Student Perspectives on the Mathematical Formalism in an Operator-Based Quantum Mechanics Course

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Quantum mechanics represents a uniquely interdisciplinary learning environment where student success depends on navigating the boundary between mathematical abstraction and physical interpretation. Students must coordinate the symbolic reasoning (e.g., linear algebra, Dirac notation, operators) with conceptual quantum ideas like measurement. Prior research has shown how this intersection often creates cognitive and epistemological tension for learners, particularly in quantum (Schermerhorn et al., 2019; Wawro, Watson, & Christensen, 2020).

Within both the mathematics education and physics education research (PER) communities, scholars have noted that students' epistemic framings, such as their views on mathematics in constructing physical meaning, are critical to developing a deeper understanding. Wawro et al. (2025) found that students often interpret eigenequations differently across linear algebra and quantum mechanics contexts, revealing gaps in how mathematical symbols acquire physical meaning. Complementary work in PER highlights that representational and epistemological struggles manifest as affective and identity challenges, where learners continually renegotiate what "counts" as math or physical reasoning in their STEM courses (Schermerhorn et al., 2019).

Broader studies in undergraduate STEM education report that students' success in advanced mathematics and science courses is influenced by both their prior preparation and their self-efficacy in applying mathematics to novel contexts (Korpershoek, Kuyper, van der Werf, & Bosker, 2011). Moreover, Matthews, Adams, and Goos (2009) argue that many science curricula treat mathematics as a procedural prerequisite rather than a tool for sense-making, thereby limiting opportunities for interdisciplinary reasoning.

The data were collected through a series of semi-structured, think-aloud interviews conducted with undergraduate students enrolled in a junior-level quantum mechanics course. Each participant would provide their attitudes, opinions, and perceptions on a variety of topics pertaining to their quantum mechanics course. Responses were coded and analyzed, revealing a range of attitudes, from appreciation and confidence in mathematical precision to frustration with abstraction and a perceived lack of physical grounding.

This poster will focus on findings suggesting a correlation between students' sense of ownership of mathematical tools and their ability to conceptually bridge quantum measurement and experimental practice. The analysis emphasizes the pedagogical significance of explicitly linking symbolic operations to interpretive and experimental contexts. These findings align with the cross-disciplinary disconnects reported by Matthews et al. (2009) and Wawro et al. (2025), suggesting that challenges in integrating mathematics and physics extend beyond cognitive to include epistemological and emotional aspects. Importantly, this study provides a student-centered representation of these dynamics, revealing how learners articulate their own mathematical understandings within the context of quantum mechanics.

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