S-STEM: Academically and Civically Engaged Scientists – Mid-Project Progress Report

Dr. LeAnn E. Faidley, Wartburg College

Dr. LeAnn Faidley is an Associate Professor of Engineering Science at Wartburg College in Waverly, IA. She teaches in the areas of Freshmen Engineering, Mechanics, Materials, and Design. Her pedagogical research areas include methods for improving student engagement with the material, service learning, inquiry based learning, and standards based grading.

Dr. Christine A. DeVries, Wartburg College

Dr. Christine DeVries is an Associate Professor at Wartburg College, Waverly, Iowa with primary teaching responsibilities in general chemistry, physical chemistry, and science for non-majors. She is a co-PI on the S-STEM program, ACES, serving as liaison to the Institute for Leadership Education, external assessment, and external advisory board. Her research interests include Langmuir films of organic molecules and STEM education.

Mariah Birgen, Wartburg College

Mariah Birgen earned her B. S. in Engineering Physics from the University of California, Berkeley in 1991 and her Ph.D. in Mathematics from the University of Michigan, Ann Arbor in 1997. She has been employed as a professor of mathematics at Wartburg College since 1997 including earning tenure in 2003 and full professor in 2011. Her interests include teaching mathematics and science through civic engagement (SENCER), teaching calculus through mathematical modeling and differential equations, and inquiry based learning in mathematics. She also dabbles in voting theory, history of mathematics in the British Isles, and anything else about which her students bring to ask her questions.
Abstract

The Academically and Civically Engaged Scientist (ACES) S-STEM program is designed to help high-achieving STEM students understand their chosen professions and vocations as giving them a responsibility as citizens to serve their community, nation, and the world. The objectives of this program are to (1) recruit diverse students to STEM fields, (2) Retain 85% of scholarship recipients in a STEM field, (3) Increase the civic mindedness and engagement among participants, and (4) Achieve a STEM placement for 90% of the program graduates. In order to meet these objectives, the PI team has implemented a series of well-established methods. Scholarships are awarded to make college more accessible and allow more time for educational opportunities through reduced need for outside employment. The group of ACES students are formed into a cohort to provide a support structure in a community of like-minded scholars with diverse backgrounds. That support structure is enhanced through mentoring relationships with peers, faculty, and alumni who can share experiences and direct students to resources. Finally, students work in teams to complete impactful projects that show them the relevance of the STEM disciplines to the important problems of the world. Throughout all of these activities, students are given ownership of their experiences through choices in the classes, projects, and activities that lead to the learning objectives of the program. Additionally, the students are encouraged to reflect regularly on their experiences, becoming more self-aware and better able to contribute to their society. The ACES program has benefited from partnerships across the campus of Wartburg College, liberal-arts private 4-year institution in Northeast Iowa. This program received funding from the National Science Foundation in the summer of 2013 and is now at the halfway point of the project implementation. This paper will present an overview of the methods implemented as well as lessons learned through the project’s implementation with three cohorts of students and preliminary results of assessment efforts.

Introduction and Background

Wartburg College is a selective, four-year liberal arts college affiliated with the Evangelical Lutheran Church in America. The college’s primary purpose is educating undergraduates within the liberal arts tradition which is seen as permeating all of the disciplinary majors. Within the context of the major and the essential education curriculum, the College strives to expand deep and integrative learning and establish critical thinking, teamwork, and communication skills all of which lead to lifelong learners who live out the College’s mission: Wartburg College is dedicated to challenging and nurturing students for lives of leadership and service as a spirited expression of their faith and learning.
In the 2017-18 academic year, Wartburg College enrolled 1,527 students from a variety of geographic, social, economic, ethnic, and religious backgrounds. Students came from 30 U.S. states and 55 countries. This included 206 (13.5%) American ethnic students and 121 (8.0%) international students. The majority of Wartburg students are traditional college students with 94.8% of the student body in the 18-22 age range. Females make up 53% of the student body. Twenty-eight percent of students qualified for Pell Grants in 2011-12, an indicator of high financial need. Wartburg also attracts a high number of first-generation college students with 414 (22.9%) falling into that category in 2011-12.

Thirty percent of all Wartburg students major in one of the STEM disciplines, with Biology being the second largest major on campus. These students are supported by 25 faculty members (11 in Biology, 4 in Chemistry/Biochemistry, 2 in Engineering Science, 3 in Mathematics, 3 in Computer Science, and 2 in Physics). The STEM majors served by the grant are: Actuarial Science, Biochemistry, Biology and Biology Education, Chemistry and Chemistry Education, Computer Science and Computer Information Systems, Engineering Science, Environmental Science, Mathematics and Mathematics Education, Neuroscience, Physics and Physics Education, and Public Health.

In addition to strong STEM programs, Wartburg has proven itself to be a leader in the areas of service-learning, leadership, and vocational discernment. The College has been repeatedly recognized for its work, including recently being named to the President’s Higher Education Community Service Honor Roll for the fifth consecutive year and having the Carnegie Elective Classifications for both “Curricular Engagement” and “Outreach & Partnerships”. Wartburg encourages students to become leaders in their current roles and future endeavors. Students take an active role in leading organizations on campus, and even the governance of the college itself and 16% of them earn a Leadership Academic Minor. All these programs lead to an educational experience that helps ensure liberally-educated students who are certain of their vocational path and prepared to become leaders in their workplaces and communities.

**Project Overview**

The goal of this S-STEM project is to guide high-achieving STEM students in becoming Academically and Civically-Engaged Scientists (ACES). As the U.S. works to meet its need for STEM professionals, it is equally important that those professionals see their STEM degrees as giving them a responsibility to serve the community, nation, and world as active citizens. We believe that, by emphasizing the opportunities for civic engagement within STEM, this project attracts and retains students who otherwise would be torn between their love of science and their desire to help people.

Unlike many S-STEM grants, the ACES program deliberately creates a cohort of students from multiple STEM majors and a variety of years of college. The intention is to create a more family-like cohort with students of varying exposures and maturity sharing their knowledge and experience with one-another. Thus, when admitting our new class of students to the ACES program, we attempt to maintain a general balance of 2-3 students per academic class for a total of ten active ACES Scholars in any given year.
The specific goals of this project are to:

- Recruit diverse students to STEM fields
- Retain 85% of scholarship recipients in a STEM field
- Increase civic mindedness and engagement among participants
- Achieve a STEM placement for 90% of the program graduates

The ACES program works to support a diverse cohort of 10-11 STEM students who are awarded scholarships of approximately $10,000 each year. Bookending their ACES experience, as members of the Warburg College Scholars Program, in their first year at Warburg, they live in a residential cluster with other Scholars’ program freshmen, complete Scholars 101, and explore what it means to be civically-minded scholars. As seniors they complete an individualized honors research project with a faculty member. Often this senior project is part, or an offshoot, of one of their ACES service projects. ACES students also earn a Leadership Minor where they practice leadership as “taking responsibility for our communities, and making them better through public action” as described by that program. Under the supervision of the PI’s, the ACES cohort completes community engagement projects each year that allow them to apply their STEM knowledge and their leadership skills. The cohort’s weekly meetings give time for mentoring programs, career development opportunities, and supervised project work.

In order to meet our objectives the proposed program is based on well-established methods (see Figure 1 for implementation schedule):

- **Scholarships** make college accessible and allow more time for educational opportunities. In the 2012-13 academic year the unmet need for the average Warburg student was $18,770 the $10,000 scholarship provided by the ACES program significantly reduces this.

- **Cohort formation** provides a support structure in a community of like-minded scholars with diverse backgrounds. Creating a small community in which students feel comfortable and supported has been found to increase students’ overall satisfaction with college [1] and retention in STEM fields.

- **Mentoring** connects students with peers, faculty, and alumni who can share experiences and direct them to resources. Effective mentoring has been shown to improve academic performance [2], improve retention rates for women and students of color [3], [4], [5], increase job satisfaction [6], and be best served by a variety of mentors at different stages [7], [8].

- **Impactful projects** show students the relevance of their disciplines to the world and improve retention by engaging them in important work early in their academic careers. Projects that emphasize the relevance of the STEM fields through helping people have been shown to increase the retention of students in STEM fields [9], [10], [11] and are particularly effective for women and ethnic minorities when used in the their freshman year [12], [13]. Community-engagement projects have also been shown to improve students’ attitudes towards civic-mindedness when used on a regular basis [9], [14].

- **Student-directed flexibility** within the program, classes, and projects give students ownership of their experiences and lead to a better understanding of their skills and interests. The ownership of their learning that comes when students are given the flexibility to choose the requirements of their curriculum and the reflection on learning
that occurs when they are asked to justify their choices, helps to improve motivation and retain minority students [15].

- **Metacognition** helps students to become more self-aware and therefore better able to contribute to their society. The Bringle-Hatcher definition of service-learning includes at its core the necessity of reflection “on the service activity in such a way as to gain further understanding of the course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility” [16]. Performing civic-engagement projects without reflecting upon the experience is simply volunteerism [17]. For greatest impact towards the project goals, students must evaluate what happened, how the events fit within their curriculum and personal development, and how their behavior will change in the future as a result of the experience.

![Figure 1: Project Method Overview](image)

The activities of this program depend upon a wide variety of partners both internal and external to Wartburg College. The ACES program will be managed through the work of 4 teams:

- **PI Team** – will manage the day-to-day activities of the project, select program participants and, interact with the ACES students.
- **Leadership Team** – will be comprised of representatives of the on-campus partners. They will support the project with their resources and give feedback on the program throughout.
- **Mentor Team** – will provide mentoring and guidance for the ACES students and oversight of the community and research projects.
- **External Advisory Board** – will meet annually to assess the program, review the projects, and interact with the participants.
Project Details

Program Demographics

By the 2017-18 academic year, a total of 16 students have been admitted to the ACES program. As can be seen in Table 1, those students represent a diversity of gender, home communities, race, parental college experience, and majors.

Table 1: ACES Program Demographics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>8 Male, 8 Female</td>
</tr>
<tr>
<td>Communities</td>
<td>7 Rural, 8 Suburban, 1 Urban</td>
</tr>
<tr>
<td>Race</td>
<td>15 White/Asian, 1 African American/Native American/Hispanic</td>
</tr>
<tr>
<td>Parental college</td>
<td>2 first generation</td>
</tr>
<tr>
<td>Major</td>
<td>1 Biochemistry, 2 Biology and Biology Education, 2 Chemistry and Chemistry Education, 3 Computer Science, 3 Engineering, 3 Mathematics and Mathematics Education, 2 Neuroscience</td>
</tr>
</tbody>
</table>

Program Activities

Professional Development

As part of the ACES program, students are expected to attend weekly meetings that were scheduled for the evening of a week night each semester after consulting students about preferred scheduling. These meetings were alternatively used for professional development and mentoring and project time. Some of the professional development activities were repeated annually while others were only held once. Those that have been done multiple times include:

- **Mentoring and Strengthsfinder discussion** -- this session is held near the start of each academic year. It introduces techniques that students could use in their mentoring pairs and discusses the results of their Strengthsfinder survey and how those help to shape how they might best approach a successful school year.
- **Resumes, Personal Statements and Cover Letters** -- students are introduced to the expectations of resumes, personal statements, and cover letters and then are encouraged to bring drafts of these documents back to a subsequent meeting to discuss them with their peers and the PIs.
- **Research Experience for Undergraduates Overview** -- students are introduced to REUs and how to find and apply for them. They also hear from senior cohort members about their past experiences with REUs.
- **Guest Speakers** -- local STEM professionals are invited to speak with our students. They are encouraged to also discuss how service plays a role in their professional lives. Guest speakers have included the City Engineer, a local OBGYN, an Ergonomics Engineer, and a Chemist from local industry.
Interview Prep and Mock Interviews -- two consecutive meetings are dedicated to first discussing position search strategies and the interview preparation techniques and then participating in mock interviews. Students identify a position they would be interested in applying for (even if they don’t really pursue it) and the following week we hold mock interviews for that position with the help of volunteer faculty and staff from across campus. Each interview had an observer taking notes about how well strategies were followed and how well students worked in the facts they wanted to share. The interviews are then debriefed to help students learn from the experience.

“Life after College” panel with recent alumni -- a panel of former students who are with 5 years of graduation talk to students about their life after graduation, what they found valuable about their Wartburg education, and give advice for success.

Presentations from Local Organizations -- Professional organizations with a professional development or service focus are invited to come and talk with our students about how they might get involved after graduation. These have included, Toastmasters, Lions, Kiwanis, and Rotary Club.

Group attendance at Campus Events -- In several instances, ACES meeting times correspond with other activities on campus that are linked to our students interests and the service/STEM focus on our project and so those are attended instead. Some examples of such activities were an author talk by Cheryl Mullenbach who wrote “Double Victory: How African American Women Broke Race and Gender Barriers to Help Win World War II”, Spooky Science outreach night, and the Big Dream Gathering.

Mentoring
The ACES program takes a three-prong approach to mentoring. First is a peer-mentoring program in which Junior and Senior members of the cohort are paired with the Freshmen and Sophomores. These mentor pairs work together throughout the year, with time set aside at the start of weekly meetings for them to touch base. The peer mentors are encouraged to discuss practical collegiate matters such as transitioning to college, self-motivation, stress reduction, and the various support services available on campus. The upper-class ACES students are also able to help the first- and second-year students navigate the challenges and benefits of participating in the ACES program.

The second mentoring prong connects students with alumni who have established a career from the same discipline. Though it took a year to get established, the intent of the professional mentoring program is that the relationships between the mentoring pairs extend throughout the students’ participation in the program. Alumni are invited to act as mentors through the Alumni office. Once the pairing has occurred, students and mentors are sent periodic discussion prompts to develop the mentoring relationship.

The third prong is the more informal mentoring that is a well-established part of the Wartburg culture. This occurs through the students’ faculty advisors, classroom instructors, and with the community partners and faculty/staff mentors that are involved in their service projects.
Service Projects
One of the core aspects of the ACES program is a yearlong service project. Over the summer months, the PIs and some students develop ideas for service projects or community partners that would make use of the students’ STEM knowledge and skills. Students then request a project and are assigned based on preference and team balance at the beginning of the Fall term. They then work with their team over both semesters to complete a STEM relevant service project. The work is student driven, in conjunction with the needs of the community partner and with the support of a faculty mentor to provide feedback as requested. The projects that have been completed by ACES students this far have been:

- **Water Testing Project for Wartburg College** - students worked with the director of the physical plant and a co-PI to collect and test drinking water from various points on campus at regular intervals to determine if water quality is consistent across campus using several common quality indicators. An older building and a dormitory were rumored to have drinking water quality issues, which, along with recent headlines in Michigan, made this a project of particular interest to the students. The students tested weekly for common problem analytes such as nitrates (a big problem for our state) and water hardness, another problem which increases costs on campus related to maintaining heating and cooling lines. The students learned and applied new laboratory techniques and analysis methods. The results were collected, analyzed, and a poster and report were created to share the results with the director of the physical plant.

- **Science Outreach Activities** - in the first year of the grant students partnered with the local public library to create and implement a series of 3 science activity afternoons for local children. The students prepared activities related to electricity, motion, and temperature and implemented those activities 3 consecutive Sunday afternoons. The reception from participants and librarians was quite positive and even led to an invitation to do some of these same activities with 30 kids at a 4H club. The outreach project was continued into the second and third years with the creation of a STEM Outreach club on campus and continued activities at the library in the 2nd year, and a shift in focus to working with the Talented and Gifted program at a local private school in the 3rd.

- **Food Pantry** - students worked with the area Food Bank to help identify a need that they could serve with their scientific knowledge. They attended several volunteer board meetings and familiarized themselves with the organization and then decided to help create curriculum for the food based summer youth program that is hosted by the food bank. Kids spend time working in the community garden and then learn to prepare some of the food that they are growing. While it is cooking, they then play a game or do some other activity related to that food. The students created eight lessons plans based around different vegetables.

- **Self-Help International** - Students worked on a two part project with a local nonprofit that serves communities overseas with a variety of initiatives. In the first semester the ACES students partnered with Self-Help and a Community Builders team for Wartburg’s leadership program to develop and implement a curriculum on clean water for local middle school students. In the second semester they developed a list of options for
nutritional enhancements to a porridge served as a school meal in a nutrition program in Ghana and analyzed anthropometric data associated with that program.

- **Meyer’s Pharmacy Parking Lot Redesign** - Students worked with the local Pharmacy owner to redesign the parking space arrangement in their parking lot. The lot needed to be re-designed because of the state renovating the adjacent road. Students investigated the costs of various options and researched code specifications for handicapped parking slots.

As part of the completion of these service projects, students also complete metacognition reflections at several points during the year. They start with a summer survey to gauge their understanding of community service, community engagement, and service learning and how their classroom learning could be connected to these. This survey also collected information to help place students in projects that interested them. This was followed by an early reflection on what they knew of their community partner and how they could contribute to their needs. In January they were asked to reflect on how the project was going what they needed to change about their participation and how they were using what they had learned in the classroom. Finally, at the end of the project they were asked to reflect on their project as a whole, on their learning through the project, and any changes in their thoughts about being a civically engaged scholar. This helped students to get more out of their service experiences and to better achieve our 3rd goal related to increasing civic mindedness in our students.

**Assessment**

**Methods**

A mixed-methods approach to assessment has been developed and implemented with the primary goals to (1) assess how well each of the six Methods are being implemented, and (2) assess how well each method helps us achieve each of the four Objectives. The assessment plan consists of four overarching categories:

1. Quantitative Data comparing ACES to similar cohorts
2. Qualitative Data with an external look into the ACES cohort
3. Questionnaires & Interviews with ACES students and similar student cohorts
4. Reflective Activities in collaboration with Scholars and Leadership Programs with ACES and similar students.

Each specific assessment tool is used to investigate one or more objectives or methods as indicated in Figure 2. Each of the categories is briefly described below.

1. Quantitative Comparisons consists of data collection from offices at the college regarding the three most easily measured Objectives: recruiting, retention and placement data for ACES students.
2. Qualitative Data with an External Look into ACES cohort consists of obtaining feedback from Admissions Counselors to investigate the effectiveness of our recruitment efforts and obtaining feedback from the professional mentors regarding the ongoing mentoring relationships.
3. Questionnaires & Interviews have been developed upon the Self-Assessment of Learning Gains (SALG) tool developed by the NSF-funded Science Education with New Civic Engagement and Responsibilities (SENCER) program. The SENCER-SALG is a research-proven survey for measuring changes in civic mindedness and civic engagement, which were applied to the ACES program. The Baseline survey is implemented as each student enters the ACES program. The SALG survey is implemented annually near the end of the academic year. The mid-year survey provides formative data with which we can make mid-year shifts so the methods could be more effectively implemented. A faculty member outside of the STEM area directs the Focus Groups to obtain additional insights on several methods. Finally, students are interviewed at the end of their senior year to provide feedback on all of the ACES program.

4. Reflective Activities are essential to experiential learning. Four service project reflections throughout each academic year are already implemented in the Scholars Program. The Leadership Minor includes a reflective portfolio with the final course in the minor. ACES students participate in both Scholars and the Leadership Minor. The reflective activities used in each program are provided to the PIs as another source of information.

<table>
<thead>
<tr>
<th>Assess Progress towards our goals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 1: Recruit Diverse Students to STEM fields x x x x x</td>
</tr>
<tr>
<td>Objective 2: Retain 85% of scholarship recipients in a STEM field x x x x x</td>
</tr>
<tr>
<td>Objective 3: Increase civic mindedness and engagement among participants x x x x x x x</td>
</tr>
<tr>
<td>Objective 4: Achieve STEM placement for 90% of the program graduates x x x x x x x</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assess the effectiveness of the following methods:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scholarships x x x x x x</td>
</tr>
<tr>
<td>Cohort Formation x x x x x</td>
</tr>
<tr>
<td>through Scholar’s Living-Learning Community x x x</td>
</tr>
<tr>
<td>through ACEs weekly meetings x x x</td>
</tr>
<tr>
<td>through peer mentoring x x x</td>
</tr>
<tr>
<td>through living together beyond the 1st year x x x</td>
</tr>
<tr>
<td>Mentoring x x x</td>
</tr>
<tr>
<td>through being a peer mentee x x x</td>
</tr>
<tr>
<td>through being a peer mentor x x x</td>
</tr>
<tr>
<td>through working with a faculty mentor x x x</td>
</tr>
<tr>
<td>through working with a professional mentor x x x x x</td>
</tr>
<tr>
<td>through professional development seminars x x x</td>
</tr>
<tr>
<td>Impactful Projects x x x x</td>
</tr>
<tr>
<td>Annual service projects x x x x</td>
</tr>
<tr>
<td>Scholars research project x x x</td>
</tr>
<tr>
<td>Off site REU x x</td>
</tr>
<tr>
<td>Internship/Part-time work in STEM x x</td>
</tr>
<tr>
<td>Student Directed Flexibility x x x</td>
</tr>
<tr>
<td>through selecting and leading a project x x x</td>
</tr>
<tr>
<td>through changing some aspect of the program expectations x x</td>
</tr>
<tr>
<td>Metacognition x x x x</td>
</tr>
<tr>
<td>through project reflections x x x x</td>
</tr>
<tr>
<td>through leadership portfolio x x x</td>
</tr>
</tbody>
</table>

Figure 2: Assessment Plan
Results

At the mid-point in this S-STEM grant, the assessments have indicated a variety of successes and challenges. Here, we summarize the mid-program results in terms of meeting the four Objectives, followed by the effectiveness of the Methods.

Objective 1: Recruit Diverse Students to STEM fields
Since the inception of the program we have admitted 16 students with an average ACT of 29.2 to the ACES program. We interpret diversity broadly. There are 8 women and 8 men, 15 Caucasian/white and 1 African American, 7 rural, 1 urban, and 8 suburban, and two first generation students.

Objective 2: Retain 85% of scholarship recipients in a STEM field
Of the 16 students admitted, one dropped out of college after his first semester and one switched to Psychology which removed him from the cohort. The remaining students are either still majoring in STEM (11) or have graduated (3). This gives us a retention percentage of 88%.

Objective 3: Increase civic mindedness and engagement among participants
In Spring 2017, eight of the ten ACES students completed the SENCER-SALG survey to measure increases in civic-mindedness and engagement. Students self-assessed their learning, attitude, and habit gains on scales ranging from no gains to great gains to indicate how they have changed over the academic year as a result of participation in the ACES program. These qualitative scales were converted to an integer 0-4 scale for determining average scores across the group. Key findings from this survey include:

- Six of the nine students rated the highest level, great gains (4/4) in understanding the connections between science and civic issues relevant to my community, giving an overall average of 3.6 on a 4-point scale.
- Eight students claimed their participation in ACES led to good or great gains in interest in civic issues. One student wrote, “I continue to be interested in addressing civic issues but have a greater interest in finding ways to address civic issues which also utilize my STEM skills. Before these projects, I struggled to see how my STEM knowledge could be applied to address civic issues.” Another student noted, “My appreciation and interest in participating in civically oriented projects and organizations has increased through ACES, and as I graduate, I intend to continue this volunteerism.”
- Students rated their participation in ACES led to the full range from no gains to great gains in various civic engagement habits, with average scores between moderate (2/4) and good (3/4) gains.

Objective 4: Achieve STEM Placement for 90% of the program graduates
Currently we have three ACES students who have graduated from the college while still a part of the program. One double majored in communications and creates online content about STEM topics such as fertility, fitness, and health. A second student is working on his PhD in biochemistry at the University of Notre Dame. A third student spent a year as a research assistant at the Mayo Clinic and is currently interviewing for top MD/PhD programs (Harvard, etc). A student who was with us through her fourth year chose to extend her education a fifth year and already has a job as an Analyst at an insurance company following graduation in May 2018.
The data indicate that each method is implemented well and is generally effective, but questionnaires and focus groups have elucidated areas of strength as well as room for improvements. Results from the 2016-17 and 2017-18 mid-year formative surveys and the Spring 2017 focus group are summarized below.

**Scholarships**
In the mid-year surveys, all but one student found the scholarship to make a difference. Twenty-two percent of responding students in 2017 mentioned that they would not have attended Wartburg College without the scholarship, which rose to 56% of responses in 2018. Over the two years of data, 25% of the students claimed they very likely would have left the college without the scholarship. The remainder found the financial impact to not be the key feature of their recruitment to study a STEM major (Objective #1) at Wartburg. The scholarship reduced the need for outside employment for 56% - 89% of respondents, which could impact their academic performance and retention (Objective #2).

**Cohort formation**
Weekly meetings, impactful projects, and peer mentoring were most effective in developing cohort formation. One student wrote, “By working together on a project, friendships and connections have been made.” Another student supported the claim that making meaningful relationships can impact retention (Objective #2) by writing, “Being forced to connect with someone who has a lot of experience here helped me with adjusting to college.” In the focus group and in the surveys, students shared a desire for more team-building social activities, such as an escape room, to better develop relationships with all ACES scholars, especially with those not connected through projects and mentoring.

**Mentoring**
Peer mentoring appeared to be very effective for some students, and ineffective for others, with a full range of responses (1 Not at all, 2 A little, 3 Somewhat, 4 A great deal), and average score of 2.3-2.7 on the related questions in the 2017 mid-year survey. Most of the constructive criticism in the survey and focus group was aimed at wanting more time dedicated to peer mentoring outside the weekly meetings. We used this formative information to make a few important changes to the peer mentoring programming. First, the co-PIs were able to be more intentional about selecting the pairings of upperclassmen with younger students, matching both by major and by personalities as we have worked with these students long enough to know them better. Second, the mentoring time during weekly meetings included specific, relevant guiding questions, such as “How do you prepare for Finals Week? What is most effective for you?” Third, rather than stick to a pre-determined time limit and cut students off mid-discussion, we let students mentor each other until they seemed to be done. This took a few minutes away from project work time, but was a good compromise. The 2018 mid-year survey questions related to peer mentoring effectiveness still included a full range of responses, but the average scores for each question notably increased to 2.9-3.3 on the 4-point scale.

Students rated mentoring from the co-PIs to be highly effective and providing a positive impact on their professional growth (3.4 – 3.8 on 4-pt scale), noting “The ACES faculty are all great mentors - they do a great job of encouraging students to make the most of their time at Wartburg.
and in the ACES program. They also do a great job of keeping us accountable in finishing our service projects.” In 2018, a student wrote, “Working with the ACES faculty has benefited me by helping me to understand the best ways to branch out and help my community.” This is evidence that this student is progressing towards a lifetime of civic engagement (Objective #3), as a result of their participation in the ACES program.

Students noted that their Project Advisor, another faculty or staff at the college, was quite helpful (3.2 – 3.7 in 2017, 3.0 – 3.4 in 2018 on 4-pt scale), writing “My faculty project advisor has been eager to provide ideas and feedback that help push our outreach program in the right direction. She is always supportive and available, and she provides outside-the-box thinking to add creativity to our work.”

The professional mentoring had mixed results, ranging from no relationship developed at the time of the mid-year survey to exceedingly helpful. Professional mentoring was intended to help with retention (Objective #2), but may also be helpful for job placement (Objective #4). One student shared, “My community partner is an architect, which is what I want to be. He met me for lunch one day and told me all about his journey to get to where he is. He even mentioned trying to set me up with an internship in the future that he once did. It has been very beneficial to have him as a community mentor. I feel as though he provide me with a lot of information and advice that I seek, and also he can open doors to opportunities I may not find otherwise.” We were surprised to see that two students who had very effective professional mentoring experiences in 2016-17 had little to no contact with those same mentors in 2017-18, showing that these relationships are not always self-sustaining after the first year.

Impactful projects
ACES students spend the majority of their program time working on the STEM service projects, and it is clear that project work develops these students towards becoming civically-engaged STEM professionals. Students indicated that the project work has very positive impacts on improving their STEM skills (3.2 in 2017, 2.9 in 2018), solving community problems (3.6, 3.2), communicating to a general audience (3.7, 2.9), working on a diverse team (3.7, 3.5), and increasing their motivation for classes (3.6, 2.9). These projects appear to be helping students increase civic mindedness and engagement (Objective #3), as one student wrote, “I have enjoyed the opportunities I have had to give back to the community via the service projects. It has given me a larger appreciation for the concept of service as a whole and opened my eyes to the importance of using the skills we have to help our communities.”

Student-directed flexibility
This method has been the most difficult to assess because students appear unaware of this aspect of the project. The co-PIs have mentioned this method at the first meeting each fall, but it is the least understood and most poorly implemented aspect of the ACES program. We have few points of assessment for this method, and student responses should be not applicable for all students except those who formally request a change in their programming. Only one student has filed the student-directed flexibility form, and the alternative activities failed to materialize. In a quantitative sense, we are at 0% success rate in formal student-directed flexibility requests.
Metacognition
When asked about the impact of weekly service logs and project reflections, most students focused on the improved accountability associated with the weekly logs. Two students resisted the weekly logs as either a painful reminder of work not accomplished in a given week or as a meaningless task on their already busy to do list. One student commented on the reflections as being a time to discover the meaning in their activities, and two students see the reflections and weekly logs as an opportunity for self-assessment towards future improvements.

When asked to identify the most beneficial aspects of the ACES program, students selected the impactful projects, professional development activities, and mentoring.

Conclusions: Lessons Learned and Future Work

Over the past 2.5 years of implementing the ACES S-STEM program at Wartburg College the PI team has learned a number of things that were somewhat surprising to us. In this section we share them to help inform future S-STEM proposals.

1. Even the top students can struggle as they transition to college.
Our cohort members are selected from top achieving high school students. Many of these students have never struggled academically and are used to being the best at everything they try. Once they get to college and find themselves in environments where many others were also the best, they may experience some struggles that they have never encountered before. Often they are also less likely to reach out for help in such situations. After we had a freshman fail to return for the second semester in our first year of implementation, the PIs decided to take a more active role in mentoring our freshmen students and tracking their progress through their coursework.

2. Students seem to struggle to find the time to take the projects as far as we had hoped.
When setting up the expectations for this program in general and more specifically, the STEM service project, the PIs determined that an expectation of 5 hours a week of work on ACES activities would be a reasonable. With scholarships of $10,000 this averages out to the equivalent of being paid $75/hr. However, weekly logs indicate that that students very rarely log anywhere close to 5 hours a week. This then becomes evident in the lack of depth and involvement of the projects. To address this, we have attempted to make our expectations clearer to our students and work with them at setting and achieving more ambitious goals for their projects. We still need to determine how we can better hold them accountable.

3. Students are resistant to adding more to their course load and busy schedule.
The same kind of students who are competitive in a scholarship program focused on passion of STEM and service are also likely to be extremely overcommitted in college. Thus, despite making the expectations of the program clear from the start, we have received some pushback from students who find various components (ie: Leadership Minor, Scholar’s Program participation, or weekly meetings) too much to add to their schedules. This attitude probably stems from the fact that this S-STEM program is somewhat unique at Wartburg in that it has requirements and expectations attached to its scholarship. Additionally, none of the ACES
specific work (projects, weekly meetings, mentoring, etc) is credit bearing and thus tends to get less attention in students’ minds than their classes and music or athletic commitments. We have worked to make the expectations of the program clear from the application stage and have also explained to students the value derived from the various components and given them the flexibility of identifying other activities that meet the same goals in their development to substitute if they desire.

4. Program flexibility is important and needs to be documented for accountability. The student driven flexibility is an important feature of this program in that it allows our students to benefit from the many opportunities that Wartburg provides them and to better fit the program to their needs. For example, we have had a student study abroad and arrange to complete her program requirements (service and professional development) independently. Unfortunately, many of our students do not seem to be aware of these opportunities and thus are not making use of them. We also need to determine ways to hold students accountable for recording and carrying through the alternative requirements arranged for them.

5. Staggered implementation is a valuable tool. Out of necessity, we have used a staggered implementation method for this project. While the key aspects of the project were implemented from the start, other aspects like some of the assessment activities and the professional mentoring were or will be implemented in subsequent years. This was found to be was very valuable in that it (a) allowed us to incorporate early observations and feedback into the design of the assessment questions and approaches, (b) allowed us to establish on-campus recognition and some successes before approaching on-campus offices for assistance, and (c) allowed us to better manage the PIs workload.

6. External Advisory Boards are extremely valuable. We have found our annual meetings with our External Advisory Board to be very valuable. They have been very supportive of the project and have given us excellent feedback and ideas for improvement. Their external voice has helped us to confirm the reasonability of our high expectations. They have also provided resources from their own areas of expertise that we have modified for use with our students. They serve as a professional audience for our students to present their projects and have provided some valuable feedback, encouragement, and accountability to them as well. Finally, simply holding this meeting annually has forced the PIs to reflect on the progress of the project and has improved the outcomes.

Overall, the ACES S-STEM program has had a successful start and we look forward to further success in the coming 2 years. In focus groups performed as part of our assessment work, the students were very positive and said that they benefit from the ACES program. They identified projects as interesting and helpful and responded enthusiastically even while acknowledging that they were difficult. They seem to have formed beneficial relationships within their cohort and with the faculty that they have worked with through the program and feel more connected with their major and field of interest. We have made significant progress towards achieving our goals and have strategies in place to move us forward through the next 2 years.
References


