

NNCI Webinar: Education and Computation

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Virtual Immersive Worlds for Experiential Learning of Quantum and Semiconductor Physics

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Abstract: Many concepts in quantum and semiconductor physics are unobservable within the bounds of normal human experience, require a revision of the laws of classical physics, and are often taught with an emphasis on mathematical formalism. The development of deep understanding of how quantum and semiconductor devices/circuits work therefore requires years of rigorous study. Research has shown students often struggle with conceptual questions even when they learn the math. How could one accelerate the development of intuition about solid-state devices and circuits for a vast and diverse group of students around the world? In this talk, I will present a series of online immersive worlds that allow students to visualize and experience fundamental concepts in semiconductor devices as a key tool toward that goal. I will start by showcasing a suite of digital games that introduce and habituate students to quantum physics, transforming some of its mathematical concepts into a rule system (game mechanics) that is easy to learn and master. These games target middle- and high-school students, undergraduate students in science and engineering, and the general public. Next, I will present a series of interactive visualizations that allow students to experiment and observe foundational concepts in semiconductor physics, gain intuition, and avoid some of the common misconceptions. The target audience for these visualizations are students in introductory courses on semiconductor physics and devices. The educational tools are publicly available on learnqm.gatech.edu. The games have been showcased at the Smithsonian National Museum of American History in 2019 and the interactive visualizations have been recognized by the Inaugural IEEE Solid-State Circuits Society James Meindl Innovators Award in 2022.

Bio: Azad Naeemi is a professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. His technical research crosses the boundaries of materials, devices, circuits, and systems, investigating integrated circuits based on conventional and emerging nanoscale devices and interconnects. His educational research includes experiential learning environments and their impact on conceptual understanding of scientific and engineering topics. He serves as the Editor-in-Chief of the *IEEE Journal on Exploratory Computational Devices and Circuits* (JXCDC) and is the Associate Director for Computation for the NSF-supported National Nanotechnology Coordinated Infrastructure (NNCI). He is a recipient of the IEEE Electron Devices Society (EDS) Paul Rappaport Award, the Inaugural IEEE Solid-State Circuits Society (SSCS) James Meindl Innovators Award, an NSF CAREER Award, an SRC Inventor Recognition Award, and several best paper awards from international conferences.



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