

**AC 2007-1977: ASSESSING PARTICIPATION AND ADVANCEMENT IN
ENGINEERING AND SCIENCE OF INDIVIDUALS AND INSTITUTIONS
UNDERREPRESENTED AS FEDERAL GRANTEES**

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Assessing Participation and Advancement in Engineering and Science of Individuals and Institutions Underrepresented as Federal Grantees

Abstract

The National Science Foundation has expressed strong interest in broadening the participation of grantees from population groups and institutions underrepresented in its grantee pool. We suggest metrics by which to gauge progress in broadening participation.

Background

The Committee on Equal Opportunities in Science and Engineering (CEOSE) of the National Science Foundation (NSF), has long encouraged the NSF to increase the diversity of its grantees, with the overall goal of including more women, underrepresented minorities, and individuals with disabilities than are currently present in the science and engineering fields. The NSF has sponsored workshops that focus on increasing participation by individuals in these groups in the fields of science and engineering[1]. More specifically, the CEOSE 2004 report to Congress included two specific suggestions targeting NSF grantees and the ways in which they approach issues of diversity [2]. First, the committee recommended the NSF strengthen its appraisals of the programs encouraging diversity, through activities such as continuing the data collection and analysis of participation by individuals from these populations, developing goals and methods of tracking and motivating their participation, and incorporating outcome measures into NSF programs. Second, the committee recommended continuation of NSF policies that require principal investigators and institutions to consider diversity as part of the Broader Impacts criterion of grant proposals, specifically how the grantee proposes to “broaden the participation of underrepresented groups (e.g. gender, ethnicity, disability, geographic, etc.)” [3] p. 22

Responding to these challenges involves two goals; (1) granting funds to increased numbers of women, underrepresented minorities, and individuals with disabilities, and (2) granting funds to increased numbers of Minority Serving Institutions (MSIs) as well as other institutions not strongly represented among NSF grantees, such as community colleges and baccalaureate institutions. In addition, NSF principal investigators at the all educational levels should demonstrate their efforts to increase diversity. To investigate these policies and goals, efforts are underway to develop methods of analyzing the participation and advancement of underrepresented individuals and institutions in science, technology, engineering, and mathematics (STEM) in NSF supported projects.

Project Overview

Analyzing the participation and advancement of underrepresented individuals and institutions requires a review of measures of diversity used in both prior research in the STEM fields and in the business, government, or education fields. This literature review uncovered several metrics for measuring diversity in a wide variety of settings as well as questions to be asked each principal investigator, school, school district, department, college, and institution regarding their research and research capacity as well as education and education capacity. Questions were classified into those to be asked about individuals from populations underrepresented in STEM, such as women, underrepresented minorities, and individuals with disabilities, and those to be

asked about individuals from institutions underrepresented in NSF grant programs, such as community colleges, baccalaureate institutions, and MSIs. In other words, each grantee, regardless of gender, ethnicity, race, or disability status, must account for underrepresented individuals and institutions with whom they work in terms of both research and education. See Table 1 for an overview of this information. In addition, schools, school districts, departments, colleges, and institutions should answer questions about the professional development and academic progression of their instructional professionals who are from populations underrepresented in STEM. Finally, each principal investigator should indicate how they plan to identify, attract, engage, support, and sustain participation by both underrepresented populations and underrepresented institutions. Thus, there are six main topics to be addressed, requiring both quantitative and qualitative information.

Table 1: Project Collaboration: Information Needed from NSF Principal Investigators, Schools, School Districts, Departments, Institutions

Participation by:	Research	Research Capacity	Education	Education Capacity
Under-represented Individuals	Percent/ Proportion Trends Over Time Participation Money per Level Responsibility Publications Type of Grant	Percent/ Proportion Trends Over Time Collaborator Sites Research Centers Money Distribution Age of Participants Academic Level	Percent/ Proportion Trends Over Time Money Responsibility Engagement Retention Rates Graduation Rates Tenure Progression	Percent/ Proportion Trends Over Time Courses Taught Advisees Money Age of Participants Academic Level Professional Development Engagement Courses Available
Individuals from Under-Represented Institutions	Percent/Proportion Trends Over Time Participation Money Responsibility Publications Type of Grant Institution Size/Type	Percent/Proportion Trends Over Time Collaborator Sites Research Centers Money Distribution Age of Participants Academic Level Institution Size/Type	Percent/Proportion Trends Over Time Money Responsibility Engagement Retention Rates Graduation Rates Tenure Progression Institution Size/Type	Percent/Proportion Trends Over Time Courses Taught Advisees Money Age of Participants Academic Level Professional Development Engagement Courses Available

Recommended Means of Finding the Desired Information

The four topics in Table 1 (research and research capacity by individuals from populations underrepresented in STEM, education and education capacity by individuals from populations underrepresented in STEM, research and research capacity by institutions underrepresented in NSF grant programs, and education and education capacity by institutions underrepresented in NSF grant programs) involve similar information being asked of the principal investigators, their schools and school districts, their departments, their colleges, and their institutions. For example, each of these four areas requires information regarding the percent and proportions of underrepresented individuals and institutions, as well as the changes over time of those numbers. Each grantee should provide the number of individuals from each underrepresented population who are involved in the funded project as either a researcher or a participant. Although the exact proportion of research participants from each population will not be known until after the project, the annual grant reporting could include the breakdown of the population of students from which the sample will be drawn. Tracking changes over time can be accomplished by using the final project reports prepared by the NSF principal investigators. In addition, the number of women and underrepresented minorities present nationwide in various levels of education and research can be assessed over time using the NSF Division of Science Resources Statistics (SRS) [4], which provides information about the gender and racial representation across STEM fields, although it does not specifically examine NSF grantees. Along with demographic information that could be provided by the grantee's institution, these reports would also provide grantees with broader data to use for comparison purposes.

The grantee's institution could also develop surveys that would allow for measurement of both actual and perceived diversity at that institution. While actual diversity can be measured by a census or other demographic questions, perceived diversity examines opinions of faculty and students. One such instrument, developed at IUPUI, examines several estimates by combining measures of real and perceived diversity. Some of the questions used are adapted from the National Survey of Student Engagement (NSSE)[5], while others provide more objective information. Some of the topics covered by this particular instrument include comparisons of diverse enrollment with diversity of the local area, comparisons of retention and graduation rates across minority and majority groups, comparisons of satisfaction with the learning environment across minority and majority groups, percent of diverse faculty and staff, and contracts with minority vendors. The survey also includes subjective ratings such as interactions with individuals of different genders and ethnicities, perceptions of how well the institution encourages such interactions, perceptions of campus climate, and frequency of including diverse perspectives in class assignments.

To further assess the participation of underrepresented individuals in research, grantees should also provide specific information regarding the contributions of individuals to the grant project. First, they should disclose the level of participation in funded research by these individuals. This includes examining the number of individuals from each underrepresented group at each level of the project (e.g. principal investigator, co-principal investigator, senior personnel, research assistants, participants) as well as the amount of money provided for each level of participation, which is provided in both the grant proposal and the final report. In addition, grantees should provide information regarding the level of responsibility of all individuals, including job

descriptions, publication number and author order, and instructions to be given to participants. Finally, the grant will provide information as to whether the principal investigator received a grant through a program directly aimed at increasing participation of individuals from these populations.

Assessing the participation of underrepresented institutions in research involves analyzing the same information used for individuals but applied to institutions. For example, rather than specifying how many individuals from each underrepresented population are involved in various levels of the research, the grantees should state how many and what types of institutions are involved as collaborating institutions. In addition to the above metrics, grantees should also provide information about the size and type of their own institution as well as those of their collaborators.

In order to assess the participation of underrepresented individuals in building research capacity, the grantees should provide further information. First, they should provide the number and proportion of collaborators who are members of underrepresented groups. Second, they should specify from where their collaborators come, specifically whether they work at an institution that traditionally serves underrepresented minorities. Related to this, they should provide information regarding any partnership they might have with well-funded research centers. In addition, the grantees should itemize the monies spent, especially the amount and proportion that provides equipment or other reusable supplies. Finally, the grantee should discuss in the proposal the age and academic level of the targeted participants in the research.

Similarly, assessing how well the grantees help build research capacity in underrepresented institutions involves relating the above metrics to institutions rather than individuals. Specifically, the grantees should explain how non-research institutions are involved in the funded project and how the faculty and students at those collaborating institutions will be involved. In addition to these, information should be gathered regarding the types of institutions that are involved (e.g. MSIs, community colleges, baccalaureate institutions).

The grantees should also supply information about individuals from populations underrepresented in STEM in education. Similar to the questions answered about research by these individuals, grantees should disclose the amount of money used for educational purposes as well as the level of responsibility given members of underrepresented populations in academia. In addition, the level of engagement in the educational process should be assessed for all individuals from these populations, which can be obtained using validated surveys (e.g. NSSE)[5]. The NSSE measures the extent to which students are involved in their educational pursuits, including both energy and time invested in activities related to their education. The more engaged students are, the more likely they are to successfully learn information and develop personally [5]. Other resources can measure faculty engagement, such as the Outreach and Engagement Measurement Instrument (OEMI), which is used at Michigan State. Qualitative data collection in the form of interviews can also measure faculty engagement [6]. The Faculty Survey of Student Engagement (FSSE) also has several questions that examine how involved and engaged faculty are in their teaching [7], and these could be adapted to fully measure faculty engagement. In addition, retention rates and graduation rates of individuals from underrepresented populations will be tracked and compared with both institutional and

nationwide rates. The grantee's institution will provide these statistics, and the rates from the grantee's department will be compared to the rest of the institution as well as the nationwide averages as gathered from both SRS [4] and CEOSE [8]. The SRS and CEOSE 2002 statistics could be used as comparisons against the grantee's institution for the number of individuals from underrepresented populations who are progressing through academic levels (i.e. years in school) as well as through tenure-track positions.

As with the assessment of research and research capacity, similar information is needed to evaluate the participation of underrepresented institutions in education as is necessary to examine individual participation. Thus, the above metrics will also apply to the consideration of institutional participation, with the exception that the engagement tools would be used to assess the involvement of the institutions in developing activities that encourage and promote learning. In addition to the above, information about the size and type of both the primary and the collaborating institutions will be gathered.

The educational capacity of individuals from populations underrepresented in STEM will also be assessed with information provided by the grantees. The institution will provide information regarding how many courses the individuals teach as well as the number of students or mentees they advise. The grant proposal itself will have information about the amount of money awarded and the age and academic level of the targeted participants. In addition, the grantees and institutions should specify the amount of professional development that is offered to professors or teachers. One method of examining individual professional development is to encourage regular goal-setting by educators and support them by institutional interventions or activities. Although assessment and implementation will vary widely across institutions, a template is available for this assessment [9]. The educational capacity will be evaluated in terms of engagement for innovative pedagogical techniques, using a validated survey such as the OEMI. Finally, the department should provide a list of available STEM courses as an estimate of the educational capacity of its students. As with the previous three topics, the educational capacity of institutions underrepresented in NSF funding will also be assessed with the above metrics. As before, they will be adapted to gather information about the institution itself, rather than the individual faculty or staff.

The fifth topic to be addressed concerns the assessment of instructional professionals at all levels of education (K through higher education) from populations underrepresented in STEM. This involves questions for school districts along with all STEM departments as well as their colleges and institutions, with questions aimed at the two broad topics of professional development and academic progression. Concerning the professional development of these individuals, departments should discuss how many and what kinds of professional development opportunities are offered to their faculty in a given year as well as provide information about whether these opportunities are internal or external to the institution. There are several models for professional development, and although many relate specifically to K-12 teachers they could be applied to college and university faculty as well. The Elementary and Secondary Education Act of 1965, which was reauthorized with the passage of the No Child Left Behind Act in 2002, presents a list of defined professional development activities, including those that expand the knowledge and skills of both teachers and administrators in terms of academic topics, class management, and support for state and national academic standards. Professional development should also happen

on an ongoing basis rather than in brief workshops, be evaluated and improved regularly, and be based on sound scientific inquiry [10]. Departments and institutions need to determine the realistic and appropriate activities that lead to professional development for each level of academia, including K-12 teachers, university faculty, and graduate and undergraduate students. Finally, the departments should indicate what proportion of their funding is devoted to the professional development of their instructional professionals.

In addition to providing information about the professional development opportunities of these professionals, departments and institutions should track their academic progression. Thus, departments should make known the number of individuals from each underrepresented population at each level of academia (e.g. teacher, instructor, assistant professor, associate professor, full professor) as well as the number of individuals who are in administrative positions. This information should be presented along with a measure of number of years since the individuals received their degree, which would also allow for comparisons across institutions and disciplines as well as across time when compared to prior results [8]. Related to this, the individuals' progress should be presented in both absolute (i.e. how long did it take the person to reach each academic milestone?) and relative (i.e. did it take more or less time for the person to reach each academic milestone compared to other faculty members?) terms. It is also important to include information regarding the type of institution and how many students the person advises.

Departments should also provide information on their policies and behaviors used for recruiting new faculty, including how and where the recruiting message is disseminated and what the message is. Effective recruitment of diverse faculty requires a concerted effort on the part of departments and institutions to hire persons from underrepresented populations. One example of this uses two criteria in a search for a new faculty member, that candidates boost the academic reputation of the department and that they improve its diversity [11]. In addition, the institution should advocate recruiting from a wide variety of applicant pools, which avoids the potential problem of narrowing a search to a select few "top tier" schools, many of which also have homogenous student populations, thus perpetuating the lack of diversity among faculty [11].

Departments should also take into account the possibility of making cognitive or attributional errors during the hiring process, and faculty members should be aware of these kinds of potential biases as they interact with other faculty. These possible errors include relying on stereotypes or first impressions when making judgments, raising the standards for candidates from underrepresented populations, looking for information that supports biases while ignoring contradictory information, and attributing all behavior of the candidate to his or her character rather than the context of the situation. However, with training and effort, faculty members can overcome these problems [12].

Academic progression is also affected by programs within the department. For example, a code of conduct could be developed by the entire department, with help from outside input. The code helps to retain faculty members by creating a supportive and friendly work environment. It involves embracing the diversity of both individuals and opinions, finding fast yet effective resolutions to conflict, and making public all departmental guidelines such as the requirements for promotion and tenure. This code of conduct should be fair and apply equally to all members

of the department in order to create a mutually respectful community of faculty members [13]. Related to this, departments and institutions should provide information about the ways in which senior faculty should mentor junior faculty. This might include research collaboration or offering to proofread a paper [13], as well as giving general advice and assistance. Mentoring has been recognized as a vital tool in retaining individuals from underrepresented populations, and for the past 10 years the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM) program has recognized exceptional programs [14]. Information about award-winning faculty mentors and programs as well as the procedures used to match mentoring pairs could be provided by their departments. Thus, departments and institutions should provide information about their code of conduct as well as their mentoring program. See Table 2 for an overview of the information required to address the fifth topic.

Table 2: Professional Development: Information Needed from School Districts, Departments, Colleges, Institutions

Assessing:	Professional Development	Academic Progression
Instructional Professionals	Number of Opportunities	Academic Level Distribution
	Types of Opportunities	Administration Distribution
	Internal/External Opportunities	Time between Degree and Promotion
	Appropriate Opportunities	Size/Type of Institution
	Funding for Development	Number of Advisees
		Recruiting Procedures
		Code of Conduct
		Mentoring

The final main topic area addressed during the literature review is that of assessing efforts by NSF grantees to include individuals from underrepresented populations as well as underrepresented institutions in their funded work. This includes identifying, attracting, engaging, supporting, and sustaining the participation of these individuals and institutions, and each of these steps builds on the previous ones. Most of the metrics for identifying and attracting fall under the broad category of recruitment, and thus many questions can be answered using the same questions as before [11], with the additional issue of relating those questions to students and participants as well as faculty and staff. In addition, the principal investigators should indicate how they recruited other institutions to collaborate by answering the same questions. Unlike with the metrics used to analyze the recruitment of instructional professionals, however, this information should include an explanation of any incentives used to recruit either researchers or participants.

Assessing how the principal investigators are engaging these individuals and institutions involves examining the level of responsibility for each person or institution in the research process, as well as measuring the overall engagement of the students [5]. Similarly, assessing the support available for individuals entails knowledge of both pay levels for all persons involved and other measures of support such as the mentoring program or code of conduct, while assessing the support for institutions involves knowledge of the proportion of grant funding that each institution receives as well as other possible methods of supporting institutions, such as

through collaborator meetings or other methods. Finally, examining how well the principal investigators are sustaining participation involves knowledge of the retention rate of all involved individuals (including both researchers and participants). See Table 3 for an overview of these topics.

Table 3: Project Participants: Information Required of Principal Investigators

Efforts to:	Underrepresented Individuals	Underrepresented Institutions
Identify	Location of Recruitment Publications/Sites for Recruiting	Location of Recruitment Publications/Sites for Recruiting
Attract	Incentives for Recruiting Recruiting Message Hiring Committee Diversity	Incentives for Recruiting Recruiting Message
Engage	Responsibility Level Engagement Level	Responsibility Level
Support	Pay Level Other Support	Pay Level Other Support
Sustain	Retention Rate Mentoring Program	Retention Rate Mentoring Program

Identifying the metrics to be used and questions to be asked is an important first step in an ongoing project. Because the literature review did not aim to objectively judge the effectiveness of each metric, the results from it will be used in the second phase of this project. The next step involves convening a committee to formulate metrics to specifically assess diversity across the NSF grantees from the field of engineering. The 10-person committee will form working groups to develop metrics that can be used broadly across programs, academic levels, and can be used by any number of investigators. Preliminary metrics will be tested in the appropriate areas and refined by the committee based on those results. These final metrics will then be disseminated to the engineering community.

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