

Section 1. Accomplishments

- 1) What are the major goals of the project?

Project Abstract

Recognizing that engineering and computer science are making concerted efforts to increase the diversity of students in their academic programs and in the workforce, the multi-institutional research team proposes a two-pronged approach: (1) To provide scholarships to a diverse population of low-income academically talented students with financial need and (2) to adapt, implement, and test a student experience model designed to increase the success of students in those fields. The model includes a set of well-established evidence-based practices that form an ecosystem of academic and co-curricular supports for students and is designed to foster retention, transfer, and graduation in STEM. The primary disciplinary foci are Electrical, Computer, and Software Engineering (ECSE) with the inclusion of cyber-security at Iowa State University, Des Moines Area Community College, and Kirkwood Community College. To broaden the impact of the effort, the proposal team seeks funding to conduct two research studies. The qualitative phenomenological study is designed to investigate and understand the development and maintenance of professional/career identity. The quantitative comparison study is designed to investigate the influence of individual motivation and the characteristics of the academic and social environments of electrical, computer and software engineering, including cyber-security, on student success, retention, transfer, and degree attainment. The project plans to award a total of 582 scholarships to 272 students (100 unique scholars at Iowa State University; 90 unique scholars at Des Moines Area Community College; and 82 unique scholars at Kirkwood Community College).

Project Overview and Goals

The S-STEM project, ECSEL: Electrical, Computer, and Software Engineers as Leaders, is a multi-institutional collaborative effort among Iowa State University (ISU), Des Moines Area Community College (DMACC), and Kirkwood Community College (KCC) providing scholarships for students majoring (or preparing to transfer) in electrical engineering, computer engineering, and software engineering. The total number of scholarships expected to be awarded across all three institutions over five years is 582. The project is implementing and testing a student experience model that leverages existing program elements from ISU's Department of Electrical and Computer Engineering, College of Engineering, Program for Women in Science and Engineering, DMACC, and KCC. The ECSEL student experience consists of common practices and supports that span institutions including: learning communities, leadership development, professional development, academic support such as tutoring, academic advising for the ISU Engineering Basic Program, academic preparation for the ECSE field (including cyber security), and state and national resources for inclusive ECSE career awareness, recruiting and teaching. Research studies are exploring how diverse students in ECSE develop and sustain their engineering identities, and what drives these students to thrive and persist in ECSE degree programs.

The objectives of the project are to:

- 1) Pursue S-STEM goals (SS1-SS3) to recruit and retain diverse students in electrical, computer and software engineering (ECSE) disciplines.

(SS1) To increase the recruitment, retention, transfer, student success, and graduation of low-income academically talented students with demonstrated financial need who pursue baccalaureate degrees in STEM and enter the STEM workforce or graduate study;
(SS2) To implement and sustain effective, supportive curricular and co-curricular activities, practices, and strategies for students in (SS1); and
(SS3) To study models and activities in (SS2) and contribute to understanding the factors that affect academic/career pathways of students in (SS1).

- 2) Implement a scholarship program and student experience that support various ECSE pathways, emphasizing leadership development and professional preparation.
- 3) Coordinate key activities (practices, supports, curriculum, prior results, models and studies) across institutions to enhance transfer student success.
- 4) Investigate research questions to study the effect of project activities and better understand and influence student success and department culture.
- 5) Establish a community of practice for ECSE faculty to support their mentoring of students, inclusive teaching, and understanding of student success based on research findings.
- 6) Improve diversity and inclusion in ECSE programs, leveraging and enhancing support for women and other students from underrepresented groups.
- 7) Strategically manage the organizational, financial, data, and communication aspects of the project within and across institutions.
- 8) Evaluate project effectiveness, outcomes and impacts.
- 9) As broader impacts, improve educational pathways and contribute to a diverse workforce prepared to address societal needs including the nation's information infrastructure and security.

A logic model approach is being used for project management and evaluation. The logic model summarizes project resources, activities, outputs, outcomes and impacts, including measurable student, program, and process outcomes. The logic model is uploaded with this report.

Expected outcomes for the project include these targets for enrollment, retention and graduation:

- Increase the percentage of undergraduate women enrolled in ECSE degree programs to 16%, thus doubling the number of women enrolled from 120 to 240.
- Attain 1-year and 2-year retention rates of 86% and 80%, respectively, for female students in ECSE majors and ECSEL scholars.
- Attain a 6-year graduation rate of 55% for female students in ECSE majors and ECSEL scholars.

The outcomes are being pursued through the ECSEL student experience. The ECSEL student experience uses many existing high-quality, evidence-based program elements, drawing on results from past NSF projects, experts at ISU, and leading researchers. Two complementary research studies are underway to contribute to the knowledge base. One research study is exploring how diverse students in ECSE develop and sustain their engineering identities. The study is examining engineering identity development through the use of Social Cognitive Career Theory (SCCT). This research study is using a phenomenological approach to examine the lived experiences and engineering identity development of ECSEL students using SCCT. The other study is using Self-Determination Theory (SDT) of motivation to understand how the environment can support diverse students to seek out ECSE programs and to persist in completing ECSE degrees. Most environmental supports have not been related to SDT. The study is examining whether environmental supports positively affect students' perceptions of competence, autonomy, and belongingness and directly and indirectly affect their satisfaction with ECSE majors and intentions to stay in an ECSE program.

The broader impacts outcomes of the project include: opportunities for low-income academically talented students with financial need; partnerships with community colleges, industry, diversity programs, and researchers to broaden participation of diverse students in ECS engineering majors; development of diverse workforce in ECS engineering fields; improved education pathway through the community college into ECS engineering degree programs; engagement with ECS engineering by prospective students, parents, teachers; and capacity-building in cyber security to support national security.

This is a collaborative report prepared by ISU, DMACC and KCC. The accomplishments sections of this report are organized by institution, with each institution's section having subsections aligned with the goals of the project.

Iowa State University

Ten students were awarded ECSEL scholarships starting spring 2017 to form the first ECSEL cohort. These were all current students in ECSE majors. An additional 23 scholarships were awarded starting fall 2017, comprised of 10 current students and 13 incoming students new to ISU. For management purposes, we have divided these scholars into the following groups (note that ISU's school colors are cardinal and gold):

- Gold Scholars: Scholars who joined the ECSEL program in a previous year (10)
- Cardinal Scholars: Scholars who joined the ECSEL program in the current year (23)

In addition, the cardinal scholars are divided into two groups: incoming (13) and advancing (10). Incoming cardinal scholars are newly enrolled at ISU. Advancing cardinal scholars were previously enrolled and are continuing in their academic programs. Incoming scholars are typically freshmen or transfer students, although some students from high school enter with sophomore classification due to earning college credits. Advancing scholars are sophomores or higher. These groupings reflect the need to support students at different entry points into ECSE majors.

Among the 33 ECSEL scholars in the program as of fall 2017, 13 are CPE majors, 7 are EE, and 13 are SE. They include 8 freshmen, 9 sophomores, 8 juniors and 8 seniors. There are 32 women. Six scholars are from underrepresented minority (URM) groups (18% of scholars), including one male student. As described below, the recruitment and selection process for the first year was directed toward women students with balanced representation across majors and classifications. Ongoing and future recruitment and programming are expanding to other diverse students.

Table 1 (see attached) summarizes undergraduate enrollment in ECSE majors at ISU as of fall 2017. ISU engineering programs have had record enrollments in recent years. Enrollments have started to level off, with EE seeing a decrease this year. SE continues to grow, and CPE remains the largest of the three majors. The percentages of women and URM students have increased among total students and within each major, with larger increases in URM students. The exception is the latest percentage of URM SE students, although the number of students has increased, and the percentage is one of the highest. The number of women and URM students in EE have decreased, although not as steeply as total EE students.

Scholarship Program Recruitment, Selection and Administration

As summarized above, 33 ECSEL scholarships have been awarded. Recruitment began fall 2016 and has been ongoing with a rolling applications process aligned with College of Engineering and university timelines for consideration and notification. Scholarship information, requirements, instructions and online application forms for both incoming and current students are available from

the ECSEL website under the “Interested Students” page (see attached):
<https://ecsel.ece.iastate.edu/students/interested-students/>.

ECSEL team members work closely with department and college student services staff to coordinate recruiting opportunities and scholarship administration. During year 1, current students meeting eligibility requirements were emailed information about the scholarship program and invited to apply. In addition, ECSEL team members, ECSE academic advisers and WISE Program staff reached out to potential students, including holding informational sessions. A marketing flyer was also created (see attached) and used by academic advisers and WISE, including at the annual spring “Engineering Scholars’ Day” when prospective (incoming fall 2017) students and family visit and participate in sessions on campus. Emails were also sent to eligible prospective students in the spring. Academic advisers continued to identify potential students during summer orientation.

Applications are compiled in an intranet database and reviewed by an ECSEL scholarship committee. The committee made decisions based on eligibility and a broad set of factors. The first scholarship cohort starting spring 2017 is now referred to as gold scholars. These scholars have diverse backgrounds and experiences and are well-positioned to serve as near-peer role models for future scholars. During spring semester, the committee made selections for scholarships starting fall 2017, referred to as cardinal scholars.

Student Experience Planning and Implementation

The ISU ECSEL student experience uses evidence-based practices to support scholars through graduation using a variety of academic and extracurricular activities focused on professional and leadership development. We are using the proposed student experience model as a roadmap, as depicted at the website (<https://ecsel.ece.iastate.edu/students/>) and shown in Figure 1 of the attached 2016 Frontiers in Education Conference paper.

During spring semester 2017, the ECSEL scholar cohort met weekly with ECSEL ECE team members to learn about the program and share information, interests, ideas, insights and experiences. A Blackboard LMS site was maintained for the group (see attached), and weekly meetings were documented in a wiki. The scholars also set up a Slack workspace for communication, which was also available to team members. Cohort-building and leadership development were fostered through an outreach service learning project to create and offer a WISE Taking the Road Less Traveled (TRLT) session for high school girls in April 2017. The scholars used an Adafruit kit for a “sunscreen reminder hat” to provide participants with a fun hands-on design activity involving ECSE skills and using technology to help people. A few slides with photos and information from the event are attached. The scholars also led a department FAN (Friday AfterNoon) Club in September 2017 to promote TRLT outreach to other students. This cohort began planning for the Grace Hopper Conference last spring, and 9 of the 10 scholars will be attending GHC in October. This cohort also helped team members set up newly allocated space as an ECSEL Lab in Coover Hall dedicated for their use.

A welcome open house was held for all ECSEL scholars at the start of fall semester 2017, launching the following meeting plan for 2017-18. Scholar meetings are held biweekly for all three scholar groups (gold, cardinal-advancing, cardinal-incoming). Cardinal scholars are expected to attend regular meetings for their first year in the program. Gold scholars have flexibility and may attend cardinal scholar meetings. Scholars participate in monthly meetings with ECSEL faculty mentors. Meetings are held as needed to participate in various ECSEL student experience activities and discussion sessions for CPRE/EE/SE 166, 294, and 394. Fall semester meeting topics include: orientation; mentoring; sketchnoting; professional networking; leadership; and design thinking. Spring semester meeting topics include: cybersecurity and other grand challenges;

diversity and inclusion in engineering; teamwork; systems thinking; agile work model; and global awareness. Flexible activities include: project-based learning; leadership development through selected ECSEL student experience activities and leadership roles; discussion topics; peer mentoring for ECSEL scholars; and industry networking. Selected WISE leadership programming is being coordinated for ECSEL scholars. All cardinal-incoming scholars are participating in a learning community (WISE, CPE, EE, and/or SE).

Faculty Engagement

ECSE faculty members are involved as project team members and mentors and also have scholars in their courses. Student-faculty interaction is both formal and informal. The formal faculty mentors include Phillip Jones, Diane Rover and Joe Zambreno (CPE students); Julie Dickerson, Mani Mina (coordinator), and Gary Tuttle (EE students); and Doug Jacobson, Suresh Kothari, and Kristin Rozier (SE students). Each mentor is assigned a small group of scholars and will be involved with a meeting topic or lab project. The following resources were selected for mentor training: selected chapters of *The Mentor's Guide*, Lois Zachary; *Talk to Me* materials, EngageEngineering.org; *Mentoring and Women in Engineering*, Catherine Amelink (SWE-AWE-CASEE); and *Mentoring and Diversity: A Handbook for Faculty Mentoring*, LSAMP Indiana.

The ECSEL project is being conducted in tandem with the NSF RED-funded RIDE project in the department. Faculty are involved with RIDE activities and change processes. The projects are synergistic in various ways, and we use both projects to engage faculty to support student success.

Diversity and Inclusion Support

ECSEL partners with diversity programs on campus including WISE, LEAD (multicultural students in engineering) and student organizations such as Digital Women and SWE. WISE Program staff are directly involved with project planning and activities, and WISE activities are part of the ECSEL student experience. The ECSEL team draws on the expertise of team members and researchers who have various experience with diversity and inclusion in programs such as ISU ADVANCE, WISE and their research. In concert with the RED RIDE project, there are efforts to enhance awareness and understanding among faculty and staff in the department. For example, a classroom implicit bias module from the college's Diversity and Inclusion Committee was discussed at a faculty meeting. Faculty and staff are encouraged to participate in ISU CELT seminars and workshops, such as the Inclusive Classroom Faculty Development Workshop.

Research Studies

Two research studies are underway: 1) ECSE identity development of ECSEL students, and 2) student motivation and the characteristics of ECSE academic and social environments. The research activities are synergistic with an NSF RED project in the department (<https://ride.ece.iastate.edu>), being conducted in tandem with the ECSEL project. A research and evaluation retreat for project team members was held at the end of fall semester 2016 to review and coordinate activities. Comments and feedback were collected and documented.

The identity research team is led by Sarah Rodriguez and includes three graduate students (one doctoral and two masters). Year 1 of this study focused on the recruitment of participants, rapport-building, and the beginning of data collection for ISU. This research study utilized a phenomenological approach to examine engineering identity development in the experiences of six undergraduate women involved in the ECSEL program and majoring in ECSE academic programs at a predominantly white public institution.

Student Questionnaire. This study utilized a questionnaire which was administered to participants at the beginning of the study in order to gather demographic and background information. In addition, the questionnaire also had items addressing engineering experiences at the institution. Data received enabled the researcher to create greater understanding of the student participant profile for the group as well as be able to tease out any aspects of a student's experience that might need to be explored in more depth during the interview and journaling processes.

Phenomenological Interviews. Each student participated in one semi-structured interview. Interviews lasted approximately one and a half hours and were digitally recorded and transcribed verbatim for analysis. Individual interviews allowed the researchers to delve more deeply into the participant's experience, particularly around engineering identity development and clarify issues which were unclear to the researcher.

Student Reflective Journals. Participants were asked to engage in an on-going process in which they kept electronic reflective journals of their engineering experiences and subsequent engineering identity development. Students were given from 4-5 questions bimonthly as a means to reflect upon their experiences and interactions with others (e.g. with faculty, peers, family) as well as a place to provide reflection on their engineering identity development.

Analysis. Using a phenomenological analysis approach, the researchers engaged in a four-step data analysis process. In Step 1, the researchers set aside their beliefs about the phenomenon (epoche) which enabled them to be receptive to the meanings that students ascribed to engineering experiences. In Step 2, they read the transcripts to gain to their core understandings (eidetic reduction). In Step 3, they examined the meaning units that students created from their experiences and considered the phenomenon from a variety of standpoints (imaginative variation). In Step 4, they integrated meanings and defined the essence of the phenomenon utilizing raw transcript data to verify the results (synthesis and verification).

The identity team met regularly to discuss data collection, analysis, and preparation of a conference proposal for initial data collection period. These meetings helped to make decisions regarding study design and analysis as well as clarify direction of the identity study in terms of dissemination and publications. The graduate students assisted with the identity study by composing protocol questions, setting up infrastructure for data collection and management, analyzing transcript and reflections data, and preparing conference and publication materials. Year 1 data collection resulted in the production of one conference proposal to the American Educational Research Association.

Rodriguez and doctoral student Kelly Cunningham also attended regularly scheduled ECSEL meetings with the larger team to discuss grant activities and provide progress reports on the identity study. These meetings helped to facilitate recruitment of identity study participants through team member connections to the project and provide context for understanding the ECSEL experience for students.

Des Moines Area Community College. Year 1 of this study focused on recruitment and program rapport-building between the ISU researcher and the DMACC team, including conversations between stakeholders to understand the recruitment process of DMACC students, determine IRB requirements, and establish a working relationship between researchers and DMACC institutional partners. These relationships will be used to facilitate identity student recruitment in Fall 2017 and continued engagement throughout the duration of the grant.

For the second research study, the motivation/quantitative research team is led by Lisa Larson and Mack Shelley. During Year 1, this research team generated survey items, obtained IRB approval, set up a Qualtrix survey, and administered the survey in late spring semester 2017 to 10 ECSEL

scholars. The survey will be administered in the coming year to all scholars (33 as of fall 2017). A part-time graduate research assistant was hired in August to assist the researchers in 2017-18.

Evaluation

The evaluation team at ISU consists of Mari Kemis (RISE evaluator), Mack Shelley, and Mani Mina. They are regular participants in project meetings.

Evaluation activities for Year 1 focused on providing information for the NSF S-STEM data reporting. Data were successfully uploaded and submitted for ISU's ten Spring 2017 scholars in May 2017. Instructions and notes were developed to describe the database variables, data sources available through the ISU registrar's system and elsewhere, and timelines for future reference.

Scholars were also surveyed at the end of the Spring 2017 semester for their feedback on their participation in ECSEL, including what they saw as positive and also their suggestions for improvement. The majority of the scholars indicated that they liked getting to know faculty and staff in the ECE Department on a more personal level, as well as joining a community of other women in their field of study, many saying that they had not met any of the others before. Two scholars noted that they enjoyed participating in the Road Less Traveled activity with youth.

Several of the scholars indicated that they would like to structure their attendance through a required course. Some said they wanted more faculty involvement, industry visits, and additional group activities, especially where they can explore ideas through a collaborative and open environment.

Project Management and Coordination

The ECSEL project team is comprised of the PI and team members listed in the participants section of this report. The ECSEL ECSE team is a subset consisting of team members who are ECSE faculty and staff members. The entire project team met every two weeks during the year, and the ECSE team met weekly. Other subsets, e.g., research, evaluation, scholarship committee, met additionally as needed. A research and evaluation retreat was held in December to review and coordinate activities. In addition to conference calls with DMACC and KCC, a cross-institutional collaborative retreat was held in May. Topics included: project management (coordination, communication); academic and faculty-related activities (mentoring, courses/curriculum); student-related activities (scholar transfer process and transition support, student experience activities); and research and evaluation activities.

An online file-sharing repository was set up for the project team using CyBox, Iowa State's Box service. A project website was created, <https://ecsel.ece.iastate.edu>. A project manager (Megan Heitmann) was added to the project team through staff support provided by the Engineering Research Institute (<https://www.engineering.iastate.edu/research/eri/>). A graduate research assistant works with PI team members on project tasks as well as cyber security research. Three peer mentors, one each for CPE, EE and SE, were hired for 2017-18. A dedicated work/study space for the ECSEL scholars was allocated in Coover Hall. A visual identity for the project and scholars program was created around ECSE icons and "The Moth" statue and story tied to Grace Hopper (<http://archive.inside.iastate.edu/2008/1024/moth.shtml> , <http://www.publicartarchive.org/work/moth-0>) (see attached visual elements).

The news articles, publications, presentations and websites listed in the Products section support communication and dissemination to various audiences. Refer to the Dissemination section of this report.

Broader Impacts

Project activities supporting broader impacts during year 1 focused on providing opportunities for low-income academically talented students in ECSE; partnering with community colleges, diversity programs, and researchers to broaden participation of women in ECS engineering majors; improving the education pathway through the community college into ECS engineering degree programs (also noted in the DMACC and KCC sections of the report); and capacity-building in cyber security (refer to the DMACC section of the report for the new Iowa Cyber Security Hub).

Another potential broader impact of the project is institutional strategic planning that enhances the visibility of engineering education research and the capacity to conduct such research. Refer to the Institutional Impacts section of the report.

Des Moines Area Community College Accomplishments

Scholarship Program Recruitment, Selection and Administration

In Year 1, DMACC reviewed and finalized the scholarship selection criteria for the full and explorer scholarships. An online scholarship application was developed to pull information directly from the college student records system to determine student eligibility. In addition, marketing materials (website, fliers and targeted emails to eligible students) were developed to promote the ECSEL (full and explorer) scholarships targeting a diverse group of low-income academically talented students interested in pursuing baccalaureate degree studies. Sample marketing materials and scholarship criteria are uploaded with this report. Information is available at the DMACC ECSEL website: <https://www.dmacc.edu/ecsel> .

To date, seven full scholarships and one explorer scholarship have been awarded for the Fall 2017 semester. Engineering faculty and academic advisors are continuing to recruit qualified applicants to award additional scholarships for fall and spring semesters. ECSEL team members are visiting engineering orientation courses (EGR 100) at three campuses to promote scholarship activities as well as to ensure students are enrolled in appropriate transfer coursework.

Student Experience Planning and Implementation

During Year 1, the DMACC team adjusted the Student Experience Model (see attached) to ensure ECSEL participants receive leadership and professional preparation to ensure a smooth transfer for baccalaureate studies. ECSEL team members will be meeting with scholarship recipients to receive feedback about what specific programmatic aspects would enhance their experiences at DMACC and prepare to enter a diverse workforce.

Faculty Engagement

Faculty leaders have established a mentoring committee to recruit, train and match faculty mentors with the ECSEL scholars. The team is exploring opportunities to engage mentors in ECSEL activities at KCC and ISU.

Diversity and Inclusion Support

The DMACC team is collaborating with DMACC's Teaching and Learning Center on training opportunities. DMACC participates in an NSF INCLUDES grant (described below) that offers resources and pedagogy support for STEM faculty. A year 2 goal is to connect pre-engineering and computer science faculty with these resources.

CIRTL INCLUDES: Toward an Alliance to Prepare a National Faculty for Broadening Success of 2-Year and 4-Year STEM Students. (Award Number: 1649105)

This project is led by the University of Wisconsin-Madison and leverages strategic partners across the country (including LSAMP). It proposes to build the foundation for a national cross-sector alliance to increase the learning, persistence, and completion of underrepresented group (URG) STEM undergraduates across the entire higher education landscape, and thereby to increase their contribution to the U.S. STEM enterprise. DMACC, KCC, ISU and IINSPIRE LSAMP are actively involved in developing strategic goal #2 which aims to expand and strengthen faculty preparation specifically for 2-year colleges, where many URG students have their first STEM undergraduate experience. More information is available at:

https://nsf.gov/awardsearch/showAward?AWD_ID=1649105

Evaluation and Research

DMACC is prepared to complete the NSF S-STEM data reporting each semester now that scholarships have been awarded. The DMACC ECSEL team met with ISU evaluation and research team members to establish a qualitative research protocol for scholars. Plans are underway to connect scholars with the research team. In the coming year, DMACC will coordinate with ISU on a survey to examine opinions about activities, progress towards project objectives, and contextual factors (Fall 2017).

Project Management and Coordination

DMACC established an ECSEL leadership team with key representatives from engineering faculty, student services, institutional research, grants department, and administration to implement ECSEL grant objectives. The leadership team met regularly during Year 1 to establish marketing and scholarship procedures.

In addition to the executive team, two sub-committees were established to focus on scholar recruitment and selection and faculty mentoring. A staff member joined the executive team to work directly with ECSEL scholars and faculty mentors. The DMACC leadership organizational chart is attached.

DMACC representatives participated in a retreat with ISU and KCC teams to ensure institutional goals were aligned to accomplish our S-STEM goals.

Broader Impacts

DMACC is continuing to strengthen our ongoing transfer partnership with ISU's College of Engineering. During Year 1 of the grant, DMACC enhanced our Associate of Science (AS) Degree to ensure a smooth pathway for transfer students interested in STEM to transfer to the College of Engineering. Semester-by-semester guides based on math placement scores were added to the pre-engineering website. Advising and marketing materials were updated. Transfer conferences and recruitment events were held in collaboration with our transfer partners. Sample materials are attached.

An outstanding collaborative partnership that stemmed from the ECSEL grant is the establishment of the Iowa Cyber Security Hub with the goal of increasing cyber security professionals to meet the future workforce needs in Iowa. This initiative is led by ISU and DMACC. One of the lead members is ISU co-PI Doug Jacobson. The presidents of both institutions signed a memorandum of understanding in July 2017.

Specific initiatives will include: development of marketing materials to recruit students into cyber security fields, middle school and high school cyber curriculum development, establishment of DMACC Cyber Security Career Academy, enhanced curricular articulation with DMACC focused AS degree to ISU BS degree, development of an AAS Cybersecurity Degree, and professional certificate as a gateway to an ISU Master Degree in Information Assurance.

News releases on the cybersecurity partnership are attached and online:

<https://www.dmacc.edu/news/Pages/20170725.aspx>

<https://news.engineering.iastate.edu/2017/07/26/isu-partners-with-dmacc-to-create-iowa-cyber-hub/>

Kirkwood Community College Accomplishments

Scholarship Program Recruitment, Selection and Administration

In Year 1, KCC reviewed and implemented the scholarship selection criteria for the scholar and explorer level scholarships. The scholarship criteria are uploaded with this report. The KCC team collaborated with the Kirkwood Foundation to use their single scholarship application. The Kirkwood Foundation scholarship application process provided a list of potential ECSEL students. Faculty recruited potential ECSEL participants in STEM classes. One \$2500 ECSEL scholarship was awarded in spring 2017 to a female computer science major on a transfer track.

Student Experience Planning and Implementation

The ECSEL student experience continues to be developed as proposed and aligned with project goals. The KCC team supported the spring 2017 ECSEL scholar by providing transfer guidance and mentoring a computer science honors project. The scholar completed the project and has successfully transferred to the computer science program at the University of Iowa.

Faculty Engagement

During year 1, KCC team members:

- Promoted the ECSEL program at bi-annual math/science department retreats, and
- Sent curriculum materials to advisors at ISU to initiate the update of transfer articulation for Kirkwood computer science and engineering courses.

KCC faculty were also involved with various activities related to the ECSEL student experience, including updating engineering curriculum and facilities, co-advising the Kirkwood STEM-Club, mentoring Kirkwood student teams for programming and robotics competitions, and supervising and mentoring a scholar's honors project.

Diversity and Inclusion Support

The KCC team is collaborating with their campus IINSPIRE (Iowa, Illinois, Nebraska) LSAMP program to recruit diverse students and share programming, information and resources as

appropriate. For example, at the IINSPIRE Alliance annual conference, team members from KCC, as well as ISU and DMACC, participated in a half-day workshop on pedagogy, "Building Capacity on Your Campus." The workshop addressed how to build capacity on campus to make systemic changes aimed at increasing success and graduation rates of domestic students of color. Online, web-based resources were assembled at the NSF SERC (Science Education Resource Center, Carleton College) IINSPIRE web portal, <https://serc.carleton.edu/lsamp/workshops/feb2017/index.html>. The SERC web portal is a repository with numerous resources related to evidence-based, inclusive teaching practices.

Evaluation

Evaluation activities including providing information for NSF S-STEM data reporting. Data were collected, uploaded and submitted for spring 2017. KCC is prepared to complete S-STEM data reporting each semester. In the coming year, KCC will coordinate with ISU on a survey to examine opinions about activities, progress towards project objectives, and contextual factors (Fall 2017), as well as on research activities.

Project Management and Coordination

During year 1, the following organizational units participated in ongoing planning and implementation for the ECSEL project: Math/Science Department, Foundation, Finance, Institutional Research, Advising, Administration, Industrial Technologies Department, and Business & Information Technology Department. Additional administrative support for the ECSEL project was provided with a new staff member in the Math/Science Department, who duties include assisting the PI with project management and reporting.

KCC team members participated in a retreat with ISU and DMACC teams held on the DMACC campus in May 2017 to coordinate cross-institutional planning.

The KCC team is developing a webpage and other marketing materials for future recruitment efforts.

Broader Impacts

The ECSEL project has contributed to efforts to strengthen transfer pathways in areas of the grant between KCC and Iowa's three public universities. KCC is working on a formal articulation process for computer science and engineering classes between Kirkwood and ISU; finalizing an articulation agreement for computer science courses with UNI; and maintaining current articulation agreements for computer science and engineering with UI.

3) What opportunities for training and professional development has the project provided?

Various training and professional development activities were provided for and/or undertaken by team members, faculty, staff and students involved in project activities.

Professional development activities for ECSEL scholars are part of the student experience, as described in the respective ISU, DMACC and KCC sections of this report. Scholars have participated in program activities to advance their academic and professional development.

Several project team members attended education conferences during the year, not only representing and disseminating the project but also using programming for professional development, e.g., FIE, ECEDHA, WEPAN, and ASEE.

Five graduate research assistants have been involved with research and other project activities at ISU. The identity research team included these graduate students:

Kelly Cunningham, M.A. (ISU): Doctoral Candidate – Applied Linguistics & Human Computer Interaction

Ronnia Estes, B.S. (ISU): Masters Student – School of Education

MacKenzie Sissel, B.S. (ISU): Masters Student – School of Education

These students, supervised and mentored by Dr. Sarah Rodriguez, assisted with the identity study by composing protocol questions, setting up infrastructure for data collection and management, analyzing transcript and reflections data, and preparing conference and publication materials.

Another graduate student, supervised and mentored by Dr. Doug Jacobson, assisted the PI team with scholar programming and project communications:

Megan Reiman, B.S. Computer Engineering (ISU): Doctoral Student – Computer Engineering and Information Assurance

4) How have the results been disseminated to communities of interest?

The news articles, publications, presentations and websites listed in the Products section support communication and dissemination to various audiences. The launch and goals of the project have been communicated through several channels. Following the announcement of the award in fall 2016, there were news releases by ISU and the College of Human Sciences. A College of Engineering news article also appeared in April 2017 highlighting the ECSEL cohort. These are linked at the project website (<https://ecsel.ece.iastate.edu/about/news/>), appeared in social media feeds such as via Twitter, and are attached. The project was disseminated to local and professional communities, including the spring Engineering College Industrial Advisory Council poster session (by Mina and Zambreno), the spring ECE graduate student poster session (by Megan Reiman), and the 2016 IEEE/ASEE Frontiers in Education Conference (by Mina and Rover) (see attached poster and paper).

Year 1 data collection by the identity research team resulted in the preparation of one conference proposal to the American Educational Research Association. The American Educational Research Association (AERA), a national research society, strives to advance knowledge about education, to encourage scholarly inquiry related to education, and to promote the use of research to improve education and serve the public good. The AERA conference is international in scope and is one of the world's largest convenings focused on education with 14,000+ attendees each year. Presence at this conference is essential for broad dissemination of this project's findings.

Rodriguez, S. L., Cunningham, K., Estes, N., Sissel, M. (under review). SSTEM Successes and Challenges: Engineering Identity Development for Women in Computer, Electrical, and Software Engineering. American Educational Research Association, New York, NY.

5) What do you plan to do during the next reporting period to accomplish the goals?

Plans for year 2 are aligned with the project objectives and logic model. Activities described in this report for year 1 will continue to be implemented. A complete cycle of scholarship recruitment and selection will be conducted at each institution. Elements of the ECSEL student experience will continue to be put in place and fully implemented at each institution.

Evaluation activities for year 2 will consist of (1) a survey with team members at ISU, DMACC and KCC to examine opinions about activities, progress towards project objectives, and contextual factors (Fall 2017), (2) coordination with the research team to prepare and conduct a survey or focus group with ISU ECSEL scholars to examine their experiences in the program (Spring 2018), (3) management of the S-STEM student tracking data (Fall 2017, Spring 2018), and (4) development of an evaluation of broader impacts, including a review of departmental records, influence on pre-college students who attend activities with ECSEL scholars or within ECE, and impact of the cyber security program.

Section 4: Impact

1) What is the impact on the development of the principal discipline(s) of the project?

Through the ECSEL project, the three institutions are influencing the pathways into and through ECSE disciplines via the implementation of a scholarship program and student experience, emphasizing leadership development and professional development. Key activities in the student experience include scholarship cohort meetings, faculty and peer mentoring, service learning projects (e.g. participating in "Taking the Road Less Traveled (TRLT)" sessions offered through WISE program), outreach activities (e.g. promoting TRLT outreach through departmental seminars), and networking trips (e.g. attending the Grace Hopper Conference).

The project is expected to improve diversity and inclusion in ECSE programs, leveraging and enhancing support for women and other students from underrepresented groups. Two complementary research studies are also underway to explore how diverse students in ECSE develop and sustain their engineering identities, and to understand how the learning environment can support diverse students to seek out ECSE programs and to persist in completing ECSE degrees. These studies will not only inform and improve project activities, but will also allow us to better influence student success and department culture, through the establishment of a community of practice for ECSE faculty to support inclusive teaching, student mentoring, and understanding of student success. Ultimately the goal is to advance knowledge and support adaptation by others, and towards this goal the larger ECSE education community is being reached through collaboration and networking.

Coordination of these key activities (both the student experiences as well as models and studies) across the three institutions is expected to enhance transfer student success.

2) What is the impact on other disciplines?

There is an extensive collaboration between the ECSE and education communities within this project. Education and social science researchers at ISU are collaborating with project leaders and

conducting research students to advance knowledge in their fields and improve understanding of STEM student success.

The project may potentially impact other faculty as they can be assisted with leveraging ECSEL project activities as building blocks for the broader impacts expected in their disciplinary research grants. In this manner, faculty participation in ECSEL will help not only the project/students but also the researcher, the targeted audience, and other stakeholders. Faculty participants will potentially enhance the competitiveness of their research grants.

3) What is the impact on the development of human resources?

As a scholarship program, a primary goal of the ECSEL project is human resource development. Scholarships will be supporting cohorts of undergraduate student scholars, including transfer students and students underrepresented in ECSE disciplines. The project emphasizes student development, as well as opportunities for graduate research assistants working on the project. The Training and Professional Development section of this report highlights some of these opportunities.

The research studies will also impact student and faculty development, e.g., understanding the how ECSE students overcome barriers, make choices, and persist along their educational and career paths. A faculty team member has already reflected that working with scholars has already increased their awareness of diversity and inclusion issues as they relate to the classroom environment.

4) What is the impact on **physical** resources that form infrastructure?

At Iowa State University, interactions with the first cohort of ECSEL scholars quickly revealed that a sense of place / belonging would be enhanced through a designated workspace for scholars. Working with the leadership in the Department of Electrical and Computer Engineering, we were able to renovate a previous graduate student research lab into a designated activity room for ECSEL scholars, which has since become a central meeting space, open lab, and project space for organizational activities.

5) What is the impact on **institutional** resources that form infrastructure?

Another potential broader impact of the project is institutional strategic planning that enhances the visibility of engineering education research and the capacity to conduct such research. The ECSEL and RIDE projects have brought attention to and reinforced engineering education research collaborations at ISU. These high impact projects reflect both the college's new strategic research area in engineering education and the university's new visionary theme of global citizen and workforce development. As part of the development of the college's new strategic plan, the following new research area on engineering education has been defined.

Engineering Education: Strengthening Student Success and Inclusion. Engineering education is evolving to ensure successful graduates have acquired a combination of highly flexible technical expertise, creativity, an appreciation of societal needs, and the ability to function in an inclusive, collaborative global landscape. Engineering educators harness techniques known to enhance student engagement and learning to improve educational outcomes. These can be achieved through the use of evidence-based pedagogical approaches such as project- or problem-based learning and the use of new technologies including blended online learning tools and interactive classroom technologies. Engineering educators aim to be engaged in fostering an interest in, and an appreciation of, engineering in the K-12 arena to help sustain and grow the

pipeline of diverse students. Focus areas: Student engagement in large enrollment classes, problem based learning, inclusive teaching and mentoring, pedagogy, flipped and hybrid instruction, broadening participation, mastery based assessment, creativity in engineering, developing the T-shaped engineer, engineering for K-12.

6) What is the impact on **information** resources that form infrastructure?

The ECSEL team has been partnering with diversity programs on campus including WISE, LEAD (multicultural students in engineering) and student organizations such as Digital Women and SWE. Specifically, WISE activities have been an influential model for the ECSEL student experience, and WISE program staff have been directly involved with project planning and activities. Examples of program collaboration between WISE and ECSEL are evident in the project activities described in this report.

Opportunities for ECSEL team leaders to interact with admissions, financial aid, advising, and scholarships leadership at the three institutions has created opportunities for information exchange that would most likely not have occurred in the absence of this project.

The program materials, websites, assessment tools, and assessment data are information resources to support faculty, staff, students, and evidence-based practices. The web-based SmartSheet platform allows for online reporting and compilation of data for easy access, tracking, and management. All data reported by the three institutions in SmartSheet is compiled in worksheets (spreadsheets) that can be accessed and formatted to meet assessment and reporting needs. Included in SmartSheet is a student database for each of the institutions that allows project directors to track student participation, persistence in ECSE disciplines, graduation, and placement.

7) What is the impact on technology transfer?

Nothing to report.

8) What is the impact on society beyond science and technology?

Project outcomes will have a longer-term impact on industry, the economy, and ultimately their products and services through workforce development. The ECSEL program is creating a student-centered, inclusive learning environment that is attractive to diverse students. With the goal of increasing the percentages of female enrollment, retention, and graduate rate, these cohorts will broaden participation and will help in diversifying the ECSE workforce.

Logic Model
NSF S-STEM: ECSEL Scholarship Program (Electrical, Computer, and Software Engineering as Leaders)

Resources	Activities	Outputs	Outcomes	Impacts
<ul style="list-style-type: none"> • NSF funding • PI team (ISU, DMACC, KCC) • Leadership team (ISU, DMACC, KCC) • Faculty mentors (ISU, DMACC, KCC) • Peer mentors (ISU, DMACC, KCC) • Graduate assistants (ISU) • Research team (ISU) • ECPE Department chair and External Advisory Board • ISU Research Institute for Studies in Education (RISE) (external eval.) • ISU programs/resources: PWSE, LC, CELT • ISU offices: Financial Aid, Institutional Research, Registrar • ISU College of Engineering: Engineering Student Services, Engineering Career Services • ISU Digital Women student organization • DMACC offices/resources: Institutional Research, Financial Aid, Foundation, Program Development, Pathway Navigators, STEM clubs 	<ul style="list-style-type: none"> • Meetings of various team members • Meetings with external evaluator • Coordination and management of the project • Website development and maintenance • Implementation and integration of scholarship application and review processes • Management of scholar information • Design and implementation of the scholar student experience based on PWSE and ECPE activities and enhancements (see ECSEL Student Experience) • Promotion and adoption of inclusive teaching practices • Promotion of and preparation for industry and research internships for rising sophomores and juniors as part of the ECSEL Experience • Mentor training (faculty, peers) • Design and administration of participant and stakeholder surveys and interviews 	<ul style="list-style-type: none"> • Scholarships • ISU scholar database • DMACC scholar database • KCC scholar database • Scholar portfolios • Scholar recognition (e.g., news articles, social media) • Website and web analytics • Dissemination through presentations and publications • Data briefs • Reports • NSF S-STEM online database • Academic advising guidelines • ECSEL experiential learning kits • Recruiting and outreach marketing materials • Training and professional development resources • Research datasets 	<p>S-STEM Student Outcomes</p> <ul style="list-style-type: none"> • Degrees granted in electrical, computer, and software engineering • Students transferring from an associate to a baccalaureate degree program • Students successfully completing the Engineering Basic Program • Doubling the enrollment of women in ECSE majors (240), including transfers • 1-year (86%) and 2-year (80%) retention rates for female students in ECSE majors • 6-year graduation rate (55%) for female students in ECSE majors <p>Other Student Outcomes</p> <ul style="list-style-type: none"> • Increased student motivation, satisfaction and retention • Increased professional identity as an ECS engineer • Placement in ECS engineering-related jobs and graduate programs • Increased percentage of women enrolled and graduating with degrees 	<ul style="list-style-type: none"> • Outcomes lead to impacts on students, faculty, department culture, institutions, disciplines, and research knowledge base <p>Broader Impacts</p> <ul style="list-style-type: none"> • Expanding opportunities for low-income academically talented students with financial need • Increased partnerships with community colleges, industry, diversity programs, and researchers to broaden participation of women in ECS engineering majors • Development of a diverse workforce in ECS engineering fields • Improved education pathway through the community college into baccalaureate ECS engineering programs • Increased understanding of and engagement with ECS engineering by prospective students, parents, teachers (e.g., experiential learning kits)

Resources	Activities	Outputs	Outcomes	Impacts
<p>on each campus, learning communities</p> <ul style="list-style-type: none"> • KCC offices/resources • Cross-institutional programs: E-APP, IINSPIRE LSAMP • Institutional data • Statistical expertise • Conferences for student professional development and networking (such as Grace Hopper Conference, SWE Annual Conference) • Relevant literature, knowledge and evidence base • ISU Digital Repository • Center for Integrating Research, Teaching, and Learning (CIRTL) Network • WEPAN Engineering Inclusive Teaching (EIT) resources • NCWIT resources 	<ul style="list-style-type: none"> • IRB updates as needed • Compilation of assessment and evaluation information • Review of project outcomes • NSF S-STEM data collection and reporting • NSF annual reporting • Third-year review • Meetings of grantees and other researchers • Faculty/staff professional development related to inclusion and equity • Role-model training (students) • Outreach and recruitment through pre-college activities: IT-Olympics (HyperStream), Taking the Road Less Travelled, SWE University, ECPE Take Your Adventure Home, DMACC Discover/Explore Engineering, PLTW • Creation of ECSEL experiential learning kits • Marketing to prospective students • Design and administration of research studies • Dissemination of effective practices and research findings 		<p>in ECS engineering</p> <ul style="list-style-type: none"> • Advancement of leadership knowledge, skills and abilities <p>Other Program Outcomes</p> <ul style="list-style-type: none"> • Improved messaging and marketing to prospective students • Increased student-faculty interaction • Positive and coordinated student experience • Increased attention to evidence-based practices to support diverse students • Collaborative structures across units to effectively and efficiently support students <p>Process Outcomes</p> <ul style="list-style-type: none"> • Extent to which proposed activities are completed and achieving project objectives and outcomes • Extent to which contextual factors help and/or hinder progress toward project goals • Extent to which assessment, evaluation, and research results are used as inputs for continuous improvement • Effect of the project on individual and group attitudes/behaviors 	<ul style="list-style-type: none"> • Capacity building in cyber security to support national security

Table 1. Undergraduate enrollment in ECSE majors at ISU as of fall 2017.

Academic Year	15-16	16-17	17-18	15-16	16-17	17-18	Change F16 – F17	
Total ECSE Students	1792	2003	2065				+62	+3.1%
Total ECSE Women	159	190	204	8.9%	9.5%	9.9%	+14	+7.4%
Total ECSE URM	252	305	340	14.1%	15.2%	16.5%	+35	+11.5%
Computer Engineering	725	806	836				+30	+3.7%
Women	56	62	66	7.7%	7.7%	7.9%	+4	+6.5%
Women (URM)	11	14	24	1.5%	1.7%	2.9%	+10	+71.4%
URM	106	130	151	14.6%	16.1%	18.1%	+21	+16.2%
Electrical Engineering	614	629	546				-83	-13.2%
Women	61	63	57	9.9%	10.0%	10.4%	-6	-9.5%
Women (URM)	12	14	16	2.0%	2.2%	2.9%	+2	+14.3%
URM	74	76	72	12.1%	12.1%	13.2%	-4	-5.3%
Software Engineering	450	566	682				+116	+20.5%
Women	42	65	81	9.3%	11.5%	11.9%	+16	+24.6%
Women (URM)	12	18	17	2.7%	3.2%	2.5%	-1	-5.6%
URM	72	99	117	16.0%	17.5%	17.2%	+18	+18.2%

IOWA STATE UNIVERSITY

OF SCIENCE AND TECHNOLOGY

Electrical, Computer, and Software Engineers as Leaders (ECSEL)

The Scholarship

Electrical, Computer, and Software Engineers as Leaders (ECSEL) is funded by the National Science Foundation. It is a scholarship for incoming students, sophomores, juniors or transfer students majoring in electrical, computer or software engineering. ECSEL awards for the 2017-18 academic year will be in the amount of \$8,000 applied to your Iowa State University Bill.

Requirements

To be eligible for the scholarship, you must:

- be a U.S. citizen, permanent resident, national, or refugee
- be enrolled in Electrical, Computer or Software Engineering at Iowa State University during the fall 2017 semester
- have demonstrated financial need through FAFSA (Free Application for Federal Student Aid)
- complete an online application with 4 short-essay questions

Scholarship recipients will be required to participate in NSF-mandated scholarship-related data collection, involving both interview and survey activities about their experiences in ECSEL. Students will also be required to participate in an ECSEL themed student experience which will focus on leadership and professional development. Applicants will be encouraged to join learning communities in their major, such as Electrical and Computer Engineering Learning Communities, as well as group-specific learning communities, such as the Women in Science and Engineering (WiSE) learning community or the Leadership through Engineering Academic Diversity (LEAD) learning community for multicultural students. Scholars will have access to WiSE and/or LEAD programs.

Scholarships are renewable if participants remain in an electrical, computer, or software engineering degree program at Iowa State University, actively engage in the ECSEL program requirements and remain in good academic standing.

Application

**Incoming Student
Application**

**Current Student
Application**

Note: you will need an ISU net-id in order to log into the application.
To register for a net-id, follow [this link](#) and fill out the requested information (that includes your ISU ID number – see the comment under that field).

Incoming Students

Applications for prospective students are currently available online.

- Follow [this link](#) to access the application.
 - Note: you will need an ISU net-id in order to log into the application. To register for a net-id, follow [this link](#) and fill out the requested information (that includes your ISU ID number – see the comment under that field).

Current Students

Applications for current students are currently available online.

- Follow [this link](#) to access the application.

Essay Questions

The application includes four essay questions:

1. The grant that funds this scholarship seeks, amongst other goals, to improve diversity and inclusion in the Electrical, Computer, and Software Engineering (ECSE) programs at Iowa State, and to improve educational pathways and contribute to a diverse ECSE workforce. Given this information, please discuss your connection or commitment to diversifying STEM fields.
2. Please select one organization or club that you have been involved with and describe how this experience has impacted your growth and development as a leader.
3. How would you like to “change the world” and how will your interest in electrical, computer, or software engineering help you meet your goals?
4. Describe one science, engineering, or programming class / workshop / camp you’ve participated in. What did you like about it, and what would you like to see changed?

Questions?

For any questions about the ECSEL Scholarship Program, please contact:

Megan Heitmann, Project Coordinator

391A Durham Hall

heitmann@iastate.edu or 515-294-9735

This material is based upon work supported by the National Science Foundation (NSF) under awards [EEC-1565130](#), [EEC-1564795](#), and [EEC-1564748](#). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.

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ECSEL: Electrical, Computer, and Software Engineers as Leaders

Renewable \$8000/academic year scholarships for up to a total of 4 years!

Scholarship Requirements

- U.S. Citizen
- Enrolled in Electrical, Computer or Software Engineering at Iowa State
- Demonstrated financial need through FAFSA



ECSEL student experience through WiSE and ECE Department

- Learning communities
- Leadership development
- Professional development
- Academic advising and support
- Mentoring
- Co-curricular and extracurricular activities



For more information and to complete application: <https://ecsel.ece.iastate.edu/students/interested-students/>



IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering



This material is based upon work supported by the National Science Foundation under grant number 1565130. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

- ECSEL Scholars Program 
- Activities
- Announcements
- About the Program
- Discussions
- Groups, e.g., Scholars Groups
- Send Email
- Help

Activities



ECSEL:

Electrical, Computer and Software Engineers as Leaders



Welcome to the ECSEL Program



Scholar List

Scholar information including name, major, ECSEL group



Program Meetings by Semester (Wiki)






Industry Information



ECSEL Scholars Calendar

ECSEL Scholars

Today   **October 2017** ▼

 Print **Week** **Month** **Agenda** ▼

Taking the Road Less Traveled

Taking the Road Less Traveled is a one day conference for 8-10th grade girls to learn about science, technology, engineering, and math college majors through hands on activities and presentations.

BE THE GIRL
TO CHANGE
THE WORLD.



<https://www.wise.iastate.edu/outreach/taking-the-road-less-traveled-career-conference->

ECSEL Session, April 2017:

Technology is helping people to care for the sick and elderly, improve people's quality of life, combat the spread of disease, respond to emergencies, and inform and motivate people to stay fit. We see this in our own homes and communities and around the world. From the FitBit on your wrist to robot-assisted surgery to first-response systems, the fields of computer, electrical and software engineering are making a difference in people's lives. In this session, you will see and do engineering work in these fields related to healthcare.

TRLT participants with their hats:



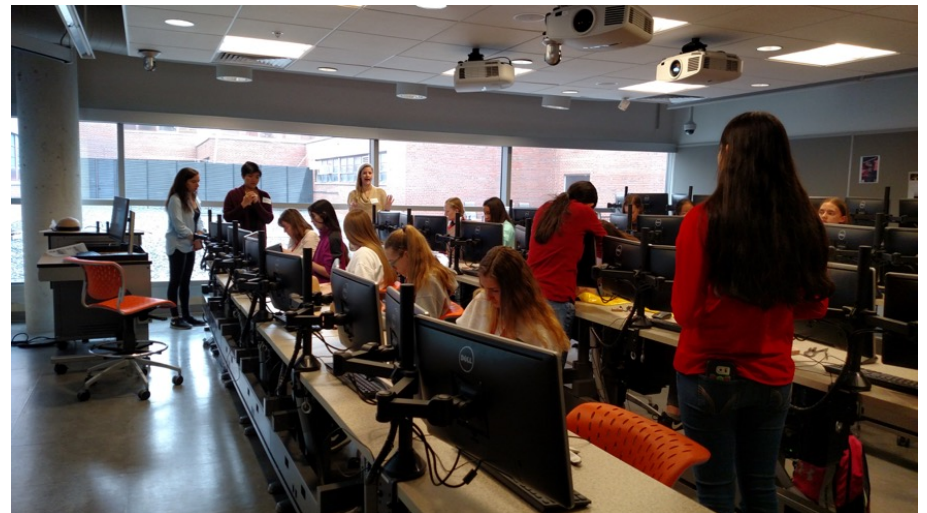
Hands-on project for TRLT participants:
Sunscreen Reminder Hat, Adafruit

<https://learn.adafruit.com/sunscreen-reminder-hat/>

Plus demonstration of MIDI Drum Glove project:

<https://learn.adafruit.com/midi-drum-glove/overview>

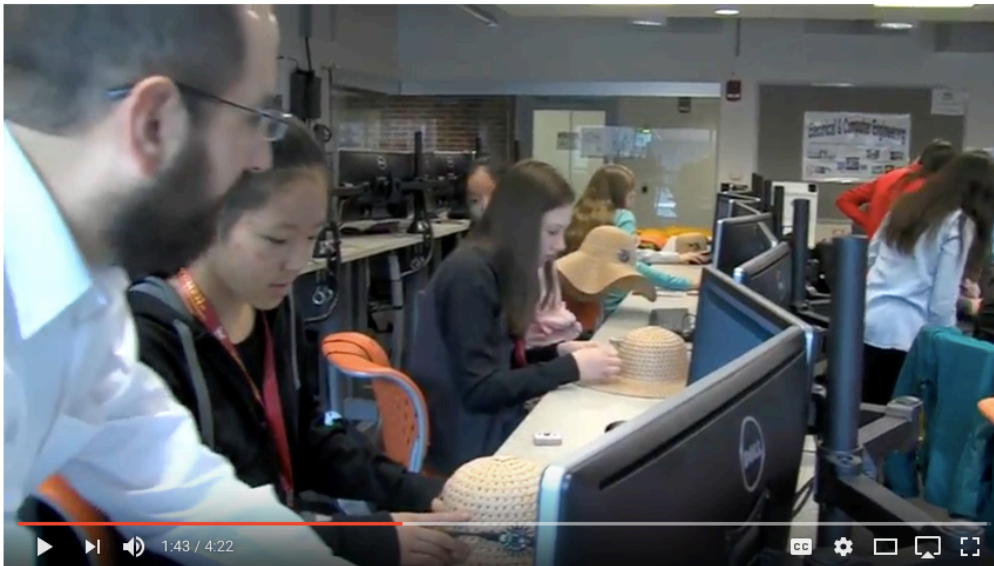
ECSEL scholars in the lab with participants:



ISU WISE TRLT Highlights Video (YouTube)

<https://www.youtube.com/watch?v=0apcWM2Rgvl&feature=youtu.be>

See time marker 1:42 for a quick peek into the ECSEL-led TRLT session with participants making “sunscreen reminder hats” (an Adafruit project) and interacting with ECSEL scholars and ECSEL PI Joe Zambreno.



Taking the Road Less Traveled Highlights Video

ECSEL scholars in the lab with participants:



ECSEL Scholars shared their TRLT outreach with other students in the department via the FAN Club:

<https://www.ece.iastate.edu/seminars-and-events/fan-club/>

IOWA STATE UNIVERSITY
Electrical and Computer Engineering

Department ▾ Academics ▾ Future Students ▾ Research ▾ News & Events ▾

FAN Club

Date/Time

Date(s) - 22 Sep 2017
12:00 PM - 1:00 PM

Location

[Coover Hall/ECpE Addition](#)

Friday Activities at Noon (FAN) Club events in Coover Hall. Free pizza for students!

📅 Download event reminder: [iCal](#)

[back to Seminars list](#)



FAN Club

Friday, Sept. 22
11:30 a.m. - 1 p.m.
1213 Coover Hall

“Taking the Road Less Traveled”

Presented by ECSEL Scholar’s Program

Open to all
ECpE students

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

The poster features a large, stylized yellow graphic of a hand with a road map pattern on the palm, set against a dark red background with a halftone dot pattern.



ECSEL



ECSEL/IOWA STATE



ECSEL/DMACC



ECSEL/KIRKWOOD

Iowa State nets \$9.6 million to increase STEM diversity, prepare future faculty

Posted 11 hours ago

AMES, Iowa -- Iowa State University has received nearly \$10 million in funding from the [National Science Foundation](#) (NSF) to improve diversity in both the professional STEM workforce and academia.

“Iowa State faculty in every college and department are focused on creating inclusive environments for their students and peers,” said [President Steven Leath](#). “We are pleased to share the federal government’s commitment to prepare a STEM workforce that is strong not only in numbers, but also in its diversity.”

The grants represent a significant win for Iowa State’s faculty researchers. The National Science Foundation typically funds only 10-20 percent of the proposals it receives. The science, technology, engineering and math programs listed below represent numerous grassroots collaborations among faculty, as well as significant outreach to educational partners, including Iowa’s community colleges.

LSAMP – Louis Stokes Alliances for Minority Participation; \$5 million

Principal Investigator: Jonathan Wickert, [senior vice president and provost](#)

Iowa State leads the Iowa-Illinois-Nebraska (IINSPIRE) LSAMP, an alliance of 16 institutions focused on increasing the quality and quantity of students successfully completing undergraduate STEM programs; and increasing the number of underrepresented students who pursue graduate degrees. Strategies to achieve these goals include supporting students’ academic, social, and professional development; expanding undergraduate research opportunities for underrepresented students; and enhancing STEM transfer partnerships between two- and four-year institutions.

LSAMP partners include the University of Iowa, University of Northern Iowa, Augustana College (Illinois), Des Moines Area Community College (DMACC), Doane University, Eastern Iowa Community College District, Grinnell College, Hawkeye Community College, Iowa State University, Iowa Valley Community College District, Kirkwood Community College, Little Priest Tribal College, Luther College, Nebraska Wesleyan University, University of Iowa, University

Contacts

Craig Ogilvie, Graduate College, 515-294-2219, cogilvie@iastate.edu

Diane Rover, Electrical and Computer Engineering, 515-294-2819, [drover@iastate.edu](mailto:d rover@iastate.edu)

Joe Zambreno, Electrical and Computer Engineering, 515-294-3312, zambreno@iastate.edu

Annette Hacker, University Relations, 515-294-3720, annette@iastate.edu

Rob Schweers, Office of the Senior Vice President and Provost, 515-294-6142, rob@iastate.edu

Quick look

Iowa State University has received nearly \$10 million from the National Science Foundation to support four programs that aim to increase diversity in science, technology, engineering and math fields. The grants will provide scholarships, support academic and professional development and encourage graduate students to pursue faculty careers.

Quote

“Iowa State faculty in every college and department are focused on creating inclusive environments for their students and peers. We are pleased to share the federal government’s

Luther College, Nebraska Wesleyan University, University of Iowa, University of Northern Iowa, Upper Iowa University, and Wartburg College.

"The ultimate goal of LSAMP is to increase the number of students who earn doctorates in STEM fields, particularly those from underrepresented populations," said Diane Rover, University Professor of [electrical and computer engineering](#). "We will be focused on expanding inclusive mentoring and teaching practices, providing high-impact educational experiences, and helping students gain confidence through undergraduate research and professional development activities."



Diane Rover

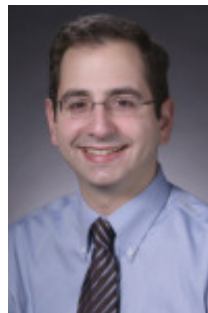
S-STEM – NSF Scholarships in STEM; \$4M to ISU

Principal Investigator: Joe Zambreno

The S-STEM program provides financial support to help low-income, academically talented students obtain STEM degrees and enter the workforce or graduate study. The program also aims to improve the education of future scientists with a focus on low-income students; and develop strategies to improve retention and graduation rates.

Iowa State's S-STEM initiative, ECSEL: Electrical, Computer, and Software Engineers as Leaders, is a partnership between the Department of Electrical and Computer Engineering, Program for Women in Science and Engineering, Des Moines Area Community College, and Kirkwood Community College. The initiative will fund 582 scholarships over the next five years for students majoring (or preparing to transfer) in electrical engineering, computer engineering, and software engineering, as well as implement a student experience model to help participants thrive and succeed in their degree programs.

"One area where we will be particularly focused is on creating opportunities for women, to address their underrepresentation in the electrical engineering and information technology workforce," said Joe Zambreno, associate professor of electrical and computer engineering. "We also look forward to working with DMACC and Kirkwood on cybersecurity education, a significant strength of Iowa State, and a high-demand field for both working professionals and graduate students."



Joe Zambreno

AGEP – Alliance for Graduate Education and the Professoriate; \$564,000

Principal Investigator: Craig Ogilvie

commitment to prepare a STEM workforce that is strong not only in numbers, but also in its diversity."

Steven Leath, president

More information

Find additional details about these programs:

- [LSAMP](#)
- [S-STEM](#)
- [AGEP](#)
- [INCLUDES](#)

AGEP's primary goals are to significantly increase the number of underrepresented students obtaining graduate degrees in STEM fields and enhance their preparation for faculty positions in academia.

Iowa State is involved through the Center for the Integration of Research, Teaching, and Learning Network (CIRTL) and is coordinated on campus through the Graduate College and Center for Excellence in Learning and Teaching. CIRTL members participating in the AGEP program include Boston University, University of Buffalo, Cornell University, University of Georgia, Howard University, University of Maryland, Michigan State University, Northwestern University, and the University of Texas at Arlington.



Craig Ogilvie

“Underrepresented graduate students often lose interest in faculty careers due to a non-inclusive climate in their academic departments,” notes Craig Ogilvie, Morrill Professor and assistant dean of Iowa State’s [Graduate College](#), and principal investigator for the AGEP and NSF INCLUDES grants. “By working and sharing best practices with our partners in CIRTL, we hope to increase students’ sense of community and belonging, and sustain their interest in academic careers after graduation.”

NSF INCLUDES – Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science; \$16K

Principal Investigator: Craig Ogilvie

The CIRTL INCLUDES group, which includes Iowa State, also received seed funding to develop a national alliance to prepare graduate students and postdocs to become new faculty, and to help them create inclusive learning environments that enable underrepresented students to succeed.

Iowa State will build a regional collaborative with Des Moines Area Community College, Kirkwood and Marshalltown community colleges, University of Iowa and University of Northern Iowa; and work with national partners that include Achieving the Dream, Advanced Technological Education Central, American Society for Engineering Education – Two-Year College Division, National Institute for Staff and Organizational Development, and American Mathematical Society of Two-Year Colleges. The current project will lay the groundwork for a five-year, \$2.5M proposal that will be submitted in the spring.

NEWS

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Sarah Rodriguez, Lorenzo Baber, and Mary Darrow are among School of Education faculty and staff leading research on National Science Foundation grants aimed at improving diversity in STEM. Photo by Ryan Riley.

Research to drive systemic change in STEM diversity

November 7, 2016 [College of Human Sciences](#) [Faculty News](#) [Research News](#) [STEM News](#)
By Lynn Campbell

[Iowa State University](#) is a leader in bringing more diversity to science, technology, engineering, and mathematics (STEM) — not only through outreach, partnerships, scholarships, and conferences, but also with research aimed at systemic change across colleges in the Midwest and nationwide.

[School of Education](#) faculty and staff members [Sarah Rodriguez](#), [Lorenzo Baber](#), [Brian Burt](#), [Mary Darrow](#), [Rosemary Perez](#), and [Mari Kemis](#) will for the next five years lead the research components of four [National Science Foundation](#) grants totalling \$11.6 million, all aimed at increasing diversity in STEM.

“We’re really poised to make a huge impact,” said Rodriguez, an assistant professor who is involved in all four projects. “The work is very purposeful in making a collective impact for underrepresented students in STEM.”

The composition of the research team is notable — not only because of their expertise in equity, access, and retention issues for underrepresented students in higher education, but because four of them are faculty members of color who have an understanding of the struggles that underrepresented students in STEM sometimes face.

“Graduate students will also be engaged in this STEM education work with us, which will help in Iowa State’s efforts to admit and fund doctoral students,” Burt said.

The research will include going to college campuses across the Midwest and nationwide to interview students, hold focus groups with faculty, collect documents, and observe the campus climate. Studies will explore both micro- and macro-level influences that affect how students thrive and persist in STEM disciplines.

“We’re creating a case study for the macro level, and on the micro level looking at the development of identity,” said Baber, an associate professor and head of the [Division of Higher Education](#) in the School of Education.



Brian Burt

Quick Look

Six School of Education faculty and staff members will lead the research on four National Science Foundation grants totalling \$11.6 million, all aimed at increasing diversity in STEM.

“We’re thinking about ways to increase diversity, equity, and inclusion in STEM. We can’t just do it by changing structure. We can’t just do it by changing individuals. It has to be a shift that looks at that interaction.”

Lorenzo Baber

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"What we're trying to look at is the interaction between individual and context, and giving attention to both," Baber said. "We're thinking about ways to increase diversity, equity, and inclusion in STEM. We can't just do it by changing structure. We can't just do it by changing individuals. It has to be a shift that looks at that interaction."

Making research a priority

STEM education, diversity, and social responsibility are key initiatives of Iowa State University, the College of Human Sciences, and the School of Education.

One of the projects funded by the National Science Foundation is called the Louis Stokes Alliances for Minority Participation, or LSAMP. The federal program created in 1991 aims to significantly increase the quality and quantity of students historically underrepresented in STEM who successfully complete baccalaureate degrees and who continue on to graduate studies in STEM disciplines.

"A big part of the LSAMP research project and why it is so significant is because it's looking at science identity," Rodriguez said. "I think that each one of us brings expertise in either STEM or STEM identity. I think it's going to be very impactful and it's a very hot area with little research in it. So this is going to make a very large contribution."

Of the \$5 million received by the National Science Foundation for LSAMP, Iowa State is devoting nearly \$1 million to research. Iowa State leaders in science and engineering not only turned to the School of Education for help, but also devoted 20 percent of their budget to research.

"What this project represents is balancing the programmatic aspects about LSAMP with research," Baber said. "The research component is a requirement after 10 years. Iowa State is doing it early. We're a leader in not waiting until it's required, but saying we know it's important."

"In my experience at other institutions, it is rare for engineering to come to education as a partner, not as an add-on, but as a partner saying, 'We want to work with you,'" Baber said. "At Iowa State, there's a true interdisciplinary nature to this."

Working with 16 colleges across the Midwest

Iowa State leads the Iowa-Illinois-Nebraska STEM Partnership for Innovation in Research and Education (IINSPIRE), an LSAMP alliance among 16 two- and four-year colleges and universities working together to broaden the participation of underrepresented minorities in STEM education in the Midwest.



The alliance has been working together for five years and is led by Diane Rover, a University Professor in electrical and computer engineering.

"Particularly in some of these smaller liberal arts campuses, they have very few students of color in STEM. In some cases, less than five," said Mary Darrow, the assistant director and evaluation coordinator of IINSPIRE LSAMP and a clinician with the School

of Education. "Connecting some of those students with larger communities of students like them can be really powerful because they're on predominantly white campuses."

Darrow said the 16-college alliance structure makes this research proposal unique because Iowa State is working with very active, engaged partners.

"They're very interested in using this data to inform what they are doing," she said. "They'll be engaged in us giving them results and going back and talking to them about what we found, and using that as a way to inform their practice."

The principal investigator of the LSAMP grant is Jonathan Wickert, Iowa State's senior vice president and provost, who's also a professor in mechanical engineering. Baber will manage the research team, whose work includes collecting data from six of the alliance's 16 Midwest colleges.

“What’s exciting about the LSAMP research project is that you have different institutional types, so we’ll be able to look at that identity development within different institutional contexts,” Baber said. “That hasn’t really been examined fully before. To have the opportunity to collect data and do analysis on this interaction across time — it’s a unique approach that we’re taking.”

Additional projects aimed at increasing diversity

Additional Iowa State University projects funded by the National Science Foundation include [four that recently received \\$9.6 million as outlined by the provost’s office](#), and another [project that received \\$2 million as highlighted by the College of Engineering](#).

Some of the research and projects will focus more heavily on engineering. Others focus on all STEM areas. One project focuses more on campus climate, while another emphasizes network alliances, and yet another looks at identity. The projects include:

AGEP (Alliances for Graduate Education and the Professoriate): \$564,000 aimed at significantly increasing the number of underrepresented students obtaining graduate degrees in STEM fields and enhance their preparation to become faculty. This is a national study over five years. The principal investigator is [Craig Ogilvie](#), a Morrill Professor in physics and astronomy who’s also assistant dean of the Graduate College. Rodriguez and Perez are among the project’s co-principal investigators who will over five years look at how campus climate influences underrepresented doctoral students’ interest in a faculty career.



Rosemary Perez



Mari Kemis

S-STEM (NSF Scholarships in Science, Technology, Engineering, and Mathematics): \$4 million for 582 scholarships over the next five years to increase the number of low-income academically talented students with demonstrated financial need obtaining degrees in STEM and entering the workforce or graduate programs in STEM. The principal investigator is [Joe Zambreno](#), an associate professor in electrical and computer engineering. Rodriguez is leading the five-year research portion of the project about identity in engineering, focusing on the scholarship recipients, while Kemis leads the project evaluation.

RED (Revolutionizing Engineering Departments): \$2 million to reshape the curriculum and culture in electrical and computer engineering. Burt, Darrow, Kemis, and Rodriguez are researchers on a 15-member team led by principal investigator [David Jiles](#), Distinguished Professor and Palmer Endowed Department Chair in Electrical and Computer Engineering, that also includes those in engineering, political science, psychology, and industrial design.

“RED is all about transforming the curricula,” Rodriguez said. “The lynchpin of transforming the curricula is through collaboration with faculty, industry practitioners, context experts, instructional specialists, and teaching assistants. These revolutionary collaborative teams are key.”

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\$4 million grant gives opportunities to women in STEM fields

April 19, 2017 Christina Creel



Back row (L-R): Claudia Athens, Erin Elsbernd, Chandler Chockalingham, Sarah Huber, Madison Jacobsen, Smruthi Sandhanam. // Front row (L-R): Lauren Arner, Erica Clark, Rachel Shannon, Lindsey Sleeth

This year, Iowa State University received nearly \$10 million from the National Science Foundation (NSF) to help improve diversity in science, technology, engineering and mathematics (STEM) fields. Within Iowa State's Electrical and Computer Engineering (ECpE) department, \$5 million over the next five years will go toward creating 272 individual NSF Scholarships for students from Iowa State, Des Moines Area Community College (DMACC) and Kirkwood Community College, with an emphasis on promoting diversity.

This semester marks the very first cohort of students benefiting from S-STEM. Ten women were selected based on a combination of student involvement, diversity, a short written essay and financial need. While gender is not a requisite for this scholarship, ECpE uses S-STEM as leverage to create more diversity in the field.

"Some of the best jobs today are in STEM fields. I think it is important that women feel that they belong," Sarah Huber, a senior in electrical engineering and one of this year's recipients, said. "Women have the opportunity to help the world, create what they imagine and support themselves financially for a better future. There should be nothing about science, technology, engineering or math that is gender specific."

In conjunction with the scholarship, students have been participating in a leadership course led by Associate Professor Joseph Zambreno and Professor Diane Rover. This course will allow them to build a module for the upcoming Taking the Road Less Traveled conference hosted by Iowa State's Program for Women in Science and Engineering (WiSE). The scholarship recipients also will be connected with young alumni, professors and industry professionals to continue their advancement in the field.

Rover spoke on her optimism for the creation of groups like this.

Recent Videos

Iowa State University College of Engineering



ME and CCEE team up for Campanile-Carillon Model Project



Experimental Multiphase Flow Lab Open House

In the Media

Iowa State Chapter of Associated General Contractors (ISU AGC) donates \$5K to Appalachia Service Project
28 Apr 2017

Andersen: Manure is valuable, should be treated like fertilizer
25 Apr 2017

Agricultural engineering and animal science professor named CALS Assistant Dean for Research
24 Apr 2017

College Events

Engineering Graduate College Pre-Commencement with LIVE WEBCAST Thursday, 4 May 2017

Graduate College Ceremony Friday, 5 May 2017

Undergraduate Pre-Commencement Receptions

"Diversity is an important aspect, but just one aspect." Said Rover, "With these grants, we are creating a more inclusive and creative environments for teaching and learning in the department. Diversity via increasing numbers from different groups will have little impact by itself, nor will it be achieved, if we don't change other things in the department. These grants are helping us change things."

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Megan Reiman, Joseph Zambreno, Diane Rover, Douglas Jacobson, Sarah Rajala, Mack Shelley, Phillip Jones, Mani Mina, Lisa Larson, Sarah Rodriguez, Lora Leigh Chrystal, Vicky Thorland-Oster, Mari Kemis



ECSEL: Electrical, Computer, and Software Engineers as Leaders

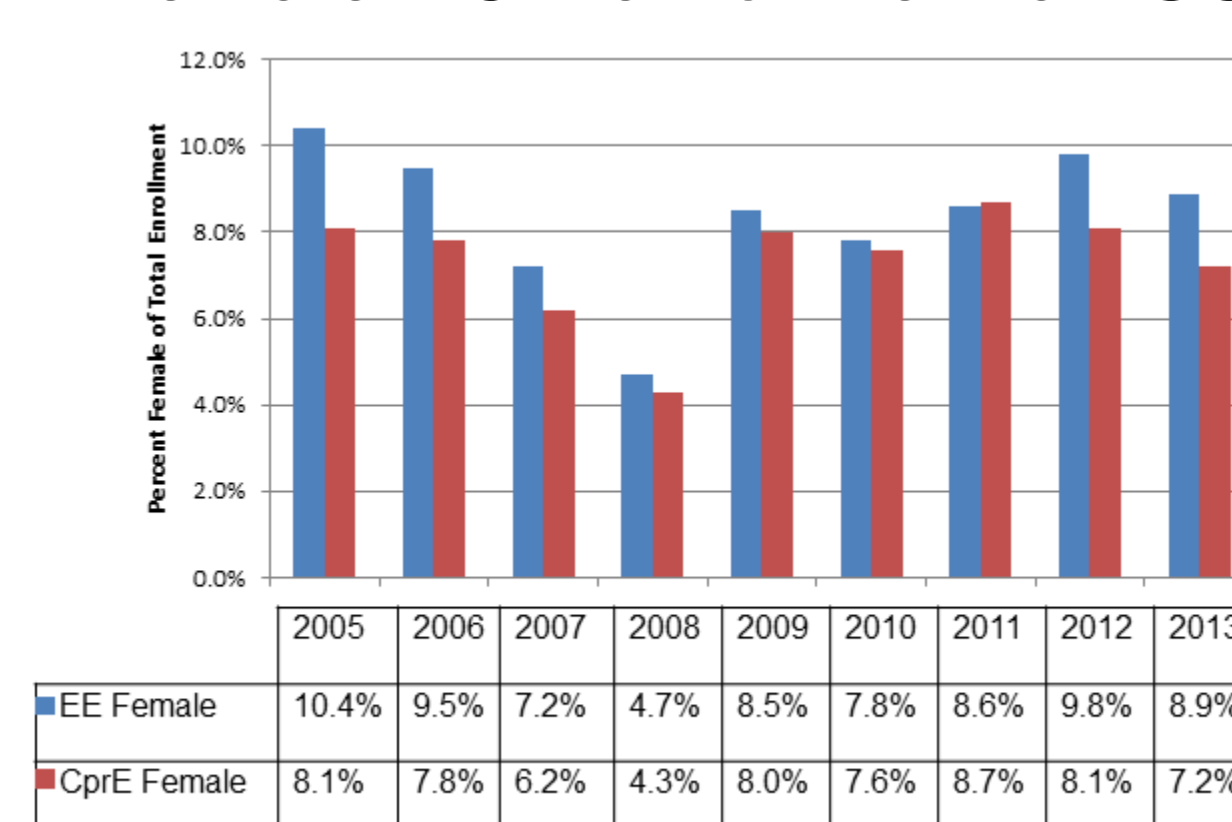
Objectives

- Improve diversity and inclusion in electrical, computer, and software engineering (ECSE) programs and in the workforce.
- Provide scholarships to a diverse population of low-income academically talented students with financial need.
- Adapt, implement, and test a student experience model, which is a set of well-established evidence-based practices that form an ecosystem of academic and co-curricular supports and is designed to foster retention, transfer, and graduation.
- Increase interest in cyber security.
- Partner with Des Moines Area Community College (DMACC) and Kirkwood Community College (KCC) to support CC and transfer students.
- Increase the percentage of undergraduate women enrolled in ECSE degree programs to 16%, thus doubling the number of women enrolled from 120 to 240.

Background

The percentage of women in undergraduate electrical and computer engineering at Iowa State University is below the national average. Based on an external assessment, the department has committed to creating an enhanced student model for women in ECSE through the ECSEL program.

Female ECE enrollment at ISU



Female ECE enrollment nationally



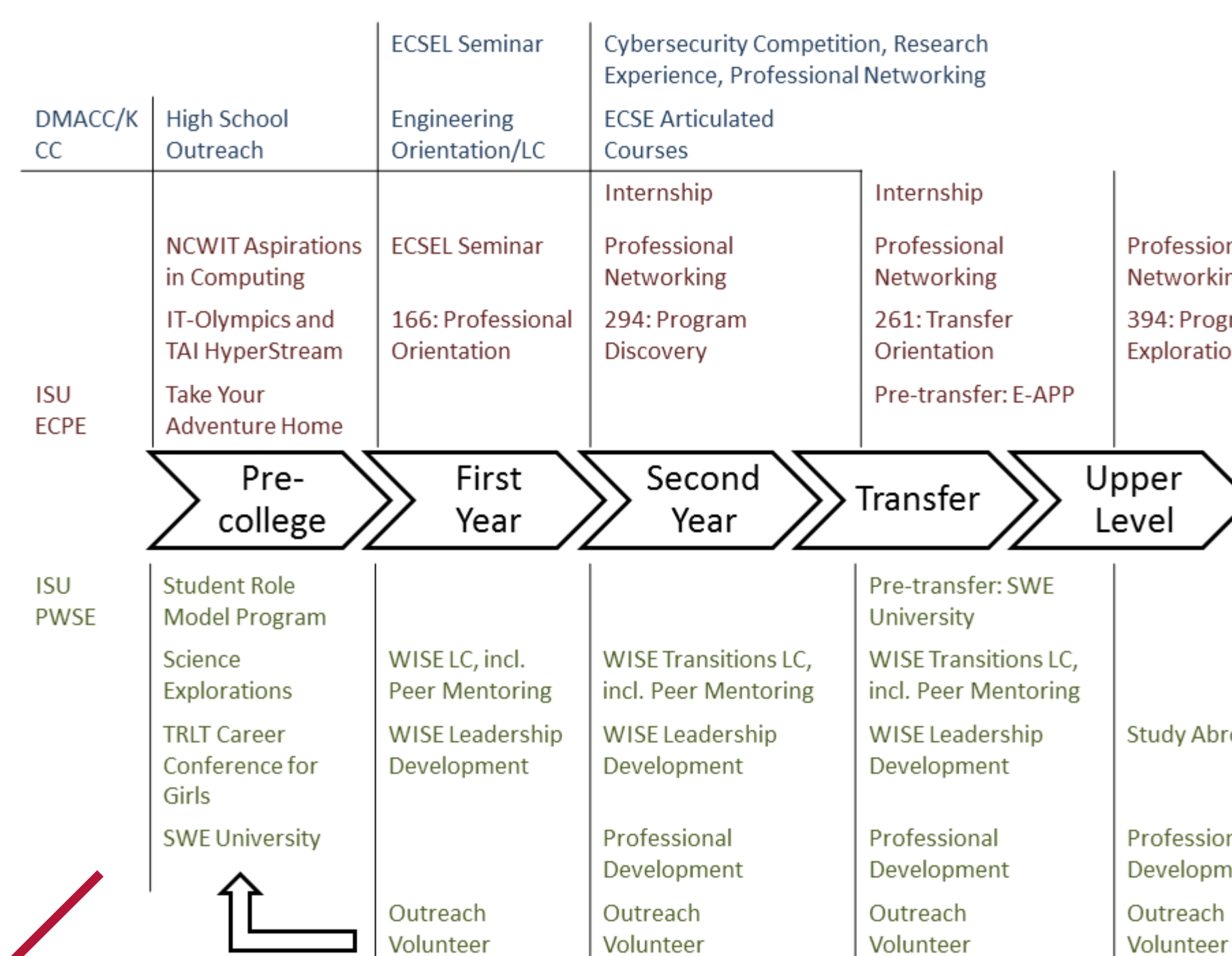
ECSEL Student Experience



At Taking the Road Less Traveled conferences, scholars lead 9th and 10th grade girls in integrating circuit components with sunhats to make "sunscreen reminder hats"



Class of 2016 of SWE University, where female high school students learn about engineering and explore Iowa State



WiSE students study abroad in London over spring break (2017)



Cyber Defense Competition, where students learn to set up and defend a computer network



ISU women attend the Grace Hopper Celebration of Women in Computing

Research

Identity Research

Research question: How do women and other diverse students participating in the ECSEL program develop and sustain their engineering identities?

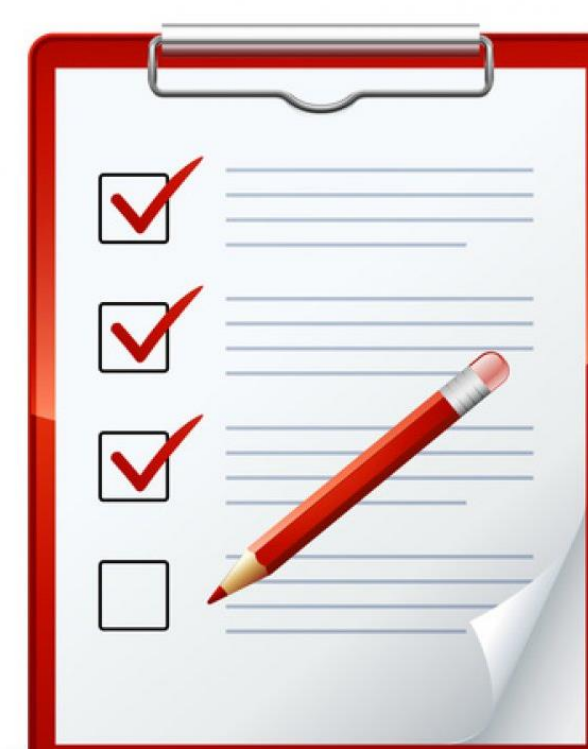
- Examine engineering identity development through the use of Social Cognitive Career Theory (SCCT)
- Perform in-depth interviews to discover perspectives of ECSEL program participants

Motivation Research

Research question: What drives underrepresented students to thrive and persist in ECSE degree programs?

- Use Self-Determination Theory (SDT) of motivation to explain how environment affects students and the factors that affect their likelihood of persisting in ECSE

Evaluation



- **Examination of Process and Contextual Factors**
Interviews with team members to examine opinions about activities, progress towards project objectives, and contextual factors.
- **Understanding of Participating Students' Experiences**
Studies with participating undergraduate students to examine their opinions about the student experience.
- **Management of NSF's Student Tracking Data**
Information required for NSF's data collection activities to track participating students.
- **Evaluation of Broader Impacts**
Departmental records, surveys to understand attitudes/engagement of pre-college audiences with ECSE, and surveys about the cyber security program.

Evidence-Based Planning to Broaden the Participation of Women in Electrical and Computer Engineering

Diane Rover, Joseph Zambreno, Mani Mina, Phillip Jones, and Lora Leigh Chrystal

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Abstract— The percentages of women in undergraduate electrical and computer engineering programs at Iowa State University averages below the national average. An external assessment of diversity and inclusion provided an impetus for faculty, staff and administrators to discuss issues, focus on specific areas, and collaborate on planning. In particular, the department has teamed up with the university’s Program for Women in Science and Engineering to better integrate their programs with departmental activities. This has resulted in an enhanced student experience model being designed for undergraduate ECE women. The model leverages effective practices including learning communities, leadership and professional development, academic support and advising for the ISU Engineering Basic Program, academic preparation for the ECE field, and state and national resources for inclusive ECE career awareness, recruiting and teaching. The WI-ECSEL Initiative has been designed to improve diversity and inclusion in Iowa State’s electrical, computer, and software engineering programs; improve educational pathways including transfer transitions from community colleges; provide a supportive and integrated student experience; establish a community of practice for faculty; and use research to inform practice.

Keywords— *diversity and inclusion; learning community; student professional development; women in science and engineering program*

I. INTRODUCTION

At Iowa State University, undergraduate female enrollment and degrees awarded in electrical and computer engineering (ECE) have averaged three to four percent below the national average. Nationally, females accounted for 19.9 percent of all bachelor’s degrees awarded by an engineering program in 2015 and comprised 21.4 percent of undergraduates enrolled in engineering [1]. The percentage of bachelor’s degrees awarded to women in electrical engineering was 12.5 percent and in computer engineering, 10.9 percent, the two lowest percentages among all engineering disciplines. Women comprise about 8 percent of undergraduates enrolled in Iowa State’s ECE programs, compared to 12 percent nationally. Across all engineering programs at Iowa State, about 16 percent of undergraduates are women.

The department ranks in the top five nationally in computer engineering degrees and the top 15 in electrical engineering degrees awarded annually. With increasing enrollments, the number of undergraduate women has increased but the

percentage has remained mostly constant. Over the past two years, with an emphasis on diversity from the dean of engineering and department chair, the department has undertaken educational and climate projects such as the Transformative Learning Area for students; industry and department support for women students to attend the Grace Hopper Conference; a study conducted by external consultants, Partners for Educational Development (PfED) [2], on the experiences of undergraduate women in electrical and computer engineering (ECE); and collaborating with education and social science faculty on proposals to National Science Foundation programs supporting advancements in engineering education (including the Scholarships in STEM program; and the Revolutionizing Engineering and Computer Science Departments (RED) program, part of Improving Undergraduate STEM Education/Professional Formation of Engineers, which was recently awarded to the department [3]).

The study and its results have provided an impetus for faculty, staff and administrators to discuss issues, focus on specific areas, collaborate on planning, and move away from traditional ‘deficit thinking’ efforts by using the Center for Gender in Organizations (CGO) framework for promoting gender equity in organizations [4-5]. The four frames of gender equity include: 1) equip the women (prepare women for success); 2) create equal opportunity (level the playing field); 3) value difference (value diversity); and finally, 4) re-vision work culture. The first three frames are traditional gender equity approaches that focus on the “symptom of the problem” and are only part of the solution. CGO asserts this fourth frame offers “a new category of organizational intervention” focused on the “underlying systemic factors in organizations” by considering gender as a social construct. In particular, the department has teamed up with the university’s Program for Women in Science and Engineering (WiSE) to better leverage their programs and knowledge resulting in an enhanced student experience model and contributing to departmental change. WiSE was founded in 1986 and offers programs and services that engage people at Iowa State, across Iowa and beyond to enhance the science, technology, engineering and math educational experience for women [6-8]. The student experience involves learning communities, leadership development, professional development, academic support such as tutoring, academic advising, academic preparation for the field, and state and national resources for inclusive ECE career awareness, recruiting and teaching. While most of these components have

been available, there was not a coordinated effort to use them on a larger scale to effect change. In addition, new research studies will be conducted to build on the PfED study's findings and inform student experience model implementation by exploring how undergraduate women in ECE develop and sustain their engineering identities, and what drives these women to thrive and persist in ECE degree programs.

This paper describes the collaborative planning process that the department has used to leverage, re-envision and integrate program elements. The student experience is based on new and existing evidence-based programming to support an improved climate for undergraduate women. In addition, this paper introduces the newly funded NSF RED project that will address organizational level change and thus a more complete solution to gender equity.

II. PLANNING PROCESS

An in-depth look at diversity and inclusion was prompted in part by a charge from the dean of engineering to each department. The ECE department chair formed an ad-hoc committee to begin a review process. As part of this effort, the PfED consultants were enlisted to conduct a needs analysis and advise the department on potential strategies for improvement.

An external assessment of diversity and inclusion focused on undergraduate education in the ECE department was conducted in 2014 by Partners for Educational Development. In fall 2014, the PfED consultants interviewed undergraduate women students in ECE and delivered a report in 2015 [9]. A working group of student affairs staff with relevant expertise from the department, college and WiSE was assembled to assist with aspects of the study and provide guidance and feedback.

The qualitative climate study was formulated around factors drawn from evidence-based research including pre-college programs, financial resources, learning environment and interactions, undergraduate research training, mentors and role models, systemic support structures and interventions, and career/professional development. The study examined personal experiences, academic experiences, confidence, resources used/needed, and relationships with faculty and peers. The report found that department retention patterns align with the literature on individual and institutional factors affecting the first and second year experiences as critical points in the academic pathway [10-16]. Findings suggested that institutional factors are significant in impacting retention of female undergraduate students in ECE and affect students' individual perceptions and behaviors. From themes that emerged from the study, both strengths and barriers were identified. The study provides the local context to address the under-representation of women in undergraduate ECE programs at Iowa State.

The report was reviewed by the working group, which then drafted a white paper for departmental action. A departmental team was formed to develop a comprehensive plan as the basis for an NSF Scholarships in STEM (S-STEM) proposal. This team was expanded into an interdisciplinary group including education and social scientists. Input was also sought and obtained from key stakeholders such as industry and community college partners. This process resulted in a new departmental and collaborative initiative called WI-ECSEL,

Women in Electrical, Computer and Software Engineering as Leaders.

The external assessment was coincident with an effort by the department to review and promote positive learning environments for all students in the department. In early 2014, an effort to reform the curriculum stalled due to faculty concerns, revealing that deeper departmental transformation was needed. Shortly thereafter, the National Science Foundation announced the RED program aimed at helping universities transform department structures, policies, practices and curricula to enable groundbreaking changes in undergraduate engineering education. The vision for the RED program resonated with the department chair and those involved in the curricular reform effort. Thus an interdisciplinary team was formed to pursue the RED opportunity. The department's proposal was not funded in the first round, however substantial improvements led to a successful proposal as part of the second cohort of RED awards.

Through the project, Reinventing the Instructional and Departmental Enterprise (RIDE) to Advance the Professional Formation of Electrical and Computer Engineers, the department has plans to involve students, faculty, practicing engineers and others in collaborative, inquiry-driven processes to collectively and systematically transform the department and the its graduates. Students are not only learning about fundamental ECE technologies in core courses during their sophomore and junior years (the middle years are the focus of RED), but also the socio-technical context to go beyond the hardware and software toward responsible development. To accomplish this, faculty will be reshaping core curricula using evidence-based pedagogical strategies and working together to enhance their understanding and integration of these strategies in courses.

The RIDE project has created a novel cross-functional, collaborative instructional model for course design and professional formation, called X-teams. The pedagogical approaches (a) promote design thinking, systems thinking, professional skills such as leadership, and inclusion; (b) contextualize course concepts; and (c) stimulate creative, socio-technical-minded development of ECE technologies for future smart systems. X-teams are also serving as change agents for the rest of the department through communities of practice referred to as Y-circles. Y-circles, comprised of X-team members, faculty, staff, and undergraduate and graduate students in the department, will engage in a process of discovery and inquiry to bridge the engineering education research-to-practice gap and contribute to an organizational culture that fosters and sustains innovations through an agile framework. A key goal for the RIDE project is to broaden the participation of underrepresented students, especially undergraduate women, in ECE. Project activities will emphasize inclusive teaching practices and learning experiences. Taken together, WI-ECSEL and RIDE encompass all four frames of the CGO framework.

III. DESIRED OUTCOMES

The WI-ECSEL initiative has been designed to improve diversity and inclusion in Iowa State's electrical, computer, and

software engineering (ECSE) programs; improve educational pathways including transfer transitions from community colleges; provide a supportive and integrated student experience; establish a community of practice for faculty; and use research to inform practice. A specific outcome is increasing the percentage of undergraduate women enrolled in ECSE degree programs at Iowa State from 8% currently to 12% (national average), and longer term to 16% (college average). In terms of baseline data, this means doubling the number of women enrolled from 120 to 240. We will also be tracking retention and graduation rates. Current rates in engineering for selected groups at Iowa State are shown in Table I. The current

1-year retention rate for female students in ECSE majors is 80%; we will target 85%. The 2-year retention rate is 63%; we will target 75%. The desired increase in the 6-yr graduation rate for female students in ECSE majors is from 34% to 60%.

The target rates (taken from the first row in Table I below) represent the positive effect of the WiSE learning community and other WiSE program activities on overall female STEM/engineering retention and graduation rates. Ideally, rates for ECSE women participating in the WI-ECSEL initiative will approach the first row of the table. However, these rates reflect persistence across all engineering majors, which allows for greater flexibility than in ECSE majors alone.

Table I. AVERAGE RETENTION AND GRADUATION RATES IN ENGINEERING BY GENDER FOR STUDENTS WHO START IN ENGINEERING (2000-2012)

	1-Year Retention	2-Year Retention	3-Year Retention	4-Year Grad.	5-Year Grad.	6-Year Grad.
Female in WiSE LC	85%	75%	74%	24%	58%	62%
F - Other STEM LC	81%	70%	67%	20%	51%	54%
Other STEM Female	75%	63%	61%	17%	36%	40%
Total STEM Female	82%	71%	70%	22%	52%	56%
STEM Male	85%	76%	74%	17%	48%	52%
Total	84%	76%	73%	18%	49%	53%

IV. INCLUSIVE STUDENT EXPERIENCE MODEL

The student experience model for the WI-ECSEL Initiative is illustrated in Fig. 1. It leverages effective practices by re-framing programmatic elements to include the four frames of gender equity in organizations and includes learning communities, leadership and professional development, academic support and advising for the ISU Engineering Basic Program, academic preparation for the ECSE field, and state and national resources for inclusive ECSE career awareness, recruiting and teaching. It includes academic, co-curricular and extracurricular activities linked through the learning community model. Activities address needs identified by WiSE, through the PfED study, and in related literature. Different entry points into the student experience are accommodated to allow flexible pathways for students, including incoming first-year students, undeclared second-year students and community college transfer students. There is a focus on professional and leadership development and engagement throughout the student experience.

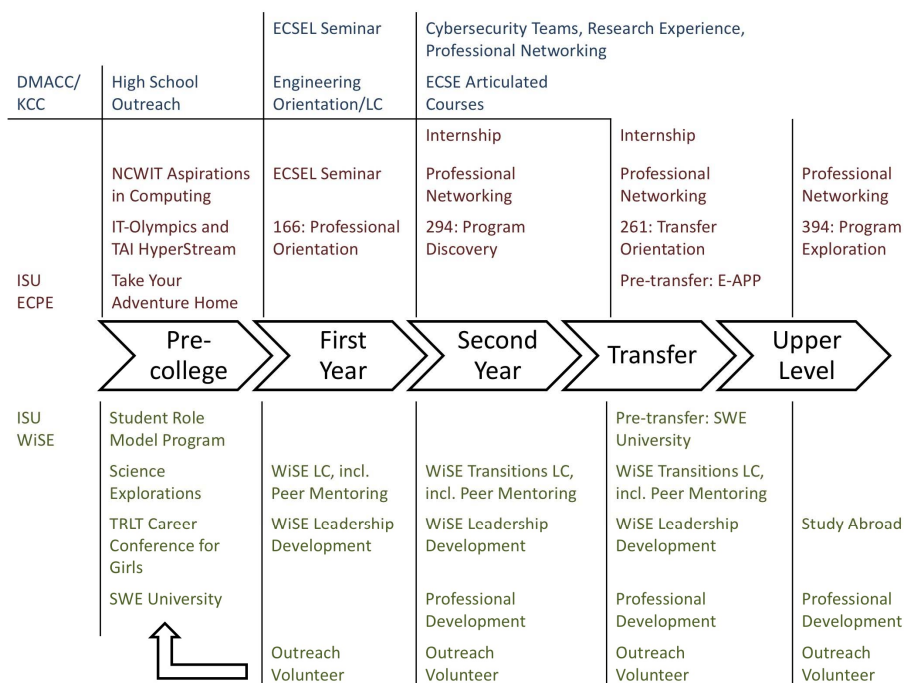
WiSE programming is based on established research and forms the foundation for the ECSEL student experience model. Most female and underrepresented minority students indicate that it was the encouragement they received from a role model or teacher that proved to be significant in their decision to enroll and remain in STEM programs. The lack of female role models overall and the opportunity to connect with them reinforces questions female students have about pursuing a STEM degree and whether they will be successful in that pursuit [10, 17, 18]. All WiSE programs have been built upon the philosophy that to increase the participation of women in STEM it is critical for girls and women to connect with other women who are involved with STEM; this role modeling allows women to visualize their ability to pursue and succeed in STEM. WiSE

mentoring provides the opportunity for women to see themselves as STEM professionals by connecting with other women in STEM.

Extracurricular activities, like the Student Role Model Program and Taking the Road Less Traveled, are essential components of gender equity. These out of school activities provide pre-college girls with experiential learning and investigative opportunities in academic areas that are not part of the regular school day. Involving ECSE students as Student Role Models, highlighting the success of faculty and students, and using hands-on activities focused on computing that show how these fields can make a difference in the world help shape interest and confidence in STEM courses and careers [19] [20].

At the undergraduate level, quantitative evidence supports Tinto [21] and Seymour and Hewitt's [10] qualitative results that there are gender differences in the reasons students leave their majors. Women are more likely to leave voluntarily due to social forces, and males, due to poor academic performance. The WiSE learning communities work to reduce these social forces through various academic, social and leadership programs within the community [11, 22, 23]. For example, leadership development programs focus on having women understand the underlying systemic effects of gender in organizations and not that women are somehow deficient. Programs center on how to handle gendered situations that may inhibit their ability to be successful and not on how to conform to traditional models of leadership. Further, participation in service-learning courses also increases retention rates for first-year students, providing an option for students who cannot participate in a residential program [24]. Beyond the first year, females show a higher risk of leaving engineering in semesters 3 to 5 than males, while the risks are similar during other semesters [25]. Therefore programming during the first three semesters is critical for retention of female STEM students.

Fig 1. ECSEL inclusive student experience model.



Abbreviations— DMACC: Des Moines Area Community College, KCC: Kirkwood Community College, ECSEL: Electrical, Computer and Software Engineers as Leaders, LC: learning community, ECSE: Electrical, Computer and Software Engineering, ISU: Iowa State University, ECPE: Electrical and Computer Engineering Department, WiSE: Program for Women in Science and Engineering, NCWIT: National Center for Women and Information Technology, TAI: Technology Association of Iowa, E-APP: Engineering Admissions Partnership Program, TRLT: Taking the Road Less Traveled, SWE: Society of Women Engineers

Findings from an ISU/DMACC NSF STEP project showed that participating in multiple learning communities was especially effective for women students in engineering (e.g., both WiSE and major-specific learning communities). This effect was determined using Kaplan-Meier survival estimates of the survival function, which compares the probability of different sets of students being retained in successive academic terms. The data show that women participating in more than one learning community are significantly more likely to be retained than are women participating in one or no learning communities [26].

While there is extensive literature on “transfer shock” or the decrease in students overall GPA when transferring institutions, there is less research on the effective practices to reduce transfer shock, the needs of transfer students, or the underlying characteristics of successful inter-institutional partnerships. Assessment from the ISU/DMACC NSF STEP project showed that participants in the Engineering Admissions Partnership Program (E-APP) have significantly increased first-year retention rates over non participants [26-30]. E-APP is a key program element that integrates community college and transfer students into the ECSEL student experience. It is designed to give Iowa community college transfer students multiple contact points and resources to enhance the transition to ISU. Iowa community college students who are taking courses that lead to transfer can enroll in ISU’s APP, and those interested in engineering are automatically in E-APP. Students are paired up

with an ISU adviser to help with transfer processes. E-APP promotes networking with students and staff via social media and campus events, including the engineering career fair. Building on the success of E-APP, transfer women participating in a visit day while still enrolled at the community college provides those students with a network of support at both their community college and at ISU through mentoring and the development of professional skills.

The ECSEL student experience model also provides opportunities for interactions with faculty mentors through departmental programming. As shown in Fig. 1, the ISU ECPE curricula include required courses such as ENGR 101 (orientation), CPRE 294 and CPRE 394, which include meetings with faculty mentors who provide professional and career guidance to students. In ENGR 101, small groups of students take an assigned professor to lunch (paid for by the department). This “take a professor to lunch” program has proven to be very useful in connecting students with at least one faculty member early on. The focus of CPRE 294 is on engineering practice, contemporary issues, and research opportunities in the department. The focus of CPRE 394 is on career guidance, professionalism and ethics, and portfolio development.

ECSEL program elements shown in Fig. 1 are described below.

A. ISU Program for Women in Science and Engineering (WiSE)

1) Pre-College Programming

Student Role Model (SRM) Program: The SRM program excites pre-college students about science and engineering through hands-on activities facilitated by ISU undergraduate women in STEM majors. Teachers from across the state access the SRM program through the WiSE website and select from over 100 STEM activities that align with the educational goals of the Iowa Core Curriculum.

Science Explorations: Through Science Explorations, students studying in STEM gain leadership experience by planning, organizing and facilitating a 4-week after school camp for girls each semester to stimulate interest and excitement for STEM fields.

Taking the Road Less Traveled (TRLT) Career Conference: One-day conferences provide 2400 attendees in grades 6-12 each year the opportunity to explore STEM careers, interact with females employed in STEM careers, participate in hands-on activities, and experience a college campus.

SWE University: SWE U. is a collaborative outreach event with the SWE student organization, College of Engineering, and WiSE. During the two-day experience, SWE U. participants explore campus, learn about engineering disciplines, connect with current students, network with other SWE U. participants, and stay overnight in an Iowa State residence hall. The event concludes with a dinner in which SWE U. participants and their parents visit with engineering faculty and staff.

2) Undergraduate Programming

WiSE Learning Communities: WiSE LCs offer living and learning opportunities for women majoring in STEM (375 first-year students in FY15). Each WiSE floor is comprised of 22-25 women in STEM majors and is led by a peer mentor. Peer mentors are upper-division STEM students who help first-year students transition to college. Peer mentors play a vital role in the planning and implementation of activities for their mentees and also refer them to applicable campus resources

WiSE Transitions Learning Communities: Students participating in “transition” learning communities focus on personal, professional, and leadership development while continuing to create community with other women in STEM. WiSE offers a one-credit success seminar each fall that helps students develop the skills necessary to be prepared for leadership roles on campus as well as internships. Additionally, students participate in a variety of career programs throughout the year including job shadows, mock interviews, career fair prep, resume workshops, and other networking events. Peer mentors meet with their mentees both individually and during larger group programs and events.

Academic Support: Together with the College of Engineering, WiSE has offered free tutoring. In addition, WiSE study groups facilitated by Academic Success Center tutors are available in the residence halls.

WiSE Leadership Development: Leadership development is an important component of the WiSE learning community experience through a variety of workshops and seminars focused on professional, academic, and leadership development. The WiSE program uses Gallup’s StrengthsQuest™ which can help students understand how to apply their talents to the choices they make in their academic, career and personal lives. WiSE hosts fall retreats for first-year students; second-year and transfer students continue their strengths journey through their individual learning communities. The signature leadership program is an annual one-day spring leadership conference. Students engage in sessions that build awareness of assumptions that drive behavior and how to identify gendered differences and situational strategies to use when encountered. Topics include: unconscious bias, stereotype threat, micro-aggressions/micro-inequities, the impostor syndrome, and becoming confident leaders. Additionally, students participate in panels and networking activities with industry professionals and ISU faculty.

CLPS 270, Community Leadership and Public Service, is an introductory leadership course that provides students with an understanding of effective leadership practices and information about campus opportunities. Students are expected to connect course content to their own lives and to become engaged in campus activities where they can apply what they learn.

Professional Development: WiSE hosts graduate school panels, networking events, and a variety of workshops to enhance resumes, networking, interviewing skills, and career fair preparation

Outreach Volunteering: WiSE Ambassadors are a small group of students who volunteer to assist WiSE by connecting with high school students during the recruitment process.

Study Abroad: WiSE provides women studying in STEM fields the opportunity to travel abroad during spring break and participate in a 3-credit course where they analyze issues facing women in STEM internationally. While abroad, participants tour science and engineering facilities, meet students and professionals, and engage in the culture of the destination.

B. Department of Electrical and Computer Engineering (ECPE)

1) Pre-College Programming

ECPE Take Your Adventures Home [31]: TYAH is an outreach program that pays transportation costs for ECSE students to go back to their hometown high school to share their ISU ECSE “adventure” with students, teachers, and counselors.

IT-Olympics and TAI HyperStream [32] [33]: IT-Adventures is an innovative program that is dedicated to increasing interest in and awareness of technology among high school students through inquiry-based learning focused on four content areas: Cyber Defense, Game Design Programming, Robotics, and Multimedia. The basis of the program is the formation of HyperStream Clubs in high schools across Iowa. HyperStream is a technology career awareness program of the Technology Association of Iowa (TAI). The capstone event for

students who participate in IT-Adventures is a two-day competition called IT-Olympics on the ISU campus.

NCWIT Aspirations in Computing [34]: ISU is a member of the NCWIT Academic Alliance and administers the state-level NCWIT Aspirations in Computing Award program for high school women who are active and interested in computing and technology. Affiliate award winners receive recognition at an award ceremony held alongside IT-Olympics.

2) Undergraduate Programming

ECPE Learning Communities: ECSE students can participate in the CprE LC or EE LC (as well as the WiSE LC), which provide various academic, social and professional support.

Professional/Engineering Orientation (CPRE/EE 166): This 1-credit required seminar introduces students to ECSE professions and career options, departmental rules, advising center, degree requirements, program of study planning, student organizations, and portfolios.

Career Awareness and Guidance (CPRE/EE 294/394): These required courses include meetings with faculty mentors.

Professional Networking: Women students in ECSE have an opportunity to travel to professional meetings, such as the Grace Hopper Conference, SWE Conference, Women in Cybersecurity Conference, etc.

Digital Women Student Organization: Digital Women [35] is a community of women dedicated to encouraging, supporting and retaining women in Computer Science, Software Engineering, Electrical Engineering, and Computer Engineering at Iowa State.

ECSE Articulated Courses at CCs: ISU defines a set of courses common to all engineering curricula, called the Engineering Basic Program. Studies via the ISU/DMACC NSF STEP project have shown increased transfer student success related to Engineering Basic Program performance [36-38].

Engineering Admissions Partnership Program (E-APP): Studies of E-APP have shown increased transfer student success [39].

Transfer Orientation (CPRE/EE 261): This 1-credit required seminar introduces transfer students to the College of Engineering and ECSE professions. It provides information about university, college and department policies, procedures, and resources.

V. SUMMARY

The WI-ECSEL Initiative is in the early stages of implementation. An NSF S-STEM proposal was submitted and is pending, which would support scholarships for low-income, academically talented, diverse students participating in the ECSEL student experience. It would also support two complementary research studies to explore how young women in ECSE develop and sustain their engineering identities, and what drives these women to thrive and persist in ECSE degree programs.

Implementation of the ECSEL student experience is proceeding using program elements from the department and WiSE. Implementation is focused on:

- Providing a positive and coordinated student experience;
- Emphasizing evidence-based practices to support diverse students;
- Increasing student-faculty interaction;
- Promoting collaborative structures across units to effectively and efficiently support students;
- Enhancing student professional identity as an ECS engineer;
- Increasing student motivation, satisfaction and retention; and
- Improving messaging and marketing to prospective students.

Additional longer-term benefits of the initiative are partnerships with community colleges, industry, diversity programs, and researchers to broaden participation of women in ECS engineering majors; education pathways through the community college into four-year ECS engineering programs; diverse workforce development in ECS engineering fields; and understanding of and engagement with ECS engineering by prospective students, parents, and teachers.

We envision that the student experience model in ECSEL will be adaptable by other departments and provide a template for collaboration and integration of program elements. The ECSEL initiative will be evaluated as it moves forward and results will be shared. The initiative resulted from a focused, collaborative planning process that matured over time and has leveraged various opportunities.

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