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Indicators of Participation: A Critical Review of Publicly-Available STEM Data Sources

Crystal M Pee, Virginia Polytechnic and State University

Crystal Pee is a graduate student at Virginia Polytechnic and State University pursuing a Ph.D. in Engineering Education. She currently is a graduate research assistant under the direction of Dr. Jeremi London. Her research interests include broadening participation in industry. Prior to attending Virginia Tech, she received a Bachelor of Science degree in Chemical Engineering with a minor in Business Administration from Clemson University.

Dr. Walter C. Lee, Virginia Tech

Dr. Walter Lee is an assistant professor in the Department of Engineering Education and the assistant director for research in the Center for the Enhancement of Engineering Diversity (CEED), both at Virginia Tech. His research interests include co-curricular support, student success and retention, and diversity. Lee received his Ph.D in engineering education from Virginia Tech, his M.S. in industrial & systems engineering from Virginia Tech, and his B.S. in industrial engineering from Clemson University.

Dr. Jeremi S London, Virginia Polytechnic Institute and State university

Dr. Jeremi London is an Assistant Professor in the Engineering Education Department at Virginia Polytechnic Institute and State University. London is a mixed methods researcher with interests in research impact, cyberlearning, and instructional change in STEM Education. Prior to being a faculty member, London worked at the National Science Foundation, GE Healthcare, and Anheuser-Busch. She earned B.S. and M.S. degrees in Industrial Engineering, and a Ph.D. in Engineering Education from Purdue University.

Gilbert Jew, Arizona State University
Teirra K Holloman, Virginia Tech Department of Engineering Education

Teirra Holloman is a doctoral student in engineering education at Virginia Polytechnic Institute and State University, where she serves as a graduate research assistant. She is concurrently pursuing a MS in Industrial and Systems Engineering at Virginia Tech with a focus in Management Systems.Teirra received her BS in Industrial Engineering from Clemson University. Her research interests revolve around broadening participation in engineering, experiential learning, and workforce development.

Dr. Chanee D. Hawkins Ash , Virginia Polytechnic Institute and University

Dr. Chaneé Hawkins Ash is a postdoctoral researcher in the Department of Engineering Education at Virginia Polytechnic Institute and State University (Virginia Tech) on an NSF grant funded project that explores broadening participation of African Americans in engineering and computer science. In addition to her work at Virginia Tech, Chaneé is the co-founder and principal consultant of Foresight Strategy Solutions, a P-12 and Higher Education consultancy, as well as an independent researcher with San Francisco based strategy and innovation consultancy Entangled Solutions. Her work is focused on supporting schools, districts, administrators, educators, policy makers, communities, and families in dismantling systemic barriers to education and social mobility in order to put in place innovative policies and practices that enhance social ecosystems and overall life outcomes for all learners.

Chaneé holds a Bachelor of Arts in English from Truman State University (Kirksville, MO) and received her Master of Arts and Ph.D. in Education Policy, Organization, and Leadership from the University of Illinois at Urbana Champaign.

Dr. Bevlee Watford, Virginia Tech

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Abstract

Several national reports convey the need for better data on the participation of underrepresented groups in engineering. The purpose of this paper is to 1) catalogue data sources that collect STEM-related information at a national level, and 2) critique their usefulness as it relates to informing efforts aimed at broadening participation of underrepresented racial/ethnic groups in engineering. To this end, we identified and reviewed multiple STEM-related data sources published by Child Trends, American Society of Engineering Education, National Center for Education Statistics, and the National Science Foundation. A critical look across these data sources revealed important themes related to reporting practices. While data at the compulsory education level related to preparedness via math and science performance indicators, data focused on higher education and workforce segments related to participation via overall numbers (e.g., degrees award). Data on gender and race intersections were largely missing. The implications of this study highlight the ways that publicly available data sources can be improved through more thorough, systematic collection, publication, and disaggregation of data.

Introduction

"In God we trust. All others must bring data." - W. Edwards Deming

In an era of accountability (e.g.,[1]), data is everything: you need it to demonstrate a problem exists; you need it to understand said problem; and, relatedly, you need it to measure progress as you work toward solving it. In the data-driven culture of the United States, you also need data to demonstrate the impact (e.g., return on investment) of funds received from government agencies [2]. The movement to broaden participation of underrepresented groups in engineering is not immune to the phenomenon. In fact, the issue of data in this context is rather complicated due to the phenomenon of *participating in engineering* occurring longitudinally and involving a multitude of stakeholders. Identifying and accessing relevant data can be challenging as different problems require data at different levels (e.g., classrooms, college, university, state, regional, national). Accordingly, organizing bodies that collect and report this data (e.g., National Science Foundation) are unable to directly serve every stakeholder's data-related needs.

In light of this issue, several national reports have conveyed the need for better data on the experiences and participation of underrepresented groups in engineering [3]. Because broadening participation in engineering is longitudinal and transient in nature, it requires stakeholders to monitor progress as early as K-12 and as late as the engineering workforce [3]. One must monitor compulsory education (i.e., primary and secondary education; K-12), higher education (i.e., associate, undergraduate, and graduate degrees) and the engineering workforce (e.g., academia and industry). To further complicate matters, stakeholders must also monitor this progress as it relates to specific groups; traditionally, these groups are specified by race, gender, and/or socio-economic status. Unfortunately, though unsurprisingly, different organizing bodies are invested in different segments and different groups, resulting in a fragmented landscape of data that is not uniformly disaggregated.

Study Overview

Our goal is to assist stakeholders with navigating this reality. More specifically, the purpose of this paper is to 1) catalogue data sources that collect STEM-related (science, technology, engineering, and mathematics) data at a national level and 2) critique the usefulness of the data as it relates to informing efforts aimed at broadening participation of underrepresented racial/ethnic groups in engineering. To address this purpose, we explored the following question:

> *Based on the landscape of publicly-available data that is currently collected at a national level, how can the participation of underrepresented racial/ethnic groups in engineering be empirically monitored?*

To this end, we identified and reviewed multiple STEM-related data sources to highlight the ways the engineering education community can quantify forms of participation in STEM across segments. (These forms of participation will be discussed in the next section.) A critical look at these data sources reveals important themes related to reporting practices and provides an opportunity to examine ways in which this data can help us better understand the problem as well as ways to address it.

Our inquiry was guided by the assertion that in order for stakeholders to use data effectively, a series of precursors must be present [4], [5]. First, stakeholders must be *interested* in the information. Next, data must be *available*. And lastly, stakeholders must be *aware* of the data and its potential *usefulness*. In this study, we presume interest exists in light of the current data-driven landscape; subsequently the focus of our analysis is on availability, awareness, and utility. The results of this study highlight numerous useful data sources and reveal opportunities for additional information that will illuminate aspects of this challenge that are currently hidden.

Conceptual Framework

Participation in engineering looks different across each segment of the education-to-workforce pathways. As a result, a conceptual framework was needed to guide our inquiry as it relates to examining the phenomenon of *participating in engineering* as it occurs longitudinally. In this study, we borrow concepts from both the Pipeline and Pathways metaphors commonly used when discussing engineering (e.g., [6], [7], [8]) beginning with elementary education and ending at either academia or industry. Based on our understanding of the issue, we divide engineering into three distinct segments: (1) compulsory education, (2) higher education, and (3) workforce.

In the United States, compulsory education involves K-12 academic levels. Because formal engineering is not yet common in the U.S. public school system (e.g., [9]), there are no direct indicators of participation in engineering. As a result, stakeholders typically use math and science performance as proxies for STEM participation [10] and efforts to broaden participation tend to focus on issues related to interest, awareness, access, and preparedness (e.g., [11]). Nonetheless, the more recent development of engineering standards (e.g., *Engineering for US All*) and the growing number of public, private, and charter schools with engineering subjects speaks to an increasing interest in integrating engineering in the K-12 curriculum. However, because such efforts are not yet widely implemented, monitoring K-12 efforts of broadening participation at the national level is unlikely. The same can also be said for informal engineering education (outreach programs, museums, toys, etc.), which is also a prominent form of participation in engineering at the K-12 level.

After compulsory education, those wishing to pursue engineering as a career then proceed to higher education. Here, this can entail the completion of an associate's degree, bachelor’s degree, master’s degree, or doctorate degree; and efforts to broaden participation tend to focus on issues related to recruitment, retention, and climate. At the university or college level, students are more traditionally encouraged to pursue bachelor's degree. Unlike many other professions that call for advanced degrees before one can fully practice, the bachelor’s degree is the minimum credential that is necessary for entry into the engineering workforce [12]. Across compulsory education, self-contained, formal engineering degree programs exist within universities that often employ a cohort model, consisting of students who declare the same major; this makes participation in engineering much easier to track. One other distinguishing characteristic of engineering in higher education is the presence of accreditation bodies (i.e., Accreditation Board for Engineering and Technology, or ABET)—the entity that sets the standard for what quality looks like across engineering disciplines and institutions [13]. Because of these structures and norms, this is the easiest level at which participation in engineering can be monitored and progress evaluated.

In lieu of immediately enrolling in bachelor’s degree programs after compulsory education, high school graduates also have the option to initially enroll in community colleges. While the community college is often touted as a potential source for more diverse engineers because of the overwhelming number of underrepresented students that enroll in them after high school [14], it is nonetheless an alternative path to engineering that is not always encouraged. Efforts to broaden participation as it relates to community colleges tend to focus on issues related to transferring to a four-year university [15], as opposed to focusing on students while they are enrolled at the community college; making the associate’s degree a unique segment as it relates to consistently collecting data related to STEM participation. At the community college level, though formal engineering courses exist and there are associate’s degree programs focused on engineering, enrollment is not as systematically monitored as it is for other areas of higher education. Thus, participating in engineering is conceptualized differently at this segment when compared to other parts of higher education—said differently, students enroll in engineering classes, but are not necessarily in a major or a part of a cohort of engineering students. Though there is a small number of partnerships with four-year institutions to help students transition into formal degree programs, these students are not often as heavily prioritized. In fact, researchers have previously considered those at community colleges as “America’s Overlooked Engineers” [14], which is unfortunately unsurprising given the “cooling out” function that community colleges have historically been believed to occupy. In short, “cooling-out” is when community colleges become a holding place before people leave higher education altogether without the desired credentials to pursue profitable careers [16].

Lastly, people can participate in engineering in the workforce segment, where participation entails either practicing as an engineering professional or working in academia. Efforts to broaden participation in industry tend to focus on employee recruitment and retention in addition to organizational climate. In industry, engineers work in a variety of sectors and across a variety of roles. Unlike higher education, industry is not partitioned by discipline or field. Because industry is organized by sectors of the economy as opposed to academic degrees [17], it becomes much harder to determine who counts as an "engineer" at this segment. This is similar to the challenge we note with data associated with the associate's degree and community colleges.

Similar to higher education participation from the student perspective, participation in academia typically happens within formal engineering degree programs that are similarly self-contained by discipline. Additionally, incentives to report data related to broadening participation are greater in higher educations than in industry. This makes it much easier to determine exactly where engineers are within this segment of the workforce. Despite these differences as it relates to the workforce, efforts to broaden participation in engineering in both industry and academia tend to focus on recruitment, retention, climate, and career advancement (e.g., [18], [19]).

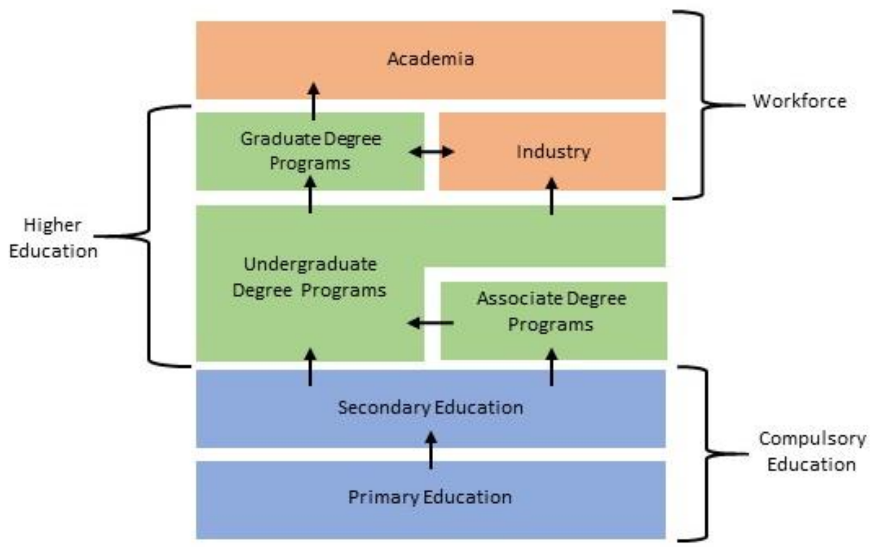

Figure 1: Broadening Participation Conceptual Framework

Establishing a clear conceptualization as it relates to participating in engineering across pathways (Figure 1) was important because the differences discussed above speak to different kinds of goals and, by extension, call for different kinds of data needed to monitor progress. It is with these differences in mind that we both searched for and analyzed the available data.

Research Design

To establish a cursory understanding of the data landscape as it relates to broadening participation, we leveraged a rapid review approach. A rapid review is a methodology that entails systematic review methods for collecting and appraising information (e.g., databases or reports), yet is restricted by time constraints as it relates to completeness [20]. In this study, institutional databases containing numerical data currently available to document educational and professional trends associated with the participation of underrepresented groups in engineering were identified and critiqued. It should be noted that our search was restricted to only publicly-available data reported at the national and/or state level across segments (i.e., K-12, undergraduate education, graduate education, and workforce), and includes both primary and secondary sources.

Data Collection

There were multiple starting points for identifying qualifying data sources. To initiate the search process, we utilized the *Google* search engine, data referenced in national reports and existing scholarship, and the field experience of our research team. As this search process led us to data sources, we reviewed each source to examine the extent to which engineering or STEM-related indicators were included. If germane data was identified within a data source, we then examined the extent to which it could be used to monitor progress related to the participation of underrepresented racial/ethnic groups in engineering. If none of the data was disaggregated by race, the database was not included. Our search led us to data sources from a variety of educational data tracking entities, federal education-focused agencies, and advocacy groups. We concluded that the following institutes reporting the most useful STEM-related data as it relates to broadening participation: (1) National Science Foundation, (2) American Society of Engineering Education, (3) United States Department of Education, (4) Institute of Education Sciences, (5) Child Trends.

Data Analysis

After identifying the data sources that would be included in our study, we critically reviewed each database or report to investigate the extent to which the data was reported by the following: race, gender, and/or socioeconomic status. Guided by our conceptual framework, our search focused on metrics we knew were possible to capture at each segment, particularly those associated with the formal forms of participation and that which is monitored by state or federal institutions. As a result, a limitation of our study is that it excludes participation in informal spaces. After identifying existing metrics, we created a table for each segment that also noted demographics and the level of data reported (i.e. school, state, and/or national). Lastly, we analyzed each data source to determine what broadening participation efforts the data address and what could further be explained; this included looking for trends related to what was reported as well as what was not.

Results and Discussion

In the data sources we identified, data was reported on the state, national, and/or school level. The data sources were the *(1) STEM Education Data database* [21], *(2) Science and Engineering Indicators reports* [22], *(3) Survey of Earned Doctorates reports* [23], *(4) Engineering by the Numbers reports* [24], *(5) Civil Rights Data Collection database* [25], *(6) National Center for Education Statistics data tool* [26], and *(7) Child Trends Databank* [27]. Table 1 includes a summary of these data sources and is organized by institution that reported the data. It should be noted that these data sources are not mutually exclusive. For example, the STEM Education Data database retrieves their data from the Science and Engineering Indicators reports. In the following sections, we will discuss the data reported by each data source across segments and critique its usefulness as it pertains to current broadening participation efforts.

Table 1: Categorization of data sources by the reporting organization or institution

Reporting Organization	Data Source	Source
National Science Foundation	STEM Education Data database	https://nsf.gov/nsb/sei/edTool/explore.html
	Science and Engineering Indicators report	https://www.nsf.gov/statistics/2018/nsb20181/assets/nsb20181.pdf
	Survey of Earned Doctorates report	https://www.nsf.gov/statistics/2018/nsf18304/
American Society for Engineering Education	Engineering by the Numbers report	https://www.asee.org/papers-and-publications/publications/college-profiles#Datamining_Tool
United States Department of Education	Civil Rights Data Collection database	https://ocrdata.ed.gov/
Institute of Education Sciences	National Center for Education Statistics data tool	https://nces.ed.gov/datatools/
Child Trends	Child Trends Databank	https://www.childtrends.org/indicators?a-z

Compulsory Education

Compulsory education included both primary (K-8) and secondary (9-12) education segments, collectively representing K-12. Data was reported in the Child Trends Databank [27], STEM Education Data database [21], Civil Rights Data Collection database [25], Science and Engineering Indicators report [22], and National Center for Education Statistics data tools [26]. Each data source reported data at the state, national, and/or school level. Overall, reported data was aggregated for race and/or gender. Some examples information reported was math proficiency at grade levels and enrollment in math courses (See Tables 2 and 3 for complete list).

Despite reporting similar information, data sources did not disaggregate information uniformly; and none of the data reported in this segment was disaggregated by intersections of race and gender. For example, data from the Civil Rights Data Collection was always disaggregated by race, but was seldom disaggregated by gender or socioeconomic status. Student enrollment in schools was disaggregated by race and disaggregated by gender. On the other hand, the Science and Engineering Indicators report and Child Trends Databank were the only data sources that disaggregated data by race and disaggregated by socioeconomic status, although inconsistently. There was also notable differences across the data on primary and secondary K-12 education. For primary education (Table 2), only math subject areas were reported as opposed to science being reported only as a general subject area. However, for secondary education (Table 3), data was also reported for science subject areas (e.g., physics) as well as AP/IB information and high school credit and enrollment. These distinctions are worth noting because, according to our conceptual framework, participation at the K-12 level involves preparedness. Therefore, data on

K-12 students' enrollment and performance in subjects most closely tied to preparedness (e.g., math, science) is critical to our understanding of progress at this level of participation.

Table 2: Data reported for the primary education segment

Subject	Database	Data Provided	Demographic Data			
			SES	Gender	Race	Gender and Race Intersections
Math	Childtrends.org *	Math Proficiency 4th grade		X	X	
	STEM Education Data *	Math and Science Proficiency 4th Grade		X	X	
	Civil Rights Data Collection°	Algebra I Enrollment: 7			X	
	Civil Rights Data Collection°	Passed Algebra I: 7			X	
	Civil Rights Data Collection°	Algebra I Enrollment: 8			X	
	Civil Rights Data Collection°	Passed Algebra I: 8			X	
	Civil Rights Data Collection°	Algebra I Classes: 7-8			X	
	Civil Rights Data Collection°	Geometry Enrollment: 8			X	
	Childtrends.org*	Math Proficiency 8th grade		X	X	
	STEM Education Data*	Math and Science Proficiency 8th Grade		X	X	
Other	Civil Rights Data Collection°	Classes in Algebra I in Middle School Taught by Certified Teachers			X	

All data is reported at a State level unless denoted with a * (National) or ° (School)

Table 3: Data reported for the secondary education segment

Subject	Database	Data Provided	Demographic Data			
			SES	Gender	Race	Gender and Race Intersections
Math	Civil Rights Data Collection °	AP Mathematics			X	
	Civil Rights Data Collection °	Algebra I Classes: 9-12			X	
	Civil Rights Data Collection °	Algebra I: 9-10			X	
	Civil Rights Data Collection °	Passed Algebra I: 9-10			X	
	Civil Rights Data Collection °	Algebra I: 11-12			X	
	Civil Rights Data Collection °	Passed Algebra I: 11-12			X	
	Civil Rights Data Collection °	Algebra II			X	
	Civil Rights Data Collection °	Advanced Mathematics (Trigonometry, Elementary Analysis, Analytic Geometry, Statistics, Precalculus, etc.)			X	
	Civil Rights Data Collection °	Calculus			X	
	Childtrends.org	Math Proficiency 12th grade		X	X	
	STEM Education Data *	Math Proficiency 12th Grade		X	X	
	Science and Engineering Indicators Report *	Highest Level Math Course Enrollment of High School Completers	X	X	X	
	Civil Rights Data Collection °	Geometry			X	
Science	Civil Rights Data Collection °	Biology			X	
	Civil Rights Data Collection °	Chemistry			X	
	Civil Rights Data Collection °	Physics			X	
	Civil Rights Data Collection °	AP Science			X	
	STEM Education Data *	Math Proficiency 12th Grade		X	X	
	National Science Foundation *	Science Course Enrollment of High School Completers	X	X	X	
All data is reported at a State level unless denoted with a * (National) or ° (School)						

Table 3 cont.: Data reported for the secondary education segment

Subject	Database	Data Provided	Demographic Data: SES	Demographic Data: Gender	Demographic Data: Race	Demographic Data: Gender and Race Intersections
AP/IB	Civil Rights Data Collection °	Other AP Subjects			X	
	Civil Rights Data Collection °	Enrollment in AP Classes			X	
	Civil Rights Data Collection °	International Baccalaureate			X	
	Civil Rights Data Collection °	Taking AP tests for some AP courses taken			X	
	Civil Rights Data Collection °	Students Who Took AP Courses but did not Take any AP Tests			X	
	Civil Rights Data Collection °	Passing Some AP Tests Taken			X	
	Civil Rights Data Collection °	Passing no AP Tests Taken			X	
Credits/Enrollment	Civil Rights Data Collection °	Dual Enrollment			X	
	Civil Rights Data Collection °	Total Enrollment (Secondary Schools)			X	
	National Center for Education Statistics	Average High School Credits Earned by Fall 2009 ninth-graders in STEM academic subject areas, by race/ethnicity: 2013			X	
	National Center for Education Statistics	Average High School Credits Earned by Fall 2009 ninth-graders in non-STEM academic subject areas, by race/ethnicity: 2013			X	
	National Center for Education Statistics	Average High School Credits Earned by Fall 2009 ninth-graders in AP/IB courses for student shwo earned any AP/IB credits			X	
	Childtrends.org	Home Computer Use and Internet Access	X		X	
All data is reported at a State level unless denoted with a * (National) or ° (School)						

Higher Education

Data on higher Education included information about associate, undergraduate, and graduate degree programs. Data was reported in Engineering by the Numbers report [24], Science and Engineering Indicators report [22], and the Survey of Earned Doctorates [23]. Data was either reported on national and/or university levels. Some examples of this kind of data include undergraduate enrollment and the number of degrees awarded for associate, undergraduate, and graduate degree programs. (See Table 4 for the complete list.)

Data was disaggregated by race, gender, nationality, and the intersection of race and gender. However, no data sources were identified that disaggregated by socioeconomic status, and only one data source disaggregated data by the intersection of race and gender. In fact, the *Engineering by the Numbers* report was the only report that presented information on the intersection of race and gender. However, they did not report the intersectional data of gender and race for the STEM bachelor degrees awarded by university. Even though the other data sources reported similar information, there were differences in the types of data that were reported. Notably, degree completion for the associates degree was the only type of information reported for this degree type, which is available through the Science and Engineering Indicators report. Some other differences among the data is that overall enrollment is only reported on the undergraduate level, the median number of years for degree completion is only reported for the graduate level, and post-graduation plans are only reported on the graduate level.

Despite its shortcomings in how often intersectional data is reported, the data on participation in engineering in higher education is the most comprehensive and consistently reported. This may explain why progress in BPE is commonly measured using data associated with degrees.

Table 4: Data reported for the higher education segment

Data Provided	Database	Demographic Data					Educational Juncture				Within STEM Differences
		SES	Gender	Race	Gender and Race Intersections	Nationality	Associates	Bachelors	Masters	Doctoral	STEM Discipline
Undergraduate Enrollment	Engineering by the Numbers*		X	X	X	X		X			X
STEM Bachelor's Degrees Awarded	Engineering by the Numbers*		X	X	X	X		X			X
STEM Bachelor's Degrees Awarded by University	Engineering by the Numbers		X	X				X			
STEM Master's Degrees Awarded	Engineering by the Numbers*		X	X	X	X			X		X
STEM Master's Degrees Awarded by University	Engineering by the Numbers		X	X	X	X			X		
STEM Doctoral Degrees Awarded	Engineering by the Numbers*		X	X	X	X				X	X
Earned Degrees	Science and Engineering Indicators report		X	X		X	X	X	X	X	X
Median Number of Years from S&E Doctorate Recipients' Entry to Graduate School to Receipt of Doctorate	Survey of Earned Doctorates		X	X		X				X	X
Number of Earned Doctorates in Science and Engineering	Survey of Earned Doctorates*		X	X		X				X	
Post-graduation Plans	Survey of Earned Doctorates		X	X		X				X	
All data is reported on the national level. If data is also reported on the univeristy level, it is denoted with a *.											

Workforce

The workforce includes careers in academia and industry. As seen in Table 5, data on participation in the workforce was reported by Engineering by the Numbers [24], National Center for Education Statistics data tool [26], Science and Engineering Indicators report [22], and National Center for Science and Engineering Statistics data tools [26] for academia and industry. As a reminder, our rapid review was not exhaustive, and we note that there are additional data sources (e.g., Bureau of Labor Statistics) beyond those included in this table. In this segment, each data source reported data on the national level. Some examples of this type of data were the number of professors in academia and employed scientists and engineers in industry.

Data was disaggregated by gender, race, nationality, and the intersection of gender and race. No data sources disaggregated data by socioeconomic status. For this segment, it is important to note that even though data sources may produce similar types of data, the data may be aggregated differently. For example, Engineering by the Numbers provides data that is aggregated by race and gender, but one must consult the National Center for Education Statistics to determine the intersectional data. Additionally, while the Engineering by the Numbers report includes metrics associated with how many women professors there are and how many African-American American professors there are, they do not report this data for African-American women professors. Another key finding was that the median salary was not reported about faculty, but was reported for careers in industry. Reported data (i.e. occupation and salary) can help researchers understand where engineers are within the workforce segment. This data is essential in understand recruitment, retention, organizational climate, and career advancement as mentioned in our conceptual framework.

Table 5: Data reported for the workforce segment

Data Provided	**Database**	**Demographic Data**				
		SES	**Gender**	**Race**	**Gender and Race Intersections**	**Nationality**
Number of Tenure/Tenure-Track Professors by University	Engineering by the Numbers		X	X		
Race/Ethnicity of College/University Faculty	National Center for Education Statistics				X	
Percent of Faculty by Specified Racial Group	Engineering by the Numbers			X		
Employed S&E highest degree holders, by sex, race, ethnicity, field of highest degree, and broad occupational category	Science and Engineering Indicators		X	X		X
Employed scientists and engineers, by race, ethnicity, and occupation	National Center for Science and Engineering Statistics			X		X
Estimate and median salary of full-time workers with highest degree in S&E field, by race, ethnicity, sex and occupation	Science and Engineering Indicators		X	X	X	
All data is reported on the national level with the STEM discipline reported as well.						

Conclusion and Implications

Data by themselves have only limited value. True transformation of educational ecosystems lies in converting these data into actionable intelligence (meaning insights and knowledge that enable learners and other stakeholders to act). – Madhavan & Richey [[28], p. 6]

If the engineering education community aims to transform the educational ecosystem so broadening participation can become a reality, useful data is needed to inform strategic action geared towards this cause. The purpose of this paper was to compile and catalogue data sources that collect STEM-related information pertaining to racial/ethnic group's participation. Our hope is to assist stakeholders with both identifying existing data sources as well as areas of opportunity or need. Doing so is important because data is key to determining if the barriers to participation that are experienced by certain underrepresented minorities are evidence of societal issues that require us to examine educational institutions [29]. Though our rapid review was not exhaustive, we critiqued and identified opportunities associated with an array of metrics spanning compulsory education, higher education, and the engineering workforce. These opportunities exist in three distinct areas: (1) expanding the scope of data currently collected; (2) increasing the availability of vital information; and (3) further disaggregating data that is already reported in ways that are more useful to broaden participation stakeholders.

Collection

The first opportunity relates to data that is likely not currently being collected. The conceptual model presented in this study presents some of the most common forms of participation at each segment and suggest metrics that matter for understanding the effectiveness of BPE efforts. There is a need to collect data on all those areas. For compulsory education, this includes data on interest, awareness, access and preparedness. For higher education, this includes data on recruitment, retention, campus climate, and degree attainment. For the workforce, this includes data on recruitment, retention, organizational climate, and career advancement. This is particularly important for segments that are not heavily governed or monitored. For example, within compulsory education, we did not identify any nationally-reported data related to participation in engineering-focused informal programs (e.g., after school programs, summer camps, extracurricular activities, museums). Similarly, we were unable to find demographics related to student participation in engineering-related courses at the community college level. If collected, such information could be disaggregated by race, gender, SES to provide BPE stakeholders with new insights.

Because such information may be dispersed across organizations that are either not uniformly governed or entail participation that are individualized and self-paced, addressing this need will likely prove most difficult. At a minimum, this calls for the need for more research on what data would be most useful and feasible to collect consistently and nationally. It may also require more localized reporting, such as those occurring at the state or program level as opposed to regional or national level. For example, organizations such the National Society of Black Engineers or programs such as First Robotics may need to be further leveraged. Identifying such reports was beyond the scope of this particular investigation, but is future work that is worth pursuing.

Publication

The second opportunity relates to data presumably already being collected, but not publicly reported. This recommendation primarily relates to the workforce. For example, many public universities produce annual reports with data on faculty salaries, but this information is not aggregated at a national level. Similarly, some companies recently started sharing information about diversity and inclusion within their organizations (e.g., [30]). Because there are no governing bodies that can mandate such reporting, the cooperation of higher education and industry leaders is required to advance in this area.

Disaggregation

The third opportunity relates to data already being collected and reported to be further disaggregated. Many institutions collect relevant data, but it is not disaggregated by race or by the intersection of race and gender. As noted by Pawley [31], being more consistent and transparent as it relates to reporting race and gender "would help us collectively begin to notice all the places where women and men of color... are quietly excluded" (p. 532). Because organizations are already collecting this data, addressing this need should not require a substantial investment as it relates to resources.

In closing, in order to understand participation trends and effectively work towards broadening participation, there needs to be additional work as it relates to collecting, publishing, and disaggregating information pertinent to understanding and monitoring the participation of underrepresented racial/ethnic groups in engineering.

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