1. Evaluation Plan

8.1 Evaluation Rationale and Logical Model

Fig.1 shows the logical model of the project evaluation. As shown in the figure, the CARES project is designed to transform input resources to accomplish NSF, CCU, S-STEM scholars', and industry partners' goals, ultimately generating new knowledge to achieve project discoveries. Summative results on the long-term outcomes of interest, retention, graduation, and meeting STEM workforce needs will be disseminated. Formative evaluation and feedback cycles will aid in checking and optimizing program delivery, and external and internal evaluators will play distinct roles in the project.

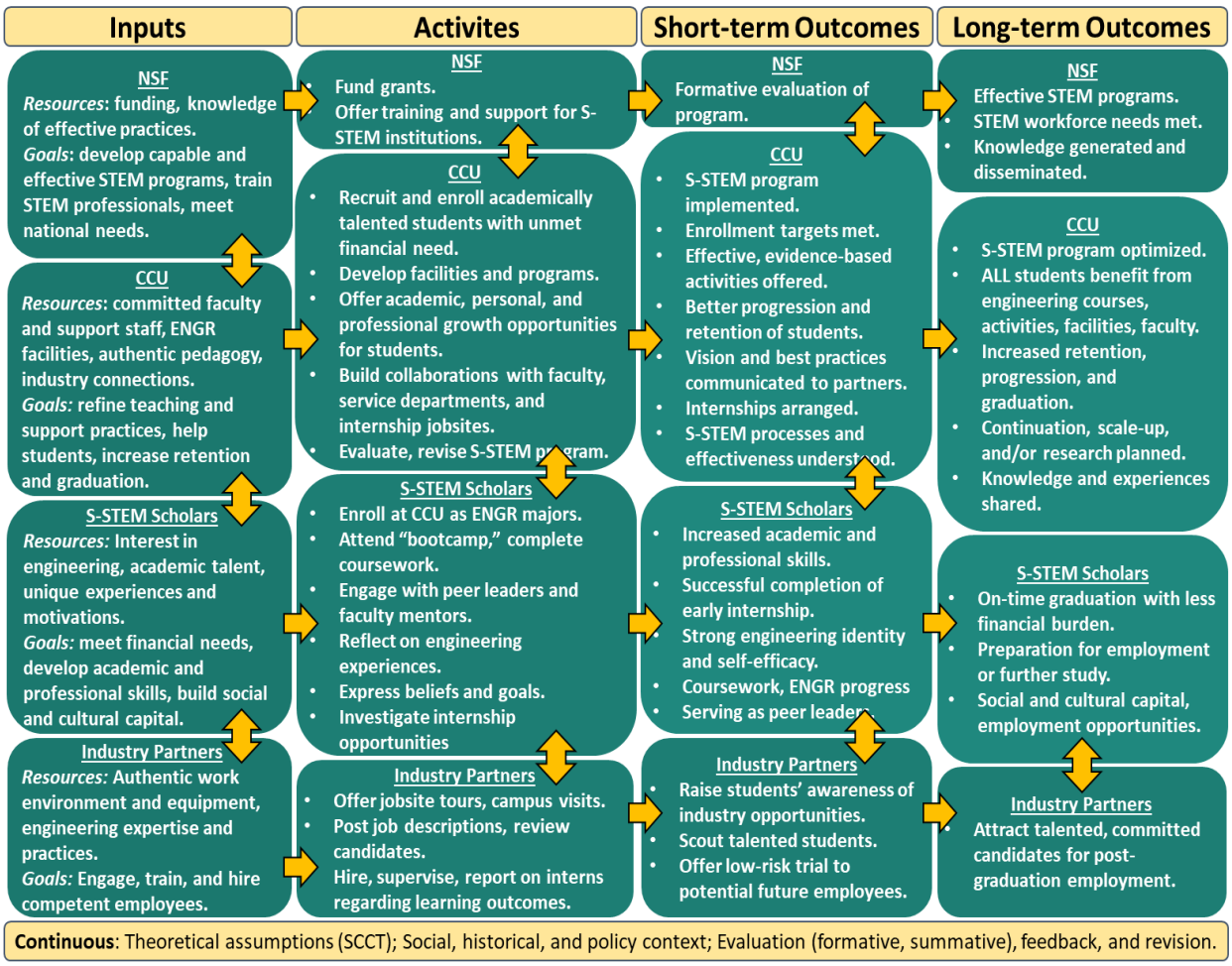

Fig.1: The logic model of the CARES project

8.2 Evaluation Questions, Instruments, and Data Collection

The evaluation makes use of existing and for-purpose data collection. The evaluation will consider scholars' profiles at the entry to the university, such as their academic, strategic, and financial needs, and whether these needs are met through the summer orientation and the bridge program, ongoing advising and mentorship, industry and research experience, and ENGR 203 Engineering Professionalism & Pathways.

Five evaluation questions (EQs) and one research question (RQ) will be established in the evaluation plan, where EQs 1 to 3 are formative evaluation questions and EQs 4 and 5 are summative evaluation questions. These questions are illustrated below:

- EQ1: Given students' unique abilities, dispositions, and needs, how does CCU S-STEM CARES prepare scholars academically and professionally for a productive internship experience?

- EQ2: Is there evidence that mentoring or serving as a peer leader contributes to the development of scholars' engineering motivations and self-efficacy?
- EQ3: How do internship experiences contribute to scholars' academic and professional development and their persistence and progression in the engineering program?
- EQ4: How has the CCU S-STEM CARES program contributed to scholars' long-term outcomes in engineering (progression, graduation, employment, further study)?
- EQ5: How have feedback systems contributed to the implementation and optimization of the CCU S-STEM CARES program?
- RQ1: What is the role of industry partners and internships in acculturating engineering students to the engineering profession, and what characterizes effective university-industry partnerships?

Table 1 illustrates the evaluation matrix. To explain, existing institutional data will be used to judge retention and progression, with processes being illuminated through for-purpose, interpretive methods, such as documentary analyses and interviews with course instructors. Internship application cover letters, mentoring/peer-leader reports, and the Motivated Strategies for Learning Questionnaire (MSLQ) will uncover students' motivations and strategic actions toward building their academic and professional skills. Potential implementation issues and growth opportunities will be raised through feedback cycles and annual formative reports from the external evaluator. Following the internship, scholars will be offered ongoing mentoring and may serve as peer leaders but are otherwise expected to proceed through traditional pathways to graduation. This includes taking advanced maths and engineering graphics courses, completing research projects, and doing internships. Formative evaluation will be ongoing but utilize mainly existing data and the annual MSLQs. Summative evaluation will take place in the final years of the program, and scholarship recipients will be directly compared with engineering students of a similar profile regarding retention, graduation, and future work and study plans. All scholars will complete a survey before graduation.

8.3 Qualifications, Roles, and Duties of Evaluators

The CARES project will be evaluated by an internal evaluator and an external evaluator. **IE/SSR L. Hitt** is the Internal Evaluator (IE) and Social Science Researcher (SSR) of the project. Mrs. Hitt is a trained social science researcher who examines the role of metacognition and self-regulation in mathematics teaching and learning [1], and synthesizes evidence for programs to reduce educational disadvantage and achievement gaps with diverse students [2,3]. L. Hitt worked with the project team to develop the evaluation plan; and will be responsible for collecting and summarizing feedback to the PI, Co-PIs, and external evaluator to check implementation fidelity and deepen understanding of individual and social processes within the SCCT framework. **EE Fegely** is the External Evaluator (EE) of the project and is an Assistant Professor and the program coordinator of the Instructional Technology graduate programs at CCU. Fegely has expertise in computer science education [4, 5], designing evaluation instruments of educational VRs [6, 7], and educational robotics [8, 9]. He was the project director of the Partnership for the Robotics Integrated with Science and Mathematics (PRISM) funded by the SC Commission on Higher Education, from which he evaluated the impacts of robotics professional development sessions for science and math teachers from underrepresented middle and high schools. Dr. Fegely will be responsible for summative evaluation of project outcomes attainment through admitted scholar profile analysis, individual scholar interviews following early internship, and quantitative graduation rate effect analysis.

Table 1: Evaluation matrix. SA is STEM Administrator; IE is Internal Evaluator; EE is External Evaluator; CI is Course Instructor.

EQ	Indicator	Data sources	Responsible parties	Timing	Analysis plan	Interpretation
Q1	Scholar profiles at entry	CCU and S-STEM CARES applications; enrollment and disbursement data.	PI/SA G Hitt collects from IR, relays to EE Fegely for analysis.	Once for each cohort.	Compare scholars' interests, academic and financial needs; previous, current eng. cohorts.	Check enrollment meets targets and needs of the cohort fit expectations.
	Academic progress	High school grades; math placement tests; academic standing, grades, and progression; Semi-structured interview with "math bootcamp" instructors.	PI/SA G Hitt collects from CI Jagannathan, relays to EE Fegely. IE L Hitt interviews CI, & reports to EE.	Grades annually. Bootcamp, once per cohort.	Describe scholars' academic progress during year 1 of the program. Analyze personalization of bootcamp.	Check for as-intended delivery of bootcamp, improved progression in engineering, math courses.
	Professional preparation in year 1	Grades in CAD and ENGR 203 courses; cover letters for internship applications; interviews with CAD instructor.	PI/SA G Hitt collects from IR. IE L Hitt analyzes cover letters, interviews CI Jagannathan.	Once per cohort.	Thematic analysis of scholars' writing about their skills and goals, and how these link to course grades.	Check courses as implemented are preparing students to apply for internships.
Q2	Program engagement	Attendance records (card swipes) from advising, industry events, and mentoring meetings.	PI/SA G Hitt collects, relays to IE L Hitt.	Each semester.	Comparisons between scholars and other engineering students.	Check levels of engagement meet goals.
	Motivations and self-efficacy	Mentoring and peer-leader reports. Online Motivated Strategies for Learning Questionnaire (MSLQ)	Co-PI Guo collects, IE L Hitt analyzes.	Annually.	Light touch thematic (SCCT) analysis, with comparisons by level of engagement.	Responses indicate benefits from engagement for motivations, goals and self-efficacy.
Q3	Internship documents	Internship learning contract; Workplace competency assessment.	SP Bell supervising internships collects, relays to IE L Hitt, who analyzes.	Once per cohort.	Light touch thematic (SCCT) analysis.	Check scholars' at setting and meeting relevant and challenging goals.
	Scholars' responses to internship	Semi-structured interviews with scholars.	EE Fegely interviews and analyzes.	Once per cohort.	Thematic analysis based on SCCT and engagement.	Check growth in professional skills and self-efficacy.
Q4	Progression and graduation rates	Institutional data.	PI/SA G Hitt collects, Co-PI Guo analyzes. EE Fegely calculates effect sizes.	Annually.	Counting, and statistical analysis, comparing outcomes for S-STEM CARES scholars, similar engineering students, and other majors.	Scholars should show improved outcomes relative to comparison groups.
	Future plans and goals	Graduation survey (online).	PI/SA G Hitt collects, relays to EE Fegely.	Once per cohort.	Thematic analysis (SCCT), comparing scholars and other students.	Scholars should show ambitious and focused engineering goals and plans.
Q5	Process feedback	Feedback reports on S-STEM cares program. Annual feedback meeting with PI and Co-PIs.	IE L Hitt relays annual feedback on to EE Fegely. EE meets with S-STEM team to review implementation updates.	Annual meetings and reports.	Phenomenological analysis, looking at conceptual and operational shifts in the CCU S-STEM program. Consideration of potential factors for scale-up.	Updates to the program should feedback and should mobilize resources and strengths to better meet scholars' needs.

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