

How to Improve Mathematics Tutors' Technology, Pedagogical, and Content Knowledge

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ABSTRACT

This study used action narrative inquiry to examine how a mathematics tutor (2014–2024) in a shadow education setting built professional learning communities (PLCs) and promoted technological, pedagogical, and content knowledge (TPACK) through technology. Data from meeting records, online notes, videos, and diaries reveal a four-phase process: formation (awareness of PLCs), construction (building TPACK via dialogue), implementation (applying TPACK with remote teaching and blended methods), and reflection (adjusting instruction based on feedback). The findings stress the importance of a TPACK community, in-person meetings for trust, and addressing student needs in tech integration.

KEYWORDS

Remote Education, Online Learning, Learning Communities, Mathematics Tutors, Professional Development, TPACK

INTRODUCTION

Jerrim and Choi (2014) established a robust framework utilizing longitudinal data from the Trends in International Mathematics and Science Study 2003 (fourth grade) and 2007 (eighth grade). Their analytical approach, specifically targeting 10–16-year-old students in the United Kingdom and East Asian nations, extended beyond mere average score fluctuations, encompassing measures of educational outcome disparities, the 90th percentile distribution, and meticulous benchmarking against international counterparts. Their findings revealed a widening performance gap with age and superior mathematical performance by East Asian students. One plausible explanation for this gap is the widespread use of private tutoring in East Asian households for both remedial and advanced educational goals (Jerrim & Choi, 2014; Ono, 2007; Sohn et al., 2010). Private tutoring may contribute to enhanced mathematical performance even among students already excelling at school. By contrast, private tutoring in the United Kingdom is predominantly utilized in wealthier households and typically focused on remedial purposes, reflecting differing cultural values.

DOI: 10.4018/IJOPCD.372474

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This study used narrative inquiry to explore how a mathematics tutor in Taiwan, an East Asian country, utilized technological tools to establish a professional learning community (PLC) for teachers and integrate information into instructional practices. PLCs refer to groups of educators who share common beliefs, visions, and goals and collaboratively engage in inquiry and problem-solving efforts to enhance student learning outcomes (Khasawneh et al., 2023). A tutor, also known as a private tutor, is defined in two ways by the *Cambridge English Dictionary* (2023): first, as a teacher who provides supplementary instruction outside regular school hours to help students overcome academic challenges; second, as a university instructor in Britain who teaches an individual student or a small group. In this study, the term “tutor” encompasses private tutoring, where a teacher provides supplementary subject-specific instruction at the teacher’s or student’s residence during non-school hours, often through one-on-one or one-on-two instructional models (Šťastný & Chvál, 2023). Unlike traditional mentorship or the team-based transmission of knowledge, tutoring involves individually tailored curricula based on students’ specific needs (VanLehn et al., 2024). The teaching approach in tutoring schemes is diverse and primarily centered on school subjects but focuses on offering additional content beyond the school curriculum (Bhorkar, 2024). Unlike instructors in cram schools, also known as *buxiban* in Taiwan and *juku* in Japan, private educational institutions provide extra academic support outside of regular school hours (Hajar & Karakus, 2024), they may use commercially available materials or reference books, and tutors may or may not use self-prepared lecture notes (Jeon & Choe, 2018). They can also provide practice papers for student drills. Students may vary in age, and tutors must independently prepare for each session. Tutors typically hold degrees in relevant disciplines or possess teaching experience, although their expertise level may be challenging to ascertain (Hawrot et al., 2023). Tutoring may also be conducted through correspondence, online teaching, or telephone guidance (Bray, 1999).

Study Aims

The overarching motivation for this research was understanding how technological progress and the widespread use of technological tools and the internet have expanded the operations of teacher PLCs beyond the constraints of a single organization. A specific aim was understanding the importance of the use of educational technology tools, such as dynamic geometry software, learning management systems (Pérez-Suay et al., 2023), online collaborative platforms, and mathematical visualization tools, by private mathematics tutors to enhance mathematics teaching and learning. The connectivity afforded by some of the aforementioned tools now allows teachers in similar teaching scenarios to be linked through online platforms, thereby facilitating the success of professional communities of practice.

For private tutors, who often worked independently prior to recent advancements in the field of information and communications technology, participation in PLCs has become an essential part of their continuous professional development. PLCs have contributed to the development of knowledge by enabling tutors to share best practices, collaborate on pedagogical strategies, and remain updated about the latest technological advancements in mathematics education (Matitaputty et al., 2024). Termed online teacher PLCs, these communities, as suggested by Belay and Melesse (2024), address the cultural inclination toward individualism that might have hindered knowledge exchanges among tutors in the past. By fostering a collaborative culture, these communities are helping tutors overcome isolation and encouraging the sharing of specialized knowledge crucial for effective teaching. Examples of this collaborative culture can be seen in some recent studies that emphasized how PLCs foster collaborative learning and collective problem-solving (Bragg et al., 2021; Smeplass, 2023; Zygouris-Coe, 2021); such collaboration and problem solving are key for teachers to adapt to the rapidly changing educational landscape influenced by technology.

Given the constraints of teachers’ busy schedules, they historically had limited opportunities to share their teaching experiences with peers. This was particularly true for private mathematics tutors, who might have often lacked the institutional support found in traditional educational settings (Joshi et al., 2021). Hence, participation in online PLCs provides teachers a niche for enhancing their

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