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## **WARP-SPEED: Increasing engineering student engagement through co-curricular undergraduate research**

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Barbra Sobhani is the Director of the Colorado Space Grant Consortium, housed at the University of Colorado Boulder, working with students on campus as well as across the state on space science and aerospace engineering projects. Barbra has been an educator for over 20 years, as a physics professor, Honors program director and STEM dean. Barbra's interdisciplinary background in physics, geophysics and biology has led to a passion for experiential learning and interdisciplinary project development. The problems facing the world are wicked and complex, so helping the next generation become innovative problem solvers is crucial.

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**Abstract:** The Colorado Space Grant Consortium (COSGC) Space Professional Education, Enrichment and Development or WARP-SPEED program engages an interdisciplinary student cohort interested in space-related research in their first semester at the University of Colorado Boulder. Coming out of COVID, our program realized the need for a way to engage new CU students, particularly focusing on diversifying our student participation in NASA-related projects and challenges that COSGC supports. Our COSGC program goals are to engage and support a minimum of 50% female and 30% underrepresented populations in STEM in our endeavors. Our current student engagement (89 students) is 39% female and 20% Latinx, Black, Pacific Islander, and Native American. WARP-SPEED was designed as an introduction of interdisciplinary project work, engineering design process, and foundational technical skills in a co-curricular setting. The program engages a cohort of interdisciplinary, diverse students with diverse staff and mentors in a supportive and collaborative environment throughout their first two semesters on campus. Scaffolding the student research experience in this way prepares students for more complex projects and professional presentations in subsequent years, helping with student retention. The WARP-SPEED program incorporates opportunities for students to work through complex problems and decision making while including and considering diverse perspectives. The program also helps students to establish their STEM identity which in turn increases their sense of belonging. This supports retention efforts by engaging students in experiential learning outside their traditional classroom experience.

## INTRODUCTION

Numerous studies have shown that the benefits of undergraduate research experience, these include improved persistence, increased pursuit of graduate education, and higher gains than comparison groups in areas including: ability to conduct research, ability to communicate, motivation to learn, confidence in their skills, understanding the research process, and ability to work independently (Lopatto 2004, 2007; Seymour et al., 2004; Russell, Hancock, and McCullough, 2007; Laursen et al., 2010). Participation in hands-on learning early in their undergraduate progress builds STEM identity, increasing performance, competence and self-recognition as belonging in STEM (Carlone & Johnson, 2007; Dou et al., 2019; Kim et al, 2018; Thiry et al., 2011). Mentored research is widely used in the University model and there is ample research as to the efficacy of this approach in building student capacity and skill (Brownell et al., 2010). Graham et al. (2013) indicated that individualized mentors can instill students with a sense of STEM identity and belonging, leading to increased persistence in STEM. These high-impact practices are particularly important in retaining underrepresented populations in STEM (Atkins et al., 2020; Kuh, 2008; Thomson et al., 2015). The Colorado Space Grant Consortium (COSGC) Space Professional Education, Enrichment and Development or WARP-SPEED program provides hands-on, experiential learning opportunities through co-curricular, NASA inspired, interdisciplinary projects. Students also gain important professional skills and build their STEM identity from the beginning of their time on the University campus. In the NASA spirit of creating cool acronyms, WARP stands for What a Rad Program.

Colorado Space Grant Consortium (COSGC) is an affiliate network of 21 colleges and universities, providing an aerospace ecosystem of educational, professional and training opportunities across the state. Through their hands-on programs, we currently engage over 500

post-secondary students in Colorado each year providing them with experiences that will aid them in their future careers. COSGC partners with industry, NASA, and faculty in Colorado and across the country to provide mentorship and project ideas for students. COSGC currently provides limited funds to its affiliate institutions to support students and faculty in undergraduate and graduate research and education, including robotics projects, suborbital and orbiting satellite missions. COSGC also provides statewide training workshops and design challenges, student scholarships and student internships, with a focus on recruitment of first-generation college students, students of color and adult learners.

In 2021, it was recognized that COVID and changes in COSGC leadership impacted how new students were recruited into undergraduate research projects within COSGC. Our COSGC program goals are to engage and support a minimum of 50% female and 25% underrepresented populations in STEM in our endeavors. Our current student engagement (89 students) is 39% female and 20% Latinx, Black, Pacific Islander, and Native American. Since increasing student diversity is a priority for both NASA and COSGC, the idea for WARP-SPEED began to take shape. WARP-SPEED was designed as an introduction of interdisciplinary project work and foundational technical skills. Scaffolding the student research experience in this way prepares students for more complex projects and professional presentations in subsequent years, helping with student retention (McPherson, 2014).

## **PROGRAM OBJECTIVES**

The WARP-SPEED program engages a cohort of interdisciplinary, diverse students with diverse staff and mentors in a supportive and collaborative environment throughout their first two semesters on campus. It provides student co-curricular experience in working on an

interdisciplinary team, applying methods of inquiry to complex problem solving, and the engineering design review process. The WARP-SPEED program helps students to establish their STEM identity which in turn increases their sense of belonging. The program also supports retention efforts by engaging students in experiential learning outside their traditional classroom experience (Stanford et al., 2017; Thompson et al., 2015).

### **COSGC Program Learning Objectives (PLO)**

- Develop student research and design skills through scaffolded intellectual inquiry
- Foster interdisciplinary collaboration of students and mentors
- Build student leadership and self-efficacy skills
- Create community and build STEM identity
- Prepare students for advanced space-related projects
- Increase participation of historically excluded or minoritized populations in STEM in NASA Space Grant projects and activities

### **WARP-SPEED Student Learning Outcomes (SLO)**

- Demonstrate the flexible thinking required in integrative learning environments
- Work collaboratively with persons from different fields of specialization in diverse, cross disciplinary teams to analyze and/or solve applied, real-world issues and problems
- Apply the tools (methodologies/content/skills) of multiple disciplines to analyze and/or solve complex issues and problems
- Effectively communicate the methods, techniques, and findings of original research or design in a professional setting

- Demonstrate the ability to design, plan, and execute an original research or design project in the appropriate discipline or interdisciplinary field that would meet professional standards in the field
- Demonstrate leadership skills (organization and planning, communication, delegation) by having taken one or more leadership roles in a project

To accomplish these objectives the program structure is as follows. First, recruit and select a diverse student cohort through an application process. Next, onboard the student cohort with an introduction to NASA Space Grant and team building activities. Then, engage students in a weekly program in the fall semester, working on an introductory design challenge project (DemoSat), identify and work toward a NASA challenge project proposal (HASP, Micro-g Next, RASC-AL, NASA Suits, etc). In the Spring semester, students work on a NASA challenge team, developing their design, submitting a proposal, going through the design review process, culminating in a professional presentation opportunity. Summative assessment of student learning outcomes wraps up the program and we then apply findings to program and curriculum components in the following year for continuous quality improvement.

## **PRELIMINARY PROJECT OUTCOMES**

With limited budget and resources, COSGC has piloted the WARP-SPEED program at CU Boulder and has had some initial success. We currently have 14 students involved with two NASA projects, mentored by our COSGC staff. From the first two cohorts, we had 66% Engineering, 12% CS, 19% Sciences, 3% Business/PES (other) majors. We have been assessing the progress and successes of the pilot and are ready to expand the program. We would like to double the size of our cohort, increase the student financial support for participation and provide more dedicated mentoring for the students. Of the first two cohorts, 80% have remained in Space

Grant for additional project experience, some moving into project leadership roles. COSGC staff currently run the program and mentor the student teams and projects. The plan for AY 23-24 is to expand this mentoring to include near peer mentors in the next cohort. We will also be implementing a pre and post assessment of student STEM identity.

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