Institutionalization Challenges for an NSF S-STEM Program

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Abstract

Based on the experience of an R1, public, land-grant institution, this complete evidence-based practice paper employs a qualitative case study research design and identifies the successes and challenges of institutionalizing a successful NSF-funded S-STEM recruitment and retention program. Institutionalization of successful educational programs is a goal of many NSF-funded programs. Reflection and critique of the institutionalization of our program will provide critical insights for similar programs on planning their institutionalization and contribute to the understanding of the institutionalization process, timeline, and effort areas. Throughout a "COVID-interrupted" 7-year period, this NSF-funded S-STEM program implemented research-based student success and retention strategies to serve 90 students and provide scholarship support to 42 students. As programmatic elements were "institutionalized" over the past few years, several institutionalization challenges were identified.

Some programmatic elements, including curricular development and adoption, department and research facility visits, tours of local engineering and computing sites, and student engagement activities, were easily institutionalized, as long as funding was provided for off-campus transportation. The top three institutionalization challenges, however, were funding, recruitment of incoming underserved students, and significant institutional infrastructure changes. While many lessons were learned through the 7-year grant experience, this paper explains and explores those lessons specifically related to institutionalization.

1.0 Introduction

NSF and other granting agencies, typically, expect that successful interventions will be institutionalized when the funding period expires. Institutionalization refers to the process by which a program is sustainably integrated into the institutional culture and becomes "standard practice" instead of being viewed as separate or special [1, 2, 3]. Many "new teaching and learning programs struggle to become integrated into the fabric of the Academy" due to the Academy's lack of intentional mechanisms for cultural change [1]. This "wicked problem" of the Academy's "resistance to innovation" [1, 4, 5, 6] leading to failure to institutionalize innovations is common for grant-funded efforts [7]. Institutionalization requires engaging institutional stakeholders to generate physical, managerial, collegial, and fiscal support for the program [1] and is affected by a variety of contextual and environmental factors [7].

While many S-STEM programs experience institutionalization challenges, little literature has documented the challenges, solutions, and recommendations to others. This research used a

qualitative method to identify the successes and challenges of institutionalizing a successful NSF-funded S-STEM recruitment and retention program in an R1, public, land-grant institution.

2.0 Program Description

The West Virginia University (WVU) Academy of Engineering Success (AcES) was created to increase the number of academically promising, low-income, and often unprepared (non-calculus-ready) students, many from underrepresented groups, who pursue engineering or computing degrees in the WVU Benjamin M. Statler College of Engineering and Mineral Resources (Statler College) and thereby increase the number and diversity of engineering and computing professionals in the engineering workforce. This goal was achieved by providing NSF-funded S-STEM scholarships as well as academic and social support to students. For reporting purposes, scholarship recipients are referred to as "AcES scholars" while the other students who participate in the AcES program but are not scholarship recipients are called "AcES students."

The AcES program includes a 1-week, structured pre-fall bridge experience followed by a two-credit hour professional development course each fall. To continue the cohort development and identity throughout the entire first year, students in the early implementations of this program were encouraged to take the same section of a three-credit hour, *Engineering in History* course each spring. That requirement was dropped in later years because of scheduling difficulties.

All first-year engineering and computing students participate in student success, career exploration, and professional development experiences, receive academic and student success support, and beginning in 2022, are advised by professional advisors (not faculty) in the college's new centralized advising center. Before 2022, the AcES program director advised all AcES participants until they moved from the first-year program to their major department and were assigned to a departmental faculty advisor [8].

Toward the end of the extended funding period and into the post-award period, the AcES program went through several changes. Currently, the summer bridge experience is open (with limited space) to all incoming engineering students, regardless of their math preparation, and the fall-semester professional development course is designated for non-calculus-ready first-year engineering students. Registration fee waivers and need-based scholarships are available on a very limited basis to low-income students. The scholarship amount varies each year due to the changes in the funding sources. In addition, in 2021 the program was expanded to a smaller WVU satellite campus that serves many commuter students.

3.0 Background

Wise, et. al. (2022) identified seven key areas of institutionalization effort, including four internal-facing activities and three external-facing activities [1].

The four internal-facing key areas of institutionalization effort are: Team Development, Program Design, Program Implementation, and Program Assessment. Team Development includes appropriate individual and group professional development, shared governance, and project implementation [1]. Program Design is the "process by which a novel program is conceptualized, budgeted, staffed, and tested" [1]. Program Implementation involves "participant recruitment and communication, program management, and materials development" as well as "ongoing internal team reflection and communication" [1]. Program Assessment can be formal or informal, is based on qualitative and quantitative data, and provides information used to document the program's impact, accommodate local requirements and restrictions, and adjust the program to improve its effectiveness [1, 9].

The three outward-facing elements of institutionalization are: Outcomes Communication, Awareness Communication, and Financial Stability. "Outcomes Communication establishes an understanding of the qualitative and quantitative impacts of the program as well as how the results of the Program Assessment are being used toward continuous improvement" [1]. Outcomes Communication is distinguished from Awareness Communication by its audience. "Awareness Communication is initiated to spread information campus-wide about the program's team, design, and potential impacts and can serve to build relationships with a wide variety of people and offices. … Awareness Communication serves as an important forum for co-creating value with stakeholders by exploring their needs, which can provide useful feedback for Program Assessment and surface campus opportunities for Financial Stability." [1]. For Awareness Communication to be most effective, the program spokesperson should occupy a position of power, have social capital, and be able to leverage their professional network to support the program [1]. Financial Stability is defined as the "processes in which possibilities for the program's local long-term funding and campus home are explored and negotiated with administrators" [1]. Wise et al. state that "a program that depends on external funding is not institutionalized" [1].

4.0 Methodology

This research was a qualitative case study of the evolution of one NSF S-STEM program implementation at a single institution. The study period was 2019 - 2023; representing the latter part of the original grant-funded period, including the interruptions due to COVID-19, and the 2-year no-cost extension of the grant funding during which the project team intentionally attempted to institutionalize the program. While the program outcomes and research results are documented and shared in previous conference papers, this paper focuses on a review of and reflection upon the existing institutional public information, and the project team's documentation, personal knowledge, observations, and experiences. In this context, we use the Wise et al [1] model of the seven areas of effort related to institutionalization and reflective practice to assess our program's institutionalization efforts and provide a summary of the successes and challenges. The lessons learned through reflection on our experience are relevant to other PIs seeking to institutionalize their S-STEM and other student support programs.

5.0 Results

The four internal institutionalization activities provided few challenges. The three externally facing institutionalization effort areas, awareness communication, outcomes communication, and financial stability provided more challenges to our team. Other challenges, such as significant leadership and fiscal changes within our institutions, may be unique to our situation.

5.1 Success

Successes related to the four internal institutionalization elements: team development, program design and implementation, and program assessment are reported and described below. These elements were more personnel-dependent and product-related and were the least challenging to institutionalize. Many of these activities were requirements of the initial NSF-funded grant and were developed, assessed, and disseminated both in reporting to NSF and to the engineering education community via conference publications and presentations.

5.1.1 Team development

Because the leadership team for the AcES program was small, Team Development – including appropriate individual and group professional development, shared governance, and project implementation [1] – was relatively easy to implement. The AcES leadership team worked in the same academic unit, which made collaboration more manageable.

5.1.2 Program Design and Implementation

Program design and curricular content were institutionalized successfully, however, the operational aspects of the program were more challenging to institutionalize.

Curricular development and adoption, department and research facility visits, tours of local engineering and computing sites, and student engagement activities were easily institutionalized, as long as funding was provided for off-campus transportation. Specific curricular content was developed and was able to be used in this program and other venues within the first-year engineering program. The curriculum was the most successfully institutionalized element. While program operations, including the summer bridge schedule and activities, as well as the first-term professional development course activities (including lab visits and guest speakers), were successfully institutionalized, their institutionalization presented challenges related to variations in social capital and professional networks of the different leadership teams.

The AcES program was originally proposed by a team of three researchers, one served as the PI and the other two researchers were co-PIs. The program, however, underwent three leadership changes during the funding period: (1) the initial PI left the institution and one Co-PI became the PI; (2) the new PI left the institution and the other co-PI became the third PI; (3) The third PI, an Assistant Dean, managed the grant through its completion but brought in a fourth leader to lead

and implement the AcES program during the grant "no-cost extension" years to assist in institutionalization and provide continuity in case of future changes. These leaders worked together to find external funding for various programmatic elements that would be needed once the funding ended. The PI and new AcES director worked in the same academic unit and were able to meet, both formally and informally, frequently as questions arose. Having the new director take over while the PI/former AcES director was still available provided continuity in program design, implementation, and assessment while providing opportunities for the new director to experiment with new ideas. By the time the fourth program director took full control, the program was well-developed, but budgeting, staffing, and implementing new ideas to improve the student experience were still required for each year.

The annual "Program Implementation" involved "participant recruitment and communication, program management, and materials development" as well as "ongoing internal team reflection and communication" [1]. Each year's updated design and implementation were based on the Program Assessment of the previous years' feedback, results, and the current institutional environment.

5.1.3 Program Assessment

Formal and informal Program Assessment activities, based on qualitative and quantitative data, provided information used to document the program's impact, accommodate local requirements and restrictions, and adjust the program to improve its effectiveness [1, 9]. These assessment and reporting activities, required during the grant-funded period, were built into the original program processes.

Because these four elements, Team Development, Program Development, Program Implementation, and Program Assessment, were, for the most part, elements of the grant-funded program and were significantly "personnel-dependent," most were easily institutionalized. The curriculum and many of the stakeholders were already familiar with the program goals, implementation, and impact. Items like the program schedule, curricula, and a list of guest speakers or lab tour hosts were established. Issues related to budget, program implementation activities, and personal contacts for presenters, lab hosts, and industry site visits, however, were still challenges because of differing professional networks of the leadership, and the institution and corporate financial changes and constraints.

The top three institutionalization challenges, however, are Financial Stability, Recruitment-awareness communication, and program implementation difficulties due to institutional changes.

5.2 Challenges

The three outward-facing elements of institutionalization, Outcomes Communication, Awareness Communication, and Financial Stability were the greatest challenges in our institutionalization process. Within our context, "Awareness Communication" is focused, not only on

communicating outcomes to the campus community but on the recruitment element of the program as well. Prospective students who are not yet on campus need to be aware of what the program offers and why it benefits them. One additional element impacted all areas of institutionalization: Institutional change.

5.2.1 Outcomes Communication

The grant-funded outcomes communication was provided annually to NSF via the NSF S-STEM annual report and to the engineering education community via conference papers and posters. While important, those avenues of communication did little to inform our university and industry partners of the successes of the program. Additional, but limited, communication materials were created to present to potential corporate sponsors, inform College leadership, and recruit new program participants.

5.2.2 Recruitment and Awareness Communication

Awareness Communication informs the university community about the program implementation, assessment, and outcomes, while recruitment informs prospective families about the benefits of the program to the incoming student.

Wise emphasizes the selection of the program spokesperson to increase the effectiveness of the communication. Someone well-connected and well-respected, in a position of power, possessing social capital, and able to leverage their professional network to gain program support [1] and to distribute the necessary information to the appropriate audiences will achieve maximum effectiveness. During the grant-funded period, the co-PIs included an Associate Dean and an Assistant Dean (who became the third PI and the AcES program director); and three of the AcES directors were teaching faculty in a first-year engineering program with varying degrees of social capital and campus and regional professional networks. The second AcES director, a teaching faculty with significant social capital was able to expand support for the program regionally through personal and professional connections. In the last year of the extended funding period, the institution went through an “academic transformation” reorganization, and the PI and co-PI were moved to other units within the institution and their replacements in the academic units overseeing the AcES program did not have the same background with, understanding of, or passion for the AcES program.

Recruitment of incoming underserved students has been a challenge throughout the project. The AcES program can be considered as an innovation (new idea) since it is not a regular component included in an undergraduate catalog, thus many prospective students and their families are unaware of it. Based on the diffusion of innovations (DOI) theory [10], awareness is the first step of an adoption process. The use of communication channels, time, and a social system are key elements of diffusing information to prospective students and their families.

To assess student awareness of the AcES program, a pilot study was conducted within the institution which indicated a low awareness [11]. Relying only on the program team to diffuse and advocate program information is not enough to reach and convince prospective underserved students to register for this program early in the recruitment process. Different recruitment strategies (email, social media, mail, phone call, student advocate, referrals from organizations serving underserved students, booth during on-campus visit days, etc.) have been attempted since 2021. Research has illustrated the importance of interpersonal communication channels on persuasion and confirmation in the adoption process [12]. The benefits of interpersonal communication channels (phone calls, campus visits, underserved student serving organizations, student advocates, etc.) in reaching and convincing prospective underserved students were observed in AcES program recruitment efforts and results.

While phone calls, conversations during campus visits, referrals from organizations serving underserved students, and statements from past scholars, all help to make the case for recruiting underserved prospective participants, the program would benefit from the integration of AcES recruitment into the university recruitment procedures. Currently, while the college recruiters share AcES information with prospective families via email and printed flyers, they rely on the AcES leadership team to implement additional recruitment communication methods. The AcES program team, however, lacks access to needed contact information before the incoming students complete the new student orientation (NSO), which is late in the process. Hence, the AcES recruitment process was not fully institutionalized. Frustration with this process has led to the creation of a new NSF-funded research project to study recruitment techniques to better understand how students and their families obtain college-related information and what "speaks" to them appropriately and persuasively.

5.2.3 Financial Stability

Developing "Financial Stability" has been the biggest challenge in the institutionalization process and has affected other areas of program implementation.

Funding for scholarships, programming (transportation, food, materials, etc.), and personnel expenses are essential to maintaining a high-quality program with scholarship and personnel expenses as the larger proportion of the expense. Significant, multi-year renewable scholarships are essential for low-income students. Program operational expenses can be divided into personnel expenses (salary or stipend for faculty, staff, or student workers) and programming expenses (transportation, food, materials, promotion/media, etc.). Programming expenses are usually a smaller proportion of the program's operational expenses and are easier to adjust when needed. For example, a long-distance engineering site visit with a nice catered networking dinner with faculty, staff, alumni, and professionals can be replaced with an on-campus facility visit with a pizza networking lunch without significant changes to the program outcomes, if funding is an issue. Personnel expenses are more fixed and can be high since summer hours, additional recruitment, and fundraising efforts, typically, are outside of a faculty member's job description. For consistency and reliability, a program cannot operate relying only on volunteers.

Replacing the NSF grant funding for program continuation past the funding period was difficult. Many campuses, including ours, lack "transparency on paths for successful, innovative programs to achieve Financial Stability" [1]. While faculty are often encouraged to fund their programs externally, Wise et al. warn that "a program that depends on external funding is not institutionalized" [1].

Currently, a small number of industry partners that support scholarships and programming expenses, and the institution's first-year engineering program which provides limited personnel funding comprise our funding sources. Due to a change in leadership and our university's severe financial crisis, the first-year engineering program support is now very limited and likely to cease. Additionally, many industry partners place restrictions on fund usage, particularly regarding scholarships and personnel expenses. Limited personnel funding hinders immediate operations (lack of student workers) and long-term program goals such as recruitment effectiveness and funding stability which can be time-consuming and labor-intensive. Finding sponsors for multi-year, renewable scholarships, however, is most challenging since industry partners tend to fund one-time scholarships/stipends and ask students to apply for other major-oriented scholarships after declaring their majors. Scholarship amounts are also significantly less than the NSF-funded scholarships and, due to economic fluctuations, the annual amounts are not consistent year over year. These issues hinder and limit our ability to provide consistent and significant scholarships to low-income students.

5.2.4 Institutional changes

Many leadership changes and organizational structure changes have occurred since the AcES program began. Those changes created challenges to the institutionalization process.

Leadership changes occurred from the institution level to the program level. Since 2016, the AcES program has experienced significant leadership changes, including a Provost, a Dean, two Associate/Assistant Deans, and three program directors. The executive-level leadership changes (Provost and Deans) impacted the support level of the program from different units within the institution, particularly the visibility and priority of the program in the system. The program director changes due to faculty departure from the institution mainly affected the continuity of intangible knowledge and connections. Although the tangible knowledge and contact information were passed down during the program director position handover and the former PIs, co-PIs, and program directors responded to follow-up questions after departure, it took time to rebuild relationships and recover many intangible assets, such as connections to spokespersons in a position of power who could increase the effectiveness of the communication and institutionalization process.

Several organizational structures also changed.

Academic Advising. The college changed academic advising models and moved from a faculty advisor model to a centralized advising model using professional advisors in the Statler College

Academic Advising Center. Therefore, program scholars advising has also changed. Before 2022, S-STEM scholars were advised by the program PI or director (faculty) while they were in the engineering college's first-year engineering program and by faculty advisors in their academic field after moving to engineering or computing majors. Those faculty advisors could see program scholars not only during advising seasons but also in classrooms and other department professional activities, creating a closer student-faculty relationship and easy access to program scholar information to follow up. In addition, since faculty advisors also work in the engineering or engineering education field, they can mentor program scholars' engineering identity and career development by sharing their professional experience and connections. Currently, all students in the college are advised by the advisors in the Advising Center. This change requires all advisors to be well-versed in this unique student success and scholarship program and fails to facilitate the student-faculty bond. Additionally, the program PI and director lost access to the advising information system and now have limited access to the program scholars' information since they are no longer academic advisors.

Academic Unit Leadership Change. The AcES program operates within the engineering college's first-year engineering program. The head of that program recently changed. The Assistant Dean (and program PI) who formerly led the first-year engineering program was reassigned duties to develop a new program within the college and another faculty member became the new first-year engineering program "director." That leadership change affected the AcES program in two ways. First, although the new unit director supported the continued implementation of this student success program, she lacked the position of power (only a director title) and resources (budget cut and years of AcES revenues repurposed for college budget shortfalls during the academic transformation) compared to the former Assistant Dean (an original NSF S-STEM Grant proposer and implementer). Second, the unit leadership title change caused the fourth AcES director to stop using the "director" title to avoid confusion, which raised concern regarding the power dynamic change when coordinating and collaborating with other units.

Institutional Academic Transformation. The entire institution is going through an academic transformation process to review and cut dozens of programs (and hundreds of associated faculty and staff) across campus, which not only placed stress on faculty including the S-STEM program PI and director but also created uncertainty regarding funding sources and losing collaborators due to the many faculty and staff cuts.

6.0 Lessons Learned

Several lessons were learned through our experience. The lessons related to protecting against leadership change, dealing with financial crises while implementing the program, recruitment, communication, and adapting to changes while keeping the program's integrity are presented in the following sections.

6.1 Protecting against leadership change

Maintaining communication with executive-level leadership is essential to reducing challenges due to leadership changes. When there is a foreseen change in Provost/Dean/Chair levels, the program director should be proactive in planning conversations with the new leader as soon as they take the position to gain their support as early as possible and ensure the program fits into their visions and priorities. Fox et al. assessed programs for undergraduate women in science and engineering related to the programs' organization and connections to the larger institution through its reporting line, director's employment fraction, funding, program age, and faculty participation, which are important elements to consider during institutionalization [13]. They found that reporting to higher levels within the university and hiring personnel with full-time appointments as a program director, instead of just add-on undertakings along with a faculty's other appointment, could mean more successful institutionalization with higher level connections and potentially greater institutional visibility. Our experiences resonated with such findings and suggested employing, if possible, a full-time appointment program director with a higher reporting line to better protect the programs against executive-level leadership changes.

To facilitate smooth program director-level transitions, it is important to maintain good documentation of both the tangible information (program curriculum, points of contact, programming materials, etc.) and the intangible knowledge like connections to people in power, operation tips, and former mistakes, and pass such information on to the new program director. In addition to the initial transition meetings, having the former program director available to respond to questions and assist in making key introductions was helpful. Beginning in 2022, a second faculty was assigned to a program-supporting role to promote familiarization with the general operations of the program to increase the program's ability to handle unexpected program leader changes.

6.2 Dealing with financial crises while implementing the program

External funding sources other than federal grants include industry, non-profit organizations, and state grants. Industry partners, often, are recruited by the institution's development office to donate to the college or department with restrictions on fund usage and, hence, are reluctant to provide scholarship and personnel funds to a stand-alone freshman-level scholar program unless the program provides significant potential and impact in their industry or the region. Alternative funding sources include non-profit foundations or individual donations that have fewer restrictions than industry partners on fund usage. For example, the AcES WVU-Tech campus received funding from a nongovernmental, not-for-profit foundation with more flexibility than the AcES WVU Morgantown campus whose funding sources are industry partners. Some states have grants to support programs aiming to broaden participation in engineering, which also could be a funding source. All external funding requires good collaborations with university or college Foundation staff, relationship development with industry, community, and government partners, and fundraising skills.

To achieve true institutionalization, internal institution funds are critical, particularly for personnel expenses and consistent scholarships. Once institutionalized, the program will be more robust to withstand financial crises if integrated into a higher-level reporting line (report to the Provost Office, Dean, or Associate Dean). For example, the AcES WVU-Tech campus was closer to the higher-level leadership and a smaller campus compared to the AcES WVU Morgantown campus and had more visibility and support within their campus. Other suggestions include appointing a full-time staff as a program director and building the personnel expense into the institution's budget. If that is not possible and the director's employment fraction is part-time of the faculty's existing appointment, then the faculty appointment should clearly identify an administrative workload and title (instead of burying them within the regular teaching, research, and service duties) and indicate the time period (12-month or summer) required for the additional duties. Another budgetary alternative is to integrate the program into the existing Engineering Living-Learning Community, often housed within Student Life which, typically, has access to institutional budget support.

6.3 Communication and Recruitment

Outcomes communication must be shared not only with NSF and the engineering education community via conference papers and posters, but need to be shared, internally, with institutional leadership and other potential stakeholders. Look for opportunities to give seminars and share data and research results within the campus community. As more people on campus know about and appreciate the value of the project, they will direct not only prospective families to you but will be supportive as budget decisions are made.

Additionally, working within the existing college and university recruiting structure to provide program information to prospective students early in the process is important. Being able to answer students' and families' questions related to scholarship support and program content and outcomes is essential to helping students, especially first-generation or low-income students, decide to participate. The program could also act as a catalyst for institutional culture change by advocating for diverse recruitment strategies, particularly more interpersonal communication channels that encourage underserved student recruitment (e.g., high school counselors or STEM teachers, mails, phone calls, program alumni as student ambassadors, organizations serving underserved students, on-campus visits, etc.).

6.4 Adapting to changes while keeping the program's integrity

Flexibility and proactivity are key to maintaining the program's integrity and goals throughout the institutionalization process. Planning for institutionalization should start from the beginning of the S-STEM project as the leadership works to build resources, professional networks, and social capital which are needed throughout the institutionalization processes. As the institutional culture changes, program leadership must work with new institutional leaders, and communicate the goals and successful outcomes to help the new leadership see the program's institutional value.

7.0 Conclusion

This reflective case study described one institution's experience in attempting to institutionalize a formerly grant-funded successful student success project. Utilizing the Wise, 2022 model of institutionalization effort, this paper presented the project's institutionalization successes and challenges. The four internal areas of effort, including team development and program design, implementation, and assessment were relatively simple to institutionalize. Challenges were presented in outcomes communication, awareness communication and recruitment, and financial stability. This project also faced additional challenges related to significant institutional changes. The lessons learned are presented along with advice to others who are beginning funded projects or are also engaged in the institutionalization process.

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