香港城市大學
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Connecting conceptual ideas to real-world applications for modernizing an undergraduate general physics curriculum

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Abstract:

In a traditional undergraduate physics class, copying notes from a blackboard and working on problem sets are the main learning activities. Over the past decade, science, technology, engineering, and math (STEM) educators have gradually adapted to the new learning needs and preferences of the Millennials and Gen Z, and increasingly incorporated graphic, digital and social media elements into the curriculum. In a fast-paced, ever-changing environment, students' attention span during a lecture is shortened and multi-media and hands-on experience allow students to learn by doing. In the case of learning quantum physics, a subject that is abstract and mathematics heavy, connections between this subject to how it contributes to the technological advancement that completely revolutionized our way of living open the door to spark students' interests. Towards this end, this proposal focuses on implementation of real-world observations and experiences to make abstract concepts in quantum mechanics tangible. Herein, the PI together with a research assistant will redesign the lecture and the tutorial sessions so that they serve as platforms for students to connect the abstract ideas to real world applications. The PI, an experimental physicist whose research heavily involves quantum mechanics, will lead the students to interact with the physics concepts through research demonstrations and virtual lab tours. Students will be exploring how the fundamental concepts and theory are being tested in an electron tunneling microscope. Single molecule circuits are fabricated and electrons flowing through a one-nanometer device are recorded. Such electron tunneling processes are the real-world visualization of the quantum mechanics problems. Moreover, how such observations of the quantum phenomena can enable new technologies that impact our daily life will be showcased, sparking ideas from the students about the future technology development in related areas. Students are encouraged to brainstorm ideas and develop entrepreneurship projects with which they can participate in programs such as HK Tech 300. In the tutorial sessions, a deeper understanding of the theory and problem-solving skills will be developed through hands-on exercises with computational modules. In this learning process, students are expected to embrace the seemingly nonsensical quantum world, master a mathematical language to describe the physics rules, and acquire fundamental analytical, collaboration, and reasoning skills that can be translated to all careers.