

Enhancing Secondary School Physics Teachers' Understanding of Quantum Concepts and Pedagogical Strategies Through Professional Learning Networks

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Abstract. This exploratory study addresses the effectiveness of professional learning networks (PLNs) in improving high school physics teachers' understanding and teaching of quantum physics (QP). The research focuses on how participation in a quantum physics-focused PLN can increase teachers' content knowledge (CK) and pedagogical content knowledge (PCK), which ultimately enhances their teaching self-efficacy. Preliminary results indicate that participation in PLNs leads to significant gains in teachers' CK and PCK, suggesting a promising path for professional development in physics education.

Introduction

Research shows that QP is difficult for students to understand and many high school physics teachers lack subject knowledge and confidence to teach it [1]. Although topic-specific PCK [2] is required to address students' difficulties with QP [3], most teachers have limited opportunities to develop this specialised knowledge [4]. PCK and teacher self-efficacy have a positive impact on student achievement [5, 6], yet many professional development initiatives have no impact on daily classroom practice [7, 8]. This study examines a professional development model that uses a PLN to improve high school physics teachers' QP knowledge, self-efficacy, and PCK.

Theoretical framework

The framework of this study is built upon the concept of situated learning within communities of practice. PLNs actively engage teachers in collaborative enquiry, knowledge construction, and critical reflection [9, 10]. Within a supportive community, teachers can openly discuss challenges, collaboratively develop solutions, implement new instructional strategies, and evaluate outcomes under the guidance of an expert. This process not only enables teachers to transform QP content knowledge into personalised PCK but also develop teaching materials that fit their individual teaching context.

Research questions

1. How does teachers' QP content knowledge develop through immersive activities in a QP PLN?
2. How does participation influence teachers' self-efficacy beliefs about teaching QP?
3. What specific aspects of the QP PLN do teachers perceive as most valuable for improving their PCK?

Method

The study will follow a mixed methods approach to allow for triangulation. Quantitative data will be collected through pre- and post-tests to measure changes in teachers' CK (n=9). Self-efficacy

will be assessed through pre- and post-interviews, and additional qualitative data will be collected through observations during PLN sessions and course evaluation forms.

Preliminary results and conclusions

Preliminary data analysis indicates the QP PLN significantly boosted teachers' confidence and conceptual understanding. Teachers valued collaborative discussions of novel teaching approaches and developing their own materials. Crucially, the PLN's flexibility to address individual needs through personalized guidance from the expert was greatly appreciated. A compelling success indicator is all participants wanting to continue next year, even requesting to explore advanced topics beyond the curriculum like quantum entanglement and computing. This enthusiasm suggests enhanced PCK and deeper interest in QP. Overall, preliminary findings are promising - participation in the PLN leads to gains in content knowledge, PCK, and teaching self-efficacy. The PLN's collaborative, supportive approach tailored to individual needs appears an effective professional development model. Further data will provide insights into the specific mechanisms facilitating teachers' professional growth in the PLN.

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