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Evolution of a Student Transition and Success Program: Reflections on a 10 Year Journey

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Abstract

A lot has happened since 2012 – in society, in education, and in one engineering student development program, called *The Academy of Engineering Success* (AcES)! AcES started in 2012 at West Virginia University (WVU), a large, mid-Atlantic, R1 institution, and received NSF S-STEM funding beginning in 2016 and corporate sponsorship beginning in 2021. The program was designed around research-based strategies to support and retain talented, but underprepared (non-calculus-ready) and underrepresented first-time, full-time engineering undergraduate students with the intention of contributing to the diversification of the engineering workforce by increasing the number of graduating engineers [1], [2]. This program has served over 100 students and provided financial support to 28 students through renewable NSF S-STEM scholarships.

Based on the results of surveys, individual and focus group interviews, and student feedback, past research has focused on AcES participants' feelings of institutional inclusion, engineering self-efficacy and identity, and their assessment of their own development of academic and professional success skills [1], [2]. Past studies have reported support for the Kruger-Dunning Effect, "a cognitive bias in which unskilled people do not recognize their incompetence in specific areas and often overestimate their abilities" [3], [4], [5]. Specifically, the students who ultimately left engineering before their second year tended to enter college with unrealistic expectations of the difficulty of the major, an underestimate of the time and effort demands needed to be successful, and an overestimate of their ability to succeed with little effort [2], [3], [5].

This paper focuses on the evolution of the program throughout several time periods, the lessons learned, and the insight gained regarding the most positively impactful and supportive programmatic elements. These insights come from feedback from students who have completed or nearly completed their engineering degree and have persisted through the challenges of an engineering education, even with the additional complications and challenges of COVID. Additional observations are made by the program leaders. These insights are shared with the engineering educational community to inform other, future programs.

1.0 History

Between 2012 and 2015, two elements comprised the AcES program: (1) A summer bridge program prior to the freshman year and (2) a first year fall professional development course. In 2016, a three-credit hour, *Engineering in History*, course was added in the second (spring) term for S-STEM scholars. That course: (1) counted toward the students' graduation as a general education requirement, (2) facilitated additional mentoring opportunities since the course was taught by a [program] faculty mentor, and (3) provided additional cohort-building in an academic setting throughout the students' entire first year. These three elements comprised AcES until the COVID-19 Pandemic. The fall 2019 cohort experienced the full three-element program. There was no fall 2020 cohort of incoming students, since all courses were online and no in-person summer or fall programs were permitted due the COVID-19 restrictions. When the program restarted with the fall 2021 cohort, the spring semester *Engineering in History* class was no longer an AcES program requirement.

While the current program extends from summer through the fall term, students have many opportunities throughout their first year for interactions with other students, faculty, and engineering professionals through a variety of co-curricular experiences related to their development as an engineering professional, some of which are required. Students also have many opportunities for career exploration as well as significant academic and student success support. Opportunities are provided for upper-level AcES students to interact with each year's new cohort.

Funding was provided by the WVU Statler College of Engineering and Mineral Resources from 2012 through 2016 and by NSF from 2016 – 2019 (with scholarship funding for previous AcES students continuing to fall 2024), and by a combination of college and industry funding for 2021 and 2022. As the NSF grant was expiring, industry sponsorship of the summer program element and scholarships was sought.

Summer Bridge Experience

The summer bridge component varied throughout the years. Typically, the one-week program was held the week directly before the fall move-in day and contained a variety of experiential learning experiences, including: a hands-on engineering design challenge, field trips, math and chemistry instruction and practice sessions, seminars, and social activities. Faculty, staff, peer, and industry mentors led and participated in the activities.

In 2013, the summer bridge experience was extended to four weeks and allowed students to earn six credit hours of college course work prior to the start of the fall semester. While the extra time facilitated stronger peer-to-peer and student-to-faculty/mentor relationships, student and faculty feedback unanimously revealed that everyone was tired before the start of the fall term and the program felt like a 20-week fall semester that started mid-summer. The one-week bridge program was reinstated in 2014 and continues to the present.

From 2012 – 2014, AcES student move-in was on Sunday late afternoon, followed by an evening social event held at the Engineering Live/Learn Community Resident Faculty Leaders' (RFL) home and courtyard. In addition to ice-breaker activities and making S'mores around a campfire, students met each other, the faculty leaders, the RFLs, and their graduate student mentors with whom they would be interacting throughout the week and the semester. This informal and welcoming time helped students meet others and become comfortable in their environment. The more formal events started on Monday morning. When the RFL program ended (2015), the schedule was modified to have students move in on Monday morning and AcES activities begin at 1:00 pm, just after lunch.

Modifications were made to several program components, including housing (common residence hall vs. move-in directly to fall residence), scheduling and activities, (start on Sunday afternoon or Monday; field trips; end of bridge event; and topic and nature of the engineering design project). While the AcES program started before the NSF S-STEM funding, the funding provided scholarships for some students who would otherwise not be able to participate, supported programming initiatives, and facilitated research regarding how students transition to college in a STEM, specifically engineering, field. The overall AcES summer bridge component is now institutionalized and has been supported to some level by local industry.

Fall Professional Development Course

The 2-credit fall professional development course, open only to AcES participants, consists of lectures, company and laboratory site visits, guest speakers, and 1-2 design projects (depending on the year). Course topics include: learning styles, goal setting, teamwork, professional communication, and career paths. Students learn about undergraduate research opportunities and emerging research in engineering fields through class visits to campus research laboratories. They experience professional context and hear from engineers during an off-campus industrial site, such as a wind turbine site, a pharmaceutical plant, or an engineering company. Guest speakers provide additional career success information related to professional life and include specific topics, such as: building a resume, career planning, professionalism, emotional maturity, and application of engineering principles. The team design project helps students develop teamwork, design, and professional communication skills.

Spring Engineering in History Course

To maintain cohort cohesion, develop their interest in and motivation toward engineering, and provide additional mentorship opportunities, the AcES cohort took the same section of the general elective *Engineering in History* course during the spring term. This course, initially taught by an AcES faculty mentor and academic advisor, explains how engineering innovations throughout history have shaped society.

Additionally, at the end of most academic years, all current and former [program] participants, including student assistants, staff and faculty, attend a social event. This celebration event not only facilitates the continuous networking and cohort-building among all stakeholders, but provides opportunities for former, now upper-level, students to share their experiences with younger students, thereby continuing their engagement in the program.

2.0 Lessons Learned

Lessons learned relate to cohort size, logistics, and mentorship. The most impactful programmatic elements include relationship-building, connections with industry, and just-in-time instruction and programming. These elements are presented below.

2.1 Logistics

Start early! There are many logistics related to recruiting, planning each day’s activities, meals, transportation, and classes. These things take time. For recruiting, emails were sent to admitted students to invite them to participate. Emails were followed by phone calls to explain more about the purpose of the program and its benefits. Many people were involved in planning or implementing specific activities or specific content. Coordinating the efforts of a large group of people takes time and effort.

2.2 Cohort Size

While cohort sizes ranged from 12 to 37, the ideal cohort size seems to be approximately 20 – 24 students. While that estimate is simply an observation, cohorts much below 20 or over 24 have different “vibes.” While each cohort has its own personality, the cohorts with cohort size closer to 20 seemed to “gel” more quickly and make stronger bonds. Our largest cohort of 37 presented some of the greatest challenges. Some of the challenges, however, relate to the logistics of designing educational experiences that meet the needs of so many students at once.

This observation informed latter cohorts. Last summer, the AcES cohort was split into two groups, based on math placement. Each group had a faculty leader. While the groups were combined for some whole cohort activities, other activities, including math lessons, were separate. The smaller groups provided more opportunities for peer-to-peer and faculty-student interaction.

2.3 Natural Mentorship

Employing graduate and upper-level undergraduate students (especially AcES completers) as assistants for the summer program and courses provides natural mentorship. First-year students are more likely to develop a relationship with those upper-level students and be comfortable asking them questions. Selecting those assistants carefully, with the mentorship role in mind, is essential to creating a successful mentorship environment.

In the early years of the program, the organizers sought to match incoming first-year students with industry mentors. It did not work well. The first-year students were focused on “mastering” college life and were not ready to interact with seasoned engineering professionals. In most instances, both parties found the interactions to be less-than-ideal, so the formal mentorship program was stopped for the first-year students. They were, instead, informally mentored by the program’s upper-level student assistants.

2.4 Just-In-Time Instruction

In early implementations of the summer bridge experience, a large amount of time was allotted to math and chemistry preparation. While College data showed students lacked in preparation for their college-level math and chemistry courses, many entering AcES students believed they were prepared for these courses and did not appreciate the extra review provided in the program. The Summer bridge curriculum was modified, first, to lessen the focus on math and chemistry review in favor of a more in-depth project, and then was restructured to increase direct instruction on specific chemistry and specific math topics along with a continuation and expansion of the in-depth project.

The student rejection of review and assistance very early in their college experience is not surprising. One study showed that students who ultimately were dismissed from an engineering college or left it voluntarily entered college with higher average engineering and math selfefficacies than students who were retained [4]. These results support the Kruger-Dunning Effect [3] which is a cognitive bias in which people with limited knowledge or competence in a specific intellectual domain overestimate their own abilities [6]. Our incoming students did not recognize their own deficiencies and were not ready or motivated to learn new concepts or practice to ensure their mastery of the subjects at the beginning of the term. Students often face their preparation deficiencies only after performing poorly on a first set of tests in a specific subject. At that point, however, they may be willing and able to seek help if they know where to find it.

Building strong peer-to-peer, student-to-faculty, and student-to-upper-level mentor relationships seemed to be key to providing the necessary "just-in-time" information about tutoring which helps students when they need it most and are ready to learn from it.

2.5 Industry Connection

One goal of the program is to treat students as pre-professionals from the first day of the summer bridge experience. The industry site visits, guest speakers, and career center counselors help students envision what it might be like to work as an engineer and how they need to begin preparing for that career. The common message of the industry representatives was to get involved in an engineering-related student organization or work in an internship or co-op opportunity to get some practical experience before graduation. Such experience increases one's marketability and helps motivate students to continue working toward their engineering degree. Students seemed to listen to the advice given by industry representatives and career center counselors. Envisioning their possible future career seemed to motivate them to continue to do the work necessary to earn their engineering degree.

3.0 Conclusions, Reflections, and Advice for the Future

Every campus, state, student, situation, and set of experiences is different. Effective programs can adapt quickly and effectively to student feedback and unique situations that may arise. Planning for inclusion of opportunities for students to form relationships with peers, near peers, and faculty leaders is key. Other impactful practices and program elements include: an introduction to research and industry-related opportunities, a team project (to facilitate the development of teamwork skills and increase the development of interpersonal relationships among the students as they work toward a common goal), and "just-in-time," relevant instruction (in small doses). Most important, however, is the passion, dedication, and energy of the faculty leader(s) and support staff. The people set the tone for the program and are the best resources for the new students.

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