Review Study on Promoting Diversity and Inclusion in Engineering Education through Digital Twins

Devon Bountry, Dr. Behnam Ghalamchi, Mechanical Engineering

CAL POLY College of Engineering

2023 Summer Undergraduate Research Program Symposium

Objective

We studied the different uses and applications for digital twins in engineering education with a special focus on their improvement of diversity and inclusion in the learning setting. This paper reviews different research papers and journals that discuss the productive use of digital twins in engineering education, and their effect on diversity and inclusion. This paper will focus on answering the following research questions.

Research Questions:

1. How can digital twins enhance and improve the learning experience?
2. Can online learning with the help of digital twins replace in person laboratories?
3. Can online engineering learning increase learning speed?
4. How can digital twins affect diversity and inclusion in the engineering industry?

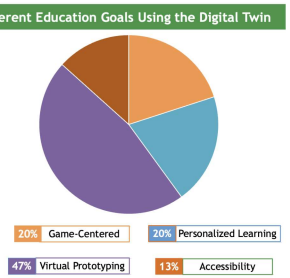
What are Digital Twins?

Digital twins have a variety of definitions, but a true digital twin consists of three parts: the physical system, the digital replication of the system, and continuous data flow between the two. This new technology can now model intricate systems including modeling systems, healthcare, construction management and safety, product design, education, safety training, energy usage, business models, and more. Table 2 discusses different definitions used by papers reviewed in this study.

Published Year	Definition of Digital Twin	Key Terms
2018	Combination of a design model with the use phase data of a product or a system	Test behavior over a lifecycle
2018	A mirror image of a physical process that is articulated alongside the process in question.	Physical replication
2020	A virtual duplicate of a system built from a fusion of models and data.	Dynamic system modeling
2020	Data flows between the physical-digital objects which are fully integrated in both directions	Control system design

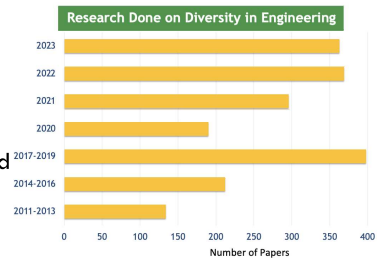
Digital Twins and Engineering Education

Digital twins in engineering can be great tools as they allow students to put what they've learned into practice with less restrictions on materials. With modern developments, the physical system of digital twins can include steel structures, geotechnical engineering, coastal engineering, environmental engineering, and hydraulics. There have been several examples of engineering classes who have implemented digital twins to make a more interactive and involved laboratory section. Even in broad terms practicing the design and build process can be costly after multiple prototypes and testing fixtures. Digital twins allow a way to performs tests faster and cheaper and faster redesigns.



Impact on Diversity and Inclusion

Digital twins provide a unique opportunity in the continuous evolution to a fair, equitable field. Using digital twins can increase economical, societal, and residential growth at a faster rate. A more digital and decentralized business allows a more diverse employee population that in turn can promote success in progress and evenly spread wealth in many different cities and populations. Digital twins' applications can also adapt to the user, once again creating a human-centered experience. By making opportunities more accessible allows people who are qualified but may not have the connections to get more of the high paying positions.



Ethical Engineering

As digital twin technology develops, it will be vital to ensure these new resources are widely available. Making these technologies do not have restrictions gives smaller communities an equal chance to utilize them and succeed. A strong ethical code regarding technology will be needed going forward to regulate and judge the new technological developments that arise. Providing the public with clear and reliable information will be vital. Not all technology will be able to be regulated, and so it is important that it can be presented in a clear way that allows the consumer public to assess the information themselves and decide on if and how to use it. Many universities have engineering classes that teach students about the ethics and morals of their designs. Students must become aware of their professional, ethical, and social responsibilities when making an engineering decision.

Future Work

Future research will focus on implementing digital twins into the Cal Poly education center. The goal of this process would be to gain further understanding on what the student and staff body of Cal Poly knows about digital twins and their effects. It is important to learn more about the desired group's prior knowledge to this new technology and gauge their interest in it. This would include asking the questions below.

1. Have you ever heard the term "digital twin" before?
2. What is your best definition of a digital twin?
3. Do you think learning how to use and create digital twins would be useful to you in industry?

Acknowledgment

This research was funded by Paul & Sandi Bonderson