

## INNOVATION IN QUANTUM PEDAGOGY, APPLICATION, AND ITS RELATION TO CULTURE (IQPARC)

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### Abstract

Innovation in Quantum Pedagogy, Application, and its Relation to Culture (IQ-PARC) is a team of Purdue faculty, graduate, and undergraduate students who collaborate and work for the National Defense Education Program (NDEP) for Science, Technology, Engineering, and Mathematics (STEM) education, outreach, and workforce initiative programs. We promote a STEM-literate workforce by providing learning opportunities for youth to understand basic principles and applications of quantum concepts through a variety of both face-to-face and online activities. This research brief describes accomplished tasks in the K-12 education space (e.g., quantum-infused middle school curriculum unit) and shares upcoming plans within the project timeline.

### Introducing Fundamental Quantum Concepts to K-12 Teachers and Students

IQ-PARC team started the quantum integration initiative into K-12 science education curricula through teacher professional development (TPD) workshops during the summer of 2020. Until now, one magazine article introducing approaches to quantum cryptography with quantum key distribution was published at *Science Teacher* (Akdemir et al., 2021). A year later, another TPD was organized to introduce quantum random numbers and the contrast of quantum computers to classical computers to middle school science teachers. The curriculum was developed by physics and K-12 education majoring graduate students, and then middle school teachers were hosted to the summer 2022 workshop to discuss curriculum compatibility with Indiana 2016 & 2022 academic standards. Teachers' feedback and suggestions were taken to improve lesson content to compare the randomness/probability concept distinguished between radioactive decay process in nature and quantum information processing. At the end of the workshop teachers were able to create holistic artwork which was generated by real quantum random binary numbers. All meeting outputs were recorded in a cloud platform and will be shared with those who are interested in integrating quantum concepts in their curriculum.

### Future Considerations of Research

The IQ-PARC team currently administers the quantum-infused unit in eight different public middle schools in Indiana. Teacher and researcher's observations recently indicated that students were highly eager to learn about quantum computers and information processing. We collected student interest, engagement, and conceptual development data before and after the lesson implementations to investigate how our K-12 initiative positively impacted young students' learning and comprehension of such an exciting new, and challenging topic in science.

### References

Akdemir, Z. G., Menekse, M., Hosseini, M., Nandi, A., & Furuya, K. (2021). For your eyes only: Introducing quantum key distribution to high school students. *The Science Teacher*, 88(3).  
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