

Energy3D: Guiding Engineering Design with Science Simulations

The new science standards mandate an appropriate integration of engineering design and science learning in precollege engineering activities. However, science and engineering education research suggests that achieving this integration is a challenging task. Primarily, three challenges hinder this integration- (a) science concepts are often invisible and alien to students thus making it difficult for students to use them during a complex design activity, (b) application of a science concept towards optimizing a design depends heavily on a good understanding of its interplay with all other related concepts that may affect the system function, a difficult practice for the students to grasp, and (c) need for continuous formative feedback to illuminate how science principles influence students' own designs in order to develop a normative understanding of science and engineering design concepts and make effective trade-offs.

Our research addresses these challenges by supporting engineering design and science inquiry learning with a computer-aided design (CAD) platform, Energy3D, that embeds powerful science simulations to provide formative feedback to students while they are working on solving an engineering design challenge such as constructing an energy efficient home within a limited budget. We have designed a curriculum unit for middle and high school students based on the Learning by Design framework that integrates the engineering and science standards and provides a project based learning environment for the students. Findings suggest that students have significantly better understanding of science and engineering concepts after completing the design challenge using Energy3D.