Pedagogical Considerations for Quantum Instruction

Paul J. Emigh[1], Elizabeth Gire[1], Corinne A. Manogue[1],
Gina Passante[2], and Peter S. Shaffer[3]

[1]Department of Physics, Oregon State University, Corvallis, Oregon 97331-6507, USA
[2]Department of Physics, California State University, Fullerton, Fullerton, California 92831, USA
[3]Department of Physics, University of Washington, Seattle, Washington 98195, USA

Abstract. We discuss developmental considerations for two quantum mechanics curricula: Paradigms in Physics (from Oregon State University) and Tutorials in Physics: Quantum Mechanics (from University of Washington).

Details

The considerations include theoretical commitments about pedagogy and practical structures shaped by the instructional constraints [1]. We compare the considerations themselves along with how instructors are typically prepared to implement each curriculum in the classroom. In the case of the Paradigms [2-3], the theoretical commitments drove changes to the practical structures. However, the Tutorials [4] were shaped in a way that the theoretical commitments had to be incorporated into a course with a relatively fixed structure. This difference contributed substantially to the fact that the two curricula prioritize different commitments and consequentially promote student understanding in different ways. We explore example activities from each curriculum to highlight some of these differences, focusing on the same topic (angular momentum in quantum mechanics) for both.

We also discuss how the alignment and tension between the theoretical commitments for each curriculum has resulted in different needs for instruction preparation. In particular, the Paradigms requires a much more intensive involvement on the part of the instructor in terms of preparing, sequencing, and adapting to what happens in the classroom. On the other hand, preparation for the Tutorials is more focused and requires less adjustment on the part of the instructor. For both curricula, however, direct preparation of the instructional team (especially if it involves multiple teaching assistants) to address student ideas in the classroom is essential. Lastly, we note some deep similarities between the two curricula: the importance of social interactions and multiple representations and the ways in which students build their own ideas.

References

[1] P. J. Emigh, E. Gire, C. A. Manogue, G. Passante, and P. S.Shaffer, Research-based quantum instruction: Paradigms and tutorials, Phys. Rev. Phys. Educ. Res.16, 020156 (2020).
[2] C. A. Manogue, P. J. Siemens, J. Tate, K. Browne, M. L. Niess, and A. J. Wolfer, Paradigms in physics: A new upper-division curriculum, Am. J. Phys. 69, 978 (2001).
[3] Webpage of the *Paradigms in Physics* project, https://paradigms.oregonstate.edu/.
[4] L. C. McDermott, P. S. Shaffer, and P. R. Heron (The UW Physics Education Group), *Tutorials in Physics: Quantum Mechanics*, preliminary edition ed. (University of Washington, Seattle, WA, 2014).