points of empirical investigation based on the committee's review of the literature are included below:

1. There needs to be additional research that includes and examines the experiences of Indigenous individuals in a variety of STEMM contexts.

¹This section draws on an expert review commissioned by the committee (Smith, 2022).

2. Deeper examinations of the factors that discourage Indigenous individuals from pursuing STEMM, and a deeper examination of factors that promote their full participation in STEMM environments.
 - a. Greater examination of these factors across a range of STEMM disciplines.
3. Continued examinations of the impact of Indigenous-centered mentoring programs on persistence and advancement in STEMM contexts.

A much more robust and nuanced body of research focused on Asian Americans in STEMM contexts is needed.² Asian Americans are not a monolithic group, and persons who identify as Asian American may claim many different geographical, ethnic, and immigrant roots. There needs to be a greater empirical examination of the following:

1. The representation in STEMM of different Asian American ethnic groups and nationalities.
2. Identify and better understand the factors that can contribute to attrition and retention of Asian Americans in STEMM contexts, with a focus on the role of feelings of belonging and inclusion.
3. Examinations of the experiences of Asian Americans in additional STEMM educational contexts, including public universities and community colleges (Kim et al., 2022).
4. Continued research identifying the specific sectors and positions in STEMM that Asian Americans remain numerically underrepresented.
5. Examinations of how immigration laws and immigration status may impact Asian American's experiences in STEMM contexts.

In addition, a much more robust and nuanced body of literature focusing on Latine individuals in STEMM contexts is needed.³ Latine is not a monolithic identity, but rather a group that comprises persons who identify as Latine claiming many different geographical, racial, and immigrant roots. There needs to be a greater empirical examination of the following:

1. Literature reviews and meta-analyses focusing on the experiences of Latine individuals navigating STEMM career pathways. These should be a priority in order to be able to track trends over time and identify whether policy advances have affected practices and outcomes.

²This section draws on an expert review commissioned by the committee (Cobian et al., 2022).

³This section draws on an expert review commissioned by the committee (Trujillo, 2022).

2. Deeper examinations of the factors that deter Latine individuals from pursuing STEMM, and a deeper examination of factors that promote their full participation in STEMM environments.
 - a. Greater examination of these factors across a range of STEMM disciplines.
3. More studies focusing on how Hispanic Serving Institutions (HSIs) impact Latine individuals' experiences of belonging and persistence outcomes in STEMM.
4. More research focused on the Latine individual's workforce experience in STEMM industry spaces outside the academy.
5. More studies on how immigration policy impacts retention and persistence of Latine individuals, with special attention to first-generation students.

A much more robust and nuanced body of literature focused on Black individuals in STEMM is needed. There needs to be a greater empirical examination of the following:

1. The benefits of optimizing Black individuals' sense of belonging and inclusion.
2. The costs of not optimizing Black individuals' sense of belonging and inclusion.
3. The policies, practices, procedures, opportunity structures, trainings, and interventions that work in producing measurable and sustainable change in increasing Black individuals' representation across all STEMM sectors.
4. The Black experience in STEMM careers. This research would benefit from quantitative and qualitative accounts that capture the full range of professional outcomes in different roles, career stages, and in different sectors.

RESEARCH PROCESS: ITEMS FOR ALL LEVELS

As discussed previously, the second half of the research agenda addresses the research process. The items discussed in the research process are meant to apply to all levels of analysis ranging from historical structures to the individual level.

Evaluation

Federal agencies have supported many programs aimed at increasing diversity in STEMM. What is needed is a retrospective evaluation of the effectiveness of these programs—under what conditions were goals

achieved or not achieved? What is the effectiveness tradeoff between term (e.g., number of years) of support and sustainable effect? Similar reports or research publications at the same magnitude of the current report are needed for each minoritized group (Latine, Indigenous, and Asian American groups) in STEMM.

Additional Populations

Much of the research examining minoritized individuals in STEMM (see Chapter 5) focuses heavily on those in the early training/career stages. Additional research examining the experiences and the consequences of racism among minoritized individuals in middle-stage and late-stages of their careers is needed.

Learners from minoritized populations may be likely to exit and re-enter academic degree programs and start careers later in life. More robust data collection methods are needed to track minoritized individuals' career pathways across institutions and life circumstances.

Theoretical Frameworks

Many gaps in the antiracism, diversity, equity, and inclusion STEMM literature persist, in part, because of the ways in which certain theoretical frameworks are used. The incorporation of more of the suggested frameworks below will help permit certain research questions to be asked and necessary data to be collected.

Many existing studies on minoritized individuals use a deficit-based framework to understand existing challenges (see Chapter 5). While deficits and challenges are important to understand, there are also many assets that exist in these populations that are ignored and underutilized as a resource. There needs to be a greater shift from an overreliance on the deficit framework to an asset-based framework in the production of new research. There also needs to be a shift away from the framework of the hero's journey (of individual resilience) to a framework that focuses more on relevant structures and conditions that promote antiracist systems.

In addition, there needs to be greater use and inclusion of an intersectional framework (Crenshaw, 1989, 2012).

1. Researchers need to consider the connections between identities and systems, and their implications for minoritized individuals in STEMM. This includes how multiple systems and structures of privilege and oppression that are connected to individuals' multiple identities inform the lived experiences of minoritized individuals across various STEMM contexts.

Finally, the “leaky pipeline” metaphor is both false and harmful, and this framework should be abandoned (e.g., Cannady et al., 2014). Persons have agency and are not a commodity. Furthermore, the system through which the persons travel is not inert; rather, leaders have the responsibility for actively creating an inclusive environment. The “leaky pipeline” framework frequently describes the points where minoritized individuals exit STEMM. While it is critical to understand the factors that contribute to attrition and the points in which they occur, this framework limits empirical investigation. Like a leaking pipe, it is presumed that these individuals are lost forever, and there are no possibilities of reentry into the pipeline.

Ways of Conducting Science

There needs to be a greater consideration of how antiracism, diversity, equity, and inclusion STEMM researchers can shift their structures and paradigms of science and science education to be inclusive of Indigenous ways of knowing.⁴ This will help increase inclusive participation, advancement, and creation and education of science across STEMM sectors.

1. In an effort to create dedicated and reciprocal relationships with tribal communities, researchers need to be transparent in their intentions in developing collaborations with them.
2. There needs to be increased efforts that identify research practices of holism that capture the strengths of utilizing multiple knowledge systems. In doing so, this may help build capacity for tribal sovereignty and improve research practices for the broader research community.
3. Researchers need to develop research questions that are central and important to Indigenous communities; they must focus on building lasting relationships with community members, and work on co-creating knowledge and science with these members.

Researchers need to examine how they can actively amplify alternative perspectives such as critical methodologies and standpoint epistemologies that actively center on challenging systems of oppressions in STEMM. Furthermore, antiracism is an emerging construct, and additional methodological research is needed to understand how to empirically measure this construct.

⁴This section draws on an expert review commissioned by the committee (Smith, 2022).

Survey Building and Analytic Techniques

Researchers who want to conduct racial and ethnic antiracism, diversity, equity, and inclusion-related STEMM research should center race and ethnicity as a primary lens of their research plan.

1. There is a greater need to make race and ethnicity central in the data collection and analysis of the research. Other factors by which diversity can occur on (personality, geography, etc.) should not necessarily be a central focus in these contexts.
2. These studies need to include questions that permit the collection of demographic data, including various racial and ethnic identities.
3. Qualitative measures can help give space for individuals to write in how they describe their own identities (Roberts et al., 2020). This may help permit greater nuance in data collection efforts.

In addition, there needs to be a greater incorporation of factors that may vary by race and ethnicity. These are essential in understanding minoritized individuals' experiences, barriers, and opportunities in STEMM contexts. Researchers should consider including measures that assess the following factors:

1. Skin color and other physical features
2. Immigration status, national origin
3. Perceptions of academic ability
4. Language and other culturally relevant factors
5. Family, social support, and tribal community ties/support
6. Accessibility to important STEMM networks
7. Socioeconomic status and or class
8. Gender identity
9. First-generation academic status

Data in STEMM contexts should be disaggregated by the following factors, when possible, to better understand the phenomenon of antiracism, diversity, equity, and inclusion in STEMM:

1. Race and ethnicity
2. Discipline or sector (physical sciences, life, math, engineering, etc.)
3. Within race and ethnicity groups. Each group is not a monolith, and greater examination of patterns within a given minoritized group is needed.
4. Immigration status

Additional research is needed that moves beyond using White participants as the only or primary comparator group. Many gaps would be filled if researchers in the areas of antiracism, diversity, equity, and inclusion and STEM fields would include a robust description of the demographic data in sections of scientific papers (Roberts et al., 2020). Cross-sectional and longitudinal studies should continue to be conducted at each level of analysis (historical to individual).

Ethical Approval and Considerations

To accurately fill the gaps in the evidence base, there needs to be a critical consideration of research ethics and how they factor into the production of knowledge. Researchers also need to critically consider how missing data for race and ethnicity are handled. The implications, risks, and benefits, of conclusions drawn from imputed race and ethnicity data should be considered carefully (Randall et al., 2021).

When collaborating and working with minoritized communities (Randall et al., 2021), there needs to be ongoing communication about the data collection, ownership of data, and transparency of the outcomes. Efforts to prevent harm to minoritized communities should be built into the ethical practices of the research studies.

In addition, researchers need to critically consider and minimize the potential risk of identifying single minoritized individuals (Randall et al., 2021), including when studying non-numerically diverse STEM spaces. For example, there may only be one Black woman in a given department of interest. In these cases, methods may be employed to examine more aggregate patterns and protect individuals.

Study leaders who are examining antiracism, diversity, equity, and inclusion across a variety of STEM contexts need to develop diverse research teams when studying these issues, as research team representation informs the knowledge gaps that are being filled.

1. There needs to be a critical and careful examination if an all-White research team is developing conclusions, recommendations, and/or speaking on behalf of a minoritized group of which they are not part (Roberts et al., 2020).
2. There needs to be increased cross-disciplinary collaborations between social scientists who are experts in the fields of antiracism, diversity, equity, and inclusion, and those within STEM fields who are not experts in antiracism, diversity, equity, and inclusion. This will help guide the formation of study designs that include valid, reliable, and gold-standard measures, and incorporate the

necessary considerations of conducting antiracism, diversity, equity, and inclusion research in this area.

Publication and Distribution of Knowledge

Gaps in the body of literature can only be filled if spaces are actively constructed that allow these very gaps to be filled. These spaces exist in publication and distribution structures (see also Roberts et al., 2020).

1. Journal editors and field leaders can generate more outlets for research on antiracism, diversity, equity, and inclusion in STEMM to be published.
2. Space in existing mainstream STEMM and social science journals, especially those with the highest impact factors, can be allocated to the dedication of antiracism, diversity, equity, and inclusion-related research. Journal editors can consider what proportion of space could be dedicated.
3. At the same time, journal editors can decrease space for research that perpetuates harm to minoritized communities in STEMM. Editors could consider how journal requirements and standards could be implemented to best achieve this.
4. There needs to be greater federal infrastructure and outlets that permit the publication of federally supported research on antiracism, diversity, equity, and inclusion in STEMM.

CONCLUSION

The scientific evidence and lived experiences presented in this report offer critical insights and form a strong foundation for the committee's research agenda. Stakeholders who conduct and fund STEMM research can use this research agenda to fill critical gaps in the empirical evidence base and improve how research is conducted. Attention to each of the priority areas identified by the committee will contribute to a more robust evidence base that is needed to advance antiracism, diversity, equity, and inclusion.

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Appendix A

Increasing Participation of Underrepresented Groups in STEM: Themes from Four Recent National Academies Reports

The National Academies of Science, Engineering, and Medicine has a long history of tackling diversity, equity, and inclusion in science, technology, engineering, and mathematics. Many reports have focused on various aspects of diversity, equity, and inclusion (DEI) relevant to this report. Of the reports that have been released, four consensus studies highlight significant recommendations that address increasing inclusivity in STEM:¹ *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011); *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce* (the National Academies of Sciences, Engineering, and Medicine, 2019); *Transforming Trajectories for Women of Color in Tech* (the National Academies of Sciences, Engineering, and Medicine, 2022a); and *Defense Research Capacity at Historically Black Colleges and Universities and Other Minority Institutions: Transitioning from Good Intentions to Measurable Outcomes* (the National Academies, 2022b).

The spotlighted consensus studies address common themes such as developing a culture of inclusive leadership, providing social and emotional support for underrepresented/underresourced individuals, support for pathway programs, and further utilization of data collection and evaluation toward measurable outcomes. Below are summaries of themes that exist across two or more of the consensus studies and a list of the recommendations included in the respective reports. The full text of each report is available for download at NAP.edu.

¹STEM is used intentionally, as medicine is not a core subject for the four reports analyzed.

THEME I: DEVELOP AND INSTITUTE INCLUSIVE LEADERSHIP PRACTICES IN STEMM INSTITUTIONS

Given the significant impact that individuals in positions of leadership in academia, nonprofit organizations, scientific societies, government, and industry have on the trajectory of the workforces that they support, if an organization is devoted to increasing the number of people from minoritized groups, then targeting its leadership practices is paramount. Intentional inclusive leadership practices assist in developing a new cadre of diverse leaders in STEM institutions and provide a visual representation of an organization's commitment to DEI. Further, implementing inclusive leadership mechanisms ensures that on-ramps undergird investments made at the beginning of an individual's education and training toward positions of influence that will provide new voices and strategies for further inclusion of people from minoritized groups.

The report on *Transforming Trajectories for Women of Color in Tech* highlights the need for expanded recruitment efforts that target disciplines and organizations with low numbers of people from minoritized groups. By incorporating community colleges and Minority Serving Institutions (MSIs) into recruitment searches to directly connect to training programs that primarily serve people from minoritized groups, institutions can directly connect with the populations they intend to serve. Additionally, providing financial assistance for undergraduate and graduate students from minoritized groups coupled with recruitment and retention strategies will support their transition from two-year and MSIs into larger institutions for postgraduate education and industry.

It is increasingly essential to incorporate evidence-based, outcome-driven programs and strategies as leadership at institutions creates a culture of intentionality through the development of policies, infrastructure, and practices. The report *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM* workforce argues that an integral aspect of developing this intentional culture revolves around investing in succession planning and professional development training programs for the next generation of diverse STEM leaders.

While increasing the number of people from minoritized groups in leadership at STEM institutions will provide a step in the right direction, solidifying the role of DEI in an institution's organizational structure will fortify long-term actions. The *Transforming Trajectories for Women of Color in Tech* report directs organizations that are serious about inclusive leadership and DEI in their workforce and training to elevate DEI professionals into executive leadership positions. These professionals can use the power of financial and human resources with evidence-based strategies to implement innovative strategies, track outcomes, and provide accountability.

Incorporating continuity in these leadership positions will support consistency in metric gathering and assessment and the sustainability of the organization's efforts.

Related Recommendations:

- *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce*: RECOMMENDATIONS 1 and 2
- *Transforming Trajectories for Women of Color in Tech*: RECOMMENDATIONS 3-3 and 4-2

THEME II: FOSTER AN ENVIRONMENT THAT PROVIDES SOCIAL AND BEHAVIORAL SUPPORT FOR UNDERREPRESENTED/UNDERRESOURCED INDIVIDUALS ACROSS STEM EDUCATION AND CAREERS

Expanding social and behavioral support for people from minoritized groups in STEM provides a mechanism for retention and recruitment. The necessary support system, however, is multisectoral and involves stakeholders from academia to industry to be successful. The report *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce* emphasizes the vital role that funding organizations have in developing programs that target social and behavioral support for people from minoritized groups. Specifically, the report calls on funders to create new and expand grant opportunities for evidence-based research on socio-behavioral and socio-cultural approaches for intervention programs at STEM institutions. Moreover, federal agencies, such as the National Science Foundation (NSF), have seen moderate success in incorporating review criteria like its broader impacts as a mechanism for ensuring that grants that support the training of students and postdocs focus on broadening participation. Other federal agencies should consider broader impacts as a template for their grant-making and diversity goals.

An adaptation of successful federal programs like the NSF ADVANCE program, which tasks STEM organizations with addressing an academic and institutional culture that has prevented or stagnated the advancement of people from minoritized groups, should be explored across governmental, nonprofit, and academic STEM organizations. These reports also recommend that federal agencies that support training should also require mentoring plans as part of grant applications, evaluations, and reporting.

Among higher education institutions, a campus-wide initiative focused on inclusiveness that manifests through funded programs and reformations to university missions and affairs is also necessary. These actions should

precipitate targeted activities such as orientations, professional development, career coaching, and peer mentoring with facilitators and leadership required to maintain regular training in culturally responsive education, racial awareness, and intersectionality. Furthermore, faculty who participate in the development of students and trainees from minoritized groups should receive an acknowledgment from their institution through professional development opportunities and attribution during the promotion and tenure process.

Professional and academic societies and industries can incorporate many of the aforementioned strategies like peer mentoring and leadership, cultural coaching, and faculty mentorship. To better leverage resources across stakeholder groups, the report on *Transforming Trajectories for Women of Color in Tech* suggests the creation of cross-sector coalitions to encourage and support ongoing activities and promote effective recruitment, retention, and advancement strategies across stakeholder groups. The recommendations also identify ways that industry should also incorporate practices that provide adequate work-life balance through remote work, flexible hours, parental and family leave, and career counseling.

Related Recommendations:

- *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads: RECOMMENDATION 6*
- *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce: RECOMMENDATION 7*
- *Transforming Trajectories for Women of Color in Tech: RECOMMENDATIONS 3-3, 4-3, and 4-4*

THEME III: SUPPORT AND INCREASE PATHWAY PROGRAMS THAT TARGET UNDERREPRESENTED/ UNDERRESOURCED INDIVIDUALS

Interest in STEM has been shown to start at an early age. Providing opportunities that engage individuals as young as possible will help nurture natural curiosity and competency for STEM concepts. The report on *Expanding Underrepresented Minority Participation* encourages stakeholders to prepare the workforce beginning in preschool and continuing through third grade by providing reading readiness, early math skills, and basic concepts of creativity and discovery. As students matriculate through primary school, improvements in K–12 mathematics and science education will support the student readiness for secondary and postsecondary education. To further support these activities, the report notes that stakeholders across sectors should prioritize developing and expanding collaborative partnerships that support education, research, and workforce training.

The federal government should seek to expand its programs and investments toward additional on-ramps for people from minoritized groups in STEM. The report on *Defense Research Capacity at Historically Black Universities and Other Minority Universities* recommends that federal agencies direct current workforce development scholarships and fellowships like the Department of Defense’s SMART program to increase the representation of MSIs as a proportion of these programs by fiscal year 2025. Interagency collaborations on programs like the ASSURE program will also provide resources for MSI principal investigators to support the training of students at their institution, where resources may be challenging to attain.

As STEM pathways diversify, a look at the adaption of credentialing toward further education and careers should be explored. Extensive incorporation of certification and training programs administered by community-based programs and institutions as supplements for undergraduate and graduate admission and job requirements will help expand opportunities for individuals seeking to (re)enter STEM programs and workforces.

Related Recommendations:

- *Expanding Underrepresented Minority Participation: America’s Science and Technology Talent at the Crossroads: RECOMMENDATIONS 1, 2, and 5*
- *Minority Serving Institutions: America’s Underutilized Resource for Strengthening the STEM Workforce: RECOMMENDATION 3*
- *Transforming Trajectories for Women of Color in Tech: RECOMMENDATIONS 6-1, 6-2, 6-3, and 6-4*
- *Defense Research Capacity at Historically Black Colleges and Universities and Other Minority Institutions: Transitioning from Good Intentions to Measurable Outcomes: RECOMMENDATION 8*

THEME IV: FORTIFY DATA COLLECTION, EVALUATION, AND ACCOUNTABILITY OF DIVERSITY, EQUITY, AND INCLUSION PROGRAMS

As federal agencies, academic institutions, industry, and professional societies incorporate diversity, equity, and inclusion metrics into their missions and programs, robust tracking, evaluation, and accountability will ensure that the initiatives are effective and evolve to better address changing demographics and intersectionality. The *Minority Serving Institutions* report recommends that stakeholders reassess and refine methods of measuring outcomes that consider missions, faculty loads and investments, population needs, and institutional resource constraints. The *Defense Research Capacity at Historically Black Colleges and Universities and*

Other Minority Institutions report recommends continual and consistent data collection and analysis across federal agencies to ensure compatibility with national databases. Given reporting structures across the federal government, agencies should, as best as possible, develop interagency guidelines for data collection and evaluation to improve tracking and annual assessments.

The report on *Transforming Trajectories for Women of Color in Tech* provides direction for increasing the accountability of federal agencies and recipients of federal funds that support the recruitment, retention, and advancement of people from minoritized groups. Recommendations include submitting an overview of the outcomes of DEI programs and initiatives as part of the annual budget request to Congress, requiring additional review panels for proposals that plan to promote DEI, and incorporating an evaluation of the grantee outcomes in annual reports and funding renewal, and conducting periodic “equity audits” on metrics such as gender and racial disparities in recruitment, retention, and advancement. These equity audits should reflect an individual institution’s specific context, geography, and resource limitations and should track an institution’s progress over time in improving the inclusion of people from minoritized groups.

Related Recommendations:

- *Minority Serving Institutions: America’s Underutilized Resource for Strengthening the STEM Workforce*: **RECOMMENDATION 10**
- *Transforming Trajectories for Women of Color in Tech*: **RECOMMENDATIONS 5-2, 5-3, and 5-4A, B, C**
- *Defense Research Capacity at Historically Black Colleges and Universities and Other Minority Institutions Transitioning from Good Intentions to Measurable Outcomes*: **RECOMMENDATIONS 3A, 3B, and 3C**

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Appendix B

Comparison Tables of Science and Engineering Degrees Earned by Race and Ethnicity and Gender in 2011 and 2019

TABLE B-1 Comparison of Science and Engineering Associate's Degrees Earned by Race and Ethnicity and Gender in 2011 and 2019

	2011		2019	
	Male	Female	Male	Female
All races/ethnicities	43,490	32,531	54,632	49,803
White	25,344	16,015	25,630	17,072
Black	4,765	4,776	4,652	5,214
Latine	4,979	4,866	12,669	17,691
Asian	2,230	1,722	5,126	4,322
American Indian or Alaska Native	490	561	427	544
Native Hawaiian or Other Pacific Islander	227	269	226	210
More than one race	411	315	2,007	1,973

SOURCE: Woman, Minorities, and Persons with Disabilities in Science and Engineering (NCSES, 2021).

TABLE B-2 Comparison of Science and Engineering Bachelor's Degrees Earned by Race and Ethnicity and Gender in 2011 and 2019

	2011		2019	
	Male	Female	Male	Female
All races/ethnicities	275,258	279,107	364,648	360,299
White	175,430	163,031	201,125	183,275
Black	16,869	29,472	22,366	34,819
Latine	22,406	29,015	46,705	59,632
Asian	26,161	24,978	38,867	34,733
American Indian or Alaska Native	1,560	1,865	1,173	1,547
Native Hawaiian or Other Pacific Islander	575	665	685	728
More than one race	3,219	3,949	13,052	15,093

SOURCE: Woman, Minorities, and Persons with Disabilities in Science and Engineering (NCSES, 2021).

TABLE B-3 Comparison of Science and Engineering Master's Degrees Earned by Race and Ethnicity and Gender in 2011 and 2019

	2011		2019	
	Male	Female	Male	Female
All races/ethnicities	82,451	68,202	113,535	96,031
White	35,935	31,777	40,239	36,971
Black	3,863	7,098	5,359	8,936
Latine	3,946	4,465	7,082	8,294
Asian	5,814	4,533	7,772	6,188
American Indian or Alaska Native	278	306	227	326
Native Hawaiian or Other Pacific Islander	114	116	92	127
More than one race	653	682	2,225	2,376

SOURCE: Woman, Minorities, and Persons with Disabilities in Science and Engineering (NCSES, 2021).

TABLE B-4 Comparison of Science and Engineering Doctoral Degrees Earned by Race and Ethnicity and Gender in 2011 and 2019

	2011		2019	
	Male	Female	Male	Female
All races/ethnicities	21,377	17,093	25,905	21,848
White	8,795	8,551	10,017	10,057
Black	501	925	727	1,629
Latine	651	746	1,111	1,334
Asian	1,175	1,158	1,502	1,580
American Indian or Alaska Native	53	69	47	64
Native Hawaiian or Other Pacific Islander	20	17	23	22
More than one race	97	105	395	529

SOURCE: Woman, Minorities, and Persons with Disabilities in Science and Engineering (NCSES, 2021).

REFERENCE

National Center for Science and Engineering Statistics (NCSES). (2021). Women, Minorities, and Persons with Disabilities in Science and Engineering. <https://nces.nsf.gov/pubs/nsf21321/>

Appendix C

Process for Panel's Interviews

This appendix details how the committee carried out the interviews reported in Chapter 4. The committee designed the general method, and it was approved by the Institutional Review Board (IRB) of the National Academies of Science, Engineering, and Medicine (the National Academies).

INTERVIEW APPROACH AND INTERVIEWERS

Interviews were conducted on Zoom, using both audio and video. The audio was transcribed, and those transcripts are confidential and have been de-identified.

The interviews were conducted by five project research assistants. Because identities inform perceptions, their positional identifications are included below. From the perspective of the interviewees, all five would be visually identified as young Black women; they introduced themselves as recent Princeton graduates who completed senior theses with Susan Fiske, co-chair of the committee.

- Ogechi Adele identifies as Black (100% Nigerian), age 22, cisgender straight woman, from Atlanta and New York, attending Columbia Law School.
- Yolore Airewele identifies as African American (Nigerian), age 23, from upstate New York, cisgender straight woman, working as research staff at Princeton University.

- Jessica Brice identifies as Black/African American, age 22, cisgender woman, from New Jersey, currently pursuing a Ph.D. in social psychology at the University of Washington.
- Dana Harris identifies as an African American, age 23, cisgender queer woman, from Cleveland, Ohio, currently living in New Haven, Connecticut, working as a research analyst with ThinkNow.
- Leezet Matos, M.A., identifies as a Black Afro-Latinx (Haitian-Dominican/Puerto Rican), age 26, cisgender queer woman from Dallas, Texas, currently living in Los Angeles, California, attending the University of California at Los Angeles.

The selection of the quotations in Chapter 4 was made by these interviewers, committee staff member André Porter, and committee co-chair Susan Fiske. Because their identities likely inform their perceptions, their positional statements follow:

- André Porter, identifies as a Black/African American, age 34, cisgender man from Washington, D.C.
- Susan T. Fiske identifies as White (25% German Jewish, 75% British Isles), age 70, mobility challenged, cisgender straight woman, from Chicago and New England, teaching at Princeton University.

The interviewers uploaded their audio interviews to a secure storage site, and the audio files were then transcribed by either an agency or an automated transcription site. A research assistant then removed any identifying information in the transcripts before uploading the documents onto the secure storage site for later use. Finally, committee and staff informally coded the information by interview questions.

The quotations that appear throughout the report were vetted by the entire committee and approved by the individual interviewee.

INTERVIEW SCRIPT

Committee members and the five interviewers developed a structured interview. The rest of this section reproduces that script. (Note that the National Academies are referred to as NASEM in the script.)

“I am [name], working as research staff with the NASEM committee on Anti-Racism, Diversity, Equity, and Inclusion in STEMM. Just for context, I have a B.A. in Psychology from Princeton, having completed a senior thesis on [topic] in Susan Fiske’s lab. So I have human subjects

training. I will follow an interview script, developed by a subcommittee of committee on Racism, Anti-Racism, Diversity, Equity, and Inclusion in STEMM Careers, as approved by the NASEM IRB.

I am so grateful for your time today. This should take about half an hour. In case it looks like we might run over, do you have a hard stop afterwards? [Respect their time.]

I'm going to ask some questions about your lived experience as a [scientist, engineer, medical professional]. As the letter from Dr. Barabino and Dr. Fiske [the committee co-chairs] noted, the research staff will aggregate most of the data for the committee's report, so in those cases, you would be anonymous. If we want to use any direct quotations, we would ask you, and your identity will still be confidential; although I know who you are, the quote would be attributed generically (e.g., Black member of NAM [National Academy of Medicine]). The whole process has NASEM IRB approval.

Would you mind if we audio record this, so I can concentrate on listening to you? You can ask me to turn off the Zoom audio recording or the video picture at any time. You can also skip any question. When I turn on the recording, your participation implies your consent to be recorded.

After we are done, a transcription service will transcribe your interview. We will keep the recording and transcript in secure NASEM storage and destroy it 12 months after the committee releases its report. Is it okay for me to turn on the audio recording? And thanks again for your time.

Could you tell me how you identify your NASEM field? And what is your racial identity?

So, tell me about being a [race and specialty]. What's your experience? [After a few backchannels—uh huh, I see, wow, great—try “anything else?” Elicit concrete details: “Tell me more about that.”]

I'd appreciate if you could say more. For example: Did you feel like you belonged—or not?

How much did you feel supported—or not?

What were the sources of your own resilience?

Now I'd like to home in on these questions at different career stages, regarding experiences of belonging or not, being supported or not, and resilience.

How did you experience training in your college STEMM major?

How about graduate school? What was that like?

Time in lab or research team?

First job?

Promotion?

Lately?

Overall, what lessons have you learned from the journey over your career?

If you have a little more time, what advice would you give someone just starting out?

What advice would you give the NASEM panel assembling this report?

What else should I be asking you?

And finally, a little more about you. Please note that your answers will be kept separately from your transcript. We simply want to describe generally the kinds of people who gave us interviews: In what year did you get your highest degree?

*How do you identify your **gender**? [Or, if it seems too awkward:] I'll record your gender as [m/f], if that's OK, unless you prefer a nonbinary identity.*

*Where were you **born**?*

*Where were your **parents** born? [If they ask, this records immigration history.]*

Thank you for giving your time to this important project. The report should be coming out by early fall."

RECRUITMENT AND DEMOGRAPHICS

To recruit participants, the committee emailed the 33 members of the Roundtable on Black Men and Black Women in Science, Engineering, and Medicine who identify as Black or African American. Additionally, to increase the number of interviews with Black elites in STEMM careers, the committee sent a recruitment email to 30 randomly selected members of the National Academies who identify as Black or African American; a second round of recruitment following the same procedure yielded 30 more

National Academies' members, for a total number of 60 members of the National Academies. The final recruitment effort was directed at members of the committee itself. The rate of response from the roundtable was 51.5 percent (17 members), from the membership of the National Academies, 13.3 percent (eight members), and from the committee, 57.1 percent (four members). Thus, the total number of interviewees was 29.

Of the 29 interviewees 12 identified as female (41.4%) and 17 identified as male (58.6%); 21 of the interviewees were born in the United States (72.4%) and three were second-generation immigrants (10.3%).

Appendix D

Glossary

American Indian or Alaska Native

a person having origins in any of the original peoples of North and South America, including Central America, and who maintains tribal affiliation or community attachment.

Antiracist

to engage in an active, intentional, and dynamic set of actions that dismantle and disrupt the policies, practices, attitudes, cultures, and systems that confer power and privilege to White people over others.

Asian

a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent; for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam. These individuals remain citizens of their home countries in Asia.

Asian American

a person who has Asian ancestry and who is now a U.S. citizen or a U.S. permanent resident.

Black or African American

a person having origins in any of the Black racial groups of Africa.

Climate

refers to the participants' perception of and experiences with the organization, leadership, and actions, including the policies, practices, and procedures that comprise its culture. Climate can help identify particular issues in an organization, notably when gaps exist between values and actions (see also Culture).

Colorblind

an ideology in which the evaluation, perception, and treatment of individuals is equal without the consideration of race and ethnicity information of those individuals. It assumes that all individuals are on a level playing field, and often ignores experiences of individual racism, structural racism, and other unique factors that occur on the basis of race.

Culture

broadly defined as "the historically, collectively evolving use of tools, practices, and norms." Organizational culture is dynamic: "Culture is not best understood as a homogeneous, cohesive and causal force, but as something that people do; it is emergent, dynamic, situationally adaptive and co-created in dialogue."

Discrimination

treatment of others based on stereotypic assumptions or emotional prejudices. This includes both active harm and passive harm, as well as active help and passive help.

Diversity

the fair representation of all different aspects of human characteristics, identities, and perspectives in the composition of a group. Diversity is contextual and benefits from specific definitions for the areas to which it applies. It can be a product of antiracist actions as well as a measure against racism.

Equality

the treatment of all individuals in the same manner regardless of their starting point.

Equity

an outcome from fair conditions (policies, practices, structures, cultures, and norms) in which all individuals and groups have the opportunities and resources they need for general well-being or success in specific metrics (such as pay or advancement).

Equity is aligned with justice and may require the systemic redistribution of power, access, and resources. Equity should not be confused with equality, which is the treatment of all individuals in the same manner regardless of their starting point.

Ethnicity

in contrast to race, has a stronger relationship to place: “a grouping of persons according to a shared geographic, national, or cultural heritage.” Ethnicity is a human-invented term used to describe people from a similar national or regional background who share common cultural, historical, and social experiences. An ethnic group likely contains a subgroup of people who share distinct beliefs, values, and behaviors. Race, even though as mentioned below is not a valid biological construct, does contain reference to biological features, while ethnicity addresses social, cultural, and historical commonalities (see also Race).

Explicit bias

blatant expressions of prejudice and explicit endorsement of stereotypes.

Gatekeeper

defined simply as any individual who possesses power in a given STEMM context or situation, where power includes the control over valued outcomes and resources. Gatekeepers in STEMM can exert their power across a range of everyday behaviors. For example, they can define boundaries, decide who does or does not get tenure, decide who should be hired, decide who gets recognition and praise, and direct the flow of and use of resources. Individuals such as managers, supervisors, admissions officers, principal investigators, heads of laboratories and research groups, deans, university presidents, and chief executive officers represent some of the most common gatekeepers in STEMM.

Hispanic or Latine

ethnicity categories referring to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race. “Hispanic” does not include individuals of Brazilian heritage, whereas Latine refers to people from Latin America regardless of language. Both are gender neutral. The committee elected to use “Latine,” unless the data source specifically denotes Hispanic.

Ideal-worker framework

characterized by a culture where workers center their profession as the primary obligation and have additional support to attend to their domestic needs.

Implicit bias

stereotypic beliefs and negative evaluations about groups that pop into mind quickly, often with little awareness or intention.

Inclusion

the feeling or sense of belonging in an environment in which all individuals, regardless of and with respect to their backgrounds, feel that they have a voice and the support for full participation in that environment. An inclusive culture is reinforced with equitable policies, practices, programs, and structures. In an inclusive environment, leaders take an active role in reflecting, learning, and listening to all members of the community to sustain a culture of dignity, respect, and trust.

Indigenous

a term that represents the racial categories of American Indian or Alaska Native and Native Hawaiian or Other Pacific Islander.

Individuation

a cognitive process whereby a person consciously considers the unique beliefs, perspectives, and intentions of another individual.

Institutional racism

policies and practices within and across institutions that, intentionally or not, produce outcomes that chronically favor White individuals and put individuals from minoritized racial and ethnic groups at a disadvantage.

Meritocracy

a system in which individuals advance based on their ability alone.

Minoritized individuals

Black people, Indigenous people, Latine people, and people from groups that have been historically and systemically marginalized based on their race or ethnicity.

More than one race

respondents who select one or more racial designations on forms or surveys in which race is asked.

Native Hawaiian or other Pacific Islander

a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific islands.

Norms

are a set of behavioral expectations within an organization or group. "Often unspoken, these norms offer social standards of appropriate and inappropriate behavior, governing what is (and is not) acceptable and coordinating our interactions with others."

Policies

the documented structure and guidance for decisionmaking in organizations.

Postsecondary

referring to formal education taking place after high school.

Practices

the formal and informal ways in which an organization completes a task.

Prejudice

an evaluative and affective bias of groups of people. This can range from simple negative-positive attitudes to complex emotions, such as envy, resentment, scorn, pity, and fear.

Race

a human-invented, shorthand term used to describe and categorize people into various social groups based on characteristics like skin color, physical features, and genetic heredity. Race, while not a valid biological concept, is a real social construction that gives or denies benefits and privileges.

Racial bias

refers to the collective of stereotyping, prejudice, and discrimination, and how they can unfairly advantage or disadvantage individuals based on race.

Racialized

the extension of racial meaning to resources, cultural objects, emotions, bodies and organizations that have previously been seen as non-racial.

Racism

the combination of policies, practices, attitudes, cultures, and systems that affect individuals, institutions, and structures unequally and that confer power and privilege to certain groups over others, defined according to the social constructions of race and ethnicity.

Stereotype

refers to a generalized belief regarding the characteristics and traits of a group of people.

Structural racism

cultural values in society that are so ingrained in daily life that they are seen simply as the way things are. This includes the wider political and social disadvantages within society.

Systemic racism

perpetuated discrimination within a system that was founded on racist principles or practices. Systemic racism focuses on the involvement of whole systems, and often all systems—for example, political, legal, economic, healthcare, school, and criminal legal systems—including the structures that uphold those systems.

Team

a small number of individuals with different roles and responsibilities that interact independently to perform tasks and accomplish shared goals.

Values

a set of priorities amid multiple interests. Values may vary based on individual judgement, biases, prejudices, and shape personal behavior.

White

a person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

Appendix E

Committee and Staff Biosketches

David J. Asai (he/him/his) is senior director in the Center for the Advancement of Science Leadership and Culture at the Howard Hughes Medical Institute. He directs the Inclusive Learning Group (ILG), which designs and leads grants and fellowships programs aimed at the development of students in the domain of formal education (<http://www.hhmi.org/developing-scientists>). ILG's initiatives are centered on inclusion and founded on the belief that the responsibility for creating equitable learning environments rests primarily with the faculty, staff, and administrators. Current ILG initiatives include: (i) Inclusive Excellence, (ii) Driving Change, (iii) Gilliam graduate program, (iv) the Science Education Alliance, (v) the HHMI Professors, and (vi) the Scientific Mentorship Initiative. Asai has served on diversity-focused advisory committees of the National Science Foundation, National Institutes of Health, the American Association for the Advancement of Science, and the Wellcome Trust. He is an elected fellow of the American Association for the Advancement of Science and an elected fellow of the American Society for Cell Biology. Asai received his bachelor's degree in chemistry from Stanford University and his Ph.D. in biology from Caltech.

Gilda A. Barabino (she/her/hers) is president of Olin College of Engineering and professor of Biomedical and Chemical Engineering. She previously served as Daniel and Frances Berg Professor and dean at The City College of New York's (CCNY) Grove School of Engineering. Prior to joining CCNY, Barabino was associate chair for Graduate Studies and professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia

Tech and Emory. At Georgia Tech she also served as the inaugural vice provost for Academic Diversity. Barabino is a noted investigator in the areas of sickle cell disease, tissue engineering, and the role of race/ethnicity and gender in science and engineering. She is president of the American Association for the Advancement of Science (AAAS), the world's largest interdisciplinary scientific society. Barabino is a fellow of AAAS, the American Academy of Arts and Sciences, the American Institute of Chemical Engineers, the American Institute for Medical and Biological Engineering, and the Biomedical Engineering Society. She is also an elected member of the National Academy of Engineering and the National Academy of Medicine. Barabino chairs the National Academies' Committee on Women in Science, Engineering and Medicine and is a member of the National Academies' Roundtable on Black Men and Black Women in Science, Engineering and Medicine, and the National Academy of Medicine's Health and Medicine Division Committee. She consults nationally and internationally on STEM education and research, diversity in higher education, policy, faculty development, and workforce development. Barabino serves on a number of advisory boards and committees including the congressionally mandated Committee on Equal Opportunities in Science and Engineering, the National Institutes of Health National Advisory Council for Bioimaging and Bioengineering, and the Defense Innovation Board, an independent advisory board for the Department of Defense. She received a B.S. from Xavier University of Louisiana and a Ph.D. from Rice University.

Susan T. Fiske (*Co-Chair*, she/her/hers) is the Eugene Higgins Professor, Psychology and Public Affairs, Princeton University, where she has studied diversity for more than 40 years. Groups relate along universal dimensions of perceived warmth (trustworthy intentions) and competence (capability). Interdependence and power dynamics determine these group images, which (i) form distinct stereotypes (e.g., warm but incompetent old person vs cold but competent rich person); (ii) generate predictable emotional prejudices (e.g., pity, envy, contempt, admiration); and (iii) result in distinct behavioral discriminatory behavior (e.g., attack, neglect, associate, help). Different racial and ethnic groups get treated in predictable patterns across 50 countries, 90 years, and evidence from surveys to neural activation. Fiske testified in Clinton's race initiative and in landmark cases related to gender, age, and LGBTQ+. A Harvard Ph.D. and member of the National Academy of Sciences, she recently won the BBVA Frontiers of Science Award. Her National Academies service includes chairing the Board on Behavioral, Cognitive, and Sensory Sciences, which proposed this panel and serving on several consensus reports as member (measuring discrimination, scientific workforce) or as chair (human subjects, aging workforce).

Jacqueline Cole (she/her/hers) is a senior program assistant with the Board on Behavioral, Cognitive, and Sensory Sciences. Prior to her position at the National Academies, she worked for The GW Medical Faculty Associates as the residency program administrator for the George Washington University Internal Medicine Residency Programs and as coordinator for the Underserved Medicine & Public Health Concentration designed for residents interested in careers in public health and serving the underserved. Prior to her position as the residency program administrator, she worked as the assistant to the founder and president of the Rodham Institute. She also worked for the Armed Forces DNA Identification Laboratory, a forensics laboratory specializing in DNA profiling run by the United States Armed Forces.

Nilanjana Dasgupta (she/her/hers) is a professor of Psychology and the director of the Institute of Diversity Sciences at the University of Massachusetts Amherst. She is a leader in research on implicit bias. Her work emphasizes the *plasticity of implicit bias*—identifying the ways in which changes in local situations modify people’s implicit attitudes, beliefs, and behavior. Dasgupta uses the science of implicit bias to tackle complex social problems by designing and testing the impacts of psychological interventions in the lab and in naturally existing settings. Her research has been funded by the National Science Foundation, National Institute of Health, and American Psychological Foundation. Dasgupta’s work has been recognized by the Hidden Bias Research Prize from the Kapor Center for Social Impact in Silicon Valley, the Application of Personality and Social Psychology Award from the Society for Personality & Social Psychology, and by the UMass Chancellor’s Award for Outstanding Accomplishments in Research and Creative Activity. She is a fellow of the Association for Psychological Science, Society for Experimental Social Psychology, and Society for Personality and Social Psychology. She received her bachelor’s degree in psychology and neuroscience from Smith College and a Ph.D. in social psychology from Yale University.

Mica Estrada (she/her/hers) is currently an associate dean of diversity, inclusion and outreach and professor at the University of California at San Francisco’s School of Nursing in the Department of Social and Behavioral Sciences and the Institute for Health and Aging. Her research program focuses on social influence, including the study of identity, values, kindness, well-being, and integrative education. Estrada’s research advances knowledge about ethnic populations that are historically underrepresented in higher education, most vulnerable to the impacts of climate change, and are providing diverse and creative solutions to the pressing challenges of our day. She writes a *Psychology Today* blog entitled Lead with Kindness. Estrada currently leads, as principal investigator, several longitudinal studies, which involve implementing and assessing inclusion, equity and kindness

interventions aimed to increase student persistence in Science, Technology, Engineering and Mathematics (STEM) careers (funded by the National Institute of Health, National Science Foundation, and Howard Hughes Medical Institute). Estrada has previously served as a member of the National Academies study on *Strengthening Research Experiences for Undergraduate STEM Students*, and currently serves as a NAS *Roundtable on Systemic Change in Undergraduate STEM Education* member. She received her B.A. in psychology from the University of California, Berkeley, and her Ph.D. in social psychology from Harvard University.

Mirian M. Graddick-Weir (she/her/hers) is formerly the executive vice president, Human Resources (HR) at Merck, where she had responsibility for all aspects of human resources for 68,000 colleagues located in over 90 countries. She joined Merck in 2006 from AT&T, where she was executive vice president of Human Resources and Employee Communications. Prior to that role, Graddick-Weir spent 20 years at AT&T holding numerous positions in HR and multiple operational roles. She is a member of the Board of Yum! Brands, Inc. and Booking Holdings, Inc. She serves on the Foundation Board of the Society for Industrial/Organizational Psychology and is a senior advisor to the Jersey Battered Women's services organization. Previously, Graddick-Weir served as the Chair of the HR Policy Association and the National Academy of Human Resources (NAHR). In 2001, she was elected as a NAHR Fellow and she was elected as a Distinguished Fellow of the Academy, the highest honor in the HR profession. Graddick-Weir earned a bachelor's degree in psychology from Hampton University and a master's degree and a Ph.D. in industrial/organizational psychology from Pennsylvania State University.

Giovanna Guerrero-Medina (she/her/hers) is executive director of Ciencia Puerto Rico, a global network of more than 15,000 scientists, students, and educators committed to promoting and democratizing science. Under her leadership, CienciaPR has become one of the largest communities of Hispanic scientists in the world. The organization has been recognized for its work promoting justice, equity, diversity, and inclusion in the areas of science communication, education, and professional development by the Union of Concerned Scientists, the AAAS-Caribbean Division, and the White House, and it received the Falling Walls Breakthrough of the Year award for its efforts bridging science with communities during the COVID-19 pandemic. Guerrero-Medina is also the director of the Yale Ciencia Initiative at Yale's School of Medicine and assistant director of Diversity, Equity, and Inclusion of Yale's Wu Tsai Institute. Through these positions she designs and leads programs to promote more diverse and inclusive academic environments at Yale and beyond. Guerrero-Medina

was part of the Committee on the Next Generation of Biomedical and Behavioral Sciences Researchers. Her work is funded by grants from the National Institute of Health/National Institute of General Medical Sciences and the Burroughs Wellcome Fund, among others. Originally from Puerto Rico, Guerrero-Medina has a Ph.D. in molecular and cell biology from the University of California, Berkeley, followed by a science policy fellowship with the National Academies and science policy work at the National Institute of Health, and the Van Andel Institute.

Camara Phyllis Jones (she/her/hers) is a family physician and epidemiologist who is currently a Leverhulme Visiting Professor in global health and social medicine at King's College London. Her work focuses on naming, measuring, and addressing the impacts of racism on the health and well-being of our nation and the world. Jones allegorizes on “race” and racism illuminate topics that are otherwise difficult for many Americans to understand or discuss: that racism exists, racism is a system, racism saps the strength of the whole society, and we can act to dismantle racism. She taught as an assistant professor at the Harvard School of Public Health and served 14 years as a Medical Officer at the Centers for Disease Control and Prevention. Jones was a Radcliffe Fellow at Harvard University, a Presidential Visiting Fellow at the Yale School of Medicine, and the UCSF Presidential Chair at the University of California, San Francisco. Jones is an adjunct professor at the Rollins School of Public Health at Emory University and a senior fellow and adjunct associate professor at the Morehouse School of Medicine. She is an elected member of the National Academy of Medicine, an elected member of the American Academy of Arts and Sciences, and a Past President of the American Public Health Association. Jones recently co-chaired the National Academies Committee on Science, Technology, and Law workshop on “The Science of Implicit Bias: Implications for Law and Policy” and is a member of the National Academies Roundtable on Black Men and Black Women in Science, Engineering, and Medicine. She earned her B.A. in molecular biology from Wellesley College, her M.D. from the Stanford University School of Medicine, and both her M.P.H. and her Ph.D. in epidemiology from the Johns Hopkins Bloomberg School of Public Health. Jones completed residency training in general preventive medicine at Johns Hopkins and in family practice at the Residency Program in Social Medicine at Montefiore Medical Center.

Samuel R. Lucas is professor of sociology at the University of California-Berkeley. He co-authored *Inequality by Design: Cracking the Bell Curve Myth*, which received a Gustavus Meyers Award, and has authored three other books, including *Tracking Inequality: Stratification and Mobility in American High Schools*, which received the Willard Waller award as the

best book in the sociology of education, and *Theorizing Discrimination in an Era of Contested Prejudice*. Lucas' work has appeared in multiple journals, including *Social Forces*, *Sociology of Education*, *Sociological Methodology*, *American Journal of Sociology*, and others, and he has served on two National Academy of Sciences panels, which produced *Minority Students in Special and Gifted Education*, *A Vision and Roadmap for Education Statistics*, and *Measuring Racial Discrimination*. He received his B.A. in religion from Haverford College and his M.S. and Ph.D. in sociology at the University of Wisconsin-Madison as a National Science Foundation Minority Graduate Fellow and Ford Foundation Dissertation Fellow, specializing in sociology of education, social stratification, research methods, and statistics.

Fay Cobb Payton (she/her/hers) is professor Emeritus of information technology/analytics and University Faculty Scholar at North Carolina State University. Payton earned the full professorship with tenure prior to her Emeritus status. She recently completed a rotation as a program director at the National Science Foundation where she initiated the CISE Minority Serving Institution Research Expansion Program and worked on several initiatives, such as *INCLUDES*, *Smart Health and Biomedical Research in the Era of Artificial Intelligence and Advanced Data Science* and others. Payton's research focuses on AI bias and data quality/curation which impacts smart health, health equity and disparities, talent management, and tech innovation along with ecosystems shaping lived experiences and metro-technology hubs. She is the author of *Leveraging Intersectionality: Seeing and Not Seeing* (Richer Press). Payton completed the American Council on Education Fellow program and was elected to Sigma Xi. She worked in the tech industry prior to entering academia. Payton maintains industry-academic partnerships, and her work has been funded by federal agencies, industry research initiatives, non-profit organizations, and corporate foundations. She is the recipient of the National Science Foundation Director's Award and serves on advisory boards for the American Society for Engineering Education, Association of Computing and National Academies of Sciences, Engineering, and Medicine. Payton has a B.S. in accounting with a minor in mathematics from Clark Atlanta University, and a B.S. in industrial and systems engineering from Georgia Institute of Technology. Payton has an M.B.A. in decision sciences from Clark Atlanta University and her Ph.D. in information and decision systems from Case Western Reserve University.

Julie Posselt (she/her/hers) is associate dean of the Graduate School at the University of Southern California (USC) and associate professor in the USC Rossier School of Education. Her research examines institutionalized inequities in higher education and organizational efforts to advance equity and

inclusion, with a focus on graduate education and the disciplines. Posselt is an expert in the dynamics of judgment and decisions that determine access to and advancement in academia. Internationally recognized for her scholarship on graduate education, she is the author of more than 50 articles and three books, most recently *Equity in Science: Representation, Culture, and the Dynamics of Change in Graduate Education* (Stanford University Press). Posselt directs two research-practice partnerships: the Equity in Graduate Education Consortium and the NSF-INCLUDES Inclusive Graduate Education Network Research Hub. She received the American Educational Research Association's Early Career Award as well as the Association for the Study of Higher Education's Promising Scholar/Early Career Award. Posselt is a member of the National Science Foundation's Directorate for STEM Education Advisory Board, in addition to boards for other national and international organizations. She is a past associate editor of the *Journal of Higher Education* and has been a member of three National Academies consensus studies, most recently on Anti-Racism, Diversity, Equity, and Inclusion in STEMM Organizations. Posselt held a postdoctoral fellowship with the National Academy of Education and Spencer Foundation and earned her Ph.D. from the University of Michigan.

André Porter (he/him/his) serves as the responsible staff officer for the Roundtable on Black Men and Black Women in Science, Engineering, and Medicine. In addition to the Roundtable on Black Men and Black Women in Science, Engineering, and Medicine, his portfolio includes Building Defense Research Capacity at Historically Black Colleges and Universities and Other Minority Institutions; and Advancing Anti-Racism, Diversity, Equity, and Inclusion in STEM Organizations. Prior to joining the National Academies of Sciences, Engineering, and Medicine, Porter's experience includes working in government and nongovernmental organizations such as the National Science Foundation, U.S. Environmental Protection Agency, the American Society for Biochemistry and Molecular Biology, and the American Association for the Advancement of Science. His work has centered on addressing higher education topics in science, technology, engineering, and medicine (STEM) ranging from pipeline development to support for early and mid-career researchers, integrating scientific evidence into policymaking, and convening stakeholder groups to develop consensus that advance policies impacting the U.S. STEM enterprise. Porter holds a B.S. and M.S. in biology from Howard University.

Victor E. Ray (he/him/his) is the F. Wendell Miller associate professor in the departments of sociology and criminology and African American studies at the University of Iowa, a nonresident fellow in governance studies at The Brookings Institution, and a Carr Center Fellow at the Harvard

Kennedy School. His research applies critical race theory to classic sociological questions. Ray work has been published in the *Annals of Internal Medicine*, *American Sociological Review*, *American Behavioral Scientist*, *Annals of the American Academy of Political and Social Science*, *Contexts*, *Ethnic and Racial Studies*, *The Journal of Marriage and Family*, *Sociology of Race and Ethnicity*, and *Sociological Theory*. His work has won multiple awards, including the Early Career Award from the American Sociological Association's Section on Racial and Ethnic Minorities, the Theory Prize from the American Sociological Association's Theory Section, and the Southern Sociological Society's Junior Scholar Award. Ray is also an active public scholar, publishing commentary in outlets such as *The New York Times*, *Time*, *CNN*, *The Washington Post*, *Harvard Business Review*, and *Boston Review*. His work has been funded by the Ford Foundation and the National Science Foundation. Ray's first book *On Critical Race Theory: Why it Matters & Why You Should Care* was recently published by Random House.

Joan Y. Reede (she/her/hers) is the dean, Diversity and Community Partnership and professor of medicine at Harvard Medical School. She has served on several committees/boards such as the Secretary's Advisory Committee to the National Institute of Health (NIH) Director; the Sullivan Commission on Diversity in the Healthcare Workforce; and the Advisory Committee to the Deputy Director for Intramural Research of NIH. Examples of past affiliations include the Steering Committee and Task Force for the Annual Biomedical Research Conference for Minority Students; past co-chair of the Bias Review Committee of the Advisory Committee to the NIH Director's Working Group on Diversity; and past chair of the Association of American Medical Colleges Group on Diversity and Inclusion. Reede is past chair of the National Academy of Medicine Interest Group on Health of Populations/Health Disparities and is a current member of the National Academies Roundtable on Black Men and Black Women in Science, Engineering, and Medicine. She was appointed to the National Advisory Council on Minority Health and Health Disparities. Reede is an authority in the area of workforce development, diversity, and leadership development. She was also appointed to the Board of Directors of the Association of American Medical Colleges.

Karl W. Reid (he/him/his) is the senior vice provost, chief inclusion officer, and professor of practice at Northeastern University. He also heads the Engineering PLUS Alliance, a national National Science Foundation-funded coalition that aims to increase the growth rate in the number of women and racially minoritized students obtaining undergraduate and graduate degrees in engineering. Prior to joining Northeastern, Reid was the executive director of the National Society of Black Engineers (NSBE). He went to NSBE from the

United Negro College Fund, where he held the title of senior vice president for Research, Innovation and Member College Engagement. Reid served on the Committee for Addressing the Underrepresentation of Women of Color in Tech and the National Council for Expanding American Innovation. He is a member of the Industry Leaders Council of the American Society of Civil Engineers, and a founding member of the American Council of Engineering Companies Research Institute Advisory Council and the 50k Coalition. Reid is a frequent contributor to the national discourse on advancing student achievement and fostering diversity and inclusion. He holds a B.A. and M.S. in materials science and engineering from MIT, and a Ed.D. from Harvard University.

Layne Scherer (she/her/hers) served as the study director for the Committee on Advancing Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations, and she is a senior program officer with the Board on Behavioral, Cognitive, and Sensory Sciences at the National Academies of Sciences, Engineering, and Medicine. Prior to joining the National Academies, Scherer was a science assistant at the National Science Foundation with the Directorate for Education and Human Resources. At this time, Scherer also served as an executive secretary under the National Science and Technology Council's Committee on STEM Education. Scherer earned her B.A and M.P.P. from the University of Michigan.

Cynthia N. Spence (she/her/hers) is an associate professor of sociology at Spelman College and director of the United Negro College Fund (UNCF)/Mellon Programs. Her interest in issues of higher education access, service-learning, criminal justice reform, gender role socialization, and violence against women frame her research, writing, community service involvement, and public speaking. As director of the UNCF/Mellon Programs, Spence creates, manages, and oversees a suite of future faculty development and faculty career enhancement programs for UNCF students and faculty. Under her leadership, students are groomed to enter the Ph.D. pipeline, and faculty throughout the UNCF consortium are supported in their development as teachers and scholars. Spence also serves as the director of the Spelman College Social Justice Fellows Program. The Social Justice Program is a living and learning community program that attempts to match students' intellectual interests with their social justice advocacy passions. She serves as the director of the Truth, Racial Healing and Transformation Center, an initiative sponsored by the American Association of Colleges and Universities. Spence has served as consultant for the Ford Foundation Institutional Transformation Project, the University of Chicago Provost Initiative on Minority Affairs, the Agnes Scott College Center for Teaching and Learning, and the Georgia Department of Corrections.

Kecia M. Thomas (she/her/her) is the dean of the University of Alabama at Birmingham's College of Arts and Sciences and professor emerita of psychology at the University of Georgia. She is an expert in the psychology of workplace diversity who relishes her scientist-practitioner identity. Thomas' scholarship and institutional engagements focus on the issues of strategic diversity recruitment, diversity resistance (especially in STEM workplaces), and understanding the career experiences of marginalized workers like high potential women of color (e.g., Pet to Threat). She is the author of numerous articles and book chapters and the first I/O diversity textbook, *Diversity Dynamics in the Workplace*. Thomas has edited six scholarly volumes and her work has been funded by federal agencies, for-profit and nonprofit institutions, and corporate foundations. She is an elected-fellow of the American Psychological Association, the Society for the Psychological Study of Culture, Ethnicity and Race, and the Society of I/O Psychology. Thomas is also a recipient of the Janet Chusmir Award for Distinguished Service from the Academy of Management.

Emily Vargas (she/her/hers) is a program officer with the Board on Behavioral, Cognitive, and Sensory Sciences. She continued working at Northwestern University as a research assistant professor in preventive medicine, funded through a National Institutes of Health grant. Throughout her research career, Vargas' research was focused on examining the intersection of individual's marginalized identities and psychosocial factors, and how they impact well-being as well as inform disparities and equity. She earned her bachelor's degree with honors in psychology from Rutgers University in New Jersey. Following graduation, Vargas earned her M.S. and her Ph.D. in psychology from the University of Michigan in the area of Personality and Social Contexts. After graduation, she completed a two-year T32 Postdoctoral Research Fellowship in cardiovascular disease epidemiology and prevention at Northwestern University, Feinberg School of Medicine.

Daniel J. Weiss (he/him/his) is the board director for the Board on Behavioral, Cognitive, and Sensory Sciences. Prior to joining the National Academies, he served as a professor of psychology and linguistics at Penn State for nearly two decades. Weiss' research focused on the processes underlying language acquisition and motor planning in children, adults, and nonhuman primates. He has also been serving as the editor-in-chief for *Translational Issues in Psychological Science*. Weiss received his B.A. from the University of Maryland at College Park and his master's degree and Ph.D. from Harvard University. After graduation, he became a postdoctoral fellow at the University of Rochester in the Brain and Cognitive Sciences program prior to his appointment at Penn State University.

M. Roy Wilson (he/him/his) is president of Wayne State University. He is chancellor emeritus of the University of Colorado Denver/Anschutz Medical Campus and former deputy director for strategic scientific planning and program coordination at the National Institute on Minority Health and Health Disparities. Wilson is past chair of the board of the Association of American Medical Colleges, and currently serves on the boards of Research!America, Alliance for Health Policy, and the Federal Reserve Bank of Chicago. His research focuses on glaucoma and blindness in populations from the Caribbean to West Africa. Wilson is an elected member of the National Academy of Medicine. Additional honors include the American Academy of Ophthalmology's Senior Achievement Award, the Distinguished Physician Award from the Minority Health Institute, the Herbert W. Nickens Award from the American Association of Medical Colleges, the National Institute of Health Director's Award, the President's Award from the American Glaucoma Society, the Lifetime Research Award from the W. Montague Cobb Institute, the National Medical Foundation Excellence in Education Award, and the Detroit News Michigianian of the Year. Wilson received his B.S. from Allegheny College and an M.S. in epidemiology from University of California, Los Angeles. He completed medical school, post-graduate residency in ophthalmology, and a glaucoma fellowship earning his M.D. from Harvard Medical School.

Sweeney Windchief (he/him/his) currently serves as an associate professor in education at Montana State University (MSU). His primary professional/research expertise includes higher education specifically under the umbrella of Indigenous intellectualism. Windchief's most recent scholarship has been around Indigenous research, mentoring American Indian and Alaska Native graduate students in science, technology, engineering, and medicine, and epistemological pluralism. His teaching privileges include critical race theory, Indigenous methodologies in research, law and policy in higher education, and institutional research. Windchief was named the President's Excellence in Teaching Award, Montana State University, Outstanding Faculty for Scholarship and Discovery, MSU Department of Education, and most recently was selected as a Montana University System Teaching Scholar. He received his Ed.D. in educational leadership and policy from the University of Utah.

