The International Education Journal: Comparative Perspectives Vol. 24, No 1, 2025
http://iejcomparative.org

Exploring the intricate relationship between educators' pedagogical content knowledge and student achievement: A case study of a rural primary school in Western Fiji

Sofia Shireen Ali
College of Humanities and Education, Fiji National University:
https://orcid.org/0000-0003-2332-7877
Ashyana Fareen Nisha
Al-Arqam Islamic School & College Preparatory, Sacramento, CA, USA:
https://orcid.org/0009-0006-2689-7655
Naseem Ali
Ministry of Education, Head of School - Drasa Muslim Primary School

DOI: https://doi.org/10.70830/iejcp.2401.20360

This research investigates the relationship between educators' Pedagogical Content Knowledge (PCK) and student achievement in mathematics. As education continues to evolve, understanding how teachers' specialised knowledge impacts the effective transmission of mathematical concepts is crucial. This study explores the role of PCK in influencing students' academic success, focusing on various dimensions and implications in the teaching-learning process. Through an analysis of pedagogical practices and their correlation with student outcomes, this research aims to offer insights into the critical factors that influence success in mathematics education. This small-scale study examines how one teacher in Fiji demonstrated PCK in teaching mathematics. The participants included a Year 7 mathematics teacher and her class of 40 students. Data were collected using a peer observation tool and interviews. Findings revealed that key elements of PCK—such as teacher preparedness, student engagement and teacher-student relationships—were effectively applied in her lesson study. The study underscores the importance of these elements for enhancing student learning outcomes. It provides valuable information on how teachers can use PCK to improve student achievement in mathematics.

Keywords: pedagogical content knowledge (PCK); lesson study; student achievement

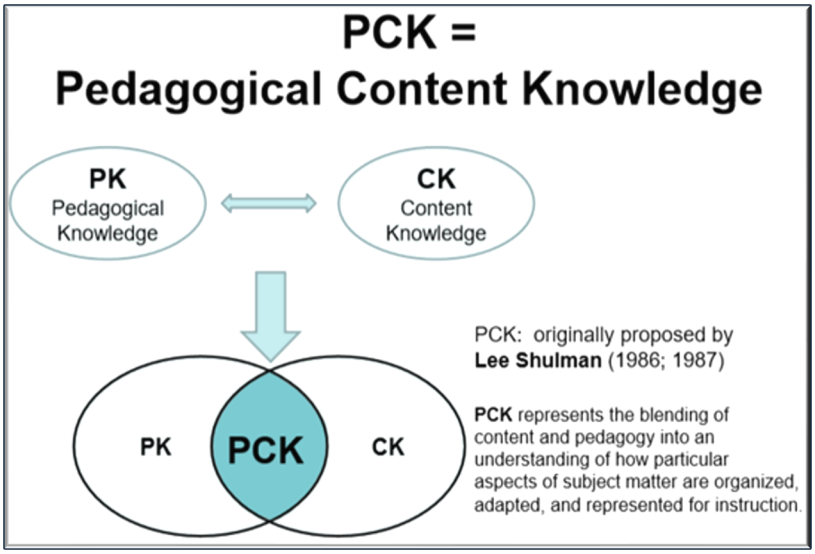
INTRODUCTION AND BACKGROUND

Effective mathematics teaching requires teachers to possess a deep understanding of Pedagogical Content Knowledge (PCK). According to Shulman (1987), PCK involves blending content knowledge with pedagogy to enhance the representation of specific topics and issues, making them accessible to learners of varying abilities and interests.

As noted by Leinhardt (1986), an effective mathematics teacher must possess strong content knowledge and a solid understanding of instructional methods to effectively transfer mathematical understanding. Sullivan and Mousley (1994) emphasise that teachers need to integrate content knowledge with appropriate pedagogical strategies to ensure effective teaching. A teacher with a solid grasp of PCK is more likely to deliver lessons effectively and respond to students' questions in ways that promote understanding.

The Cockcroft Report (1982) asserts that numeracy involves not just familiarity with numbers but also the ability to apply mathematical knowledge confidently in real-life contexts. According to the Ministry of Education, Heritage and Arts (MEHA, 2015), Fiji's national numeracy rates are concerning, with 42.5% of Year 4 students, 39.2% of Year 6 students, and 38.8% of Year 8 students meeting numeracy standards. This data highlights the need to explore PCK elements that can support teachers in improving students' foundational mathematical understanding.

Figure 1: Pedagogical Content Knowledge



Source: http://www.hamk.fi/aokk)

As discussed in the literature review, effective mathematics teaching relies on several PCK elements, including teacher content knowledge, preparedness, use of relevant resources, collaborative learning, student engagement and positive teacher-student relationships. This study investigates how PCK elements can be applied to mathematics teaching to enhance student learning outcomes. The central research question is: How does a teacher demonstrate pedagogical content knowledge in teaching mathematics?

LITERATURE REVIEW

As highlighted in the introduction, the need for a stronger foundation in basic mathematical skills is a significant factor contributing to the poor performance of students in Fiji. To improve students' performance in mathematics, teachers must demonstrate a deep understanding of PCK. According to Shulman (1986), effective teaching requires compound professional knowledge, encompassing subject matter knowledge, pedagogical knowledge, curricular knowledge and PCK. A teacher proficient in these areas displays various elements of PCK, such as subject matter expertise, preparedness, provision of relevant resources, student engagement, collaborative learning and fostering positive teacher-student relationships. These

elements are supported by research in the field and are essential for promoting quality teaching and learning in mathematics.

Mwaraksurmes (2024) explored factors influencing lesson planning among mathematics teachers in Vanuatu secondary schools, focusing on challenges in implementing student-centered learning. The study, involving lesson plan analysis and interviews with 20 teachers in Port Vila, highlighted the need for enhanced support in designing and enacting student-centered approaches within Vanuatu's educational context. This research sheds light on teacher readiness and pedagogical influences in the Pacific region.

Pedagogical content knowledge

To refine and advance students' thinking, teachers must possess appropriate PCK. Shulman and Grossman (1988) define PCK as the knowledge of how to represent specific subject matter topics that cater to students' diverse abilities and interests. Graeber (1999) emphasises the importance of subject matter knowledge, such as content knowledge in mathematics, as essential for teaching. Kennedy (1998) further asserts that teachers should know the subject matter and understand how to teach it effectively.

Ball (2000) echoes this sentiment, highlighting that PCK involves the 'how' of teaching, which is developed through qualifications and school experiences. Duschl and Gitomer (1997) argue that teachers must clearly understand content and pedagogy to meet students' learning needs. Additionally, Darling-Hammond and McLaughlin (1995), Garet et al. (2001) and Sparks and Hirsh (1997) suggest that the Ministry of Education (MOE) should offer teachers opportunities and support to continuously improve their pedagogical practices. Such initiatives will empower teachers to deliver lessons effectively, ensuring productive responses to students' learning needs.

Shulman (1987) identified several critical elements of PCK, including knowledge of the subject matter, student's understanding of the content and implications for teaching specific subjects. Ball et al. (2001) agree that PCK includes selecting tasks, presenting and explaining tasks, facilitating classroom discussions, addressing student responses and analysing student difficulties. Magnusson et al. (1999) further elaborated on PCK, stating that it involves the ability to organise and adapt subject matter to accommodate the interests and abilities of diverse learners. Teachers' ability to transform subject matter knowledge into effective teaching strategies is central to fostering deep student understanding. A teacher equipped with explicit PCK can deliver more effective mathematics lessons, motivating students and encouraging collaborative learning. The use of appropriate resources and pedagogies is crucial for achieving high-quality teaching outcomes.

Lesson study as a pedagogy

In the context of teacher education, lesson study is an instructional strategy that can significantly enhance teachers' PCK. Shulman (1986) argued that professional teaching requires content and pedagogical knowledge. Lesson study is a method that facilitates the development of these essential components. Cerbin and Kropp (2006), Murata (2011), and Stigler and Hiebert (1999) advocate for lesson study as an effective means of improving teachers' PCK through collaborative learning and professional development. Depaepe et al. (2013) emphasised that lesson study fosters collaborative learning and mentorship, which

enhances teachers' pedagogical knowledge. Lewis (2005) supports this idea by noting that lesson study offers multiple pathways for teachers' learning.

Murata (2011) suggested that teachers should engage in shared questions regarding their students' learning, plan lessons together, observe student responses and discuss their findings. Collaborative discussions help improve teachers' thinking and practices, including enhanced subject matter knowledge, instructional skills and ability to observe students, and the development of professional networks. Furthermore, lesson study creates a more robust sense of motivation and efficacy among teachers and improves preparedness through the development of lesson plans and teaching resources. Dela Cruz and Punzalan Magno (n.d.) note that lesson study contributes to teachers' effectiveness because it directly influences student achievement. Shaw et al. (2022), in their comparative study of mathematics teaching across the United States and England, identify persistent tensions between conceptual and procedural approaches in curriculum design and delivery. These tensions resonate with the Fijian context, where lesson study enabled the teacher, in this case, to deliver structured, student-centered mathematics instruction that prioritised conceptual clarity while reinforcing procedural fluency. By embedding collaborative discussion and refinement opportunities, lesson study fosters pedagogical innovation that directly enhances PCK and student learning outcomes.

During lesson study, when students work in groups, they develop multiple problem-solving approaches. This process enhances PCK by fostering teachers' competencies in delivering conceptual understanding and problem-solving skills. Collaborative learning fosters a sense of ownership among students and promotes a collegial relationship in the classroom. Through lesson study, teachers become more prepared with each lesson they revisit, leading to more effective teaching practices.

Elements of PCK

Research has demonstrated that teacher preparedness is a key predictor of successful mathematics lessons. Urdan and Schoenfelder (2006) found that teachers' self-confidence, linked to their professional conduct, also positively affects student achievement. Studies by Monk (1994) and Saderholm and Tretter (2008) highlight that teacher content preparedness significantly impacts student performance. Proper planning is at the core of teacher preparedness, and substantial research shows that planning must be done ahead of time for effective teaching (Zaidatol et al., 2000; Johnson, 2007; Wandberg & Rohwer, 2003). Effective planning ensures student learning objectives are met, and the teaching process is productive. Additionally, preparing valid and relevant teaching resources contributes significantly to lesson delivery. Using well-prepared teaching materials is essential for enhancing student achievement, as evidenced by research from Adeogun and Osifila (2008) and Esu et al. (2004), who demonstrated that teaching resources facilitate effective lesson delivery and help students grasp abstract concepts.

Teacher preparedness extends to the creation of engaging resources that support student-centered learning. Using appropriate resources, such as worksheets and collaborative tasks, ensures students are actively engaged in learning.

Bomia et al. (1997) defined student engagement as the active participation of students in their learning activities, which directly correlates with academic success. Research by Skinner et al. (2008) and Fredricks et al. (2004) indicates that student engagement is a critical factor in achieving academic success because students who are engaged are more likely to perform well. Student engagement, fostered by teacher preparedness and resource availability, leads to increased motivation, a positive classroom climate and improved learning outcomes.

Building positive teacher-student relationships is also crucial for fostering a conducive learning environment. Studies by Bryson and Hand (2007) and Boynton and Boynton (2005) show that teachers who show interest in their students' success and provide continuous support are more likely to create a positive learning atmosphere. Brown (2010) and Bartlett (2003) further argue that positive teacher-student relationships combined with a supportive learning environment lead to increased motivation and student achievement.

Collaborative learning

Collaboration among students is vital for enhancing classroom learning. MacMath et al. (2009) emphasized that collaboration fosters mathematical understanding and increases confidence in mathematics. Suurtamm, Quigley, and Lazarus (2015) argued that a collaborative learning environment enables students to explore and share ideas, promoting deeper understanding and greater self-confidence. Similarly, Fleming (2000) highlighted that collaboration enhances problem-solving skills by improving coordination and cohesion among group members. Roschelle and Teasley (1995) defined collaboration as the mutual engagement of students in a joint effort to solve problems, which builds a rich learning context where students can contribute to and learn from one another's mathematical thinking. Collaborative learning encourages teamwork, strengthens personal relationships, and supports the development of math talk, where students can explain, evaluate, and build on one another's ideas. This social learning context is essential for fostering deeper understanding and problem-solving abilities.

The literature underscores the critical role of PCK in improving the effectiveness of mathematics instruction. Teachers who possess a deep understanding of both content and pedagogy are better equipped to support student learning, especially in foundational areas like mathematics. Implementing strategies such as lesson study and fostering collaborative learning environments can further enhance teachers' PCK and improve student outcomes. Effective teacher preparation, supported by thoughtful planning, valid resources, and positive teacher-student relationships, is essential for creating engaging and successful mathematics lessons.

METHODOLOGY

The research approach employed to explore PCK was grounded in a qualitative design to capture a deep, nuanced understanding of the phenomenon. Qualitative research is particularly effective in investigating human behaviour, beliefs and experiences within their natural context because it provides rich, detailed insights rather than relying on numerical data. According to Rubin and Rubin (2005), qualitative research focuses on creating comprehensive narratives that reflect the complexity of human experiences. This methodology is inherently explanatory and open-ended, enabling the exploration of multiple perspectives through interviews and other narrative-driven techniques. The data collected in this study was valid and reliable, grounded in teachers' lived experiences with PCK, ensuring an authentic and meaningful representation of the subject under investigation.

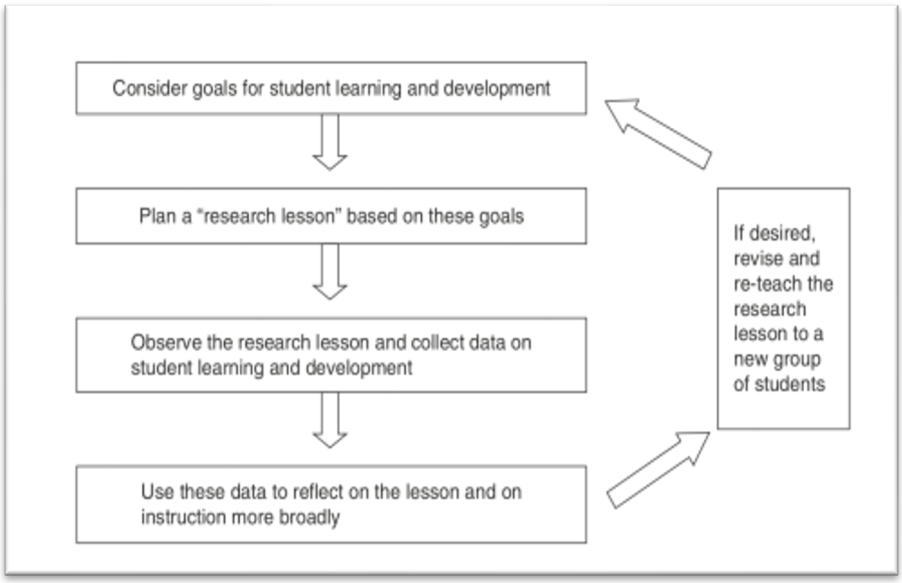
The study was conducted at a semi-rural primary school in Lautoka, Fiji, where the participants consisted of a Year 7 mathematics teacher and her class of 40 students. The teacher employed lesson study as her pedagogical approach. This context provided an ideal setting to explore how PCK was integrated into the classroom and how it influenced the teaching and learning processes. The teacher's lived experiences and the students' perspectives were central to understanding the practical application of PCK within this specific educational setting.

Lesson study

Lesson study, when implemented effectively, has significant positive implications for teaching. Originating from Japanese elementary education, it involves a cycle of identifying a teaching problem, planning the lesson, teaching and observing it, recording observations for analysis, revising the lesson and teaching it again (Lewis & Tsuchida, 1998). According to Hiebert et al. (2002), lesson study emphasises improving teaching practices and building knowledge through a collaborative, reflective process. Stigler and Hiebert (1999) note that it encourages teachers to work together, share ideas and reflect on their practices, requiring considerable time and commitment. As a reflection-driven method, lesson study promotes continuous revision and improvement of teaching practices.

The iterative nature of this process is captured in the lesson study cycle (see Figure 2), which illustrates the stages of planning, teaching, observing, and refining.

Figure 2: The lesson study cycle



Source: Murata, A. (2011). Introduction: Conceptual overview of lesson study. In L. C. Hart, A. S. Alston & A. Murata (Eds.), *Lesson study research and practice in mathematics education* (pp. 13–24). Springer.

In the context of this study, the teacher identified a specific teaching problem, planned the lesson and delivered it with the researcher observing. The researcher used a peer observation tool to assess the strengths and weaknesses of the lesson. Following the observation, feedback was shared with the teacher, who then reflected on the findings before proceeding to the second phase of the lesson.

Data collection tools

Data for this study were gathered through pre- and post-lesson interviews and peer observation of a mathematics lesson focusing on the teacher's pedagogical practices. The participant was approached informally and voluntarily agreed to take part. All interviews were conducted outside official school hours to ensure minimal disruption to the teaching schedule.

Interviews, as Kvale (2003) notes, are effective tools for collecting rich narrative data and exploring participants' perspectives in depth. This study used open-ended questions, allowing the teacher to reflect on her pedagogical approach. Each session was audio-recorded and later transcribed to maintain accuracy and authenticity, as recommended by Duranti (2007).

The pre-lesson interview, lasting six minutes, was held in the morning. It focused on the teacher's intended teaching strategies and the rationale for her chosen approach. The interview aimed to capture her planning process and pedagogical intentions.

The lesson was then observed using a structured peer observation tool during official teaching hours. Although video recording was initially considered, MEHA policy prohibited this method, prompting the use of a detailed observation framework instead. Peer observation, identified by Harris et al. (2008) as a key strategy for enhancing teaching quality, enabled a comprehensive review of the lesson in action.

The observation tool included a scoring rubric with four levels—ranging from 'not evident' to 'very evident'—across several categories: lesson organisation, content knowledge and relevance, presentation, collaborative learning activities, implementation, instructional methods and student responses. Each area featured clear indicators and space for comments to provide formative feedback. The 40-minute observation also captured student engagement, particularly during group work, offering further insight into the effectiveness of the pedagogy.

A follow-up interview was conducted the next day, lasting four minutes. This session focused on the teacher's reflection and her PCK, clarifying elements observed during the lesson. Additional questions were included to address initial data gaps and support comparisons with existing literature.

This approach to data collection was particularly effective in fostering open dialogue because the teacher felt at ease sharing her insights. However, a notable limitation was the additional preparation time required, which placed some demands on the teacher's schedule.

Ethical considerations

Ethical protocols were carefully observed throughout this study to protect the rights and well-being of all participants in line with the principles outlined by Eisenhauer and Wynaden (2001). The research was conducted only after securing all necessary approvals, ensuring full compliance with institutional and governmental requirements.

Initial ethical clearance was obtained from Fiji National University (FNU), followed by formal approval from the MoE because the study involved classroom observation of both teachers and students. The necessary documentation—such as the university approval letter, consent forms and a copy of the birth certificate—was submitted to facilitate this process.

Once official permissions were granted, the Head of School and the participating teacher provided their informed consent. Subsequently, consent forms were distributed to 20 Year 7 students accompanied by detailed explanations of the study's purpose.

Parents were also required to provide written consent for their children's participation. The process was transparent and designed to ensure understanding and voluntary involvement. One student was absent during the lesson observation; the remaining students participated willingly.

Year 8 students were supervised by the Head Teacher during the 40-minute lesson observation, ensuring student safety and duty of care.

All participants were informed—using age-appropriate language—of their rights, including the freedom to withdraw from the study at any point without consequence. No student chose to withdraw, and the observation proceeded without disruption.

Data collection occurred over two days after the teacher requested additional preparation time. Throughout the study, MoE policies and procedures were strictly followed to uphold ethical standards. Participants' autonomy and comfort were prioritised, and no coercion was involved in any research phase.

To maintain confidentiality, all interview recordings and observation data were securely stored on a password-protected computer. The teacher received feedback from the interviews and lesson observation, while students were only given feedback related to the observed lesson. Data analysis focused on identifying recurring patterns and insights into the role of PCK in mathematics instruction.

As part of the dissemination process, a final copy of the research report will be submitted to the school and MoE. Following MoE policy, the report will be archived in their research library and accessible to Ministry and Government officials. MoE also reserves the right to publish the report or an edited version for broader educational use.

Data security

The interview and audio-recorded data were stored on a secured computer with password protection. The findings of the lesson observation were shared with the students and the teacher. However, the interview data were only shared with the teacher to maintain confidentiality. The participants were informed that their responses would contribute to understanding key aspects of PCK in mathematics lessons. Data analysis was conducted by identifying patterns in the responses, with a focus on the effectiveness of the teacher's pedagogy and PCK.

Analysis of data

The data was thematically analysed, a qualitative method that involves identifying patterns or themes within the data (Braun & Clarke, 2006). This approach is considered flexible and suitable for analysing the diverse aspects of learning and teaching. Thematic analysis helps recognise key patterns or themes from the data collected.

Braun and Clarke (2006) provided a six-phase framework that guided the data analysis process: familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and producing reports.

The first step in the analysis was familiarisation with the data. This process allowed for a comprehensive understanding of the content gathered from interviews and the peer observation criteria tool. The audio-recorded interview was transcribed, and the data obtained from the peer observation tool was reviewed to extract relevant information. The next step involved generating initial codes, where interesting data components were organised under various headings, such as creativity, interest, good listening skills, teaching aids, student engagement, preparedness, pedagogy, group work, organisation, peer learning and effective lesson delivery.

The third step focused on searching for themes, where the distinct codes were categorised into potential themes. These included content knowledge, teacher preparedness, resources, student engagement, collaborative learning, student-teacher relationships, practical lessons and time management. During the fourth phase, these themes were reviewed and refined.

The final themes identified were content knowledge, teacher preparedness, resources, student engagement, collaborative learning and student-teacher relationships. Relevant data about these themes were revisited and reorganised to enhance understanding and contribute to the research's goals.

The fifth step involved defining and naming the themes, which helped to highlight the most significant themes emerging from the data. These themes were analysed further to group key ideas and identify patterns. Finally, the sixth step consisted of the final analysis and preparation of the written report, which is presented in the findings and discussion.

FINDINGS AND DISCUSSION

As discussed in the introduction, PCK is crucial for effective teaching and student achievement because it depends on the teacher's knowledge of the subject matter, teaching practices, and beliefs about effective teaching. In this study, the teacher applied Lesson Study as her pedagogical approach, ensuring that key elements of PCK, such as teacher preparedness, student engagement and student-teacher relationships, were evident throughout the lesson. This section explores the PCK elements contributing to effective teaching and high student achievement.

Teacher preparedness

A teacher's PCK is closely linked to effective lesson preparation, which in turn enhances productive learning. Hill et al. (2005) emphasise the importance of teachers' PCK in mathematics and its impact on student learning.

Ogar (2006) further supports this by stating that a teacher's understanding of pedagogy and subject matter significantly influences students' learning outcomes. According to Hill et al. (2004), PCK is essential for a teacher's success in the classroom.

In this study, it was evident that the teacher demonstrated strong knowledge of fractions, particularly in converting mixed fractions to improper fractions and vice versa. The teacher's preparedness was clear during the Lesson Study process. In the interview, the teacher stated, 'I thoroughly investigated the pedagogy and concept, and then I prepared my lesson. I did this to be better prepared for my lesson.'

The teacher also explained that she chose the Lesson Study approach because it provided a step-by-step process that helped students understand the concept and stay engaged throughout the lesson, which was observed in practice.

Peer observation revealed that the lesson was well-structured, and the teacher effectively clarified the concepts. She provided relatable, real-life examples to illustrate the lesson. For instance, she explained the concept of fractions by comparing the arrangement of people in an assembly—shorter individuals in the front and taller ones in the back. She likened this to proper fractions, where smaller numbers represented the numerator and larger numbers the denominator. This comparison helped students grasp the concept of improper fractions. The teacher also took the time to define key terms and concepts, such as the difference between numerator and denominator, when one of the students appeared confused.

Furthermore, the teacher had prepared a detailed lesson plan, which Borich (2007) describes as a crucial tool for achieving lesson objectives and enhancing teaching effectiveness. The lesson plan serves as a guide for teachers, helping them stay focused and ensuring that the lesson objectives are met. In the interview, the teacher explained, 'I told my students at the beginning about the expectations and clearly outlined the lesson objectives'. The objectives, which included helping students identify and convert mixed and improper fractions, were communicated clearly to the students at the start of the lesson.

The lesson plan also addressed the cognitive, psychomotor and affective domains, ensuring a holistic approach to learning. The teacher utilised the Mathematics Syllabi and Textbook for Year 7 as references to structure the lesson and ensure that the objectives were aligned with the curriculum.

Teacher preparedness in the classroom: Exploring PCK in mathematics instruction

PCK serves as a vital framework for improving the quality of mathematics instruction. It encompasses a deep understanding of the subject matter, and the pedagogical strategies required to make this knowledge accessible and meaningful to students.

This study examined the role of PCK in a Year 7 mathematics classroom, focusing on blackboard management, teacher preparedness, student engagement, collaborative learning and the teacher-student relationship. The observed mathematics instruction aligns with trends in international education research that advocate for a balance between conceptual understanding and procedural skill-building. As Shaw et al. (2022) discuss, meaningful mathematics teaching in the 21st century must move beyond rote learning to embrace instructional approaches that develop reasoning, communication and problem-solving skills. In this study, the teacher's use of blackboard design, real-life analogies and differentiated group activities reflect this shift toward more inclusive and responsive pedagogies.

Additionally, the Lesson Study model enabled ongoing refinement of teaching strategies through a cyclical, evidence-based approach to professional learning. This aligns with Hunter's (2022) analysis of Lesson Study as a powerful tool in mathematics education, where collaborative inquiry and reflection lead to enhanced pedagogical content knowledge (PCK) and more responsive instructional practices. In contexts such as the Pacific, where educational systems often operate with limited resources, Lesson Study fosters locally driven, school-based innovations that empower teachers as agents of change and contribute meaningfully to broader conversations on educational improvement and sustainability.

Teacher preparedness and classroom design

Classroom arrangements and lesson preparation are key indicators of teacher preparedness and PCK. Mohanan (2000) describes classroom design as 'built pedagogy', where the layout mirrors educational philosophies and supports social interaction. The observed classroom was a spacious and well-organised environment that supported effective teaching practices. The teacher thoughtfully planned seating arrangements and prepared diverse resources, including charts, worksheets and models aligned with lesson objectives.

According to Awiotua-Efebo (2001), teaching aids—ranging from textbooks to natural objects—are integral to effective instruction. The teacher demonstrated this by strategically using visual aids to support the lesson on Proper, Improper and Mixed Fractions. Her preparedness reflected a clear grasp of content and pedagogy.

Lundahl, C. (2022) highlighted that collaborative learning provides students with immediate support and feedback from peers, fostering a supportive environment that enhances motivation. The study emphasized that such environments encourage students to celebrate achievements together, thereby strengthening their engagement and interest in the learning process.

Blackboard management as a pedagogical tool

An often-overlooked aspect of instructional delivery is blackboard management, a critical component of PCK, especially in resource-limited settings where digital tools are not always available. Gagne et al. (1993) and Chauhan (2011) emphasise that organising visual materials enhances clarity and facilitates real-time concept reinforcement.

In the observed lesson, the teacher's blackboard was logically divided into sections: one for objectives, another for group responses and a section for summaries. She used different coloured chalk to highlight key terms and visually distinguish between types of fractions. This structured approach supported cognitive processing and accommodated diverse learning styles.

Moreover, the teacher's blackboard layout evolved through participation in a school-based lesson study, where peer feedback enhanced her visual presentation strategies. Zeichner and Liston (2013) argue that effective board work reveals a teacher's planning, pacing and ability to anticipate student difficulties—attributes demonstrated in this case. Fernandez and Yoshida (2004) advocate integrating blackboard strategies into teacher professional development and lesson study cycles to improve teaching effectiveness. Holden (2020) investigates the implementation of online lesson study cycles among primary school teachers, utilizing digital tools to facilitate collaborative planning, observation, and reflection highlights how such collaborative processes can lead to the refinement of instructional strategies, including the use of blackboard layouts, as teachers engage in peer feedback and shared practices.

This aligns with your observation that the teacher's blackboard layout evolved through participation in a school-based lesson study, where peer feedback enhanced her visual presentation strategies.

Fostering student engagement and motivation

Student engagement, defined by Axelson and Flick (2010) as the level of involvement and motivation students bring to learning, is a key outcome of effective PCK. The teacher began her lesson with words of encouragement and a motivational quote: 'The mediocre teacher tells, the good teacher explains, the superior teacher demonstrates, the great teacher inspires'. This helped create a positive emotional climate, leading to active student participation.

The teacher's use of positive reinforcement, such as 'Well done' and 'Great effort', especially toward students with lower learning abilities, aligned with Winter's (2011) findings that supportive feedback promotes motivation and sustained interest. Students demonstrated high levels of engagement during collaborative group tasks involving the differentiation of fraction types, highlighting the strong relationship between motivation, active participation, and improved learning outcomes (Johnson & Johnson, 2020; Hwang & Chang, 2022).

Collaborative learning and constructive communication

Collaborative learning, another facet of PCK, was evident through the teacher's use of mixed-ability group work. Dillenbourg (1999) and Otero (2015) highlight the importance of peer interactions in enhancing learning. The teacher grouped students to encourage peer support, provided differentiated worksheets, and guided joint problem-solving.

This approach promoted the development of communication and critical thinking skills, as supported by Van Boxtel, Van der Linden, and Kanselaar (2000). The collaborative

environment also nurtured meaningful teacher-student and peer relationships, contributing to sustained academic engagement.

The role of teacher-student relationships in learning

A strong teacher-student relationship enhances academic and social development. Freeman (2015) noted that such relationships significantly influence learning outcomes. During the lesson, the teacher created a caring and inclusive environment, ensuring that all students had an opportunity to contribute. Her metaphor, 'Teachers are like needles, and students are like threads. Both come together to create something beautiful students' successes captured the essence of her supportive approach.

Davis (2003) further emphasised that teacher care and responsiveness stimulate student motivation and intellectual growth. The teacher's positive rapport with students in this classroom cultivated a culture of trust, effort and achievement.

This case study highlights the transformative role of PCK in mathematics instruction. From meticulous lesson planning and effective blackboard use to fostering engagement, collaboration and strong teacher-student relationships, the observed practices exemplify how PCK can enhance teaching quality and learning outcomes. Although limited to a single case, these insights offer valuable implications for teacher education, especially in rural and resource-constrained contexts.

A strong teacher-student relationship significantly enhances both academic and social development. Recent studies have reaffirmed that such relationships are pivotal in influencing learning outcomes. For instance, a study by Ma et al. (2022) found that teacher-student relationships positively correlate with academic performance, with parental involvement moderating this relationship. Furthermore, research by Chamizo-Nieto et al. (2021) highlighted that emotional intelligence and flourishing, influenced by teacher-student relationships, play a crucial role in academic achievement among adolescents. In the observed lesson, the teacher fostered a caring and inclusive environment, ensuring all students had opportunities to contribute. Her metaphor, 'Teachers are like needles, and students are like threads. Both come together to create something beautiful students' successes,' encapsulated her supportive approach.

Future research should explore the application of PCK across diverse settings to better understand its impact. Moreover, teacher training programs should prioritise PCK development through integrated strategies, such as lesson study, collaborative planning and reflective teaching practices. Policy efforts should also support the systemic incorporation of PCK in curriculum and professional development frameworks to improve mathematics education in the Global South and beyond.

RECOMMENDATIONS

This study emphasises the critical role of PCK in enhancing mathematics education in Fiji. To strengthen the quality of mathematics education, it is essential to integrate PCK systematically into pre-service and in-service teacher education. The following recommendations are proposed to foster an effective implementation of PCK and improve student learning outcomes:

1. **Strengthen teacher education and professional development:**

   In collaboration with the MoE, teacher training institutions should prioritise PCK as a fundamental component in pre-service and in-service teacher education programs. Teacher

training should focus on developing the skills needed to transform content knowledge into engaging, contextually relevant lessons that address the diverse needs of learners. Additionally, professional development programs should include strategies for managing classroom dynamics, using formative assessments to guide instruction and differentiating teaching to meet varying student needs.

2. **Encourage collaborative learning and cluster-based support**:

   Professional development should be designed to encourage collaborative learning environments. The establishment of (PLCs within school clusters can foster peer learning, enabling teachers to share best practices, co-plan lessons, observe one another's teaching, and provide constructive feedback. Collaborative workshops and peer-learning sessions will support teachers in developing their PCK and offer opportunities for ongoing professional dialogue that enhances teaching practices.

3. **Provide sustained and practical support**

   Teachers require ongoing access to practical support for PCK to be effectively integrated into everyday teaching practices, including providing teaching resources, digital tools, sample lesson plans and continuous mentorship from experienced educators. School leaders should actively ensure that teachers receive the guidance they need to apply PCK in the classroom. Such support will enable teachers to refine their teaching strategies and improve their instructional effectiveness over time.

4. **Embed monitoring, feedback and reflective practice**

   To promote the continuous development of PCK, it is essential to incorporate systematic classroom observations and feedback mechanisms into the school culture. Administrators and curriculum advisors should regularly observe lessons and provide feedback on the effective use of PCK. Teachers should also be encouraged to engage in reflective practices such as journaling, peer reviews and self-assessment. These reflective activities will allow teachers to critically assess their teaching practices, identify areas for improvement, and make adjustments that lead to better student outcomes.

5. **Foster research and evidence-based practice**

   This study has highlighted a significant gap in research concerning the application of PCK within the Fijian educational context. It is recommended that the MoE, universities and teacher training providers invest in and promote research into how PCK influences teaching and learning outcomes. Future research should explore the impact of PCK across different subject areas, grade levels and cultural contexts.

   Additionally, studies could investigate which professional learning approaches yield the best results in terms of improving teacher practice and student achievement.

6. **Enhance policy and leadership support**

   For PCK to be effectively integrated into the education system, it is necessary for policies to explicitly recognise and support the development of PCK as a framework for quality teaching. Education leaders must be trained to identify and nurture effective teaching practices, provide mentorship and foster a culture of innovation and accountability within schools. Aligning school policies with the principles of effective pedagogy will ensure that teachers have the systemic support needed to continually improve their practice and contribute to the overall improvement of education in Fiji.

CONCLUSION

The modern education system must cultivate critical thinking, adaptability, and resilience in students (Tebabal & Kahssay, 2011), a goal significantly supported by PCK. Effective teachers with strong PCK demonstrate better classroom management, content delivery and resource utilisation, enhancing student engagement and outcomes.

This study examined a Year 7 teacher's application of PCK in mathematics, revealing that teacher preparedness, student engagement and teacher-student relationships significantly impact student achievement. Thorough preparation, including pedagogical research and comprehensive lesson planning, is crucial. Student engagement, driven by motivation and positive reinforcement, enhances learning. Collaborative learning through group work fosters deeper understanding, and positive teacher-student relationships create a supportive environment conducive to academic success. These findings are consistent with those of Filgona, Jacob, John, and Gwany (2020), who emphasized that a teacher's mastery of PCK—combined with emotional and social support—positively influences student performance. Their research reinforces the idea that academic success is not solely based on content delivery but is deeply intertwined with how teachers connect with and motivate their learners.

Ultimately, this research underscores the importance of PCK in strengthening mathematics education. Integrating PCK into teacher training, promoting peer collaboration and investing in research can improve teaching practices and student outcomes, contributing to a more resilient and responsive education system in Fiji.

REFERENCES

Adeogun, A. A., & Osifila, G. I. (2008). Relationship between educational resources and students' academic performance in Lagos State, Nigeria. *International Journal of Educational Management*, *5–6*, 144–153.

Awiotua-Efebo, E. B. (2001). *Effective teaching: Principles and practice*. Heinemann.

Axelson, R. D., & Flick, A. (2010). Defining student engagement. *Change: The Magazine of Higher Learning*, *43*(1), 38–43. https://doi.org/10.1080/00091383.2011.533096

Ball, D. L. (2000). Bridging practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of Teacher Education*, *51*(3), 241–247.

Ball, D., Lubienski, S., & Mewborn, D. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 433–456). American Educational Research Association.

Bartlett, S. (2003). The development of teacher appraisal: A recent history. *British Journal of Educational Studies*, *48*, 24–37.

Bomia, L., Beluzo, L., Demeester, D., Elander, K., Johnson, M., & Sheldon, B. (1997). *The impact of teaching strategies on intrinsic motivation*. ERIC Clearinghouse on Elementary and Early Childhood Education.

Borich, G. D. (2007). *Effective teaching methods: Unit and lesson planning* (6th ed.). Pearson Merrill Prentice Hall.

Boynton, M., & Boynton, C. (2005). Developing positive teacher-student relationships. In *Educator's guide to preventing and solving discipline problems*. ASCD.

http://www.ascd.org/publications/books/105124/chapters/Developing_Positive_Teacher_Student_Relations.aspx

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*, 77–101.

Brown, T. (2010). The power of positive relationships. *Middle Ground: The Magazine of Middle-Level Education*, *14*(1), 49–60. https://www.amle.org

Bryson, C., & Hand, L. (2007). The role of engagement in inspiring teaching and learning. *Innovations in Education and Teaching International*, *44*(4), 349–362.

Cerbin, W., & Kropp, B. (2006). Lesson study as a model for building pedagogical knowledge and improving teaching. *International Journal of Teaching and Learning in Higher Education*, *18*(3), 250–257.

Chamizo-Nieto, M., Arrivillaga, S., Rey, L., & Extremera, N. (2021). The role of emotional intelligence, the teacher-student relationship, and flourishing on academic performance in adolescents: A moderated mediation study. Frontiers in Psychology, 12, 744. https://doi.org/10.3389/fpsyg.2021.343541

Chauhan, S. S. (2011). *Innovative applications of teaching technology*. Vikas Publishing House.

Cockcroft, W. H. (1982). *Mathematics counts: Report of the Committee of Inquiry into the Teaching of Mathematics in Schools*. HMSO.

Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan*, *77*(7), 597–604.

Davis, H. A. (2003). Conceptualizing the role and influence of student-teacher relationships on children's social and cognitive development. *Educational Psychologist*, *38*(4), 207–234. https://doi.org/10.1207/S15326985EP3804_2

Dela Cruz, A., Punzalan, A., & Magno, M. (n.d.). *Lesson study as a professional development model*. http://www.slideshare.net/upnismedmultimedia/lesson-study-research-upnismed-revised-625

Depaepe, F., Verschaffel, L., & Kelchtermans, G. (2013). Pedagogical content knowledge: A systematic review of how the concept has pervaded mathematics educational research. *Teaching and Teacher Education*, *34*, 12–25.

Duranti, A. (2007). Transcripts, like shadows on a wall. *Mind, Culture, and Activity*, *13*(4), 301–310.

Duschl, R. A., & Gitomer, D. H. (1997). Strategies and challenges to changing the focus of assessment and instruction in science classrooms. *Educational Assessment*, *4*, 37–73.

Eisenhauer, L., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of Nursing Scholarship*, *33*(1), 93–96.

Enqvist, J. (2001). Pedagogical content knowledge. HAMK University of Applied Sciences. http://www.hamk.fi/aokk

Esu, A. E. O., Enukoha, O. I. T., & Umorem, G. U. (2004). *Curriculum development in Nigeria for colleges and universities*. Whyte and Whyte Publishers.

Fernandez, C., & Yoshida, M. (2004). *Lesson study: A Japanese approach to improving mathematics teaching and learning*. Lawrence Erlbaum Associates.

Fredricks, J., Blumenfeld, P., & Paris, A. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*, 59–109.

Freeman, D. (2015). *Teacher-student relationships: The heart of the classroom*. Routledge.

Freeman, S. (2015). An analysis of the relationship between implementation of school-wide positive behavior interventions and supports and high school dropout rates. *Project Muse*, 290–315.

Filgona, J., Jacob, F., John, S., & Gwany, D. M. (2020). Teachers' pedagogical content knowledge and students' academic achievement: A theoretical overview. Journal of Global Research in Education and Social Science, 14(2), 14–44.

Gagne, E. D., Yekovich, C. W., & Yekovich, F. R. (1993). *The cognitive psychology of school learning* (2nd ed.). HarperCollins College Publishers.

Garet, M., Porter, A., Desimone, L., Birman, B., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*(4), 915–945.

Graeber, A. O. (1999). Forms of knowing mathematics: What preservice teachers should learn. *Educational Studies in Mathematics*, *38*, 189–208.

Harris, K. L., Farrell, K., Bell, M., Devlin, M., & James, R. (2008). *Peer review of teaching in Australian higher education: A handbook to support institutions in developing effective policies and practices*. Australian Learning and Teaching Council Ltd.

Hiebert, J., Gallimore, R., & Stigler, J. (2002). A knowledge base for the teaching profession: What would it look like, and how can we get one? *Educational Researcher*, *31*(5), 3–15.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, *42*(2), 371–406.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *The Elementary School Journal*, *105*(1), 11–30.

Hunter, J. (2022). Lesson study in mathematics education. In M. A. Peters (Ed.), *Encyclopedia of teacher education* (pp. 1–6). Springer. https://doi.org/10.1007/978-981-16-8679-5_235

Hwang, G.-J., & Chang, C.-K. (2022). Effects of collaborative learning on students' motivation and learning achievement in mathematics: A meta-analysis. Educational Technology Research and Development, 70(3), 1533–1556. https://doi.org/10.1007/s11423-021-10052-3

Johnson, D. W., & Johnson, R. T. (2020). Cooperative learning and social interdependence theory. In R. M. Ryan (Ed.), The Oxford Handbook of Human Motivation (2nd ed., pp. 354–368). Oxford University Press.

Kvale, S., & Brinkmann, S. (2009). Interviews. Learning the Craft of Qualitative Research Interviewing (2nd ed.). Thousand Okas, CA: Sage.

Kennedy, M. M. (1998). Education reform and subject matter knowledge. *Journal of Research in Science Teaching*, *35*, 249–263.

Leinhardt, G. (1986). Expertise in mathematics teaching. *Educational Leadership*, *43*(1), 26–32.

Lerman, S. (2000). Methodology in mathematics education research. In *Handbook of research on mathematics teaching and learning* (pp. 27–33).

Lewis, C. (2005). How do teachers learn during lesson study? In P. Wang-Iverson & M. Yoshida (Eds.). Building our understanding of lesson study. Philadelphia: Research for Better Schools, Inc.

Lewis, C. & Tsuchida, I. (1998). A lesson is like a swiftly flowing river: Research lessons and the improvement of Japanese education. American Educator, Winter, 14-17 & 50-52.

Lundahl, C. (2022). Supportive environments and collaborative learning: The role of feedback and peer interaction in student motivation. Stockholm University. https://www.diva-portal.org/smash/get/diva2:1835730/FULLTEXT02.pdf

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), Examining pedagogical content knowledge: The construct and its implication for science education (pp. 95-132). Dordrecht, the Netherlands: Kluwer Academic.

Ma, L., Liu, J., & Li, B. (2022). The association between teacher-student relationship and academic achievement: The moderating effect of parental involvement. Psychology in the Schools, 59(2), 281–296. https://doi.org/10.1002/pits.22608

Ministry of Education, Heritage & Arts. (2015). The Annual Report: Fiji Islands.

Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. Journal of Teacher Education, pp. 49, 165–176.

Murata, A. (2011). Introduction: Conceptual overview of lesson study. In L. C. Hart, A. S. Alston & A. Murata (Eds.), Lesson Study Research and Practice in Mathematics Education (pp. 13–24). New York, NY: Springer.

Mwaraksurmes, A. S. (2024). Teachers' perspectives of factors affecting lesson planning practices in Vanuatu mathematics classrooms. *International Education Journal: Comparative Perspectives*, *23*(2), 23–35.

Rubin, H. J., & Rubin, I. S. (2005). Qualitative interviewing: The art of hearing data. Sage Publications.

Saderholm, J. C., & Tretter, T. R. (2008). Identification of the most critical content knowledge base for middle school science teachers. Journal of Science Teacher Education, 19, 269-283.

Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? Journal of Educational Psychology, 100(4), 765-781.

Shaw, S., Rushton, N., & Majewska, D. (2022). Tracing the trajectory of mathematics teaching across two contrasting educational jurisdictions: A comparison of historical and contemporary influences. International Education Journal: Comparative Perspectives, 21(1), 37–54.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Shulman, L., & Grossman, P. (1988). The intern teacher casebook. San Francisco, CA: Far West Laboratory for Educational Research and Development.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. Free Press.

Sullivan, P., & Mousley, J. (1994). Quality mathematics teaching: describing some key components. *Mathematics Education Research Journal, 6*(1), 4-22.

Tebabal, A. & Kahssay, G. (2011). "The effect of student-centered approach in improving students' graphical interpretation skills and conceptual understanding of kinematical motion," Lat. Am.J. phy. Edu, 5(2): 374-381.

Urdan, T. & Schoenfelder, E. (2006). Classroom effects on student motivation: Goal structures, social relationships, and competence beliefs. Journal of School Psychology, 44 (5), 331-349.

Wandberg, R., & Rohwer, J. (2003). Teaching to Standards of Effective Practice. A Guide to Becoming a Successful Teacher. Englewood Cliffs, NJ: Pearson Education.

Winter, B. (2011). PraiseMyStudents: A Social Network Designed to Reinforce and Motivate Positive Student Outcomes. 63–66.

Zaidatol, Akmaliah, & Habibah. E. (2000). Pengajaran dan pembelajaran Perdagangan, Keusahawanan dan Ekonomi Asas. Serdang: UPM.

Zeichner, K. M., & Liston, D. P. (2013). Reflective teaching: An introduction (2nd ed.). Routledge. https://doi.org/10.4324/9780203850591
