

Using an Internet of Things System Design to Develop Problem-solving and Critical Thinking Skills in Underrepresented Minorities in Engineering

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Abstract: At Chico State, less than 10% of the engineering students in the EECE department (Electrical, Electronics, and Computer Engineering) are women, with an even lower percentage of women from underrepresented minority groups. These students face various challenges when participating in the field, such as the lack of leadership opportunities, gender bias, and stereotyping during team or group projects. All engineering programs require students to enroll in capstone classes, where they can apply their knowledge and technical skills to practice the design process. However, these courses only ensure that some students get practice with every aspect of the design process by delegating tasks to group individuals. This approach may make it difficult for female students to participate equally in the design process and they may be overshadowed by their male peers. Typically, project groups have at most one female student with many male peers.

This research project took a unique approach by empowering students from underrepresented minority groups. Over ten weeks, these students actively participated in proposing, planning, designing, and executing an Internet of Things (IoT) project. They were involved in all aspects of the project planning process, from identifying the problem statement and designing the goal to implementing the solution using a combination of hardware and software. By the end of the ten weeks, these students had developed and implemented a practical and impactful innovative door-locking system. The system, which utilized several digital and electronic components, allowed the user to connect to the door and remotely open and close the lock, demonstrating the project's tangible results.

The research evaluation used a qualitative assessment tool. Participants were asked to evaluate the study outcomes by responding to various prompts reflecting on their research experience. The feedback from the students highlighted their growth in areas not typically encountered within the engineering community. They developed critical thinking, problem-solving, and self-confidence, and gained experience in project leadership. This involved creative and strategic decision-making, timeline and deadline planning, seeking expertise when necessary, and troubleshooting hardware and software issues.

Keywords: *Internet of Things (IoT), Problem-solving Skills, Critical Thinking.*