Expanding the National AI Research Resource: Building Capacity and Community through Sustainable Research Pathways

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ABSTRACT

Focused on facilitating artificial intelligence (AI) research through the U.S. National Science Foundation (NSF) National AI Research Resource (NAIRR), the Sustainable Research Pathways (SRP) program provides an effective model for building an innovative, interactive, and wide-ranging community of research-competent computing sciences professionals. Aimed at expanding access to NAIRR for higher education faculty and students, SRP provides networking opportunities and cultivates collaborations with related researchers using structured, evidence-based approaches built on over 10 years of experience. More specifically, SRP incorporates three principal programmatic and interactive training strategies: 1) broadly recruit students and faculty/student teams from a wide range of backgrounds and institutions, 2) establish active collaborative research relationships through an iterative and successively more intensive matching process, and 3) catalyze the development of relevant competencies and of systemic and participatory research capacities. Accordingly, SRP operates to pave the way for further expansion of NAIRR.

SRP is aimed at developing skilled talent poised to address the pressing challenges facing the AI workforce. It has the potential to develop into a new and effective paradigm for expanding access to NAIRR while making significant progress in AI accessibility and providing a broader spectrum of perspectives on the development of AI models and methods. The program builds strong connections among the existing NAIRR researchers, institutions, and individual participants across the U.S., especially those who would not typically engage in NSF-sponsored AI research.

SRP expands NAIRR by democratizing, increasing the variety of AI talent, and advancing safe, secure, and trustworthy AI. The program explores changes to the approaches and practices of AI research through collaborations between NAIRR projects and new and emerging researchers–a crucial activity for future AI efforts.

KEYWORDS

Workforce Development, AI, Talent Development, U.S. NSF NAIRR, Trustworthy AI

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1 INTRODUCTION

A critical challenge marking today's complex artificial intelligence (AI) ecosystem and landscape has been gaps in access to resources for conducting research and training the next generation of researchers. In the United States (U.S.), recognizing this issue, the National Science Foundation (NSF) National Artificial Intelligence Research Resource (NAIRR) Pilot was launched in January 2024 to provide a shared national research infrastructure designed to bridge these gaps [10]. The espoused goal of the NAIRR Pilot was to spur innovation, increase variety of talent, improve capacity, and advance safe, secure, and trustworthy AI in research and society. To that end, as described in this article, an evidence-based program and approach has been adopted in pursuit of this goal in keeping with the broader issue of AI access. More specifically, the Sustainable Research Pathways (SRP) program is examined here as a model for expanding access to NAIRR by matching existing NAIRR researchers with faculty and students at accredited U.S. academic institutions of higher education who are new to NAIRR. Its principal operative approach is to establish research collaborations through an experiential practicum along with community building activities and participation and presentation of research in a national professional forum.

AI has had a dramatic impact on scientific research with ubiquitous effects. However, with it comes a set of complexities. The ethical and fair development and engagement of AI is a topic of much debate as a socio-technological issue, especially since some algorithms have been found to mimic and exacerbate implicit unfairness and inequities in society [2]. Other problems have surfaced with algorithms due to directive assumptions and lack of data, resulting in the exclusion of some individuals from employment recruitment efforts. While the reasons behind such outcomes are complicated and under some debate, they suggest the importance of developing an AI research ecosystem comprised of individuals compelled and versed in the intricacies of related issues to ensure a broad spectrum of perspectives and considerations—which also speaks to a more democratized approach to AI disposition and engagement.

Democratizing, increasing variety of talent, improving capacity, and advancing safe, secure, and trustworthy AI require including and meaningfully engaging a broad spectrum of talent in the AI research enterprise. While a variety of efforts have been and are underway, the current cyberinfrastructure workforce is largely stagnant, reflecting a variety of complex socio-historical, political, cultural, and economic issues [11, 13]. Typically, as in other fields, AI researchers use their own networks to recruit collaborators just in time for project awards, creating a self-perpetuating stationary pool of talent. The NAIRR Pilot represents a significant opportunity

to expand and establish the national AI research enterprise utilizing a range of approaches in cultivating the AI workforce of the future.

It is in this sense that SRP for NAIRR (SRP-NAIRR) represents a crucial activity for the future of AI efforts in the U.S. It has been designed to address the perspectives and practices governing AI research throughout participating NAIRR projects. The program builds strong connections among existing NAIRR researchers and new and emerging researchers across the country, especially those who had not typically engaged in NSF AI research. The program is based on a highly successful Sustainable Research Pathways program established in 2014 to expand the U.S. Department of Energy (DOE) National Laboratory workforce [4, 5]. The goal is to broaden access to NAIRR resources by providing training opportunities and building meaningful connections between NAIRR researchers and new and emerging AI researchers and institutions.

2 SUSTAINABLE RESEARCH PATHWAYS

Sustainable Research Pathways (SRP) evidence-based techniques are the foundation for the SRP-NAIRR program. SRP-NAIRR focuses on three main affective strategies: 1) broadly recruit faculty/student teams and independent students from a variety of backgrounds and institution types, 2) establish meaningful collaborations through an iterative and successively more intensive matching process, and 3) foster broadly participatory and innovative AI ecosystems.

The following components are fundamental SRP activities: 1) recruit existing NAIRR project principal investigators (PIs) and faculty-student teams and independent students not currently engage in NAIRR and from accredited U.S. academic institutions of higher education; 2) facilitate a virtual matching workshop to identify collaboration partners; 3) provide a 10-week summer experiential research practicum; 4) organize post-summer Cultivating Ubiquitous Learning Through InnoVATive and Engaging (CULTIVATE) Conversations seminars; and 5) fund participants to attend the Building Engagement (BE) program at the Society of Industrial and Applied Mathematics (SIAM) Computational Science and Engineering conference where they present their summer work and begin to develop their professional standing.

The overall program design utilizes an integrated baseline intervention model grounded in techniques for engaging people in science, technology, engineering, and mathematics (STEM) [6], as posited in, for example, the Tinto model of student engagement and others [13–18]. SRP emphasizes five key focus areas, as shown in Figure 1, all of which contribute to building and engaging epistemic and professional community [6, 7].

As is apparent, the SRP is an integrated intervention approach, drawing support and direction in research and practice [14]. Among others, exemplary programs include the Meyerhoff Scholars [16], Minority Engineering Program (MEP) [15, 17, 18], and The Mathematics Workshop [7] The Meyerhoff Scholars program focuses on knowledge and skills, motivation and support, monitoring and advising, and academic and social integration. Elements of the MEP, which has been replicated on more than 100 campuses, include strong pre-college and community college outreach, concentrated efforts in working with freshman and sophomores, and emphasis on cooperative learning, clustering of students into learning communities, study centers, professional development with role

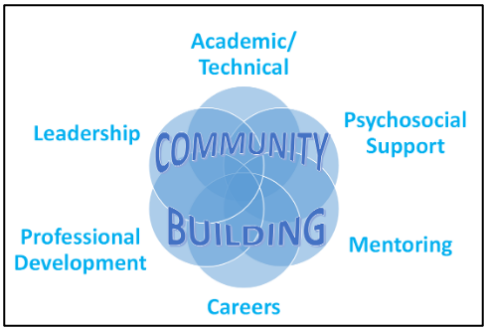


Figure 1: SRP Baseline Intervention Model

models, academic support, and personal counseling. The Mathematics Workshop, with more than 40 years of success, emphasizes group learning and community building. SRP adopts and combines a number of like features in its integrated approach, centered on building community, academic preparation, and strengthening self-efficacy.

In an overall sense, the SRP model has two principal defining features. 1) It includes components that address community building integrated through a mutually sustaining combination of academic preparation, psychosocial support, career exploration and preparation, and professional and leadership development, as detailed in Table 1. While each of these components contribute to breaking barriers to participation, their combination and integration strengthen the overall effect. Moreover, 2) SRP activities are realized in mainstream professional scientific communities in ways that balance critical mass and full engagement within and by the broader community. The point here is to strengthen the sense of community and belonging across all participants. The focus is not on "fixing the participant"; rather, the aim is to catalyze transformation and participation within the broader community.

Table 1: SRP Baseline Intervention Model Components

Component	Description
Academic Preparation	Students receive appropriate preparation for the rigors of STEM academic requirements, including expanded familiarity and engagement with "the language of science."
Psycho-Social Support	The individual develops a positive and active relationship with the scientific culture and belonging in the community.
Career Development	It is essential for persistence that the individual develops a vision of eventual acquisition of a rewarding and productive career.
Professional Development	Individuals must acquire both technical and non-technical skills necessary in professional life, including an understanding of the unspoken rules and behaviors of practice.
Leadership Development	Skills and attitudes must be developed to conduct research, lead people, and direct projects to thrive in STEM.

2.1 Recruiting

2.1.1 NAIRR Project Leader Applicants. SRP-NAIRR builds upon a program originally designed to match DOE national laboratory staff researchers with faculty and students who were unlikely to engage with the DOE laboratories otherwise [6]. Extending this idea to NAIRR led to recruiting existing NAIRR project leaders to train other faculty and students, not then engaged with NAIRR, on their projects and the use of NAIRR resources. NAIRR project leaders were recruited through direct electronic mail messages and communications through NAIRR community forums.

A total of 38 NAIRR project leaders responded to the call for SRP participation, representing NAIRR projects: Classroom (5), Pilot (26), and Resource allocation (7). Faculty principal investigator institutions ranged from Carnegie classification Research 1: Very High Research Spending and Doctoral Production, Research 2: High Research Spending and Doctoral Production, and Professions-focused Baccalaureate Small, as shown in Figure 2.

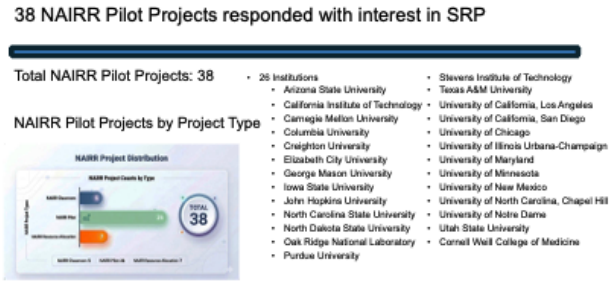


Figure 2: Call for Participation: NAIRR Pilot Projects

2.1.2 Faculty/Student Team Applicants. The SRP model utilizes faculty/student team cohorts to lower possible barriers for students at smaller and less research-intensive institutions who may be reticent to engage with high research organizations. The students enter into the research experience with a faculty member with whom they are already familiar, a factor which can provide certain levels of psychological assurance and confidence [3, 9]. This relationship can play a critical role in developing a sense of belonging in a research community.

As a programmatic issue, belonging is a process that requires intention. Encompassed in the SRP aims, belonging is a dynamic relational process co-produced through interpersonal interactions and can be influenced by leadership behaviors [1]. In that regard, faculty/student teams or cohorts have been identified as effective in expanding STEM participation and improving self-efficacy through building a sense of epistemic belonging [8].

This approach also provides the advantage of including a research trained faculty member on the team who is already familiar with the student(s) and can play a transitional and bridging role, collaborating with the project leader, and assisting in supervising the student(s).

Thirty-nine faculty/student teams applied for SRP which included 58 students to accompany the faculty. The teams represented 19 states, 31 institutions, and 7 department types, as shown in Figure 3.

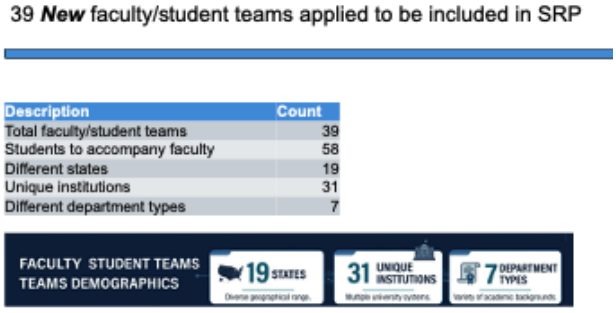


Figure 3: Call for Participation: Faculty/Student Teams

2.1.3 Independent Student Applicants. Independent students were recruited using electronic mail and social media posts through the Sustainable Horizons Institute mailing list and social media sites, as well as through partner organizations reaching over 12,000 individuals. One hundred forty-two students applied on their own, representing 33 states, 69 academic institutions, and 52 different majors. Student applicant institutions ranged from community colleges, predominantly undergraduate teaching institutions, and doctoral degree-granting institutions, as shown in Figure 4.

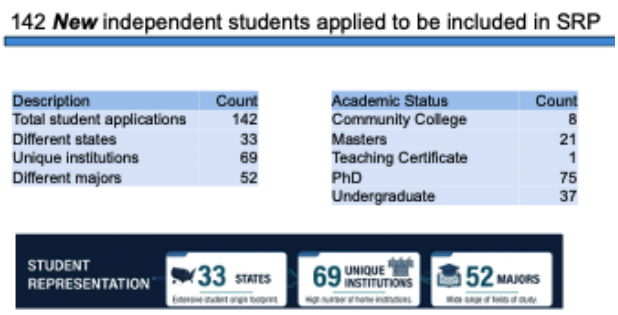


Figure 4: Call for Participation: Independent Students

2.2 Virtual Matching Workshop

The virtual matching workshop is a core component of SRP-NAIRR, occurring over four days with sessions each day ranging from one to two hours in length and providing successively more intensive opportunities for participants to interact and explore possible collaborations. The workshop includes a welcome, lightning talks, exploratory sessions for informal followup, and one-on-one meetings to consider possible projects, culminating in the designation of summer research preferences. The 2025 workshop was co-located with matching for DOE national laboratories and the High Performance Software Foundation (HPSF). Participation by track is shown in Table 2, with a total of 171 participants in the matching workshop.

SRP employs a deliberate two-way matching design. Potential matches are identified when the faculty/student and the NAIRR researcher both select each other. This approach creates some competition for matches while also empowering individuals. NAIRR

Table 2: Virtual Matching Workshop Participation by Track

Track	Number of Participants
Project PI: NAIRR	20
Project PI: DOE Lab	18
Project PI: HPSF	5
Faculty	24
Students of Faculty	28
Independent Students	76
Total	171

researchers must compete for students, and students must compete for projects; all the while, no one is assigned a match in which they have not expressed an interest. Two-way matching begins the formation of deeper, meaningful collaborative relationships.

A total of 45 faculty and students were matched with NAIRR projects including 8 faculty with 12 students and 25 independent students.

2.3 Research Experiences

Carrying out research tasks allows for increased mastery such that the research experience itself represents an opportunity to develop science self-efficacy [8]. Funded NAIRR projects fall into four main categories: Healthcare and Biomedical AI, Smart Infrastructure and Transportation, Energy and Climate Systems, and Foundational AI, Safety, and Education. After matches were identified, participants developed brief project plan proposals based on their interests relative to projects being conducted in these areas, describing the team members (project leaders, faculty, and/or students), motivation, goals, approach/methodology, expected outcomes, computing resource requirements, participation mode, collaboration plan, and period of performance. The project plan proposals were reviewed for support by an external review committee comprised of cyberinfrastructure researchers and related professionals who evaluated the technical merit and the potential developmental and professional impact on the faculty and students.

A total of 40 faculty and students were funded to collaborate with 14 NAIRR project PIs including 21 independent students, 7 faculty, and 12 students of faculty. The student academic status was 63.6% doctoral with master and undergraduate students representing 18.2% each. Thirty-four percent of students and 57% of faculty were first generation scholars and 14% of students and 17% of faculty were from Established Program to Stimulate Competitive Research (EPSCoR) states, as shown in Figure 5. (EPSCoR states in the U.S. are those that have been identified by the government as historically receiving less federal research and development funding.)

Virtual office hours, question and answer sessions, and a kick-off event prepare participants for the summer research experience. The participants complete progress reports throughout the summer. A mid-summer event provides a professional development activity allowing participants to share, practice, and receive feedback on their research progress. At the end of the summer, sessions are held for participants to practice presenting lightning talks and to receive

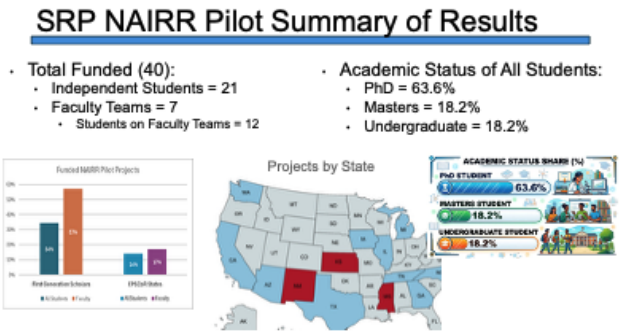


Figure 5: NAIRR Summer Research Matches

feedback and suggestions for improvements to their presentations. During an End of Summer Celebration event, participants share their final results and engage in interactive discussions.

2.4 CULTIVATE Conversations seminars

Community building is a central theme for SRP and begins in the matching workshop and continues throughout the summer and the following fall and spring. Monthly Catalyzing Ubiquitous Learning Through InnoVATive and Engaging (CULTIVATE) Conversations seminars stimulate learning, maintain regular contact with the community, and extend summer relationships. The sessions include introductions to the activity and topic, interactive facilitated conversations, and discussions of what was learned and reflections on their experiences. The activities are coordinated by SRP staff and all faculty, students, and NAIRR researchers are invited. Fall 2026 CULTIVATE Conversations seminars include 1) Taking the Next Steps in Utilizing NAIRR Assets and 2) Next Steps in Your Academic Journey.

2.5 Research Presentations

After the summer experience, faculty and students have the opportunity to present their research results at the Society of Industrial and Applied Mathematics (SIAM) Computational Science and Engineering professional conference, through the Building Engagement (BE) program [12]. This kind of activity is critical for helping students develop their professional standing and confidence in a mainstream professional society. They experience critical mass in the BE groups, while also participating in what may be their first conference experience. BE offers activities aimed at extending and deepening students' connections with NAIRR researchers.

BE aims to include students early in their academic careers, including community college and early undergraduates. For many participants, BE is their first time attending a cyberinfrastructure professional conference, or any scientific conference for that matter. To make the experience more accessible, a variety of activities are offered to demystify the often very dense technical material and create a welcoming environment. A small number of community volunteer faculty, graduate students, and professionals serve as guides or leaders for focused activities that engage students in conference venues, such as poster sessions, technical presentations, and networking, career, professional, and leadership development.

Pre-event sessions and participation in conference sessions serve to strengthen the learning including technical discussions and tutorials. Training and mentoring are other important components included in BE activities as described in Table 3.

Table 3: BE Activities

Activity	Description
Welcome and Question-Answer Session	Virtual welcome session six weeks prior to the start of the conference, overview of activities, introduction to the guided affinity groups.
Orientation	Introduction of participants to the program and other BE members. Conference agenda and program events are reviewed. Includes structured networking activities with other participants, conference organizers, SIAM leadership, and BE committee. Held onsite prior to conference student orientation and reception.
Guided Affinity Groups	Learning groups designed to help students get more out of conference sessions. Led by volunteer professional society members, these groups explore conference topics from an entry level perspective. Affinity groups meet virtually one month prior to the conference, meet daily each morning before the conference sessions start, and attend conference sessions together. Each group presents what was learned from the experience during a BE Wrap up session at the end of the week.
Mentoring	Mentoring engages students with mentors to encourage career development and professional incorporation. Volunteer mentors are recruited through the conference registration system and then paired with mentees based on questionnaires. Guided affinity group leaders also serve as mentors and often recruit their colleagues to visit the morning meetings and serve as additional mentors.
Presentation Tips and Lightning Talks	Session to learn effective presentation tech-niques and tips. Participants share their work in a "lightning round" session and address questions from the audience and receive constructive feedback.
Technical Posters	BE participants are encouraged to present posters in the conference poster session. Assistance with preparations is provided in the Lightning Talks session.
Wrap Up Session	Participants present what they learned during the week and through the Guided Affinity Group, and engage in general networking.

2.6 Individual Accomplishments

Regarding accomplishments, note that SRP faculty alumni, which includes those from non-research intensive institutions (e.g., Bronx Community College, Texas State University, and University of South Dakota), received NSF Early Career and DOE awards in the Reaching a New Energy Sciences Workforce, Early Career, and Funding for Accelerated, Inclusive Research programs, as well the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. Also, student participants have been hired full time at several DOE laboratories; decided to pursue graduate degrees; won best paper and poster awards; been awarded the NSF Graduate Research Fellowship and DOE Computational Science and Stockpile Stewardship Graduate Fellowships; presented their research at venues such as the Supercomputing Conference; and participated in the Oak Ridge National Lab Artificial Intelligence Workshop and the Argonne Training Program on Extreme-Scale Computing.

3 SUMMARY AND CONCLUSION

Sustainable Research Pathways is an evidenced-based program designed to establish effective ways of cultivating AI talent and participation. More to the point, specifically in the U.S., it is poised to address pressing challenges facing the country. The approach and features of the SRP program constitute mechanisms for bridging gaps in access to NAIRR such that it potentially can develop into a new paradigm for expanding STEM access and participation more generally. While making significant progress in broadening access and making AI accessible to all, SRP-NAIRR also has the potential to bring a wide spectrum of perspectives to the development of AI models and methods. SRP offers a path to building strong connections among NAIRR researchers and institutions with individuals across the U.S., including those who typically would not have access nor opportunities to engage in related research.

The SRP approach to expanding NAIRR capacity offers an effective programmatic means to strengthen opportunities to democratize, increase the variety of talent, improve capacity, and advance safe, secure, and trustworthy AI. The program stimulates changing perspectives and practices in AI research through participating NAIRR projects and new and emerging researchers–a crucial activity for AI efforts today and in the future.

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REFERENCES

[1] M. Antoniadou and M. Crowder (Eds.). 2026. *Introduction to Belonging in the Workplace.* Edward Elgar Publishing, Northampton, MA.
[2] B. Christian. 2020. *The Alignment Problem: Machine Learning and Human Values.* W. W. Norton & Company.
[3] H. A. Kobulnicky and D. A. Dale. 2016. A Community Mentoring Model for STEM Undergraduate Research Experiences. *Journal of College Science Teaching* 45, 6 (2016), 17–23.
[4] M. A. Leung. 2018. Developing Sustainable Methods for Broadening Participation: Transforming Mainstream Science and Technology Communities through Normalization of Inclusion. *American Behavioral Scientist* 62, 5 (2018).
[5] M. A. Leung, S. Crivelli, and D. L. Brown. 2019. Sustainable Research Pathways: Building Connections across Communities to Diversify the National Laboratory Workforce. In *Collaborative Network for Engineering and Computing Diversity (CoNECD).* Washington, DC.
[6] M. A. Leung and C. L. McNeely. 2015. Opening Doors to Communities of Practice: Programmatic Interventions for Inclusion in the Computing Sciences. In *Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT).*
[7] M. A. Leung and C. L. McNeely. 2015. Opening Doors to Educational Attainment: A Programmatic Model for a More Inclusive Engineering Community. (2015). Submitted.
[8] M. M. C. Musgrove, M. E. Ko, J. N. Schinske, and L. A. Corwin. 2024. Broadening Participation in Biology Education Research. *Life Sciences Education* 23, 1 (2024).
[9] National Academies. 2019. *The Science of Effective Mentorship in STEMM.* National Academies Press, Washington, DC.
[10] National Artificial Intelligence Research Resource. 2023. Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem: An Implementation Plan for a National Artificial Intelligence Research Resource.

[11] Office of Advanced Cyberinfrastructure. 2021. *Blueprint for Cyberinfrastructure Learning and Workforce Development.* Technical Report. National Science Foundation, Washington, DC.

[12] Sustainable Horizons Institute. 2024. Building Engagement Program. https://shinstitute.org/the-building-engagement-be-program/ Accessed: 04 12 2025.

[13] V. Tinto. 1987. *Leaving College: Rethinking the Causes and Cures of Student Attrition.* University of Chicago Press, Chicago, IL.

[14] K. Topping. 1996. The Effectiveness of Peer Tutoring in Furthering Higher Education: A Typology and Review of the Literature. *Higher Education* 32, 3 (1996), 321–345.

[15] A. Torres. 2000. Rethinking the Model. In *Access Denied: Race, Ethnicity, and the Scientific Enterprise.* Oxford University Press, New York, 219–221.

[16] J. C. H. Trippi. 1991. Counseling Effects on African American College Student Graduation. *Journal of College Student Development* 32, 4 (1991), 342–349.

[17] R. Wilson. 2000. Barriers to Minority Success in College Science, Mathematics, and Engineering Programs. In *Access Denied: Race, Ethnicity, and the Scientific Enterprise.* Oxford University Press, New York, 193–206.

[18] L. Wolf-Wendel. 1998. Models of Excellence: The Baccalaureate Origins of Successful European American Women, African American Women and Latinas. *Journal of Higher Education* 69 (1998), 141–186.