Online Education in Environmental Engineering
California State University, Fullerton, a Case Study

The online graduate program in environmental engineering (MSEnvE) at California State University, Fullerton (CSUF) was launched in 2012. Since then, the program has witnessed rapid growth in enrollment, which is a testimony to its quality education. To assure long-term sustainability and relevancy of the program, it is imperative that structural changes such as enhanced course content and innovative content delivery be implemented. Recognizing the diverse student enrollment in the online MSEnvE program, targeted institutional interventions to attract, recruit, and retain graduate students is needed for the long-term success of the program.
Rapid growth in information technology has increased the reach of human communication through a computer network. Technological innovation has not only led to the expansion of quality education to remote areas but also radically altered the content delivery, instruction style and the relationship between the learner and instructor. The net result of these changes is a paradigm shift from classroom-confined instruction to anytime, anywhere, readily accessible online education. For example, according to one estimate, in 2013, 11.1 percent of all undergraduate students in the United States were enrolled in a fully online degree program, and more than 25 percent of students had taken at least one online course.1

Similarly, students earning undergraduate degrees in environmental engineering rose from 486 in 2008 to 1,201 in 2017, while there was a 65-percent net increase in MSEnvE degrees across all instruction modes during the same period.2 The MSEnvE program at CSUF targets both traditional students and non-traditional working professionals who want to advance their career. The majority of the students (54.5%) in the MSEnvE program are currently working in the environmental field, while around one quarter (27.03%) are working in another engineering field.

This article documents the growth of the online MSEnvE program at CSUF with particular emphasis on the participation of diverse student groups, including ethnic, first-generation, and underrepresented minority students. Further, it analyzes the challenges and prospects for sustainable growth of the MSEnvE program at CSUF. This article is intended to help academicians, environmental professionals, and educators better understand the educational trend of online instruction in environmental engineering and appreciate the strengths and future challenges faced by the MSEnvE program at CSUF.

Online Education at CSUF
The MSEnvE program at CSUF is a fully online degree program that has been offered since fall 2012 to serve the growing demand of environmental professionals. California is one of the top five states in the United States with the highest demand for trained environmental professionals. Nationally, environmental engineers are always in demand and remain so in the foreseeable future. According to the U.S. Bureau of Labor Statistics, employment for environmental engineers expected to grow by 8 percent from 2016 to 2026.3

Additionally, job prospects, particularly for the candidates earning a master’s degree in environmental engineering, will remain high due to expected large-scale retirement. The course content of the MSEnvE program has been streamlined to better accommodate employment trends and demands in the various sub-specialty of environmental engineering. Since its inception, the online MSEnvE graduate program at CSUF has been successful in meeting the growing demand by making quality education readily accessible, anytime, anywhere, yet challenges remain.

Enrollment Trends
Since the launch of the MSEnvE program at CSUF in 2012, enrollment has doubled from 46 students in 2012 to 95 students in 2018. Over the past six years, the number of applicants seeking admission in the MSEnvE program rose by 75 percent. Even though the entire instruction delivery of the program is online, the class size is capped at 30, as such not everyone who applies to the program is accepted. The small class size enables the program to maintain its high-quality instruction.

Figure 1 shows enrollment trends in the MSEnvE program at CSUF. CSUF is a minority-serving institute with more than 40 percent of its student population is minority. The program caters to the sizeable population of underrepresented minority students with nearly one-third of the current enrollment representing minority students.

Demographic Profile
A strength of the MSEnvE program at CSUF is its diverse student population (see Figure 2). The current ethnic distribution of students is: Asian (33%), White (30%), and Hispanic (19%). Enrollment of Asian and Hispanic students in the MSEnvE program is high, yet the number of degrees earned by these students is low. The mismatch between enrollment and degrees awarded is potentially due to attrition in student population and timely completion of the degree program.

Even though the program follows a two-year cohort-based model, not all students enrolled in the program graduate within two years. Between 2012 and 2015, the average two-year graduation rate in the MSEnvE program was 60 percent. The relatively low enrollment and graduation rate of Hispanic students indicates a potential achievement gap between Hispanic and their majority counterpart.

Unlike a traditional face-to-face MSEnvE program, the online program is not popular among international students. There are a multitude of reasons for this, including student immigration status and the requirements for mandatory full-time enrollment in face-to-face classes.

Distinctive Features of the Online MSEnvE Program at CSUF
The MSEnvE program at CSUF is a fully online, asynchronously delivered, and cohort-based program, where students access pre-recorded course material (e.g., PowerPoint slides and recorded video) through electronic media at their convenience. Course communication facilitated through social media tools, such as Zoom meeting, Skype meeting, and mandatory online blogs, are used to facilitate student-teacher and student-student collaboration. Blogs are often used by students to post questions and seek clarifications.
The program requires students to earn 27 credit units of course work and an additional 3-credit unit for culminating graduate project report. The graduate project report is an intensive writing course akin to a thesis or capstone project. One of the unique features of the program is that it enables students to pursue a thesis option. Students pursuing this option are required to conduct two-semesters worth of extensive laboratory/field studies as part of their thesis requirement. The thesis option is a clear departure from the traditional online graduate programs offered elsewhere. This feature has real currency since it makes the program more akin to the conventional face-to-face graduate program. The online MSEnvE program is popular among female students. As shown in Figure 3, female students account for 34 percent of the total number of degrees awarded. This trend is consistent with the nationwide trend in engineering degrees earned by female students. For example, in 2017, the proportion of engineering degrees earned by female students reached a 10-year high. Female students received 50%, 45.7%, and 48.7% of environmental engineering
degrees at the bachelor’s, master’s, and doctoral level, respectively. Increasing the enrollment of female students is one of the most promising areas for the online MSEnvE program at CSUF. A focused approach to increase the participation of female students in the online MSEnvE program should be an institutional priority.

Additionally, the disproportionate representation of minority students is a cause of concern. Minority students often have competing priorities and are unable to participate in a traditional face-to-face curriculum. Given this scenario, one would expect their higher participation in the online MSEnvE program due to its flexible schedule and anywhere, anytime accessibility. Surprisingly, only 24 percent of underrepresented minority students earned an online MSEnvE degree in 2017. Ethnicity is an important factor that impacts students’ perceptions of online education. For example, one study showed that Asian (Singaporean) students typically prefer face-to-face interaction to complete their school activities, while Australian students prefer online interaction. Such studies reflect the role of ethnicity and its role in preferential participation in face-to-face and online education. Concerted efforts should be made to promote the participation of underrepresented minority students in the online MSEnvE program at CSUF.

**Future Growth and Challenges**

Following on the heels of technological innovations, online education has witnessed rapid growth in the last decade, offering students wider access to educational opportunities, reduced commute times, and flexible schedules. At CSUF, since its launch in 2012, the MSEnvE program has shown promising growth with an overall enrollment increase in the program by more than 50 percent. The online program is now well established with a sustained increase in graduation and enrollment.

Nationally, the MSEnvE program at CSUF currently ranks 16th among the best online graduate programs, yet challenges for future growth remain. Challenges include redesigning the online learning experiences through effective integration of real-world examples in course curricula; using tools to simulate a traditional classroom environment; developing a structured protocol for student-teacher and student-student interaction to better engage online students; and reducing the perceived differences between conventional and fully online instruction. Continued enhancement in course content by establishing industry liaisons to meet the demands of the environmental industry is essential to keep online student abreast with the development in the field.

Many schools offer an online graduate degree in environmental engineering, in order to compete with them and remain relevant, it is vital for the CSUF program to continue to make innovations in course content delivery, course realignment, and provide graduate thesis options for those who prefer to engage in research activities and evaluate a
hybrid approach (i.e., real-time lecture delivery with online participants). Complacency and a lack of innovation could potentially make the program obsolete and may not withstand the competition from universities that offer a similar program.

Structural changes are necessary and timely to make the program vibrant and sustainable. The curriculum should be streamlined to meet the demands of the industry to maintain program relevancy. Now is the time for the MSEnvE program needs to go through a program evaluation to better align the program outcomes with actual program activities to improve overall quality. Furthermore, the explosion of Massive Open Online Courses (MOOCs) offered by many schools poses a direct challenge to the future growth of MSEnvE program at CSUF.

The impressive growth of the program over the last six years is the testimony to its high-quality education, yet in order to maintain continued growth and relevancy, the program requires systemic changes both at the program and institutional level.

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Disclaimer
The narrative presented in this article and the conclusions made by the author are born out of his own experience of teaching online MSEnvE courses at CSUF. The views expressed in this article are those of the author and do not necessarily reflect the views of CSUF or other faculty members who teach in the online MSEnvE graduate program.

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