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Jamaican Primary Teachers' Perspectives on Mathematics Pedagogical Content Knowledge and Grade 6 Students' Underperformance in Mathematics

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This is to certify that the doctoral study by

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Walden University
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Abstract

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MA, Northern Caribbean University, 2013

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Project Study Submitted in Partial Fulfillment

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Curriculum, Instruction and Assessment

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Abstract

Teachers' mathematics pedagogical content knowledge (MPCK) is a necessary component for mathematics achievement. Despite the importance of this component, some teachers demonstrate limited knowledge of how best to facilitate mathematics instruction. The problem addressed through this study was the consistently low mathematics achievement of Grade 6 students at a Jamaican primary school district. The qualitative study aims to examine Jamaican primary teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics. Shulman's pedagogical content knowledge (PCK) development model was the conceptual framework for this study. The model suggests that pedagogical knowledge is related to the ability of teachers in delivering an effective teaching and learning atmosphere for all learners, which determines the improvement of students' learning outcomes. Two research questions were used to guide inquiry into primary teachers' perspectives on their PCK and underachievement. Data from 11 interviews with primary school mathematics teachers identified through purposeful sampling were analyzed using thematic analysis. The study revealed that Jamaican primary school teachers believe that having strong MPCK contributes to teachers' overall job satisfaction and increases teaching efficacy. Furthermore, teachers recognize the importance of support from stakeholders such as principals and parents in enhancing their growth in MPCK. Positive change will occur when stakeholders discuss and provide the necessary support for teachers, and when teachers use workshop strategies in Jamaican classrooms.

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Dedication

This project study is dedicated to all who supported, guided and encouraged me through this journey. My husband, daughter, mother and sister who endured inconveniences to ensure I remained on task to the completion of the study. My colleagues who showered me with words of encouragement in difficult times and my church family from whom I constantly draw spiritual strength.

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Section 1: The Problem

The Local Problem

The problem addressed in this project study is that primary teachers in a school district in Jamaica, referred to in this project as Jamaica Primary School District (JPSD), display limited mathematics pedagogical content knowledge (MPCK), and Grade 6 students continue to underperform in mathematics. Yet, a national standards curriculum has been implemented with a focus on science, technology, engineering, and mathematics (STEM) as one of its central tenets. From 2015 to 2019, the average performance Grade 6 students in JPSD remained 2% below the national average (see Table 1). In 2019, when there was a change in the country's classification of mastery, only 37% of JPSD students attained proficiency or highly proficiency in the subject (see Table 1).

Table 1

Mathematics Performance of Grade 6 Students in Jamaica Primary School District

Period	District average	National average
2015	54%	56%
2016	55%	57%
2017	57%	59%
2018	59%	61%
2019	37% (proficiency or higher)	57% (proficiency or higher)

Note. Percentage of Grade 6 students showing proficiency in mathematics from 2015 to 2019, according to data from the Ministry of Education and Youth, Jamaica.

At JPSD, the development of students' mathematics skills begins to be monitored from as early as Grade 1 where students participate in the Grade One Individual Learning Profile (GOILP). This diagnostic assessment identifies students who are ready, almost ready, or not ready for mathematics instruction at the Grade 1 level and propels teachers

to tailor instruction to meet the needs of these students. In Grade 3, another diagnostic assessment is done to track the progress and further diagnose gaps in the development of mathematical skills. Mathematics assessments conducted at the end of fourth and fifth grade are used to determine students' achievement at both grade levels. Despite these measures, the data still revealed that many students are unable to gain proficiency in mathematics in the Primary Exit Profile conducted at the end of Grade 6. Reports from the National Education Inspectorate (NEI), a subsidiary of the National Quality Assurance Authority with the responsibility to identify issues of performance and accountability in the education system in Jamaica, revealed that in some primary schools, Grade 6 students continue to underperform in the discipline and show minimal progress in relation to their start point rendering these schools as ineffective.

Data from the chief inspector's report indicated that of the 189 schools inspected in 2017, 59 were deemed unsatisfactory due to poor pedagogical practices observed in core areas, including mathematics. The report identified clear challenges in teachers' inability to engage students in the learning process meaningfully and identified areas for improvement, such as teachers' knowledge of the subjects and how best to teach. The report further revealed that some teachers had limited knowledge of the subjects they teach and could not extend students' understanding of the subject. This gap also limited students' learning of facts and basic concepts, which negatively impacted students' overall work output. In 2018, 109 mathematics teachers were trained to function as mathematics coaches and specialists in several schools across the island where mathematics teachers were deemed to need support. In the 2021 sectorial debate, the

Minister of Education Jamaica revealed that 202 of the primary schools inspected were ranked unsatisfactory in the last NEI report. Two were ranked as needing immediate support in the area of teacher effectiveness, including teachers' knowledge of how best to teach the subject (Ministry of Education, Youth, and Information, 2021).

Instructional walk-throughs conducted throughout the school district identify practices where teachers employed inappropriate strategies to deliver mathematics content. In some cases, according to the convener of the quality education circle, teachers complain that they do not know how to teach the subject. In a school district meeting held among middle managers and principals in May 2021, participants lamented that despite the numerous initiatives implemented in their schools to improve mathematics performance among students, little or no improvement is seen. One principal remarked that in their particular school, teachers expressed that they were not confident in teaching the subject, and it was burdensome even to plan the lessons.

The quality of mathematics teaching and how it influences student performance have been the focus of studies conducted by different scholars (Bourne, 2019; Crossfield & Bourne, 2017). A growing number of researchers have identified teachers' limited MPCK as directly influencing students' learning outcomes (Aksu & Kul, 2019; Stevenson, 2020). Some believe that since teachers' pedagogical content knowledge (PCK) directly impacts teaching quality, their MPCK should be high if they are going to improve student outcome. Mok and Park (2022) found that when teachers' MPCK increases, their capacity to teach for students' success expands.

Mathematics teachers must design instruction so that the content becomes relevant to students, thus enabling them to use increased knowledge to solve social, economic, and environmental problems. Teachers must develop mathematical competence in students and possess strong and adaptable mathematics knowledge (Esendemir & Bindak, 2019). To realize this, teachers must possess the skills and knowledge to facilitate student learning effectively. Teaching knowledge and pedagogy influence how students' interests and career aspirations are developed and have been proven to be the most significant school-related factor in student achievement (Wright et al., 2019). For this reason, teachers' perspectives on their knowledge and practice is critical in planning for teachers' and students' knowledge in mathematics (Marfan & Pascual, 2018).

Teachers' beliefs and attitudes influence their planning, instructional decision-making, instructional practices, curricular materials, and pedagogical approaches (Spillane et al., 2018). The authors suggested that teachers' beliefs influence their responses to the need for PCK growth and reform efforts. Their beliefs and attitudes regarding MPCK are critical indicators of practice and must be considered since teachers' beliefs about their PCK can impact their practice (Lai & Lin, 2018). These studies indicate that teachers' perspectives on mathematics teaching, their MPCK, and students' underperformance in the discipline is a topic worthy of investigation.

Rationale

Evidence of the Problem at the Local Level

I conducted a basic qualitative research in a primary school district in Jamaica. This approach was considered as it allowed primary teachers within the JPSD to share their perspective on teachers' MPCK and Grade 6 students' underperformance in the discipline. The recently implemented National Standards Curriculum is designed to equip students with the requisite skills to excel in STEM (Ministry of Education, Youth, and Information, 2017). Like other school districts, teachers, and students in JPSD would have participated in many initiatives implemented nationally to heighten performance in mathematics. Some of these include initiatives such as Math Counts and Mathematics Leap, a partnership with countries such as Singapore and Finland to share best practices on facilitating mathematics instruction, and numerous workshops on creating a mathematics classroom environment. Despite the varying approaches taken, the desired level of performance from teachers and students in the discipline still needs to be realized. Teachers are expected to implement strategies learned through varying modes. As the deliverer of the curriculum, teachers are expected to act on the increased knowledge to a greater degree. As indicated by one Grade 6 mathematics teacher, the action that is needed in all the approaches undertaken is an investigation into teachers' perspectives on whether these strategies support teachers' knowledge growth and teachers' perspectives on the conditions that support students' success in mathematics.

Exploring a central phenomenon within a particular context is an identifying feature of a basic qualitative research design. Principals of schools in the district want to

know how best to support teachers' MPCK growth and create conditions for success in mathematics at the Grade 6 level, as expressed numerous times at school district primary principals' meetings. An increased understanding of teachers' perspectives on factors that support their MPCK growth and conditions that support students' success in mathematics may have implications for the design of professional development (PD) sessions and the creation of school culture beyond the school district's boundaries. Understanding teachers' perspectives on their PCK growth is a critical consideration that must be made as strategies are explored to change teachers' mathematical instructional beliefs for alignment with reform-oriented views of mathematics (Spillane et al., 2018).

Evidence of the Problem from the Professional Literature

Teachers' perspectives are salient to their pedagogical practices (Colton et al., 2022). MPCK is concerned with how mathematics is taught and awareness of students' mathematical thinking. Mathematical thinking relates to understanding what makes the learning of specific concepts easy, while knowledge of mathematics encompasses knowing "the ways of representing and formulating the subject that make it comprehensible to others or complex" (Shulman, 1986). Colton et al. (2022) found that when teachers can identify positive perceptions about their proficiencies in 21st-century skills, they are likely to make the necessary arrangements in their classrooms to contribute to student's cognitive and affective outcomes (Anagün, 2018). Beliefs, attitudes, and perspectives are critical to PCK growth (Anagün, 2018; Gozde et al., 2017). This relationship between teachers' perspectives on their PCK and its growth has been overlooked. One participant in a mathematics PD session argued that growth in teachers'

MPCK and students' performance in mathematics will only be realized when teachers are allowed to verbalize the conditions that best support their knowledge growth.

Teachers' knowledge of students and how to teach the content has been viewed by scholars and identified in professional standards as crucial to promoting effective instruction for students' learning (Hill & Chin, 2018). Many researchers have identified a positive correlation between teachers' MPCK and students' mathematics achievement in Jamaica and education systems in other regions (Algani & Eshan, 2019; Bourne, 2019; Hill & Chin, 2018; Steinig, 2016). Bourne (2019) posited that pedagogical practices in delivering the curriculum are vital to changing how mathematics is taught and the successes thereafter.

There is a demand for research on teaching pedagogies in Caribbean schools (Jennings, 2017). Widodo (2017) suggested that since teachers' pedagogical knowledge is crucial in shaping teaching practice, facilitating such growth must be prioritized. Consequently, this qualitative study examines Jamaican primary teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics. Although there have been extensive studies on teachers' MPCK, more is needed to know how teachers' perspectives on such knowledge relates to its growth and students' success in mathematics. There is also an absence of scholarly studies on the issue in the local setting.

Definition of Terms

Terms used throughout the study are defined as follows:

Mathematics pedagogical content knowledge: An understanding of how students learn mathematics, how to teach it, and how to assess and evaluate students' understanding of mathematics materials (Setyaningrum et al., 2018; Shulman, 1987).

Mathematical knowledge for teaching: Mathematics knowledge for teaching refers explicitly to the knowledge, skills, and understanding that teachers need in teaching the subject matter for effectiveness (Aksu & Kul, 2019; Shulman, 1987).

Pedagogical content knowledge: A comprehensive understanding of the subject matter knowledge and pedagogy that is unique to teachers (Setyaningrum et al., 2018).

Primary teacher: An educator trained as a generalist to satisfy the curricular needs of students prior to advancing into the secondary system (Rossum et al., 2018).

Student achievement: Measure of content knowledge and skills, in mathematics in this case, that students learn in a determined amount of time and level through standardized tests (Ballafkih & Middelkoop, 2019).

Subject matter knowledge: An understanding of the subject content or horizon (Lee et al., 2018).

Significance of the Study

The significance of this study is determined relative to primary teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics in a school district in Jamaica. More research is needed to examine teachers' perspectives regarding their MPCK and Grade 6 students' underperformance in mathematics despite abundant evidence regarding teachers' perspective on demographic and classroom-based predictors of students' academic excellence (Hill & Chin, 2018). Teachers' perspectives

on conditions that support their mathematics pedagogical growth and support needed to improve students' performance in mathematics are needed to add to the literature. Delivery of quality education through improved teachers' efficacy is one of the priority policies of the Ministry of Education, Jamaica (Ministry of Education, 2021). Consequently, understanding teachers' perspective on conditions that support MPCK growth and factors that increase students' mathematics performance is a direct step to prioritizing the policy and addressing a problem in the local setting.

This study will support professional education practice in the local setting and will provide much-needed insights on the support needed to realize MPCK growth. A positive correlation exists between teachers' MPCK and student achievement (Hill & Chen, 2018). Insights from this study will aid developers of teacher training curricula in adopting practices that best support teachers' MPCK development. School leaders and policymakers can use insights gained from this study to assist in identifying ways to support teachers and determine practices and resources needed to help teachers experience MPCK growth. The teaching profession consists of a diverse set of individuals with varying philosophies of education. Using knowledge of teachers' perspectives on support for their mathematics pedagogical content development, the frequencies of these practices will be better sustained and supported by allocating more resources by school leaders and policymakers. Establishing these supports should positively impact social change as the increased knowledge resulting from the practices can motivate practicing teachers to continue improving efficacy, leading to more

diversity in the cadre of mathematics educators to cater to the diverse needs of learners since highly motivated teachers are more likely to remain in the profession.

Research Questions

Many principals are searching for strategies and approaches to increase teachers' MPCK growth and realize increases in students' performance in mathematics. Without solutions, the goal of producing 21st-century leaders who are collaborators, critical thinkers, and adept at innovations will not be attained. A plethora of literature provides evidence that considering teachers' perspective on their MPCK growth forms an essential part of the conversation about developing PCK for efficacy in mathematics instruction (Hill & Chin, 2018). On this premise, I used a qualitative approach to examine primary teachers' perspectives on conditions that support teachers' MPCK and factors that improve Grade 6 students' performance in mathematics. The following research questions were employed to provide answers for the central focus:

RQ1: What are primary teachers' perspective regarding the value of teachers' MPCK in improving students' performance in mathematics?

RQ2: What kind of support, knowledge, and skills do teachers feel is essential to experience MPCK growth?

Review of the Literature

The problem that was the focus of this study is the consistently low mathematics achievement of Grade 6 students in a primary school district in Jamaica. Many researchers have identified a positive relationship between students' academic performance and teachers' pedagogical knowledge (Aksu & Kul, 2019; Stevenson,

2020). In examining the growth of PCK and understanding of mathematics, Aksu and Kul (2019) found that limited PCK contributes to teaching anxiety, which negatively impacts teaching efficacy and students' outcomes.

The need for this study is justified since teachers' beliefs, values, and attitudes toward their PCK impact their attitude to education reforms, the quality of their classroom interaction, students' achievement, and job satisfaction (Lai & Lin, 2018; Perera & John, 2020). This section describes the literature search strategy, the conceptual framework, and the literature review related to key concepts. Literature focusing on PCK specific to mathematics was reviewed and organized into four sections: PCK as a component of teaching efficacy, (a) components of MPCK, (b) acquisition of MPCK, (c) and perspective on barriers to teachers' MPCK growth.

Conceptual Framework

Shulman's PCK theory purports that knowledge can be compartmentalized as (a) knowledge of the subject matter, (b) knowledge of pedagogical practice, and (c) knowledge of how to teach (Shulman, 1986, 1987). The PCK theory influenced numerous conceptual frameworks and has been extensively used in many aspects of teacher preparation. Seven domains of knowledge are used to emphasize the different levels of interactions that influence how teachers think about and deliver the content of a subject. Successive research and applications of Shulman's theory have provided insights on conditions to consider in facilitating teachers' MPCK growth, allowing insight into context-specific practices that support this knowledge development (Holtsch et al., 2019; Stevenson, 2017; Zolfaghari et al., 2021).

Shulman's (1986) theory on PCK not only justifies the significance and relevance of the study but also grounds the study in this specific context and serves as a guide to identifying the relationships among the ideas in the theory and how they relate to the subject of the investigation. Since the aim of this study was to examine primary teachers' perspective on their MPCK to include resources that support such growth, the theory, including the seven domains on which the concept is built, can be used to understand better the support needed to improve professional practice.

Shulman (1986), who stressed the importance of teacher knowledge in enabling them to become effective practitioners, put forward seven distinct domains that must be considered as constituting teachers' knowledge: (a) content knowledge; (b) pedagogical knowledge; (c) PCK; (d) curriculum knowledge; (e) knowledge of learners' characteristics; (f) educational context knowledge; and (g) knowledge of educational outcomes, objectives, values, and philosophical and historical foundations. Teachers' PCK combines their content knowledge and pedagogical knowledge. Content knowledge comprises knowledge of the subject matter, knowledge of the skills embedded in the subject, knowledge of the educational context, history, and philosophy, and knowledge of the educational context of the subject. Pedagogy knowledge consists of understanding the subject's content relating to pedagogical aspects, knowledge of the learner, and knowledge of the educational goals and purposes (Mok & Park, 2022).

According to Shulman (1986), teacher expertise is subject matter knowledge. This knowledge concerns teachers' awareness of the units of facts and the organization of a particular subject, which defines and distinguishes it from other subjects. The component

involves understanding and skills to be learned (Herold, 2019). Understanding why the subject is the way it is, on what grounds its warrant can be asserted, and under what circumstances belief in its justification can be weakened and even denied must be evident (Shulman, 1986). Such knowledge helps the teacher understand why specific skills are needed for particular disciplines.

The second domain is knowledge of the various skills entrenched in particular subjects that students must develop to be successful in the discipline (Shulman, 1986). In this domain, special reference is made to broad principles and strategies of classroom management and organization and transcends subject matter (Herold, 2019). Teachers must have "a veritable armamentarium of alternative forms of representation, (p9)" as there is no single most helpful form of representation (Shulman, 1986).

Teachers' knowledge of how the subject evolves also constitutes one of the domains of PCK. Competence in this area means that teachers possess knowledge that enables them to correctly explain why concepts in the subjects are connected and state how they are connected (Shulman, 1986). A sound philosophical understanding of a particular subject enables the teacher to explain concepts to provide a holistic viewpoint for students by appropriately explaining what has been studied in the past relating to the subject and potential areas for investigation.

Shulman (1986) identified the fourth domain of teaching expertise as teachers' knowledge of educational context. This subject area should contribute to the broad sphere of education, and growth is part of this knowledge. Teacher contextual knowledge includes awareness of who, where, and what they teach, whether teaching occurs in a

classroom or the community, and the level and relationship to local and state standards (Shaked, 2021).

General content relating to the pedagogical aspect of the subject has also been identified as a domain for pedagogical knowledge competence (Shulman, 1986). Such knowledge is aligned with teachers' ability to sequence, arrange, organize, and effectively and appropriately explain the subject matter to students. This knowledge will influence what concepts are taught before others, to ensure a better grasp of concepts.

Knowledge of student understanding is the sixth domain concerned with the learner's preconceptions of the learning situation. The teacher understands students' learning difficulties, misconceptions, and reasoning (Mok & Park, 2022). Awareness of the diverse learning needs of each learner falls under this domain. Such knowledge of the learner will influence teachers' decision to sequence the body of knowledge in the subject area based on appropriateness for the group of students (Mok & Park, 2022).

The seventh domain of Shulman's (1986) teaching expertise is knowledge of the goals and purposes of the subject. This knowledge also refers to the normative and theoretical understanding of the goals and values of education (Shaked, 2021). Teachers competent in this area can present the content in a way that forces students to understand the goals and purposes of learning the subject and how it benefits them.

Review of Broader Problem

Search Strategy

The literature in this review was derived from various electronic databases, including SAGE Journals, Google Scholar, Science Direct, Taylor and Francis, ProQuest,

and the Walden University Library. Peer-reviewed journals that were published in the last 5 years were targeted. Keywords searched in each database included variations of *pedagogical content knowledge, MPCK, teachers' perspectives on underperformance in mathematics, primary teachers, mathematics teaching,* and *mathematics pedagogical content knowledge gaps*. These keywords with delimiters to include date range, subject area, and document type (abstract, article, and full text) were used to narrow the search. New terms embedded in previously located articles that influence new searches were identified through iterative search actions.

The articles included are relevant to the conceptual framework and methodology of the study. Teachers limited MPCK and the consistently low mathematics achievement of Grade 6 students is the problem addressed throughout the study. Despite increased expectations for teachers to employ strategies to improve students' understanding and mastery of mathematics concepts (Burton, 2022), some mathematics teachers still demonstrate limited MPCK (Copur-Gencturk & Doleck, 2021; Zolfaghari et al., 2021). Teachers' conceptual understanding of concepts in mathematics plays a crucial role in teaching students how to solve mathematical problems (Copur-Gencturk, 2021); however, more than subject knowledge of mathematics is needed to effectively facilitate instruction in the discipline. Mohr-Schroeder et al. (2017) explained that teachers must draw on all aspects of mathematics knowledge. The evidence suggests that sound PCK is a prerequisite for teaching efficacy.

PCK: Component of Teaching Efficacy

Many researchers identify PCK as critical for teaching efficacy and students' overall learning outcomes (Hammack & Ivey, 2017; Richardson et al., 2018; Thomson et al., 2017). Mok and Park (2022) explained that PCK integrates subject matter knowledge, knowledge of students' understanding, curriculum knowledge, and knowledge of instructional strategies. Gricier and Hendricks (2018) added that such knowledge comprises teachers' values and beliefs about education and guides teachers in formulating context to make it more understandable to others, which plays a crucial role in teachers' development. In a study conducted on the relationship between PCK and teaching efficacy, Aksu and Kul (2019) found a positive relationship between teaching efficacy and PCK. Teachers with higher teaching efficacy used student-centered educational strategies and varying teaching materials in applying methods and employed diversified educational methods. In another study on teaching efficacy and mathematics efficacy developmental trajectories, Thomson et al. (2021) found that deeper mathematical knowledge presented higher efficacy for teaching mathematics. The result also proved that highly efficacious teachers are more persistent in learning and are more willing to take risks with new instructional strategies. These findings suggest that deeper PCK of a subject will likely positively impact teaching efficacy.

Limited PCK has been identified as a hindrance to teaching efficacy (Aksu & Kul, 2019). Odumosu et al. (2018) found that teachers with limited MPCK produced students with low mathematics scores. In another study on the mediating role of mathematics teaching efficacy on the relationships between PCK and mathematics teaching anxiety,

Aksu and Kul (2019) found that teachers with limited PCK experienced mathematics teaching anxiety, resulting in difficulty learning mathematical concepts or how to teach mathematics effectively. Both studies clarify the link between teachers' pedagogical knowledge and students' performance.

Factors Influencing Students' Achievement in Mathematics

Students' achievement in mathematics has sparked many debates over the last 50 years (Ballafkih & Middelkoop, 2019). This achievement is exemplified by students' ability to apply learning to new situations on standardized tests (Ballafkih & Middelkoop, 2019). Researchers have varying views on how students develop this ability to perform mathematics tasks. Yep et al. (2019) opined that students use diverse abilities to attain varying levels of competencies in mathematics. Boaler (2016) explained that students are not born with a "math brain," but growth and changes in their mindset can enable them to perform mathematics tasks competently.

Research has also shown that varying factors influence students' mathematics performance, including school management, government policies on education, and accountability systems (Ballafkih & Middelkoop, 2019). Students' attributes and attitudes toward mathematics and the classroom environment are related to their academic performance (Darmawan, 2020). As the debate over factors impacting students' outcomes in mathematics continues, a growing number of researchers are identifying teacher competence as one of the leading factors (Ballafkih & Middelkoop, 2019; Stevenson, 2020; Yeh et al., 2019). Some factors identified include teachers' academic ability, teaching knowledge, and teaching behaviors. Yeh et al. (2019) opined that control of

teacher-directed instruction in mathematics classrooms could be the reason for students' underperformance among some students. Underperforming students are particularly impacted by the pace and short time to concretize concepts (Yeh et al., 2019).

Four main teacher-related behaviors have been identified that negatively impact students' outcomes (Sidabutar, 2016). The first is the systematic delivery and sequence of the lessons. With such behavior, the teacher teaches a more complex lesson without regard for foundation knowledge. Secondly, there are occasions when the focus is on committing contents to memory without regard for understanding the requisite concepts for mathematics lessons. The third behavior is a need for interconnectivity with the subject matter taught. When students encounter unclear content, their ability to comprehend the taught concept becomes significantly challenging due to this behavior, and teachers lack the capacity to offer the required guidance. The final behavior is the teacher's incompetence in mathematics pedagogies, resulting in failure to transfer the knowledge required to master mathematics content (Sidabutar, 2016). The impact of the deficiencies warrants a deeper understanding of what constitutes the knowledge teachers need to teach mathematics effectively.

Components of MPCK

MPCK is derived from infusing PCK in mathematics education (Lo, 2022). Copur-Gencturk and Tolar (2022) further explained that MPCK is the intersection of content knowledge and pedagogical knowledge. This particular form of expertise represents teachers' unique professional understanding, which influences the blending of content and pedagogy into an account of how specific topics, problems, or issues are

organized for instruction (Shulman, 1987). In a review of the literature on PCK and preparation of stringed-instrument teachers, Grieser and Hendericks (2018) found that teachers use both content knowledge and pedagogical knowledge to transform the subject matter in a way that students can understand. Likewise, Powell (2017), in examining teachers' PCK in social studies, reported similar findings as teachers who experienced PCK development were those who were provided the opportunity to experience the marriage of deep subject matter knowledge with knowledge of the contexts of teaching and the teaching strategies which enable students to learn the subject matter being taught. These findings suggest that content knowledge can be connected to pedagogical knowledge as both form the united body of knowledge needed to facilitate instruction effectively.

Content Knowledge. One of the two tenets on which PCK is built is content knowledge. This knowledge concerns the specific subject matter knowledge, understanding, and skills to be learned (Shulman, 1987). Other areas of awareness in this domain are knowledge needed to perform a particular activity, such as knowledge of rules, techniques, tactics, errors, and content representations (Chang et al., 2020). Content knowledge is a crucial element needed in teaching and is a prerequisite for teaching a subject matter (Copur-Gencturk & Tolar, 2022). Copur-Gencturk and Tolar (2022) adapted three indicators of mathematics content knowledge (MCK): conceptual understanding, mathematical reasoning, and word problem-solving skills.

Conceptual understanding is the form of understanding concerned with knowing the meaning behind mathematical rules and definitions (Copur-Gencturk & Tolar, 2022).

In a study on mathematics coaching for conceptual understanding, Russell et al. (2020) found that coaching programs improved teachers' conceptual understanding, directly impacting students' conceptual understanding. Likewise, in an inquiry into quantitative reasoning strategies for comparing fractions, Crawford et al. (2018) discovered that before teachers could lead students to a deeper understanding of comparing fractions, they first had to possess that understanding of numbers and their relationships. This knowledge enabled them to offer the necessary scaffolding to lead students to think based on the context of the items. The findings indicated that teachers can only guide students to deeper conceptual understanding when they fully grasp the concept being taught.

Another critical component of MCK is mathematical reasoning. Copur-Gencturk and Tolar (2022) explained that this form of reasoning is thinking logically about the relationships among concepts and situations, like reasoning through one's solution and evaluating its mathematical soundness. Weiland et al.'s (2019) study on mathematics teachers' ability to identify situations appropriate for proportional reasoning revealed that teachers' proportional reasoning knowledge was counterproductive if this knowledge was used to teach students that when given three quantities to solve for a missing quantity, they should always set up a proportion and use the cross-multiply and divide algorithm to find the unknown quantity. This knowledge is counterproductive as not all such situations are proportional. Teachers' mathematics reasoning knowledge impacts the accuracy of the content presented.

Word-problem solving is the third critical component of teachers' MCK. Such knowledge is the strategic competence enabling teachers to choose particular strategies

and presentations to translate word problems into mathematical expressions (Copur-Gencturk & Doleck, 2021a). After examining teachers' flexibility with referent units in solving fraction division, Lee (2017) found that teachers' strategic competence is highly contingent on whether they can devise a valid solution strategy and how they deal with known and unknown quantities in each word problem. Competence in all three areas indicates the teacher has sound MCK (Mohr-Schroeder et al., 2017). Shulman (1986) purported that competence in the content knowledge in a specific discipline means the teacher knows and understands the subject they teach as well as the theories, procedure, and framework.

Specialized content knowledge is the fourth critical component of subject knowledge (Charalambous et al., 2020). Copur-Gencturk and Tolar (2022) explained that specialized content knowledge is an amalgam of conceptual understanding, reasoning, and word problem-solving involved in mathematics in the work of teaching. Mathematics teaching has been categorized as a content-specific area of knowledge that requires specific knowledge for teaching. This specific knowledge includes teachers' understanding of mathematics and how it is to be taught, understanding of students' mathematical thinking, instructional practices, and ability to notice content-related issues in the moment of mathematics teaching (Copur-Gencturk & Tolar, 2022).

Mathematics content in primary school consists of five content strands: number and operation, algebra, geometry, measurement, and data analysis and probability (Remillard, 2020). Copur-Gencturk et al. (2018) explained that MCK includes teaching in ways familiar with how the concept is used in many other professions or occupations that

also use mathematics. Correctly recalling and executing grade-level-appropriate ideas are essential components of MCK. In a study by Yilmaz and Demir (2021) teachers experienced difficulties teaching perimeter and area because they needed to understand the relationship between the two concepts. These findings suggest that teachers' content knowledge is necessary to present factual information to increase students' mathematics knowledge base.

PCK. Pedagogical knowledge is described as an educator's construct, philosophy, and beliefs about their practice. It shapes how they see their practice, the role of education, and the processes and purposes of learning (Sandri, 2020). Educational pedagogy in sustainable education and how it is applied and shaped in favor of sustainability education has gained focus because of its potential to achieve educational reform (Restrepo et al., 2017). In a study conducted on visible mathematics pedagogy as a model for transforming classroom practice, Wright et al. (2020) found that teachers' worldview of teaching led them to employ a teacher-centered approach, which negatively impacted student learning outcomes. In contrast, in another study on the impact of a PD program on teacher self-efficacy, competence, and pedagogy, Murphy et al. (2020) found that after participating in a teacher development program, teachers changed their views about the teaching of science. With the inquiry-based approach to instruction, teachers realized improved students' learning outcomes.

The depth of understanding students will gain from a discourse should be interpreted by the teacher's approach to instruction (Hill et al., 2020). Myers et al. (2019) explained that mathematics teachers should engage students in authentic problems and

contexts to develop students' individual and shared understandings of mathematical concepts and practices in ways that nurture their abilities to problem-solve, reason, and communicate mathematically. Copur-Gencturk (2019) added that pedagogy knowledge includes various teaching strategies, such as sequencing mathematical activities, choosing which activity precedes another, and knowing the affordances and hindrances of different representations for teaching a specific mathematical concept. Teachers' MPCK is essential to mathematics teaching and students' learning (Copur-Gencturk & Doleck, 2021).

PCK can be viewed through knowledge of students' mathematical thinking and mathematics teaching (Copur-Gencturk & Tolar, 2022). Knowledge of students' mathematical thinking is awareness of what makes learning specific concepts easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring to learning (Shulman, 1986). In a study on teaching practices for differentiating mathematics instruction for middle school students, Hackenberg (2021) found that a critical knowledge set teachers had to possess before effectively offering middle school mathematics concepts was what students brought to the learning situation. Consequently, the knowledge that students enter middle school operating with three different multiplicative concepts that significantly influence students' rational number knowledge influenced the approach taken to instruction thereafter. Similarly, Evans and Gold (2020) found that teachers' knowledge of early childhood students learning through play led them to adopt approaches such as 'numerosity." Teachers' knowledge of

mathematical thinking plays a vital role in the teachers' decision to employ particular approaches to instruction.

Teachers' knowledge of mathematics teaching is another component of teachers' PCK. This knowledge encompasses knowing how to represent and formulate the subject that makes it comprehensible to others (Copur-Gencturk & Tolar, 2022). Copur-Gencturk and Tolar (2022) explained that when a teacher can use another appropriate representation or instructional strategy when students are having difficulty comprehending a concept, this indicates the teacher's knowledge of mathematics teaching. The result of a study conducted on Turkish pre-service middle-level mathematics teachers' knowledge of teaching fractions by Avcu (2019) revealed that in a lesson on fractions, most teachers could employ strategies to effectively teach the construct and alter strategies whenever difficulties were observed. Therefore, teachers with sound MPCK can identify mathematics difficulties among students and redesign instruction and approach for greater understanding.

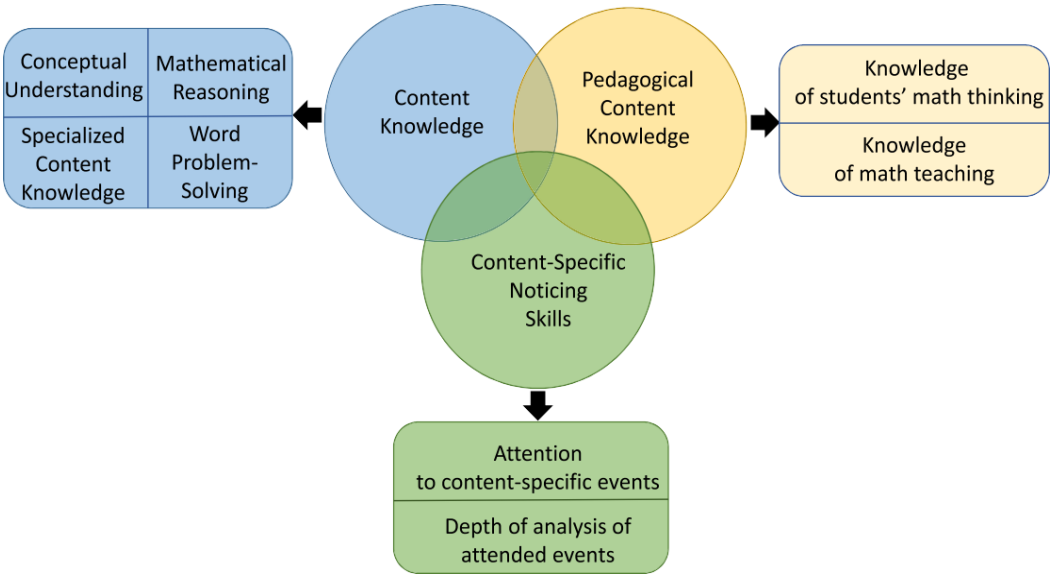
The teaching of mathematics requires more than mere subject matter expertise. The action requires knowledge of how to represent and formulate the subject that makes it understandable to others. Many studies highlight the importance of pedagogical knowledge to teaching efficacy (Hammack & Ivey, 2017; Ní Ríordáin et al., 2019; Richardson et al., 2018; Thomson et al., 2017). Ní Ríordáin et al. (2019) opined that this knowledge positions teachers to facilitate the body of knowledge coherently and effectively. While general pedagogies can aid in teaching mathematics, there are skills and processes unique to the discipline that must be taught in a targeted way (National

Council of Teachers of Mathematics [NCTM], 2009, 2014). The council posited that mathematical skills and processes should be learned through interacting with materials, peers, adults, and the environment instead of rote and memorization.

Content-specific noticing skill is a component of teachers' pedagogical content skill that has recently gained prominence as a construct for elementary school mathematics teachers (Charalambous et al., 2020). This knowledge involves teachers paying attention to complex situations and how they interpret these events. Charalambous et al. (2020) explained that appropriate mathematics content and PCK might only create an effective learning environment if noteworthy events around the content, student, and teaching situation catch teachers' attention. Criswell and Krall (2017) further noted that teacher noticing constitutes three important actions: (a) attend: decide what particular events to attend to in an instructional setting, (b) interpret: reason and make sense of the events, and (c) respond: make informed teaching decisions based on the analysis of observations. The researchers agree that teachers' PCK will guide them to create a classroom environment that caters to the academic, social, and affective domains of learning. Figure 1 is a pictorial representation of MPCK components.

Figure 1

Component of Mathematics Pedagogical Content Knowledge



Note. This framework categorizes mathematics pedagogical content knowledge and identifies the components under the three main categories. From "Mathematics Teaching Expertise: A Study of the Dimensionality of Content Knowledge, Pedagogical Content Knowledge, and Content-Specific Noticing Skills," by Y. Copur-Gencturk and T. Tolar, 2022, *Teaching and Teacher Education, 114* (https://doi.org/10.1016/j.tate.2022.103696).

Acquisition of MPCK

MPCK is acquired through mediums such as PD sessions and workshops (Copur-Gencturk et al., 2019; Mok & Park, 2022), classroom experiences (Mills et al., 2020), teacher training programs (Baumert, 2017) and institutional best practices (Koç & Bastas, 2019). Additionally, researchers found that teachers' value, attitude, and belief about their PCK also influence their knowledge acquisition. In an inquiry into the relationship between beliefs, values, and technological PCK among teachers, Lai and Lin (2018)

found that teachers with high student-centered pedagogical beliefs and high technology values also had high technological PCK. The authors opined that these values and beliefs regarding their PCK will determine their decision to participate in PD sessions or other activities to increase their MPCK.

Professional Discourses. Teachers can experience MPCK growth from the activities they are involved in as they facilitate mathematics instruction (Spillane et al., 2017). These include the practical circumstances and possible conflicts in actual events, conversations with peers, peer observation and feedback, and advice seeking about instruction are opportunities to increase MPCK growth. Teacher collaboration may help teachers' practical knowledge development by providing opportunities to draw on the valuable experience of veteran teachers through classroom observation and benefit from open and close discussions with peers about daily teaching issues (Waterhole et al., 2016). The authors believe that when teachers interact with colleagues with more reform-oriented math beliefs, their beliefs become more reform-oriented over time.

In examining the impact of mathematics-specific pedagogy training, O'Meara and Faulkner (2021) found that training and workshops led to statistically significant improvements in mathematics teaching efficacy and a shift from procedural or teacher-led approaches to more student-centered approaches that focused on developing understanding. In another study on PD for PCK development in the center of teachers' online community, Liljekvist (2018) found that Facebook served as a valuable tool for sharing knowledge and curricular material, giving advice, and getting support on issues of importance to their teaching. Consequently, participants realized PCK growth.

Professional discourses remain a helpful pathway to increase teachers' PCK (Wongsopawiro et al., 2017).

A positive correlation exists between organizational culture, instructional practices, and student achievement (Çimen & Karadağ, 2019). School culture, which school principals create, can build synergy to increase the effectiveness of the school, improve teacher knowledge and efficacy, and the students' success (Koç & Bastas, 2019). School cultures that enhance teacher learning, in particular, are those in which teachers actively and collaboratively examine, share, and construct authentic classroom material and develop new knowledge regularly and over a more extended period (Coenders & Verhoef, 2018). A growing number of researchers are identifying school cultures characterized by professional discourses such as development sessions, professional learning communities, and workshops to improve MPCK (Copur-Gencturk et al., 2019; Hill et al., 2020; Silver, 2019). Teachers can undoubtedly learn about pedagogy and learning theoretically by attending various courses and participating in as many PD sessions as possible. Putting this knowledge into the classroom depends on a way of knowing that cannot be learned entirely outside practice (Lund, 2018). Lund believed that instructional practices influence changes in teachers' actions, forcing them to think about their teaching.

Instructional Practices. Classroom interventions positively impacted students' outcomes and increased teachers' PCK (Gess-Newsome, 2019). In a study on improving PCK through a blended model, Alimuddin et al. (2020) found that as teachers explore varying instructional practices in their classrooms, reflections were used to identify which

aspects of teaching they need to be the focus. Teachers were able to reflect and improve teaching quality. Similarly, Burton (2020) found that after participating in a science, technology, engineering, and mathematics STEM teaching and learning experience, teachers changed their perceptions about teaching mathematics and adopted practices that were more aligned with mathematical teaching principles. In investigating teacher learning in lesson study, Karslen (2019) found that classroom interactions provide many opportunities for teachers to experience PCK growth. Through question-and-answer sessions, teachers learn which approach allows for a greater understanding of the concept taught. Discussions facilitated in student-centered lessons help teachers understand common misconceptions and enable teachers to increase their knowledge of how students learn (Vrikki et al., 2017).

Teachers' use of action research is a means to increase their PCK (James & Augustin, 2017). The rigorous task of planning, observing, and searching for clues to address students ' learning needs increases teachers' achievements in problem-solving and knowledge creation and sharing, promoting a sense of professional accomplishment (Wei & Chung, 2022). In investigating the impact of action research on teachers' practice, Manfra (2019) found that the approach situates teachers as learners and offers a systematic and intentional approach to improving PCK and changing teaching. The actions carried out in action research result in PCK growth.

Teacher Preparation Program. Teacher education preparation program is another avenue through which teachers acquire PCK (Stevenson, 2020). Adel and Noughabi (2022) explained that the training provided at training institutions should lead

pre-service mathematics teachers to shift from an instrument-based view of learning to a meaning-focused outlook of the PCK. In a similar study examining teachers' PCK, instructional behavior, and students' success, Gess-Newsome et al. (2019) found that teacher training programs provided teachers with opportunities to study materials and broaden their content knowledge to implement the curriculum. The authors suggested that the series of activities in which participants of teacher education programs are engaged increases their PCK.

Furinghetti (2019) suggested that developers of mathematics teacher education programs are in a position to significantly improve teachers' MPCK by exposing participants to the history of mathematics. In a study on transfer skills in a teaching training program, Sasson (2020) found that the approach helped develop teachers to adapt the behavior they will need in a new learning situation. Chen et al. (2017) examined how experts acquire knowledge and found that the learning structure for novice learners must have a mix of time on task activity and high cognitive engagement. Chen et al. explained that while instructional time in teacher preparation is not necessarily confined to allocated lecture and workshop time, condensed learning timeframes and the lack of formal lectures delivered in person invariably add to the responsibility of pre-service teachers to manage their learning and reduce the opportunity for them to access expertise in the discipline.

Several countries have reformed their teacher training programs and implemented measures to assure the quality of entrants to primary teacher education. Countries such as Canada, Chinese Taipei, Finland, and Singapore are well known for their effective

recruitment policies at the national level (Ingvarson & Rowley, 2017). A notable practice is their high standards for entry to teacher qualification programs. The increase in the qualification suggests that policymakers believe that with an increase in the quality of intake in teachers' colleges, the quality of teachers produced will also increase.

Even with the importance of teacher training programs for MPCK development, teacher preparation programs face a significant challenge in determining how to design learning experiences that develop the combination of knowledge, practices, and dispositions needed for effective classroom teaching (Santagata, 2018). A review of bachelor's degree requirements in elementary education at West Virginia universities and some similarly ranked universities revealed that of 30 universities, 21 require fewer total math courses than total language courses. Further analysis revealed that seven universities require the same number of math courses as language courses; two universities require more total math courses than language courses to earn a bachelor's degree in elementary education (Best Elementary Education Degrees, 2019).

Perspectives on Common Barriers to MPCK Growth

One of the barriers to PCK growth is issues surrounding the generalist approach to instruction (Santagata, 2018). Santagata explained that time constraints and the theory–practice divide are two well-documented concerns related to the teaching approach and that teacher educators often have limited time to prepare teachers for their profession. This lack results in decisions that privilege specific content and experiences over others. In Jamaica, prospective primary teachers are required to complete a minimum of 90 credits, including a minimum of nine credits for university foundation courses, a

minimum of 30 credits outside the school of education, and the remainder of credits shared for foundations of education courses, educational theory, and up to 21 credits in methodology in the teaching of the relevant subject or subjects or specialization in an area (Joint Board of Teacher Education, 2020). A primary teacher specializing in a subject such as social studies will complete less than 21 credit hours of mathematics and mathematics methodology courses; however, the teacher is still required to teach the subject in the school setting.

While teachers benefit from such structure as it lends itself to the development of the academic, social, and emotional needs of the 'whole child, there is the concern that teachers have underdeveloped content knowledge and lack confidence in effectively facilitating core subjects such as science and mathematics due to the curriculum demands of their generalist teacher role (Flückiger et al., 2018). In a study conducted by Mills et al. (2020) the authors found that primary teachers' general approach to the teaching of mathematics did not prove that teachers know how best to teach the subject and recommended that teachers participate in instructional coaching to team- or co-teaching to realize growth in this area. The data suggested that even after participating in teacher preparation courses, teachers would not have the skills to effectively facilitate all subjects. Therefore, teachers must engage in activities that foster growth in their mathematics and PCK.

Another hindrance to pedagogy content knowledge development is ineffective leadership. Teacher knowledge growth and leadership only exist with the principal's support and inspiration through a transformational climate (Li & Lu, 2020). School

leaders set the learning tone for teachers and students (Munna, 2021). In a study exploring how instructional leadership affects teaching efficacy in 50 secondary school principals with 714 teachers in a minority region of Western China, Xiaorong and Russ (2019) found that the instructional leadership approach employed by school leaders not only impacts teacher efficacy but positively impacts the learning climate and sharpened teachers' pedagogical skills. In an inquiry on the teachers' perceptions of principal leadership and teachers' perceptions of school climate in the high school setting, Sanchez (2020) found that school leaders played a crucial role in implementing school improvement efforts such as raising student achievement and building teacher capacity and knowledge base through various initiatives.

School leaders also support teachers' knowledge growth by allocating necessary resources to support the varying initiatives (Ning, 2018). Ning opined that a critical resource principals use to support teacher growth is time. Principals must be deliberate in their practice to set aside time for implementing and sustaining school-wide inclusive practices to impact teacher development. Li (2017) explained that implementing a pedagogical reform is a continuous endeavor if growth among teachers and students is to be realized. Li believed school leaders must use a sense-making lens to ensure resources are allocated to support the desired pedagogical reform.

Teachers' perspectives on their PCK has been identified as another hindrance to MPCK growth (Lai & Lin, 2018). Richardson et al. (2017) found that teacher self-efficacy belief was a strong determinant of future teaching behaviors and desire for further development in a study proposed to develop preservice teachers' PCK and

teaching efficacy beliefs in environmental education. Thomson (2018) saw teachers' perspective on their PCK affecting their knowledge growth in two ways. First, teachers might doubt their ability to teach the subject and dismiss all efforts to develop their pedagogical skills. The second is where the teacher believes their knowledge level is high enough and there is no need for further development. The source magnifies the danger of not having teachers as part of the decisions on approach for their PCK development.

Teachers' self-efficacy belief has been identified as a significant factor influencing PCK development and teaching efficacy (Biasutti & Concina, 2019; Leung, 2020). In a study on teachers' self-efficacy belief for teaching mathematics, Spillane et al. (2018) found that mathematics teachers' beliefs and attitudes influence their planning, instructional decision-making, instructional practices, curricular materials, and pedagogical approaches. The authors also found that these beliefs affect their responses to the need for PCK growth and reform efforts. Similarly, in a study conducted on factors associated with teachers' self-efficacy and outcome expectations for integrating science into teaching in elementary school, Chen et al. (2022) found that teachers' perspective on the importance of science and their ability to teach the subject played a significant role in directly predicting their science teaching outcome expectations and overall teaching efficacy. This evidence indicated that teachers' self-efficacy beliefs influenced their approach to classroom instruction and their attitude to PCK, which is enhanced through these instructions.

Another hindrance to teaching efficacy, as identified by (Stevenson, 2020) is teachers' inability to employ the best teaching methods to facilitate learning in given

subject areas. In a study on PCK and the integration of content knowledge and pedagogical knowledge, Grieser and Hendericks (2018) found that the choice of a pedagogical approach that enables students to understand the underlying concepts and can process shifting knowledge is achieved through sound knowledge of how pedagogical knowledge works in tandem with the body of knowledge of facts, theories, principles, ideas, and vocabulary of the subject. Similarly, Mok and Pak (2022) found that teachers needed help finding the best methods to deliver specific content because their subject matter knowledge needed to be improved, as their knowledge of students' understanding of mathematics concepts and instructional strategies had gaps. The evidence suggests that teachers must develop a sound understanding of each component of MPCK to impact their teaching decisions positively.

Teachers' decisions and actions during classroom interactions are fundamental to mathematics education (Friesen & Kuntze, 2020) and can be conceptualized in several ways (Manizade & Orrill, 2020). Manizade and Orrill (2020) cited some of these ways as teachers' preexisting character traits, mathematics competencies, knowledge and skills, child-centered mathematics activities, and students' achievement in mathematics. With the many approaches being employed to address the gap in teachers' MPCK, the absence of teachers' perspective on these approaches has been identified as a considerable obstacle to teachers' PCK development (Even-Zahav et al., 2022). In examining teacher PD to teacher personal-professional growth, Even-Zahav et al. found that PD sessions in which teachers were actively involved in deciding the content and the approach increased well-being components, including competence, relatedness, autonomy, and aspirations.

Darling-Hammond et al. (2017) identified active learning and the involvement of teachers in their instructional practices and learning as a critical component of structured professional learning that results in changes to teacher knowledge and practices and improvements in student learning outcomes. The authors agree that teachers benefit more from learning structures when they are a part of the decision-making process of designing the activities.

Implications

The literature review provides information on teachers' MPCK and how such knowledge is acquired. It also looks at common barriers to mathematics pedagogical knowledge growth. This information will be used to guide the study as I seek to develop an understanding of Jamaican primary teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics. This study aims to examine Jamaican primary teachers' perspective on MPCK and Grade 6 students' underperformance in mathematics. The focus was on teachers' position on conditions that support MPCK growth and factors that support increased student performance in mathematics. The information gathered could help other principals and teachers identify unique conditions supporting local growth. The identification of varying modes of MPCK acquisition could give school leaders insight into ways that can be explored to suit the unique context. The information provided has implications for the developer of teacher training programs. Features of PD presented could assist school leaders in designing and implementing PD sessions in their institutions. Harris and Hofer (2017) explained that when educators

receive continuous PD centered on a particular focus, they are more likely to develop competence and confidence in using the approach to increase efficacy.

As teachers share other modes of MPCK acquisition, support, and conditions to support student performance in mathematics, other considerations may arise, such as the need to create a tool for feedback on training activities, review the PD cycle, or create budgets to support resource allocation for MPCK growth and creating ‘mathematics friendly environment. Perspectives shared might call for PD to bridge the theory and practice gap. Santagata (2018) explained that steps must be calculated to ensure that theory is associated with the practice due to the theory-practice divide.

Since principals play a critical role in allocating resources to support teacher classroom practice and creating a conducive environment for learning, principals should be able to use data-gathering tools to ascertain the requisite resources needed and source and deploy accordingly (Ning, 2018). Consequently, a possible project is a workshop for principals focused on using feedback to influence the development of PD sessions and creating a supporting budget for resources. Additionally, a teacher workshop using ‘trashables’ to create mathematics learning activities could be convened if teachers perceive the absence of resources hinders their MPCK growth. The study will provide the possibility to offer PD sessions (see Appendix A) for principals to gain competence in using feedback as the foundation for development sessions and the allocation of resources. Additionally, PD sessions will likely be convened to find solutions to identified barriers.

Summary

Teachers have many responsibilities not only for the well-being of their students but also to positively impact their students' performance, given students' consistently low mathematics performance. The research articles presented in the literature review are varied to include qualitative, quantitative, and mixed-method studies relating to teachers' MPCK and students' mathematics performance. The importance of MPCK as a component of teaching for student achievement has been studied by many researchers (Hammack & Ivey, 2017; Richardson et al., 2018; Thomson et al., 2017). Several studies examined the PCK of pre-service and practicing teachers across various disciplines (Chen et al., 2021; Rossum et al., 2018). Many studies also used Shulman's theory as the conceptual framework (Holtsch et al., 2019; Stevenson, 2017; Zolfaghari et al., 2021); however, none examined teachers' perspective on their MPCK. In examining the PCK of prospective mathematics teachers on the subject of limits, Aliustaoğlu and Tuna (2019) found that teaching efficacy is obtained through sound knowledge of students, curriculum, and the context in which learning occurs. Even as stakeholders in education strategize to address this problem, teachers' perspectives on their PCK has been identified as missing. Consequently, this study is timely as it seeks to provide the missing link.

The following section provides a detailed outline of the methodology. It includes information on the research design, approach, participants, access to participants, research site, data collection, data analysis, validity and trustworthiness of the findings, and limitations of the study. The research strategies, reliability and validity measures,

data presentation, ethical considerations, and protection of participants' rights are also outlined.

Section 2: The Methodology

This basic qualitative study aimed to explore primary teachers' perspective on teachers' MPCK and students' underperformance in mathematics. Understanding the phenomenon of MPCK and students' performance in mathematics has been a concern for many decades. There is growing evidence suggesting that teachers' MPCK impacts students' performance in mathematics (Aksu & Stevenson, 2020; Kul, 2019; Park, 2022); however, little is known about teachers' perspectives on such knowledge and students' underperformance in mathematics (Hill & Chin, 2018). In this study, I used Shulman's (1986) PCK theory to ascertain primary teachers' perspectives on MPCK and students' underperformance in mathematics. The results of this study could potentially assist principals in selecting the content for PD sessions, guide policymakers on budgetary allocations, and help teachers employ strategies for professional growth.

This section is organized into different segments to outline the methodology used for the study. The first section outlines the research design and rationale for its use, as well as the research questions and how they are related to the study. A detailed account of the sampling strategy, a justification for the use of the strategy, and the participants are also included. The next section includes discussion of the data collection process, including how permission was obtained and the instrument that was used. Also included are procedures for recruitment, data collection, and analysis, and a description of how issues of trustworthiness and validity of the study were addressed, as well as the role of the researcher. A detailed account of ethical procedures in treating human participants, including Walden's Institutional Review Board (IRB) approval, protecting the

participants' rights and the collection, use, and storage of data, is also presented. Details of the methodology provide clarity on the systematic framework employed to secure the reliability and validity of research results and the replicability of the study procedures.

Research Design and Approach

The conceptual framework and related literature guided the development of the guiding research questions for the study. To explore teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics, the following questions were used:

- RQ1: What are primary teachers' perspectives regarding the value of teachers' MPCK in improving students' performance in mathematics?
- RQ2: What kind of support, knowledge, and skills do teachers feel is essential to experience MPCK growth?

The comprehensive understanding I desired to obtain by exploring teachers' perspective on MPCK and underperformance in mathematics necessitated using an approach that allows for an in-depth investigation of the central phenomenon. For this reason, a qualitative method of investigation, rather than a quantitative approach, was the more suitable paradigm.

With the decision to employ a qualitative approach, several research designs were considered. Among them were case studies, phenomenology, basic qualitative, grounded theory, and ethnography design. Given the purpose for which case studies are used, a case study was one of the first to be examined. Creswell and Creswell (2018) explained that in a case study, the researcher examines a unit extensively to generalize. A case study would require the amalgamation of varying parts of the issue to form an accurate

picture of what is being investigated (Burkholder et al., 2020). The requirement for the use of multiple sources of data was one reason this design was not employed. Data triangulation enhances a case study's validity (Merriam & Tisdell, 2016). Given the purpose of the study, there was no need for a variety of data sources as the answers to the questions were best provided through participants' responses. Thus, a case study design was rejected.

An ethnographic design was also considered. According to Creswell and Creswell (2018), in an ethnography study, participants are observed over a prolonged period, and conclusions are drawn about individual and societal behavior (p. 55). Data for such an ethnographic study are often collected through observations and interviews. An ethnographic study aims to examine shared patterns of behaviors, language, and actions of a cultural group in a natural setting (Creswell & Creswell, 2018). In an ethnographic study, the researcher lives within and participates in the culture rather than just observing or ascertaining perspective (Burkholder et al., 2020). Exploring teachers' perspective on teachers' MPCK and students' performance in mathematics did not necessitate participation in the school district's culture. Perspectives are best provided by teachers with experience providing mathematics instruction to students in Grade 6. For this study, observation of behavior, language, and pattern would need to provide more details of teachers' perspective on MPCK and Grade 6 students' underperformance in mathematics. Hence, an ethnographic design was not used.

I also considered narrative design since the purpose of the study was to examine educators' perspectives through interviews. Narrative research is designed to account for

an individual's lived experience (Creswell & Creswell, 2018). Narrative inquiry supports the representation of first-person accounts of experience told chronologically (Merriam & Tisdell, 2016). The approach does not allow for the experience of individuals to be shared in a manner that provides as many details about the individuals' perspectives. Order is significant in collecting this data as the story must be represented in how it occurs. With this consideration, the narrative design was not employed.

A basic qualitative design was chosen as it allows the researcher to interact with participants in their natural settings to find answers to a complex social phenomenon (Burkholder et al., 2020). Basic qualitative research explores the meaning people have constructed, how people make sense of their world, and the experiences they have in the world (Merriam & Tisdell, 2016). In addition to the design's usefulness in interacting with participants in their settings, basic qualitative research incorporates participants' voices in presenting the findings (Burkholder et al., 2020). Consequently, the basic qualitative study was employed.

Qualitative studies are most suitable when the aim is to ascertain views on a particular topic. These studies focus on the depth of investigation rather than the breadth of coverage (Shaheen & Pradhan, 2019). Fewer participants must thoroughly account for their perspective on the central thought. The focus was on participants who have experienced the phenomenon and can provide a rich account of the encounter; consequently, a purposeful sampling strategy was employed. A qualitative researcher must ensure that the approach taken to recruit participants for the study will ensure the individuals involved are the most suitable to answer the questions (Merriam & Tisdell,

2016). Therefore, qualitative studies can answer questions that could not be provided through observation.

Merriam and Tisdell (2016) explained that qualitative inquiry allows individuals to construct reality by interacting with their social worlds. A small number of participants characterizes a qualitative study and allows for data collection through interviews, which are analyzed through themes (Moser & Korstjens, 2018). The research problem and purpose of the study influence the research questions and data collection methods. Qualitative designs allow researchers to ask open-ended questions and relevant probes to understand the central phenomenon better. In analyzing the data, patterns, and themes are typically identified. A basic qualitative approach is the most appropriate method because of its usefulness in uncovering participants' experiences and views.

The district from which these teachers were recruited had schools rated from "good" to "unsatisfactory" by the NEI (2017), the local body established to determine the success of educational institutions and to offer recommendations for improvements. Some of these schools needed to meet minimum standards in teaching and learning, especially in the core subjects of which mathematics is a part. Consequently, educators from this school district are the most suitable to help ascertain teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics.

Participants

Purposeful sampling is an effective technique in recruiting participants who can best provide answers to the questions posed in a study. Many researchers used purposeful sampling in qualitative studies since participants are usually related to the bounded

system being investigated (Merriam & Tisdell, 2016). Using purposeful sampling also allows the researcher to select participants based on definite characteristics (Creswell & Creswell, 2018). As such, I purposefully selected participants from a particular school district with ratings ranging from "good" to "unsatisfactory" based on the last NEI report. Teachers' perspectives are needed to help understand how MPCK and students' underperformance are viewed in this district.

Criteria for Selecting Participants

Selecting the right participants for a study is a crucial step that requires careful consideration and adherence to specific criteria. Grade 6 teachers of mathematics with at least 5 years teaching experience and who had a minimum qualification of a bachelor's degree were eligible for the study. Teachers also had to be serving in the JPSD. The number of participants was based on the need to reach saturation.

Justification for the Number of Participants

The explorative nature of qualitative research prohibits researchers from studying large numbers of individuals since the focus is on depth rather than coverage. While there are varying views on the number of participants needed for a qualitative study, many qualitative research scholars advise that the number of participants should be at most 12. Patton (2015) explained that saturation could be achieved with two to 10 participants. Creswell and Creswell (2018) recommended that a qualitative study's small sample size allows the researcher to engage and collect rich and thick details about the phenomenon. Gill (2020) explained that since generalizability is not a goal of qualitative research, small size populations are acceptable.

The sample size of a study can ascertained by considering the data analysis plan. For this basic qualitative study, the data analysis plan included data saturation. Creswell and Creswell (2018) explained that saturation in qualitative research occurs when the researcher stops collecting data because new data no longer unearth novel insights. For this reason, the researcher must ensure that the appropriate number of participants is recruited. One to two people would be adequate if this study were a narrative. If it was a grounded theory study, 20–30 would be appropriate, but considering this study is of a basic qualitative design, where in-depth semistructured interviews were used to gain the answer to the research questions, 30 would have been too many, and one or two too few. Therefore, data for the study were collected through individual semistructured interviews with 11 Grade 6 primary teachers in JPSD. The justification for the number of participants was that 10 to 12 primary teachers would be adequate, given the study's timeframe and depth of information needed. A smaller number would not have resulted in saturation, given the number of qualified educators in the school district.

Access to Participants

As soon as IRB permission was granted to begin the study, I initiated contact by emailing colleague principals using the district's directory. Principals were asked to assist in recruiting individuals who satisfy the criteria to participate in the study. The purpose of the study, participant's role, contact details, and the voluntary nature of the study were presented on a brochure used in the recruitment process. As soon as participants were agreed on, I contacted them to provide information on how they would participate in the study.

Researcher–Participant Working Relationship

Establishing the researcher–participant relationship is important in assuring the quality of the study. Despite my involvement in several workshops across school districts, I was not familiar with any of the participants in this particular school district. As the researcher in this study, my role as the interviewer made me the primary data collection instrument. The researcher is the primary instrument for data collection and analysis in a qualitative study since data has to be filtered through that individual's particular theoretical position and biases (Merriam & Tisdell, 2016). Consequently, establishing the researcher–participant relationship can help to identify and eliminate biases before the beginning of the data collection process.

Qualitative researchers play an interpretive role in ensuring that perspectives are accurately captured and correctly describe the contextual components of the research findings (Creswell & Creswell, 2018). My role as the researcher in this study was to gather and analyze data to acquire new knowledge that could further assist the academic community in employing strategies that teachers identified as supportive of their MPCK growth. Since the quality of the study is influenced by the researcher's action, the researcher must ensure their responsibility as the study's designer, data collector, analyst, and presenter of information is done with much diligence (Yin, 2014). Additionally, the researcher must become involved with the study's setting and participants (Creswell & Poth, 2018).

Methods for Ethical Protection and Human Subject

In March 2023, I completed the Collaborative Institutional Training Initiative, which expanded my knowledge base on ethical principles to follow when conducting my research. I used a semistructured interview protocol (see Appendix B) and a script to ensure consistency with all the interviewees. All participants were asked the same in the same language to prevent bias. Some direct steps were taken to ensure the study was conducted ethically, that responses were kept confidential, and that participants' privacy and rights were respected. I used a password-protected computer and a handwritten journal to record transcripts and summaries from each interview. Hard copies of the materials used were kept in a locked cabinet at home, which only I can access. Participants' information and responses will be securely kept for 5 years, after which all data and audio recordings gathered during the research process will be destroyed by file deletion and shredding as per Walden University's requirements to dispose of data.

Data Collection

Data collection in a study is critical as this aspect determines the degree to which the research questions will be answered. Gathering good data is the primary focus of a qualitative study (Merriam & Tisdell, 2016). Acquiring quality data depends on the interviewer asking well-chosen open-ended questions, appropriate probes, and requests for more details. The primary data collection instrument in this study was interviews. An interview protocol is the most appropriate tool to collect data about participants' perspectives and lived experiences (Creswell & Creswell, 2018). Observing participants or viewing archival records would not have provided the quality and depth of data

needed. Surveys would not have been ideal since the focus was more on gathering depth of information rather than capturing the views of many participants. For this study, the sample size was 11. Burkholder et al. (2020) explained that to achieve saturation, the data gathered must be sufficient to answer the research question. In addition, Burkholder et al. also suggested that, since it would be difficult to predict the number of people to be interviewed to attain saturation, there should be an estimate of the expected number of hours of recorded transcripts. Examining other studies with similar designs and focus is also critical in determining the sufficiency of the data collection instrument (Samuels, 2022). Interviews were employed to record participants' experience and answer questions relating to teachers' MPCK and students' underperformance in mathematics.

Interviews suffice for gathering the necessary detailed information about teachers' perspectives on MPCK. This instrument captures rich information from participants, including the text of responses, vocal tone, and inflection (Burkholder et al., 2020). Burkholder et al. (2020) explained that although interviews are used to triangulate data in some studies, interviews are adequate in providing the essence of participants' shared experiences. A focus group interview was considered but eliminated as the aim is to make participants as comfortable and open as possible when speaking about the topic (Guest et al., 2017). Consequently, individual interviews were conducted to allow participants to feel comfortable expressing their views.

Interviews provide the best opportunity to better understand primary teachers' perceptions, experiences, and beliefs regarding their MPCK and Grade 6 students' underperformance in mathematics. Use of interviews in this qualitative study is justified

since it allows for the deep exploration of a central phenomenon (Burkholder et al., 2020). An interview protocol was developed using other published teachers' interviews as a guide (Hastings, 2022; Peters-George, 2021). Researchers examined teachers' perspectives on issues that impact their practice. The scope of questions included perspective on the value of teachers' MPCK to students' performance, support, knowledge, and skills required for MPCK growth. Questions included reflect the MPCK conceptual framework of this study.

Questions utilized in this study were deemed appropriate as they are aligned with the study's research questions and MPCK framework. Other clarifying questions were developed based on participants' responses as the interviews progressed. The purpose of the research was presented in the initial stage of the interview process (see Appendix B). Open-ended questions followed, soliciting answers to questions about teachers' perspective on MPCK, support required to experience MPCK, and students' underperformance in mathematics. Section three of the interview protocol asked participants to provide any additional information that could help provide clarity on the subject. In concluding the interview, participants were reminded about how the data will be used and the mediums through which I may be contacted.

The selection of participants for the study is considered a critical component of the process. A random sampling technique was not considered as there was a need to ensure potential participants satisfied the requirements needed to meet the study's needs. Convenience sampling was also not employed as the researcher needed participants who could answer the central questions rather than participants' involvement based on their

accessibility and convenience (Creswell & Creswell, 2018). Considering the desire to identify the most suitable participants to answer the questions rather than availability, convenience sampling was not used. The specific focus in the interview stage was on Grade 6 teachers who teach mathematics to 10- to 12-year-olds. Grade 6 teachers were chosen as at this level, teachers' job functions include equipping students with the requisite mathematics skills to demonstrate proficiency in the exit assessment, Primary Exit Profile.

Procedures for Gaining Access to Participants

In a qualitative study, investigators want to discover, understand, and gain insight and, therefore must select a sample from which the most can be learned (Merriam & Tisdell, 2016). I employed a purposeful sampling technique to ensure the individuals selected were the most suitable to answer the research questions. Purposeful sampling ensures that the study participants possess the qualification to address the questions posed (Creswell & Creswell, 2018). Permission was sought from the principals of the schools in the district to conduct the study upon receipt of approval from Walden University's IRB. These measures ensured that the right participants were selected and that actions taken were in alignment with the qualitative approach and the approved actions proposed.

I was deliberate in ensuring the actions undertaken were those outlined in the plan. Before contacting possible participants, I sought permission to conduct the study from Walden University IRB, evidenced by the approved study number 03-13-23-1041744. After gaining approval, I emailed colleague principals using the contact list provided by the district office. Principals' assistance was solicited to assist in recruiting

potential participants. As part of the introductory process, a brochure was attached outlining my professional education history. Additionally, I expressed my intention to undertake this particular study and critical aspects of the study, such as the title, background, purpose, and methodology. The voluntary nature of the study was shared with prospective participants, as well as the steps that were taken to secure confidentiality. Invited participants were all teachers of Grade 6 who have been teaching mathematics at this grade level for the past 5 years with the minimum qualification of a bachelor's degree. Participants were informed of the purposeful sampling criteria.

Each confirmed participant was then contacted by telephone or email to agree on the details of the Zoom meeting. Using the Zoom virtual meeting platform allowed me to observe intonations throughout the interview (Archibald et al., 2019). Having met the stated criteria, potential participants were formally informed of the purpose of the study and then asked to volunteer to participate. A voluntary agreement to participate in the project study was then emailed and verified through consent forms. Once consent forms were discussed, teachers were asked to read the consent form for themselves again and then respond to the email with the statement: "I consent." Participants' detail (alpha-numeric code) was recorded in the order they consented to participate in the study. The consent form that provided the necessary information about the study protects both the researcher and participants. Creswell and Creswell (2018) described the consent form as a critical document containing a standard set of elements that acknowledges protection. It also allows the participants to indicate their agreement with the provisions of the study before providing data.

The recruitment process lasted for three weeks. Considering the data collection process began in April when the Primary Exit Profile Curriculum-Based Tests were administered, most participants asked that the interviews be done after this period to allow them the time to prepare their students for the terminal assessments. As soon as the meeting logistics were decided on, I sent each participant the Zoom invite. Participants could decide where they wanted to do the interview provided the environment was conducive; however, all selected times after 5 p.m. so interviews could be done from the confines of their homes. Two participants were rescheduled due to personal emergencies and participated a few days later. Interviews took 4 weeks to be completed; May 6–May 31, 2023. All protocols established and approved in the proposal were observed in the data collection process. With participants' permission, interviews were audio-recorded on Zoom and saved on a password-protected computer in my home office.

To begin each interview, I expressed gratitude to participants for agreeing to participate in the study, reviewed the purpose of the study, the voluntary nature of their participation, research questions, and their right to withdraw from this study at any time during the interview process. Participants were asked questions based on the research questions (see Appendix B). I kept a reflective journal to document my thoughts and record reflexivity during and after each interview. Each interview ended with an expression of gratitude to the participants for their contribution to my study and the member checking process, where a summary of the study's findings will be sent for review.

At the end of each interview, I transcribed the responses from the recordings. Even though audio recording was done, word dictation was also taken during the interviews to help transcribe each interview. To initiate the transcription process, I listened to each recording and read the word dictation for accuracy. While checking for accuracy, I made corrections based on evidence from the transcripts. Transcriptions of all interviews lasted three weeks. Audio-recordings and transcripts were saved in a file on a password protected computer, and all printed and written documents stored in a security enabled filing cabinet at my home office.

Role of the Researcher

Qualitative researchers play an interpretive role in ensuring that perspectives and contextual components of the research findings are accurately captured and described (Creswell & Creswell, 2018). In a qualitative study, the researcher plays several critical roles. These include the study's designer, the data collector, the data analyst, and the presenter of information (Yin, 2014). The research site in this study is a school district in Jamaica. My role as the researcher was to recruit participants within the school district. Participants were purposefully selected and, upon gaining consent to proceed, were engaged in semistructured interviews, which were audio-recorded. I later engaged in the analysis of data and interpretation of findings. Another critical role I played throughout the data collection and analysis process was to ensure participants' rights were protected and to employ strategies to ensure the study was trustworthy.

I currently serve as principal in a K1-6 primary school in a school district in Jamaica. Considering my nearly two decades of experience teaching in a primary school

and my experience marking mathematics at the national level, I frequently conduct workshops and seminars with teachers in various school districts. None of these districts or teachers I supervise were considered for this study. Merriam and Tisdell (2016) explained that trustworthiness is tied directly to those who provide and collect the data and their demonstrated competence. Establishing the researchers' role in the study was very important.

Setting

The setting in a study details the context and environment within which research takes place, influencing various aspects of the research process and outcomes. Participants for this study were primary teachers teaching at the Grade 6 level in a school district in Jamaica. All participants had a minimum qualification of a bachelor's degree and were teaching mathematics at the Grade 6 level for at least 5 years. A total of 11 participants were interviewed concerning their perspective on teachers MPCK and Grade 6 students' underperformance in mathematics.

The district in which the study was done has 13 primary schools and one high school. Primary schools in the district were rated from 'good' to 'unsatisfactory.' None of the schools were rated as 'exceptional' in teaching and learning, which is the highest rating for a school to attain. Participants were recruited from a mixture of schools rated as good, satisfactory, and unsatisfactory. A total of 11 participants contributed to the study. Three participants, even though they were Grade 6 teachers, held supervisory positions. Of the 11 participants, nine were females and two males. Nine participants held a bachelor's degree, while two held a master's degree. Participants' teaching experience

span from 5 to 20 years. Demographic information on each participant is listed in Table 2. Personal or organizational connections did not influence the participants' perspectives at the time of the study.

Table 2

Demographics of Research Participants

Participants	Years of experience	Level of education
1	10–15	MA
2	10–15	BA
3	10–15	BA
4	10–15	BA
5	5–10	MA
6	10–15	BA
7	15–20	BA
8	10–15	BA
9	15–20	BA
10	5–10	BA
11	15–20	BA

Note. Each participant had at least 5 years' experience teaching at the Grade 6 level and the minimum of a bachelor's degree.

Data Analysis

Data analysis assisted me in organizing and transforming raw data received from participants into research findings (Bloomberg & Volpe, 2018). In qualitative studies, data analysis follows some sequential steps from specific to general and involves numerous levels of analysis (Creswell, 2017). These sequential steps form an intricate process that consolidates, reduces, and interprets the data the researcher has gathered and reads into a meaningful report (Merriam & Tisdell, 2016). Through rigorous data analysis processes, qualitative researchers gain deeper understanding of complex phenomena and

advance insights. The recommendation is that qualitative researchers engage in ongoing data analysis for effective streamlining of these data (Miles et al., 2014). Consequently, data gathered was analyzed by merging, reducing, and decoding the data. Comparative technique was employed while utilizing the following key steps:

- methodical examination of data
- systematic search for codes
- examination and refinement of codes
- exploration for relationships among open coded to group and form axial codes
- examination of axial codes to arrive at themes
- abridging and integrating data into a clear understanding of the central phenomenon

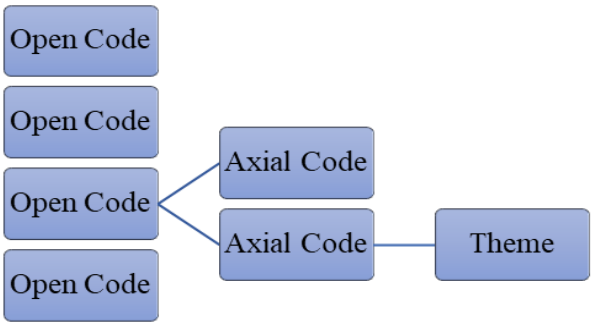
Merriam and Tisdell (2016) explained that data analysis is inductively derived from data collected through interviews. In embracing the foregoing, I analyzed the data simultaneously with data collection. Interviews audio-recorded on Zoom platform were transcribed using Hyper Research then proofread for transcription inaccuracies. This software allows for coding using themes, data management, and systematic analysis, which enables the researcher to create and compare matrices and mapping categories (Creswell, 2015). The iterative nature of the process allowed me to develop a greater appreciation for data in the field of education.

At the end of the interview, I listened to the recordings and read through the completed transcripts before sending them back to the participants for member checking. Each participant was provided a transcript of their interview to review for accuracy and

make corrections where necessary. All except one of the 11 participants accepted the transcript as presented. One participant elaborated on what the statement meant that "teachers are doing all that they are supposed to do where the teaching of mathematics is concerned." Based on the review given, I made the changes as recommended. Transcripts were later saved on a password-protected computer in my home office. Alphanumeric identifiers were used to protect the identity of each participant, after which responses were emailed to each participant. Open coding was used to examine and classify data into themes of primary teachers' perspectives on teachers' MPCK and Grade 6 students' underperformance in mathematics. Figure 2 shows the relationship of the open code with the axial code and the themes developed.

Figure 2

Data Analysis Structure Showing Coding Process



Note. This figure displays the process of analyzing qualitative data from the point where open codes are condensed to generate the axial codes and axial codes further condensed to form broad themes.

The purpose of this basic qualitative study was to explore Jamaican primary teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics. It is important to understand teachers' perspectives on MPCK to inform

policies for in-service development and provide the requisite support to expand teachers' MPCK growth. Exploring teachers' perspectives on MPCK and students' underperformance in mathematics can enhance the conversation about developing PCK for efficacy in mathematics instruction (Hill & Chin, 2018). The following research questions guided the study:

- RQ1: What are primary teachers' perspectives regarding the value of teachers' MPCK in improving students' performance in mathematics?
- RQ2: What kind of support, knowledge, and skills do teachers feel is essential to experience MPCK growth?

I collected data by conducting semistructured open-ended interviews with 11 Grade 6 teachers to address the research questions. Earlier in this study, I discussed the research's problem, purpose, conceptual framework, and research questions. I also included a literature review which provided evidence of the role of MPCK in teaching and learning. These components of the study are important in understanding the need for this study.

To begin the data collection process, I explored primary teachers' perspective on MPCK and Grade 6 students' underperformance in mathematics in a school district in Jamaica. All participants were asked identical open-ended questions in the interview process. Audio recordings from interviews were transcribed using Microsoft Word 365. The data analysis began with the transcription of 11 interviews using the Hyper Transcribe software. To increase my familiarity with the data, I listened to the audio recordings and read each transcription numerous times. I conducted a line-by-line review

of transcripts to identify codes to label and summarize chunks of the data. After getting familiar with the contents of the data, initial codes were generated in the second step to capture the critical features within the data. These codes were the recurring patterns in the data developed during this familiarization process.

Open Codes

Merriam and Tisdell (2016) explained that in the open coding phase of the analysis, the researcher can be as expansive as they want in identifying any segment of data that might be useful. Merriam and Tisdell added that the researcher is open to anything possible in open coding. Saldaña (2016) explained that in open coding, which is referred to as initial coding, the researcher breaks down data into discrete parts, closely examining them and comparing them for similarities and differences. Merriam and Tisdell (2016) added that in open coding, the researcher captures any data with a word or phrase that seems to be responsive to the research questions, sometimes resulting in repetition of the exact word or phrase used by the respondent. In breaking down the data and comparing for similarities, I identified analytic leads for further exploration, forming the open or first cycle coding. After the first cycle of coding, I followed Saldana's (2016) advice and began to identify segments of data that might be useful and looked for repetitions, groups, and patterns in the data (Saldaña, 2016).

Axial Coding

After identifying codes to label and summarize chunks of data, I revisited each transcript to reflect, refine, and revise the identified codes. Satisfied I had accurate descriptive words assigned to chunks of data from the transcripts called open codes, I

began to group these codes. Saldaña (2016) explained that axial coding describes a category's properties and dimensions and explores the relationship between the categories and subcategories. As I searched for commonalities and discrepancies, themes emerged within the data. Axial codes that emerged from open codes were: *teacher morale, teaching efficacy, students' performance, stakeholder support, learning resources support, subject matter knowledge, pedagogical content knowledge, collaboration in professional groups, PD sessions, exploration in the classroom, and mathematics content materials.* Journaling and memos were used to reflect on the coding process and to consider relationships among categories and themes. Table 3 lists the axial codes from which themes were developed.

Table 3

Axial Codes and Themes

Axial codes	Theme
Teaching morale Teaching efficacy Students' performance	The role of MPCK in teaching and learning
Stakeholder support Learning resources support	Support needed for MPCK growth
Subject matter knowledge Pedagogy content knowledge	Categories of understanding and skills needed for MPCK growth
Collaboration in professional groups PD sessions Exploration in the classroom Mathematics content materials	MPCK acquisition

Note. Axial codes and themes from the data analysis.

Evidence of Quality

Trustworthiness is a critical component of a qualitative study, as it relates to the credibility and reliability of the findings and interpretations produced through qualitative methods. Ensuring trustworthiness is essential to demonstrate the rigor and validity of the research. Burkholder et al. (2020) explained that trustworthiness is the degree to which one can have confidence in the sources and methods used to gather the sources. Credibility, transferability, dependability, and confirmability are key components of trustworthiness. These measures ensure findings are free from biases and accurately represent participants' perspectives and experiences. Steps taken to secure trustworthiness are detailed below.

Credibility

Credibility in qualitative research is important in building trust in the validity and reliability of the study. Burkholder et al. (2020) explained that credibility in a study means that the study's findings are believable given the data presented. One-on-one interviews were the first step taken to ensure credibility. Interviews allowed participants to share their perspectives and provide necessary follow-up responses to ensure the topic was fully ventilated. Prolonged engagement facilitated in the one-on-one interview provided sufficient time in the research context to gain a deep understanding of the subject matter. I also used member checking to confirm the legitimacy of findings by allowing participants to review the findings which limited any form of biases. I also did a thorough review of the findings to ensure my interpretation accurately reflected participants' perspectives. Reflective journaling used to record my biases and the detailed

description of participants' demographics are also measures to realize credibility. By employing these strategies and criteria credibility was established.

Transferability

Applicability of research findings beyond the specific context in which the research was conducted increases the trustworthiness of a study and is referred to as transferability. Transferability refers to how the study's findings are transferred to other situations (Merriam & Tisdell, 2016). Acknowledgment of the uniqueness of this particular study and its potential to offer valuable insights and ideas that may resonate with and inform other contexts or situations is an important consideration. To secure transferability, I present a detailed description of the participants, site, and methods used in the study. Direct quotes and coding examples of the data analysis can also help users of the study decide on the study's applicability. Merriam and Tisdell (2016) expressed that transferability is achieved when a user not in the research can identify and visualize what is being read. The transferability of the researcher is determined by its reader.

Dependability

Consistency in results is featured in a study concerned with trustworthiness. Dependability refers to consistency in data collection, analysis, and reporting (Burkholder et al., 2020). Rigorous and well-documented processes were followed throughout this study to ensure findings can be replicated and trusted by others in the scientific community. One way this was done was through reflexive journaling. I used reflective journaling to manage my biases to ensure questions were identical and remained the same for all participants. I ensured interview questions were consistent and aligned with the

research questions. Direct quotes used were also a measure to ensure what was conveyed in the analysis was true representations of participants' perspectives. Member checking was also used to address the accuracy of the reported findings based on participant's perspectives.

Confirmability

There is evidence of confirmability in research if other informed researchers arrive at the same conclusions when examining the same data set. Ravitch and Carl (2016) explained that confirmability refers to the objective view of the researcher and whether the study is established on the procedure of data collection or influenced by the biases and knowledge of the researcher. To establish confirmability, I detailed the research process and recorded the interviews. Additionally, journaling was used to detail my reflections and assumptions. The summary of findings made available to participants to check for accuracy also ensured confirmability. Identifying my role in the study and accurately documenting the research process through journaling and audit trail are deliberate actions I employed to secure confirmability. Journaling, identifying my role in the study, and audit trails ensured I maintained rigor, transparency, and neutrality in the research process to ensure that findings were firmly grounded in the data.

Discrepant Cases

The data collected provides depth of knowledge for the study. Discrepant cases will sometimes emerge in the collection and analysis of data. Discrepant data disconfirm expected results (Miles et al., 2014). According to Miles et al., researchers should refine findings by pursuing discrepant data and conducting further investigation. Follow-up

member checks were conducted to discover credible explanations for discrepancies. Member checking helped prevent bias, strengthen the results, and improve the study's credibility (Miles et al., 2014). There was no discrepant data from the perspective on teachers.

Limitations

Researchers often have little control over the study's limitations; discussing these confinements allows readers to identify possible research directions (Creswell & Poth, 2016). Limitations that emerged from this qualitative research study were teachers' qualifications and location. The minimum criteria for teachers in a primary school is a bachelor's degree; however, there are teachers with many years teaching experience whose highest qualification is a diploma or an associate degree, so the results may only represent some Grade 6 mathematics teachers. The school district in which the study was done is a rural district; hence, results may not represent the perspectives on teachers in suburban and urban districts.

The basic qualitative approach taken and the researcher as the primary data collection instrument can lead to researcher bias. Thomas (2017) recommended that researchers view how their biases may influence or interpret the study. To reduce bias, I kept a reflective journal to document activities relating to the process. Member checking was also used, where a summary of findings was sent to confirm the veracity of findings with participants' responses. Reducing bias in research is an ongoing process that can be achieved through reflexivity.

Data Analysis Results

In this study, I explored primary teachers' perspective on MPCK and Grade 6 students' underperformance in mathematics. Eleven participants responded to the open-ended questions used to collect data. In this section, I discuss the study's results by presenting the themes that emerged from the data. The themes that emerged supported the focus of the study and research question RQ 1: What are primary teachers' perspectives regarding the value of teachers' MPCK in improving students' performance in mathematics? and RQ2: What kind of support, knowledge, and skills do teachers feel is essential to experience MPCK growth? The axial codes and themes that emerged were (see table 2): the value to teachers' MPCK to teaching and learning, stakeholder and learning resources support needed to realize MPCK growth, kinds of understanding and skills needed for MPCK growth, and MPCK acquisition.

The role of MPCK in teaching and learning emerged as a theme from responses to the question regarding the value of teachers' MPCK in improving students' performance in mathematics. Participants shared valuable insights on how teachers understand and can effectively teach mathematical concepts. To answer the second research question that addresses teachers' perspectives on the kind of support, knowledge, and skills teachers feel are essential to experience MPCK growth, participants shared factors impacting the teaching and learning of mathematics. Three themes emerged from the responses. They are: (a) stakeholder and learning resources support for MPCK growth; (b) categories of understanding and skills needed for MPCK growth; (c) MPCK acquisition. The themes that emerged foster a deeper understanding of the central phenomenon.

Theme 1: The Value of Teachers' MPCK to Teaching and Students' Learning

Teachers provided detailed accounts of the value of teachers' MPCK to teachers and students. All eleven participants noted that teachers' MPCK is crucial in guiding instructional decisions and fostering students' learning. Values identified included teaching morale, teaching efficacy, and student performance. Most participants view teachers' MPCK as the leading guide to the professional decisions taken about instructional delivery. The following document is the values participants presented.

Teaching Morale

Some participants noted that sound MPCK gives teachers a certain level of confidence and comfort when presenting mathematics instruction which heightens their teaching morale. P-6 stated, "If it is that you are not comfortable with the content that you are trying to deliver there's no way you are going to present that content confident enough to and this is going to affect your teaching morale." A similar view was shared by P-4 who expressed, "I know that as teachers we want to have that level of enthusiasm and interest in teaching, and this is what good MCK gives." P-11 shared, "Some teachers do not have knowledge of how best to teach mathematics and I often wonder, do they know the mathematics content enough to confidently take themselves out of the picture." P-1 opined, "PD sessions could help some of these teachers who genuinely do not know how to teach mathematics and have a desire to learn." P-9 believes "it is this high level of MPCK that will give the teacher the confidence to teach knowing that what is presented can stand up to scrutiny." P-7 expressed, "when there are gaps in teachers' MPCK, the teacher is afraid to make the classroom a laboratory as she is afraid exploration will cause

students to pose questions she cannot answer." In commenting on the value that teachers' MPCK present in offering mathematics instruction, P-11 relayed the following scenario: "A teacher gave a class the sum 17 + 200 + 36 + 119 and explained that the number must be arranged in descending order with the biggest number at the top before they begin to find the sum." The participant explained how teachers' confidence was destroyed upon realizing that a child who did not arrange it in the order she explained but instead used her own method still got the sum correct. I note that this teacher has now become so book oriented. She hardly facilitates discussion in her class, and I know this has to do with how she sees herself as a teacher.

The scenario supports the point posited by Aksu and Kul (2019) that limited MPCK negatively impacts teachers' self-efficacy beliefs. P-7, P-9, and P-10 all agreed that increased MPCK will increase teachers' interest and enthusiasm in teaching mathematics.

Teaching Efficacy

Several participants identified accuracy in teaching concepts as a value that good MPCK offers. P-2 shared, "If nowhere else, teachers at the primary grades need adequate content knowledge to ensure the correct content is being presented to students." In agreeing, P-1 explained, "Primary school teachers have the awesome task of laying a solid mathematical foundation by teaching the correct foundational skills students will need later." P-7 added that "Gaps in teachers' knowledge of how to teach mathematics can cause the teacher to pass on wrong concept to students." P-2 shared "learning correct concepts in mathematics at the foundational level is so important as it can ultimately

determine the career path students take." Comments such as this one presented by P-4 gives the perception that gaps in teachers' MPCK negatively impact students' progress in mathematics. P-4 explained,

> Much effort is needed to ensure students understand the basic of mathematics from the foundation grades so this can be built on in upper grades but if the teachers do not have the knowledge how can they share it with students?

Some participants attribute teachers' ability to go in depth in mathematics concepts to foster understanding as a component of teaching efficacy. P-4 believed "teachers cannot explore a topic to certain kinds of levels if we do not understand the concept ourselves." P-5 explained that "it is teachers' MPCK that will allow them to create opportunities for students to explore ways to solve mathematical problems instead of telling students what to do. P-2 added, "teachers with sound MPCK facilitates student centered learning where students are given opportunity to make mistakes in trying to get a sum correct. P-8, expressed a similar thought in commenting, "when the teacher has sound MPCK she presents content through many media knowing whichever route is taken the response will be correct." In agreeing that MPCK enable teachers to provide depth of knowledge for student in mathematics, P-9 explained that "teachers who have MPCK deficiencies remain bound to sources and divorce themselves from the process."

Four participants reported that teachers' MPCK is important in helping them make instructional decisions such as use of particular teaching strategies. P-2 expressed, "What I find is that the teaching of mathematics is not a one-size-fits-all. So, you have to constantly be thinking of how it is that you are going to get the particular topic across to

the students." P-3 added, "If you do not have this knowledge, you will not even know what to think about." P-7 articulated, "No number of years at teachers' college can tell you the teaching strategies to use at all times in the teaching experience. It is your experience and knowledge that will help you decide which will work." P-11 suggested, "with the thousands of theories out there and more emerging daily on how instruction is best provided, teachers have to have that awareness of which will work for their students at a particular time and why."

About MPCK teaching self-efficacy, some participants hinted that teaching efficacy is not only concerned with the cognitive aspect. Three participants identified non-cognitive awareness such as classroom arrangement, use of motivation and rewards and how behavior is managed as teachers' actions that contribute to students' success. P-2 shared "I utilize a lot of group activities and I find that especially the boys they really like this, and they are competitive." P-9 shared there is much more knowledge that supports students' learning than the number, measurement, the use of manipulatives and praise and rewards cannot be ignored." P-6 communicated, "I make everything in the classroom related to mathematics. For example, even in sending them outside I might say make a vertical line or a horizontal line or do not spend more than 5-minutes. All of this is mathematics."

Students' Performance

All participants agreed that teachers' MPCK determine the success or failure of their students. P-1 explained "Having a good grasp of certain concepts and content in the mathematics curriculum is indeed important. Teachers should have strong knowledge in

that area or else we are going to have poor mathematics students." P-5 lamented "sometimes teachers' knowledge of how to teach mathematics is so weak. They do not understand how and what to do, therefore there is no knowledge going to these students." P-9 shared "I have had the unfortunate experience of watching teachers presenting incorrect content to students and in one case the student had to correct the teacher. A similar view was expressed by P-10 who said "as a Grade 6 mathematics teacher and supervisor of some classes I have had instances where I have to take over mathematics lessons because of the injustice being done in the lesson delivery. P-7 perceived that "Gaps in teachers' knowledge of how to teach mathematics can affect students' ability to do well in mathematics." In agreeing with the other participants, P-10 shared "teachers' MPCK can either support or ruin their mathematics capabilities."

In sharing the value of MPCK to student success, some participants see catering to the needs of diverse learners and different learning styles as a component of high teaching knowledge. P-3 voiced, "Teachers' MPCK should lead them to employ appropriate strategies to cater to the unique needs of learners, so they attain the level they ought to in mathematics." P-7 illustrated "even though we are adults we have a particular way that makes the information meaningful to us. Same with students so teachers must be aware of these styles that make learning impactful." P-10 explained that teachers must be knowledgeable of how to make learning practical and presented this scenario:

> When we were doing kilometer I didn't just tell students from which point to which would be a kilometer. I drove to find out where a kilometer started and where it ended and then had the students walk a kilometer. When we got back to

> school, we were tired but now students got a true picture of what walking a kilometer feels like. Based on how they knew what a kilometer looks like and feel like they were able to now tell where they are living from school whether it was more or less than a kilometer. They were also able to say who could walk to school and who needed to take a taxi based on the number of kilometers from school to their homes. So, as I said, it has to be practical.

All participants agree that teachers' MPCK influence how they teach and how students learn.

Theme 2: Support Needed for MPCK Growth

All participants noted that different categories of support were needed for teachers to realize MPCK growth. They purported support for the growth of MPCK is crucial for educators to effectively teach mathematics concepts and skills to their students. To answer the second research question that relates to the support, knowledge and skills teachers feel is important to their MPCK growth, three themes emerged: human, organizational, and material support, components of understanding and skills for MPCK growth and MPCK acquisition. Support from school leaders, parents, and learning resources such as manipulatives and access to the internet were identified as critical support mechanisms for expanded understanding of MPCK as important to their growth.

Stakeholder Support

Several participants identified support given by school leaders and supervisors as important to their MPCK growth. P-1 emphasized, "Teachers need support from administrators and their supervisors." P-8 believe "the onus is on supervisors to ensure

skills such as lesson planning and instructional delivery is developed whether through workshops, coaching sessions or other creative means." Similarly, P-11 illustrated, "let us say that I am an administrator of a school where mathematics is an area of deficiency and that is understood, it will be my duty to ensure that teachers understand and are comfortable with the content before it is presented." P-4 also expressed "administrators have a role to help their staff to keep up with current changes and to improve on their abilities and capabilities of teaching." Likewise, P-7 shared "Administrators play a key role in identifying gaps and taking a targeted approach to addressing these gaps." P-8 revealed "I know of cases where principals are reluctant to release teachers for PD sessions, in some cases common planning time is not even on the school's timetable. How do they expect teachers' MPCK to grow?" P-7 painted the following scenario: If I know I have a problem driving at night, but part of my daily routine causes me to be on the road at night, I must either overcome my fears or get someone to drive me. Same if school leaders cannot help teachers develop mathematics competencies they can host PD sessions and invite experts to share."

Four participants expressed that support to teachers' MPCK growth is given through school wide programs and plans. P-5 expressed that "From a school level, clubs and societies could be established to give teachers the platform to show the applicability of mathematics to real life and this forces teachers to search for creative ideas to implement at the school level." P-1 gave examples of school-wide activities such as OMG day (Oh Math's is great) Mathematics Bag Day, Wear a Mathematics Day and Mathematics Coronation Day and how these activities force teachers to come up with

other creative activities. P-3 shared "We have common planning time where teachers look at progression in the curriculum and this is held every week, and this is supported from a school level it is on the timetable." P-10 shared, "when gaps are identified in teachers' MPCK this is where PD sessions and common planning comes in very useful. In these sessions lesson demonstrations are done and misconceptions clarified." Participants all agreed that the actions put in place to get an entire institution to focus on the need to improve mathematics support their MPCK growth.

Support from parents was also identified as a contributor to teachers' MPCK growth. P-10 believed "if parents understand the concepts and can help their children this reduces the amount of time teacher spend reviewing concepts already taught allowing them to focus more on their PD." P-3 agreed by saying,

> For example parents are in the kitchen cooking, they can allow the children to help measure the flour and water… Those rich conversations help students to develop critical thinking skills and will cause students to pose questions to teachers that force them to do further research.

P-1 also believed "parents play a key role in students' overall academic development and can help teachers broaden their knowledge base on how to teach mathematics." P-1 also shared,

> Parents can go to school and assist teachers where necessary even by sharing strategies they use at home with their children that prove useful. This could reduce the time teachers spend trying to identify learning styles and focus on other aspects of development.

Learning Resources Support

A third support identified by all eleven participants is that regarding learning resources. P-2 and P-3 noted "If teachers do not have the resources needed for delivery, it's going to affect their efficacy. P-5 believed "teachers need more resources, manipulatives and technology, anything that can be used to improve efficacy in teaching the subject." When sharing on the support teachers need to realize MPCK growth, P-11 expressed, "Another thing that hampers teachers' MPCK growth is lack of resources. Sometimes teachers would want to research on particular strategies that are used to teach certain concepts and there is no some cases not even access to the internet." P-7 added, "A lot of times teachers do not have the resources and sometimes this frustrates the teacher …. So the lesson turns out to be something of a chalk and chalk or maybe just doing some random activities." P-6 noted "Learning resources are important for students as teaching resources are important for teachers' own development."

Theme 3: Categories of Understanding Needed for MPCK Growth

At least seven of the 11 participants shared teachers must understand key components of teaching methodology, subject matter, and diverse learners to realize MPCK growth. P-10 shared, "Sound MPCK knowledge means that the teacher is competent in different domains of knowledge." P-6 noted, "A teacher can know mathematics content in terms of the content strands but is very poor at classroom management and this cause to the teacher to be ineffective." P-2 also noted that "Teachers' must have the right balance of the branches of knowledge and be able to apply them." P-5, P-9, and P-11 explained, "Teachers must have good knowledge of the

mathematics to be able to teach it effectively." P-1 opined, "It is the body of MCK that will help teacher realize growth in mathematics teaching." The participants' responses suggest that all domains of MPCK knowledge must be fully developed for a teacher to be considered as having adequate MPCK.

Pedagogical Content Knowledge

Some participants identify teaching methodology as an important kind of understanding that expands MPCK. P-3 expressed, "Teachers will have to continuously seek ways to master the art of teaching especially a subject like mathematics and ensure we are very knowledgeable of best practices in mathematics instruction." P-11 shared, "Teachers have to be very knowledgeable of their instructional practice and constantly ask themselves did this strategy work with these students even though they know it worked for a particular cohort." P-10 believed "Teachers' ability to employ appropriate strategies and cater to the unique needs of learners …. Comes about through adequate knowledge of how best to teach mathematics." P-5 and P-6 believed that teachers' awareness of effective teaching strategies can positively change students' view of mathematics while P-2 believed "teachers' instructional choices set the tone for the class." P-4 shared how the child centered approach she employed enabled her to realize knowledge growth. Students were provided with the opportunity to share, and they shared a method such as the lattice method she was not familiar with, and she had to go and do further research. P-9 added,

> Many books have been provided; therefore, teachers have been using the content from the books, but I believe that if a student can read then we don't need to teach

> content the focus should then be to get teachers to understand concepts and procedures hence teachers need to learn how teach concepts and procedures.

Subject Matter Knowledge

Five participants identified subject matter understanding as a branch of awareness needed to support MPCK growth. P-1 expressed, "teachers cannot teach the content if they themselves do not know it." P-8 shared,

> Teachers must have good knowledge of the content strands in mathematics including how to apply the strands in problem solving and algorithm methods. So, knowledge of numbers, statistics, algebra, geometry and measurement is very important. I witnessed a teacher at a lower grade teaching adding fractions of like denominators and explain to the students that the numerators are added likewise the denominator. Initially, I thought it was a new approach to teaching the subject but then it was just left like that.

P-7 shared, "Teachers need to know how to solve mathematical problems for themselves first before they can teach students and the truth is some teachers do not possess this knowledge." P-9 in agreeing stated,

> It does not matter the number of mathematics textbooks that a teacher consults, they will not be exposed to all the mathematics problems there are. Therefore, teachers must know the steps to take in solving the particular problem so that this can be applied in any unfamiliar situation and this same approach is taught to students.

P-11 demonstrated,

> Take for example a teacher who gives a student the sum 17 + 200 +36 + 119 and tells the student the number has to be arranged with the biggest one at the top otherwise the sum will be incorrect. A teacher who understands the number strand would know that the order is not important, what is important is having the digits in the correct place.

Theme 4: MPCK Acquisition

In responding to the support needed to experience MPCK growth, all respondents suggested avenues through which MPCK can be expanded. Some of the suggested sources include PD sessions, exploration in the teaching and learning environment and mathematics resource materials. P-1 explained, "Teachers in today's age have no reason not to expand their mathematics knowledge as there are now many ways this knowledge can be acquired." P-3, P-5 and P-10 all agreed that the kinds of conversation that take place in professional groups such as professional learning communities provide the opportunity for teachers to expand their knowledge base. P-4 in relaying the example of the student who introduced her to the Lattice method of multiplication remarked "It looked strange to me, so it pushed me to try to find out more about this method. So, I went back two grades to talk to the teacher and she was able to share her knowledge with me …. we keep our eyes open we try to keep up with what is happening because information change and methods change, and we have to keep up with what is happening to help the children in their own time."

P-3 illustrated "So I might say I want to start off my lesson with a song. Another teacher can share a song they learnt elsewhere or even from their student." Participants

agreed that structured and unstructured professional discussions are means of expanding their MPCK.

PD Seminars and Workshops

Many participants identified PD seminars and workshops as media through which MPCK is expanded. P-3 noted, “PD sessions are very useful in helping teachers to plan and deliver better lessons but more need to be done to help with areas of difficulty.” P-2 further added that workshops where presenters are knowledgeable about the gaps in teachers’ knowledge and can present content in a relatable manner will expand teachers’ knowledge base. Similarly, P-6 explained, “Conveners of PD sessions and training have a responsibility to appraise themselves of latest developments in education so that participants can benefit optimally from the sessions.” P-7 suggested, “Interactions with coaches and participation in seminars and workshops help teachers select appropriate strategies to deal with learning challenges they experience in their classrooms.” P-10 shared how her MPCK base was expanded as a result of her participation in PD workshops where mathematics specialists demonstrate approaches that could be employed in delivering certain concepts that teachers often find problematic. P-4 shared, “The ministry of education has convened numerous workshops, but more is needed to help teachers better understand mathematics content and best practices in instructional delivery.” Participants concur that teachers’ MPCK base expands when they participate in PD sessions and workshops.

Exploration in the Teaching and Learning Environment

Several participants shared their knowledge of how best to teach mathematics was developed through classroom exploration. P-2 expressed,

> A teacher might have said, this worked last year, and this is what I'm going to take into the next academic year but meet upon a roadblock. Over time with this continuous search for new approaches teachers now have an arsenal of successful strategies.

P-9 shared, "I had a student …. she would bring her mathematics homework to me. It was nothing like what I would have shown her, but they were always correct. And I learn some of the approaches she used and realize they are quite logical and even use them with other students." P-2, P-4, P-8, and P-10 all provided examples of valuable lessons they learnt through classroom exploration. P-2 said, "I discover boys love competitive activities and any activity that requires them to move a lot will grab their attention", while P-8 shared "I find that when I place students in small groups with group work cards students understand the concepts better. Evidently, "experiences gained in the teaching and learning situations increase teachers' MPCK".

Mathematics Resource Materials

Eight participants highlighted the importance of research and interacting with mathematics resource materials to expand teachers' MPCK. P-2 suggested "Teachers must find out what works for each cohort of student, and this requires constant research." In responding to what supports teachers' MPCK growth P-3 replied, "It goes back to research. For me as a teacher I view various websites and YouTube channels on how to

deliver lessons." P-4, P-5 and P-8 expressed that when they are in doubt about instructional decisions their first inclination is to research. While acknowledging the role teacher training institutions play in helping teachers develop mathematics teaching skills, P-6 opined, "It is good for prospective teachers to go to college and university to acquire their teaching diploma or degree, but they also have to engage in constant research to keep up with current development in education and in particular the subject they are teaching." Similarly, P-7 suggested "Teacher must be researchers. They have to be willing to find new information, not only find the information, but check to see if the information is correct." Previous research on teaching success was identified by P-9 who remarked "We must take our learning into research that has been done by other people and the best practices are shared. Mathematics is revolving because it is a science, it is revolving according to the social etiquette of people. The unanimity is when teachers engage in research and interact with mathematics resource material their MPCK is enhanced.

Summary of the Findings

Chen et al. (2022) found that teachers' perspectives on the importance of the subject they teach and their ability to teach the subject significantly impact their teaching outcome and overall teaching efficacy. Research interviews conducted offered to elucidate teachers' perspectives on support required for MPCK growth and students' underperformance in a primary school district. Responses to semistructured interview questions were transcribed and analyzed, resulting in four themes: (a) role of MPCK in teaching and learning, (b) support needed for MPCK growth, (c) categories of

understanding and skills needed for MPCK growth and (d) MPCK acquisition. A summary and interpretation of the findings are presented below.

The study's conceptual framework, Shulman's (1987) theory of teachers' knowledge, can be noted in supporting the kinds and quality of knowledge teachers need to teach effectively and successfully. Teachers' beliefs about their PCK influence their practice and overall teaching efficacy (Lai & Lin, 2018). Marfan and Pascual (2018) found teachers' perspective on their knowledge and practice play a crucial role in planning for teachers' and students' success in mathematics. In the current study, participants' findings reflected on the value of MPCK, the support required to experience MPCK growth, and students' success in mathematics and MPCK acquisition.

Theme 1: The Role of MPCK in Teaching and Learning

The role of MPCK in teaching and learning emerged as a theme and was supported by the findings from the interviews to help answer RQ1. Teachers' perspective on the role of MPCK in teaching and learning determine their attitude toward initiatives to expand mathematics pedagogy knowledge base (Spillane et al., 2018). Primary responses from participants dealt with the role of MPCK in improving teaching morale, increasing teaching efficacy, and heightening students' performance. Findings reveal participants believe MPCK influences perceptions of themselves, their teaching capabilities, and students' success. Participants expressed limited MPCK negatively impacted teachers' comfort and confidence in presenting mathematics content. These findings align with research by Flückiger et al. (2018), which found that underdeveloped PCK stifles teachers' confidence in effectively facilitating core subjects. Results also

associated with Aksu and Kul (2019) research findings that limited PCK results in teaching anxiety, negatively impacting teaching efficacy and students' outcomes. These findings suggest that limited MPCK retards teachers' ability to teach mathematics for students' success in the discipline effectively.

Outcomes show that participants believe sound MPCK positively impacts teaching efficacy behaviors to include: planning lessons that meet the objectives of the curriculum, designing materials that support the lesson, and creating a positive learning environment. These behaviors of teaching efficacy caused by adequate MPCK are supported by Copur-Gencturk and Tolar (2022), who found that when teachers can use another appropriate representation or instructional strategy when students are having difficulty comprehending a concept, this action is an indicator of teachers' sound knowledge of the curriculum they teach and students they are engaging. Similarly, Avcu (2019) found that teachers with sound MPCK can easily detect mathematics difficulties among students and redesign instruction and approach for greater understanding. Increased teaching efficacy is therefore, the result of adequate knowledge of how to successfully plan and implement lessons in an environment that supports students' learning.

Results of this study show students' performance improves when teachers' MPCK increases since teachers now have a broader and more diverse knowledge base of how best to cater to diverse needs of learners and contemporary teaching methods. Lai and Lin (2018) expressed "increased MPCK helps teachers to embrace education reforms and impact the quality of classroom interaction, students' achievement, and job satisfaction."

Responses associate addressing the diverse needs of learning as a condition of improved student outcomes. Mok and Park (2022) expressed awareness that the diverse learning needs of each learner influence teachers' decision to sequence the body of knowledge in the subject area based on appropriateness for the group of students and various needs of the learner. Educators, therefore, can improve students' learning outcomes by expanding their MPCK to meet the diverse needs of learners.

Theme 2: Support Needed for MPCK Growth

Support needed for MPCK growth was another theme that emerged from this study. Some participants expressed they receive adequate support from different stakeholders, which enhances their MPCK. Past research indicated that teachers experience MPCK growth when they receive support from stakeholders such as school leaders (Munna, 2021). Teachers are motivated to aim for greater levels of expertise with the support and inspiration of school leaders through a transformational climate (Li & Lu, 2020). Xiaorong and Russ (2019) found that the instructional leadership approach employed by school leaders impacted teachers' efficacy, positively impacted the learning climate, and sharpened teachers' pedagogical skills. Primary responses with this theme identified support from school leaders, parents, and collaboration with other teachers as necessary for MPCK growth.

Some findings showed strategic school-wide practices as a means of supporting their MPCK. Responses identified practices such as time-tabled planning sessions, and institutionalization of clubs and societies as school-wide support mechanisms for teachers' MPCK growth. Li (2017) found teachers realize an improved knowledge base

when principals are deliberate in their practice to set aside time for implementing and sustaining school-wide inclusive practices to impact teacher development. Principals play a critical role in implementing school improvement efforts by building teacher capacity and knowledge base through various initiatives (Sanchez, 2020). School cultures that enhance teacher learning, are those in which teachers actively and collaboratively examine, share, and construct authentic classroom material and develop new knowledge regularly and over a more extended period (Coenders & Verhoef, 2018). Findings from the study and those of other studies show that planning for teaching and learning activities from an organizational level creates a climate that supports teachers' MPCK growth.

Outcomes also show teachers require support through the provision of adequate resources to realize MPCK growth. Some resources identified were supplementary materials, access to reliable internet, and time for planning which (Ning, 2018) identified as critical resources teachers require to experience knowledge growth. School leaders must use a sense-making lens to ensure resources are allocated to support the desired pedagogical reform (Li, 2017). Since principals play a critical role in allocating resources to support teacher classroom practice and creating a conducive environment for learning, principals should use data-gathering tools to ascertain the requisite resources needed and source and deploy them accordingly (Ning, 2018). These findings suggest that adequate required resources should support teachers' MPCK; therefore, school leaders should acquire and deploy necessary resources informed by data.

Theme 3: Categories of Understanding and Skills Needed for MPCK Growth

The third theme that emerged is the categories of understanding and skills needed for MPCK growth. Responses indicate teachers must be aware of teaching methodology and subject matter if MPCK is to be increased. As an indicator of teaching efficacy, teachers must possess the skills to engage students in authentic problems and contexts to develop individual understandings of mathematical concepts and practices that nurture their abilities to problem-solve, reason, and communicate mathematically (Myers et al., 2019). Copur-Gencturk (2019) found teachers must be knowledgeable of various teaching strategies, such as sequencing mathematical activities, choosing which activity precedes another, and knowing the affordances and hindrances of different representations for teaching a specific mathematical concept. Respondents believe that adequate content and pedagogical knowledge will cause teachers to respond spontaneously to classroom situations. Researchers agree that knowledge of students' mathematical thinking will guide decisions on selecting teaching strategies based on the nature of the learner and the content being learned.

Results of this study show teachers believe that in expanding their MPCK, educators must be knowledgeable of the subject matter, such as mathematics content strands and process strands. Copur-Gencturk et al. (2018) found correctly recalling and executing grade-level-appropriate ideas are essential for MCK. Recalling the facts includes teaching in ways common with how the concept is used in many other professions or occupations that also use mathematics. Subject matter knowledge is related to conceptual understanding, mathematical reasoning, and word problem-solving skills

(Copur-Gencturk & Tolar, 2022). Therefore, teachers should possess sound knowledge of content strands of mathematics and process strands to effectively facilitate mathematics instruction.

Theme 4: MPCK Acquisition

MPCK acquisition was the fourth theme that emerged. Responses identified collaboration in professional groups, PD seminars and workshops exploration in the classroom, and mathematics content materials as avenues through which MPCK is acquired and expanded. Participants believe when professionals interact in groups about their practice, they realize MPCK growth. Waterhole et al. (2016) found teacher collaboration provides opportunities to draw on the valuable experience of veteran teachers through classroom observation and benefit from open and close discussions with peers about daily teaching issues. Conversations with peers, peer observation and feedback, and advice seeking about instruction are opportunities to increase MPCK growth (Spillane et al., 2017). Professional collaboration is therefore accepted as a means of expanding teachers' MPCK.

Participants believe involvement in PD seminars and workshops enhances teacher MPCK. Earlier studies discovered when teachers participate in PD sessions, their teaching knowledge grows, resulting in teaching efficacy (Harris & Hofer, 2017; Santagata, 2018). PD sessions should support teachers' intentional efforts to expand their knowledge of how best to teach mathematics by providing hands-on approaches, and opportunities to ask questions and seek clarity on misconceptions (Hill et al., 2020). Murphy et al. (2020) found teachers' views on teaching a subject changed after

participating in PD sessions. One measure to ensure teachers benefit optimally from these sessions is to engage these educators in deciding on the session's content and providing the opportunity to ask and answer questions (Thomson, 2018). The results of this study show participants felt PD sessions and workshops where teachers are actively involved from planning to implementation are reliable ways to support teachers' MPCK growth.

Outcomes of this study show classroom exploration, as discussed by Gess-Newsome, 2019 who discovered implementing interventions in classrooms enhances teachers' MPCK growth. Some findings show undertaking action plans, discussions facilitated in student-centered lessons, and adjusting instructions based on experience build teachers' repertoire of effective teaching strategies. Alimuddin et al. (2020) found as teachers explore varying instructional practices in their classrooms, reflections were used to decide on best practices and identify gaps to be further addressed. Karslen (2019) also found question-and-answer sessions allow teachers to learn which approach allows for a greater understanding of the concept taught. Through classroom practices, teachers learn from their actions and the experience students bring to the learning environment.

Some findings show teachers expand their MPCK base by engaging with mathematics resources. Participants shared they gained mathematics knowledge by watching online videos and researching specific mathematics content. Results associated with Liljekvist (2018) found online resources such as Facebook serve as a valuable tool for sharing knowledge and curricular material, giving advice, and getting support on issues of importance to teaching. Teachers' knowledge base is expanded when there is a mix of time on task activity and high cognitive engagement (Chen et al., 2017). Results

from the study and findings of prior research concur engagement with online and offline mathematics content resources supports teachers' MPCK growth.

Section 3: The Project

Introduction

In this section, I present the PD that I developed based on the findings from the project study. I conducted basic qualitative research to explore Grade 6 teachers' perspective on MPCK and students' underperformance in a primary school district in rural Jamaica. The findings provided answers to the two RQs. Participants shared PD sessions that were useful in increasing teachers' MPCK. Responses indicated that PD sessions have been proven to increase MPCK, resulting in increased teaching morale, greater efficacy, and heighten students' performance and emphasize the need for teachers to be active in the decisions about the design and processes of teacher PD in Jamaica.

Rationale

The problem that was addressed through this basic qualitative study is that primary teachers in JPSD display limited MPCK, and Grade 6 students continue to underperform in mathematics. Outcomes from the study revealed that teachers' MPCK is expanded when the requisite human, physical, and organizational support is provided. After reviewing the approved genres relating to the research findings, I decided on a PD plan. Participants' responses revealed the following findings that addressed the research questions.

RQ1: What are primary teachers' perspectives regarding the value of teachers' MPCK in improving students' performance in mathematics?

RQ2: What kind of support, knowledge, and skills do teachers feel is essential to experience MPCK growth?

- Adequate MPCK increases teaching morale, improves teaching efficacy and students' outcome in mathematics.
- Teachers require support from school leaders, middle managers, parents and mathematics specialists to expand their MPCK growth.
- Support from a system-wide perspective such as the ministry and school's level enhances teachers' MPCK growth
- Physical resources including manipulatives, access to reliable internet and devices, supplementary materials support teachers' MPCK growth.

Based on careful analysis of the findings of the study and observation of the examination of the field of study and the local context in which I operate as an educator, a PD workshop aimed at addressing the need for increased MPCK to improve teaching morale, teacher efficacy, and students' outcome was deemed to be the most appropriate action for the project. The data revealed some teachers feel one form of support that could be provided is more strategic PD sessions to address specific aspects of mathematics instruction that teachers often find problematic. The PD workshop will be conducted among teachers of mathematics in two phases. I have titled the workshop "Building Bridges in Mathematics."

The overarching goal of this 3-day PD workshop is to inform participants of the findings of my study and present current literature on the topics identified in the study that are associated with teachers' MPCK. The workshop participants will also be exposed to principles of teaching adult learners and recommendations for support for teachers' MPCK development. The workshop will focus on tested and proven approaches that can

be employed when teaching concepts identified by participants as problematic. Study participants indicated an interest in participating in PD sessions to increase their knowledge of best practices in teaching mathematics. Even-Zahav et al. (2020) found that when teachers are actively involved in deciding the content and the approach for their PD sessions, they realize an increase in well-being components, including competence, relatedness, autonomy, and aspirations.

Review of the Literature

I conducted a review of literature on developing a PD plan based on the four themes identified from the data analysis. The review aimed to explore and present a scholarly evaluation of PD and the themes that emerged from the data analysis and linking current theory to the PD plan. Research-based evidence is provided on PD, the value of MPCK, support required for MPCK growth, and MPCK acquisition in Jamaica. The literature review informed the development of a PD plan, drawing insights from four key themes identified through data analysis.

In my research, I thoroughly examined peer-reviewed articles sourced from Walden University. Library databases such as ERIC, Francis and Taylor Online, and Sage Journal websites were accessed for information relevant to the study. I also used the search engine Google Scholar. Keywords used to search for peer-reviewed journal articles within the last 5 years included: *PD, value of MPCK, human support required for MPCK growth, system-wide support required for MPCK growth, physical resources required for MPCK growth, mathematics subject matter acquisition and mathematics*

pedagogy acquisition. The Walden EdD librarian at Walden University also guided me on using different search strategies to find articles related to my topic of interest.

The literature review supported the themes that emerged from the analysis of the data. Teachers shared that (a) MPCK increases teachers' morale; (b) MPCK improves teaching efficacy; (c) MPCK heightens students' performance; (d) MPCK is expanded through stakeholders' support;(e) system-wide initiatives support teachers' MPCK growth; (f) teachers require physical resources to support their MPCK growth; and (g) subject matter knowledge and PCK are knowledge and skills indicating MPCK growth.

The literature review is structured to offer a holistic analysis, demonstrating the alignment between the project's content and relevant theory and research. The following topics form the content of the literature review: PD for teachers, the value of MPCK to teachers and students, support required for MPCK growth, and MPCK acquisition. Current studies support the planned PD and its content.

PD for Teachers

In the ever-evolving field of education, teacher PD is pivotal in enhancing instructional practices and fostering continuous growth among educators. Darling-Hammond et al. (2020) defined PD as structured professional learning that results in changes to teacher knowledge and practices and improvements in student learning outcomes. Teachers' participation in PD can impact their teaching practices and lead to instructional reforms. Spiel (2020) explained PD bridges the gap between what is known in research and what is done in school practice. PD can benefit teachers when they are active participants, and their professional needs are being met. Teachers benefit more

from PD activities when they are given opportunities to collaborate and problem-solve together and when subject-specific and subject-didactic content is at the center of PD instead of focusing on pedagogical content such as learning theories more generally (Cooper et al., 2018; Ehlert & Westfalische, 2023). Researchers concur that when teachers are actively involved in PD, there will be positive changes in classroom practices.

PDs meet their objectives when deliberate actions are taken in how the programs are designed. Effective PD comprises five central tenets: content focus, learning opportunities, coherence, sustained duration, and collective participation (Ehlert & Westfalische, 2023). Considering these tenets in the design of a PD means the event will have a specific focus using activities that provide numerous learning opportunities. Coherence in the activity will be represented by clear connections between the program's objectives, content, instructional strategies, assessment methods, and participant needs. Sustained duration indicates the amount of time needed to adequately cover the content of the PD and provide enough time for participants to cement learning. Opportunities provided for teachers to be active in PDs deepen learning and make it more lasting. Active learning provides opportunities for hands-on experience, problem-solving, and exposure to best practices (Darling-Hammond et al., 2017). PD is essential for helping teachers navigate the needed knowledge domains and deepening their content knowledge (Yang et al., 2018).

The Value of MPCK in Improving Teaching Morale

Sound MPCK significantly contributes to increased teacher morale and enthusiasm in the classroom. Alkahtani (2022) found when a teacher has a high PCK this knowledge increases their confidence and feeling of preparedness when teaching. Aksu and Kul (2019) explained there is a positive relationship between teachers' self-efficacy belief and their teaching morale. Teachers' self-efficacy belief is their expectation that they will be able to bring about improved student outcome (Fung et al., 2017). MPCK equips educators with the specialized skills and strategies necessary for effective mathematics instruction, ultimately fostering a more positive and confident teaching environment.

The Value of MPCK in Improving Teaching Efficacy

Heightened MPCK improves teaching efficacy. Sound MPCK pertains to teachers' knowledge of instructional strategies, representations, use of models, experiments, and educational observations (Meschede et al., 2017). Thomson et al. (2017) found that as teachers' PCK increased, higher efficacy became evident by teachers' use of student-centered educational strategies and different teaching materials in applying their methods and educational goals. Increased MPCK guides teachers in most instructional decisions, including lesson planning and implementation, classroom layout, and assessment procedures. Fortsch et al. (2016) explained that teachers with higher PCK can better implement challenging tasks at a high cognitive level. Higher PCK increases teachers' awareness of tested and proven instructional strategies. Notably, teachers who firmly believe in their ability to be successful are more likely to remain motivated and

committed to trying new instructional practices with struggling and achieving students (Baleghizadeh & Shakouri, 2017).

The Value of MPCK in Students' Success in Mathematics

MPCK is essential in shaping students' success in mathematics. Teachers with strong PCK focus on students' thinking, provide explanations based on students' cognitive level, and provide more accurate content by employing educational strategies, such as giving examples and using metaphors. High MPCK also addresses non-academic aspects of learning relating to students' learning outcomes. Korong and Maria (2019) posited there is a correlation between the teachers' knowledge of how best to teach and students' motivation to learn. Teachers' support for students is guided by their awareness of how students learn. Students' engagement and performance can be boosted through instructional practices that encourage in-depth inquiry and student participation (Yang et al., 2017). Furthermore, Wang et al. (2022) noted that a teacher's subject expertise and interpersonal skills may influence student engagement. Communicating with students includes various specific practices, such as providing clear expectations and directions, presenting content accurately using academic and error-free language, and encouraging students to think critically. Using questioning and discussion techniques is related to teachers' ability to form and pose high-quality questions and facilitate practical classroom discussions to deepen student learning. In this process, encouraging all students to participate and contribute to the discussions is also critical. Similarly, engaging students in learning requires ensuring their high interest in the content and active participation in all learning activities. In order to do that, teachers use various

classroom activities and assignments with appropriate materials. Therefore, teachers' self-efficacy, motivation, and general classroom practices can positively affect learning outcomes.

Support Necessary for MPCK Growth

School leaders and parents can play important roles in supporting the ongoing development of teachers' PCK in mathematics. In educational organizations, leadership is vital for improving teachers' professional learning and student achievement (Bellibaş et al., 2021). Wang (2023) indicated that supportive and shared leadership helps teachers develop their inner qualities for PD. Leaders who value stimulation and openness to new ideas will encourage their team members to exhibit greater risk-taking and more innovative ideas (Da'as, 2023). School leaders who promote professional dialogue among teachers through collaboration, peer coaching, inquiry, collegial study groups, and reflective discussion directly support teachers' knowledge growth. However, teachers cannot work alone; they need support from school leaders who, according to Marschall and Shah (2016), can design and implement school policies and shape the norms, expectations, and school culture.

Active involvement of parents is a dynamic aspect of support for teacher development. Parent-supportive attitudes toward processes in education, high academic expectations, emotional encouragement, and academic interest influence positive learning behaviors and mental well-being in students and teachers (Perry et al., 2018). When parents are involved in education, teachers are forced to equip themselves with the requisite knowledge, enabling them to engage parents in meaningful conversations. Li et

al. (2020) suggested that where parental involvement is implemented, teachers can learn more about the children in their care through their parents. The knowledge gained about different students builds teachers' repertoire of successful strategies. Parental involvement positively impacts students' academic outcomes and teachers' knowledge base.

Resource Availability

Adequate resources are needed to empower students and teachers to acquire knowledge, develop skills, and achieve academic and personal success. Different kinds of resources, material and non-material, are needed to support effective mathematics education (Gracin & Trupčević, 2022). Fan et al. (2018) added different kinds of resources are used and developed with the aim of creating an effective mathematics education, for example, textbooks, teacher guides, digital tools, and manipulatives. Teachers and students must employ the use of relevant resources to keep abreast of the ever changing field of education.

Pedagogical Content Knowledge

PCK forms a fundamental pillar of teachers' MPCK as it engenders effective teaching, influencing how educators convey complex subjects to their students. Setyaningrum et al. (2018) explained that PCK combines content and pedagogy to understand how topics or problems are organized, knowledge of students' difficulties, frequent errors, and the teacher's ability to identify and treat them. Teachers with such knowledge can go beyond the topic's peripherals and facilitate rich discussions on alternative strategies. Pedagogy knowledge empowers the teacher with various teaching

strategies, such as sequencing mathematical activities, deciding the sequence of activities, and knowing the affordances and hindrances of different representations for teaching a specific mathematical concept (Copur-Gencturk, 2019).

Subject Matter Knowledge

Subject matter knowledge is a necessary body of understanding for MPCK. Lee et al. (2018) explained that subject matter knowledge is an understanding of mathematics content or horizon and involves knowing its structure, the body of concepts, facts, skills, and definitions. Specific content knowledge is associated with mathematics, which forms part of the teachers' overall MPCK knowledge. Remillard (2020) explained that mathematics subject matter knowledge falls under the following categories: number and operation, algebra, geometry, measurement, data analysis, and probability. Subject matter knowledge is crucial for teachers, especially in mathematics, as it forms the foundation for adequate PCK.

Project Description

Based on the findings of this study, I designed a PD project to provide teachers with an opportunity to experience MPCK grow. A 3-day PD workshop will be held with Grade 6 teachers from primary schools in Jamaica's rural primary school district. I will seek approval from the convener of the school district to execute this workshop. The general objective of the workshop will be to present the study's findings to teachers and provide them with opportunities to expand their MPCK to influence students' success in mathematics. The workshop will allow participants to collaborate with colleagues from their local schools and other schools in the district on specific aspects of mathematics

instruction with which they have challenges. The PD workshop aims to enhance teachers' MPCK, equipping them with effective strategies to improve their mathematics teaching.

Potential Resources and Existing Supports

To successfully host this PD workshop, some resources are essential to ensure its effectiveness and impact. Some required resources are multimedia projectors, computers, flip charts, markers, cartridge paper, handouts, sign-in sheets, evaluation forms, and access to the internet. The Teacher Resource Center (TRC) in the local setting is already outfitted with a multimedia projector and has reliable internet services. A formal request will be made to the school's principal where the TRC is located, seeking permission for the sessions to be held at the center and for the resources to be available. If the institution is not able to facilitate the request for the resources, I will make available my multimedia projector and computer as well as procure flip charts, cartridges, and markers.

Potential Barriers

There might be a few barriers to the successful execution of this PD workshop. One potential barrier could be the availability of teachers to participate in the workshop. I do not intend for the PD workshop to interrupt teaching and learning sessions; hence, active teaching and learning days are not considered possible for the workshop. A solution to this barrier would be to work with principals of the schools in the district to consider day releases or reserve national PD days that are normally held during the break for teachers to participate. Support of the convener also ensures teachers are given the time to participate in PD sessions when less intense teaching and learning days are available.

Another barrier that could impact the success of the PD is the availability of mathematics specialists. This 3-day workshop will be intensive and will require the support of personnel with the requisite knowledge and skills to help teachers develop mathematics content and process skills knowledge. The possible solution to this barrier will be to liaise with the region's mathematics specialist and other specialists from the core curriculum unit who are responsible for planning PD to increase teachers' MPCK in the local district. The benefits of the workshop will far outweigh the barriers; hence, planning on how to deal with the challenges will minimize the likelihood that they will impact the quality of the workshop.

Proposal for Implementation and Timetable

To begin, I have developed a proposal for implementing the PD session and present a timetable for its seamless execution. One of the first steps for the implementation is to meet with the convener of the quality education circle to share the study's findings and current literature relating to PD. Based on the findings shared, the convener will be asked to make recommendations on the participants to be targeted and the workshop's schedule. I will then brief school principals on the plans to host the PD workshop and seek their support in allowing their teachers to participate. The first 30 participants will be enlisted for the workshop. PD workshops will be proposed for national PD days or close to Christmas, Easter, or summer break.

Diverse activities will be provided for teachers to broaden their MPCK. Findings of the study and the necessary steps to execute a PD workshop will be the focus of day 1. The second day's focus will be skills for mathematics success: teaching mathematics

content and process skills. On day 3 teachers will discuss areas of difficulty in mathematics teaching, then review case studies and arrive at a resolution for these problems. Table 4 presents an overview of the focus for the three days and the proposed time frame.

Table 4

Proposed PD Schedule

Day	PD topic	Time
1	The role of teachers' mathematics pedagogical content knowledge how it can be supported and expanded.	9:00 a.m. to 2:30 p.m.
2	Mathematics content strand	9:00 a.m. to 2:30 p.m.
3	Mathematics process strand	9:00 a.m. to 2:30 p.m.

A well-structured timetable is the cornerstone for successful implementation of this project, serving as the roadmap that will guide me towards meeting the goals and deadlines efficiently. Table 5 presents the actions to be taken each month leading to the successful implementation of the PD workshop. Presented are key persons for the execution of each task and the means of verification.

Table 5

Proposed Timeline

Date	Action to be taken	Person responsible	Means of verification
August	Share introductory email with convener and principals of the school district	Researcher	Email
September	Share invitation emails with teachers	Convener and principals of participating schools.	Document with study findings and project outline
October	Confirm attendees for PD, make follow-up contacts as necessary	Researcher	Confirmed list of 30 attendees for PD sessions
November	Meet with a focus group of Grade 6 teachers of mathematics to identify approaches teachers would appreciate and share possible areas in mathematics teachers normally have problem teaching.	Teachers and researcher	List of approaches Agenda for meeting with teachers, meeting notes
December	Confirm availability of venue for PD session and resources with school administration	Researcher	Request letter shared with school administration
January	Finalize PD agenda, activities, handouts and purchase resources.	Researcher	Daily agenda, handouts, resources
February	Engage in simulation exercise guided by mentor	Mentor, researcher	Evaluation sheet provided
March-April	Check on venue and multimedia, projector, back-up power supply, Host PD workshop	Researcher Participants and researcher	PD resources secured/procured to include: refreshment, certificate materials and cartridges

Note. Professional Development = PD.

Roles and Responsibilities of Researcher and Others

My role in this PD varies. Firstly, I am the organizer and one of the main presenters at the PD sessions. I also collaborated with the district convener to ensure they provide the necessary support for teachers to participate in the sessions. My responsibilities also involve inviting participants to the workshops. Essentially, I coordinate logistics, content, and participant engagement to ensure a successful and enriching experience for all attendees.

Support from two other stakeholder groups are needed to execute this PD session. The convener decides which schools and groups of teachers should be targeted to participate in the sessions. Selected groups of teachers will be identified beforehand based on their principals' recommendation to review the workshop's schedule and content. Both stakeholder groups will be key in organizing and facilitating the PD workshop.

Project Evaluation Plan

At the end of each day of the workshop, participants will provide feedback, which will form the formative evaluation (see Appendix A). Evaluation forms will require participants to share what went well, what could be improved, any new insights gleaned, and their satisfaction or dissatisfaction with the content and delivery of each session. Forms will be submitted anonymously; hence, names will not be required, so participants should have no reservations about providing feedback. Forms for each day will be developed based on the review of the previous day's workshop. Review of the feedback

of the entire workshop will guide the development of subsequent workshops. Johnson et al. (2018) explained that feedback on PD improves the developers' practice.

Overall Evaluation Goals

The expansion of knowledge and development of skills is the overarching goal of this PD. Participation in this PD will expose teachers to best practices in teaching mathematics and allow them to collaborate on addressing mathematics teaching difficulties. Data collected from summative evaluations can be used to inform future PDs; consequently, the PD's evaluation plan aligns with the program's goals and objectives. The primary objective of this PD session is to foster the acquisition and enhancement of knowledge and skills. Evaluation of each day's activity allows participants to respond to the session's content, sequence, and relevance to their teacher roles. Evaluation exercises are also designed to clarify participants' understanding of the topics and guide improvement in future PD sessions.

Key Stakeholder Groups

Some key stakeholders are needed to help shape the success and impact of any PD session to influence its outcomes significantly. The program is designed to equip its participants with knowledge and skills to identify and correct misconceptions in mathematics. Furthermore, it is believed that as a result of the program, teachers will be better able to facilitate mathematics instruction at their various institutions. Therefore, students should receive higher-quality instruction that positively impacts their performance in mathematics.

The convener of the district where the study was conducted will be a key stakeholder. Results of the study will be shared, following which the proposal for the PD will be shared. Support will be solicited regarding the planning and implementation of the PD. Opportunities will be provided for the convener to make recommendations on any area that contributes to the success of the PD. Principals of schools in the district are another set of key stakeholders. After their exposure to the study's findings, it is hoped that principals will understand and appreciate the importance of the information and strategies that will be shared with their teachers. Knowledge of the session's content and how teachers and their institution can benefit will motivate the teachers to participate in the session. Furthermore, support is also required from the school's principal, where the TRC is located, in hosting the PD sessions. Targeted teachers who are interested in participating in the workshops will form one of the stakeholder groups. These teachers will provide guidance and suggest recommended activities to engage teachers in the session so they can benefit optimally.

Project Implications

Social Change Implications

This project can bring about positive social change that benefits various stakeholders. Firstly, the findings from this study reveal the importance of teachers' MPCK to both students and teachers. The project also exposes conditions that support teachers' MPCK growth. The PD sessions will serve as a model to school leaders who want to support teachers' MPCK growth through PD.

Importance of the Project to Local Stakeholders

Outcomes from the basic qualitative study guided the development of a PD plan that will expand teachers' knowledge base on the value of MPCK and strategies to support their MPCK growth and enhance students' learning. Principals can draw from the study the process of developing and implementing a successful workshop and use this knowledge to guide future workshops, whether similar or of a different nature.

Conveners of school districts and principals of K1-12 schools across Jamaica can benefit from this study by examining the model on which the PD was built. The project can be adapted to be used in other contexts similar to that of schools in the school district where the study was done. Increased knowledge of effective strategies to overcome teaching challenging contexts in mathematics could result in teaching efficacy, which can positively impact students' learning outcomes. Parents may also be able to benefit from the development of this project. Furthermore, this PD is designed to respond to the needs of mathematics teaching.

Summary

This project aims to broaden teachers' knowledge base on successful strategies in providing mathematics instruction. Findings from the study revealed that teachers believe PD sessions greatly enhance their MPCK. After reviewing the study's outcomes and teachers' expressions for more opportunities, such as PD workshops to be provided for teachers to expand their MPCK base, a PD project was developed. A review of the literature was completed, and the findings were used to inform the development of the

PD content. An evaluation plan and the potential for positive social change are also discussed.

Section 4: Reflections and Conclusions

In this section, I present my reflections on teachers' limited MPCK and students' underperformance in mathematics. Principals are sometimes challenged with designing a PD session to enhance MPCK growth. In this study, I explored primary teachers' perspective on teachers' MPCK and students' underperformance. This project study was developed as a response to responses provided by the study participants. The content of this PD can positively impact stakeholders in education. In the following section, I will provide details on the project's strengths and limitations, recommend alternative approaches, and discuss the project development, leadership, and change. Also in Section 4 is a reflection on the importance of this project study and its implications, applications, and directions for future research. Finally, the conclusion of the study is presented.

Project Strengths and Limitations

Project Strengths

The strength of this project study lies in its ability to comprehensively analyze, address, and potentially resolve complex issues or challenges within this local school district by offering valuable insights for both academic and practical applications on expanding teachers' MPCK. Using semistructured interviews created a non-threatening environment where participants felt comfortable responding. Four major themes emerged from the data received that indicated teachers' perspectives on MPCK and students' underperformance in mathematics.

- The value of teachers' MPCK to teaching and students' learning
- Support needed for MPCK growth

- Categories of Understanding Needed for MPCK Growth
- MPCK Acquisition

The findings of the kinds of support required from school principals highlighted the need for principals to be strategic in the procurement and allocation of resources. Results help amplify the call for material resources to be made available for teachers to expand their knowledge. The project was developed based on Shulman's (1986) theory domains of teachers' knowledge. Shulman's (1986) theory also guided the selection of activities. Another strength of the project is that little to no cost is required to implement this study. No expense is attached for the use of the venue and its resources. Finally, the robust evaluation program will deduce sufficient, valid, reliable, and relevant data to measure the PD's efficacy.

Project Limitations

The PD was designed to explore teachers' perspective on their MPCK and students' underperformance in mathematics. Eleven participants provided the baseline data for this PD. A sample size of 11 teachers may be considered small and does not adequately represent a wide cross-section of Grade 6 teachers. Furthermore, the program evaluation will be completed by these 11 participants, which might be inadequate to provide the volume of data to ensure reliability and validity of data to make decisions that can be considered reliable and valid from which information decisions can be deduced.

Recommendations for Alternative Approaches

The focus of the study was on Grade 6 teachers' perceptions of teachers' MPCK and students' underperformance in mathematics. Exploring principals' perspective on

teachers' MPCK could be an alternate approach. Principals' perspective is important since they have direct responsibility for the shaping of school culture (Coenders & Verhoef, 2018). Gaining principals' perspective would offer a new viewpoint potentially providing new insights and a more comprehensive understanding of the subject matter.

The problem that influenced this study was that primary teachers in JPSD display limited MPCK, and Grade 6 students continue to underperform in mathematics. An alternative definition to the problem could be that teachers lack the requisite support to enhance MPCK. An alternative approach to the PD sessions to the one being proposed could be the PD with principals developing a guide to designing and executing successful PDs. Viewing the problem from a different perspective could provide new insights into the phenomenon.

Scholarship, Project Development and Evaluation, and Leadership and Change

No form of funding or scholarship was provided for this study. From the iterative nature of the research process from the development of the prospectus and proposal, conducting the literature review, collecting and analyzing data, and creating the PD workshop, one insight gleaned is the sense of community that must be built around all aspects of teaching and learning. Leadership and change lessons learned from the PD project emphasize the importance of adaptability, effective communication, and fostering a collaborative culture to navigate and drive organizational transformation successfully.

Growth of Self as a Scholar

Several opportunities for personal and professional growth were provided through the research process. After interacting with several bodies of peer-reviewed documents, I

now have a better understanding of the need for a scholarly tone. I have also sharpened my data collection schools, particularly in collecting data that is objective and free from bias. Developing and implementing a PD project facilitated my scholarly growth by enhancing my research skills, expanding my knowledge base, and fostering a deeper commitment to lifelong learning.

Growth as a Project Developer

Developing a project aligned with the study's outcome provided numerous growth opportunities. I got first-hand experience of how data can be used to impact important decisions in education. Another area of growth is the targeted approach to address the problem associated with teachers' MPCK and students' underperformance in mathematics. Creating the PD workshop helped me employ this structured approach in other areas of my professional duties. The proposed PD workshop underscores the multifaceted nature of growth, revealing that it arises from a complex interplay of internal and external factors, personal development, and the pursuit of knowledge and experience.

Reflection on Importance of the Work

The problem I addressed through this basic qualitative study was that primary teachers in JPSD display limited MPCK, and Grade 6 students continue to underperform in mathematics. A review of the study's outcome identified support required to expand teachers' PCK growth. Such knowledge led to the development of a PD workshop plan that can be used as a reference to other school leaders in developing PDs to address gaps in their locale. The PD workshop will play a pivotal role in enhancing educators' skills, fostering continuous learning, and ultimately improving the quality of education.

Implications, Applications, and Directions for Future Research

Data collected from the 11 Grade 6 teachers provided valuable insight into their perspective on teachers' MPCK and students' underperformance in mathematics. The result of this study impacted the design of a PD that will broaden teachers' knowledge base on important mathematics content and process strands while highlighting the support required to experience MPCK growth. The study also expands the body of literature on teachers' MPCK using Shulman's (1986, 1987) model of teachers' knowledge. The implications, applications, and directions for future research highlight the practical significance of the findings and their potential real-world applications and provide a roadmap for further exploration and investigation in the field.

Potential Implications for Positive Social Change

The PD is designed to expose teachers to the knowledge and skills needed to expand their MPCK. Findings from the study indicated that teachers believe that more PD workshops should be held to provide teachers with first-hand experience of approaches that can be employed to deal with teaching complex mathematics concepts. Content of the PD will also be shared with principals of the schools in JPSD, which will help them recognize the kinds of support teachers need to expand their MPCK. During the PD sessions, teachers will be exposed to best practices in teaching mathematics and the seven domains of teachers' mathematics knowledge posited by Shulman (1987). Ultimately, students' academic achievement in mathematics should improve with time. This PD program has a detailed evaluation plan designed to expose teachers to strategies that can be employed in teaching content deemed problematic by teachers. The

evaluation plan can be tailored and used by conveners and school leaders to evaluate the impact of PDs and other initiatives at the district and national levels. The perspective shared in PD evaluation instruments could guide the Ministry of Education, Jamaica, in designing more targeted PD to deal with real issues teachers face in the delivery of mathematics instruction, which could result in an improved education system and, ultimately, positive social change. The PD, when implemented, is expected to have a positive effect on all the stakeholder groups that are affected by teachers' limited MPCK.

Methodological, Theoretical, and Empirical Implications

Teachers' limited MPCK and students' underperformance in mathematics were the focus of this study. The completion of the study highlighted important methodological, theoretical, and empirical implications. Semistructured interview protocol allowed for direct conversations with educators who could best answer the central research questions. A qualitative study design enabled participants to provide insights into teachers' perspective on MPCK and Grade 6 students' underperformance within their specific local contexts.

Shulman's (1986) model of teachers' knowledge formed the conceptual framework for this study. The model outlines seven domains of teachers' knowledge: content knowledge, general pedagogical knowledge, curriculum knowledge, PCK, knowledge of learners and their characteristics, understanding of educational contexts, and knowledge of educational ends. The theoretical implications of this study suggest that teachers must have adequate knowledge in all seven areas to be effective in teaching mathematics.

Results from this study indicated that teachers believe MPCK improves teaching morale, teaching efficacy, and students' progress and support required for MPCK, including leadership and material support aligned with Shulman's (1987) concept of teachers' knowledge growth. Copur-Gencturk and Tolar (2022) further explained that MPCK is the intersection of content knowledge and pedagogical knowledge. The intersection of both forms of knowledge is a particular form of expertise representing teachers' unique professional understanding, which influences the blending of content and pedagogy into an account of how specific topics, problems, or issues are organized for instruction. This study may promote positive social change by offering insight into the support teachers may need to realize MPCK growth. Knowledge of the support required may provide awareness to education stakeholders on the need for targeted and structured ongoing PD and careful consideration of the allocation of resources. More serious discussions on the need to mandate a specialist teacher policy for teaching mathematics in all schools could result from this study. Mathematics teaching requires specialized content knowledge, which includes teachers' understanding of mathematics and how it is to be taught, understanding of student's mathematical thinking, instructional practices, and ability to notice content-related issues in the moment of mathematics teaching (Copur-Gencturk & Tolar, 2022).

The empirical implication of this study suggests teachers are aware that their MPCK is important to students' overall academic outcomes. The results also suggest teachers expect principals' support and material resources to enhance their MPCK development. Another empirical implication of this study is that mathematics teachers

can benefit from other studies that suggest tested and proven mathematics teaching strategies. The empirical implications of this study underscore the practical and tangible consequences of its findings in real-world applications and decision-making processes.

Recommendations for Future Research

As I conclude this study, I have two recommendations for future research. Firstly, researchers could explore how principals' perspectives on teachers' MPCK relates to their support for teachers' MPCK growth. Sanchez (2020) purported that school leaders play a critical role in implementing school improvement efforts to build teacher capacity. Munna (2021) also believed principals set the learning tone for teachers and students. Future research studies could examine how principals' perspective on teachers' MPCK relate to the culture they create to support MPCK growth using knowledge gained on the impact of school leaders on teachers' teaching and students' learning.

Another recommendation for future research is examining teachers' perspectives on what constitutes an effective PD program that increases teachers' MPCK. Researchers have suggested teachers should help create the PD session content. Marfa and Pascual (2018) suggested teachers' perspectives on their knowledge and practice is critical in planning for teachers' and students' knowledge in mathematics. Even-Zahav et al. (2022) further added that PD sessions should be developed using teachers' perspectives on approaches. Active learning and the involvement of teachers in their instructional practices and learning are critical components of structured professional learning that result in changes to teacher knowledge and practices and improvements in student learning outcomes (Darling-Hammond et al. 2017). There is a need for awareness of

procedures to establish a successful PD program. This study offers a basis for future research recommendations considering data, research design, and population. These recommendations for future research suggest promising avenues to explore, offering potential insights and solutions to advance our understanding of the subject matter.

Conclusion

In this basic qualitative study, I explored primary teachers' perspectives on MPCK and Grade 6 students' underperformance in mathematics in a school district in Jamaica. Eleven Grade 6 teachers with over 5 years of experience teaching mathematics at the Grade 6 level and a minimum qualification of a bachelor's degree were interviewed. An NEI report revealed that in some schools, teachers demonstrate limited knowledge of how best to teach mathematics. This study sought to fill the gap by providing knowledge on primary teachers' perspective on MPCK and the support needed to realize MPCK growth. The study's findings revealed that teachers believe MPCK is important in increasing teaching morale and efficacy and heightening student's performance in mathematics. Teachers consider support from school leaders, parents, and other teachers essential to realizing MPCK. Responses also indicate teachers require resources to expand their MPCK. Understanding and skills critical to MPCK growth were viewed as pedagogical and subject matter knowledge.

The findings from this study may inform education stakeholders on the support needed to increase teachers' MPCK. This study could also lead to policy changes on how PD sessions are designed and resources are allocated to impact education. In conclusion, if teachers' MPCK expands, indications for positive social change can lead to policy

decisions on who can deliver mathematics instruction, system-wide teaching efficacy, and improvement in students' mathematics performance. Effective implementation of the PD should result in improved teacher effectiveness. It is hoped this project study will positively impact teachers' by providing an avenue for them to develop their MPCK to influence their practice. The findings underscore the importance of ongoing, targeted training initiatives for educators, emphasizing the need for continued investment in improving teaching practices and, by extension, student learning outcomes. Moving forward, educators must build upon these insights and continue to prioritize the PD of teachers as a fundamental element in the pursuit of quality mathematics education.

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Appendix A: The Project

Purpose

The purpose of this PD workshop is to provide teachers of mathematics at the primary school level with the opportunity to collaborate in various forms to expand their MPCK knowledge. The sessions were developed to expose educators to the principles of teaching adult learners. They will be provided with opportunities to explore strategies and make recommendations on support for improvement in mathematics teaching and learning.

Goals

The goals of this 3-day PD workshop are to: expose teachers to strategies to teach content that normally pose difficulty for teachers to teach, and to provide participants with opportunities to work collaboratively to problem solve and make recommendations for embracing best practices in teaching mathematics. On the first day of training, the findings from the study will be shared. On the second and third days strategies for teaching mathematics will be discussed.

Learning Outcomes

At the end of the 3-day PD the participants will:

- Discuss factors impacting teachers MPCK growth
- Discuss factors impacting students' performance in mathematics
- Support needed to expand mathematics teaching and learning

- Knowledge and skills needed for mathematics teaching efficacy.
- Learn strategies for interacting with adult learners
- Identify possible solutions to problems relating to parent-teacher relationships that relate to parent literacy levels
- Demonstrate at least one way to engage parents with low literacy skills

Target Audience

The targeted audience for this PD plan will be early childhood teachers from select early childhood institutions.

Components

This PD will be divided into three main topics that are aligned with getting participants to appreciate parent-teacher relationships and explore strategies to support adult learners with low literacy skills.

Building Bridges In Mathematics

Day 1: Research Findings

- Mathematics Pedagogical Content Knowledge
  - Lifts teachers' morale
  - Increases teaching efficacy
  - Heightens students' performance
  - Teachers require support in the following ways:
    - Stakeholder support
    - Resources
    - MPCK is developed though:
      classroom practices
      Professional development session
      Mathematics Resources

Day 1 Continue

- Day 1: What will the PD workshop look like?
- Think Pair-share (30 minutes)
- Presentation

Day 1 Evaluation

- What went well?
- What could be improved?
- What are come new insights gleaned?
- What do I want to know tomorrow?

Day 2

- Welcome and Registration
- Ice-breaker: Mathematics riddles

How do you make the number 7 even without addition, subtraction,

multiplication, or division? **Answer:** Drop the "S".

How can you write down eight eights so that they add up to one thousand? **Answer:** 888 + 88 + 8 + 8 + 8 = 1000.

MODELS OF TEACHER KNOWLEDGE

Shulman (1986) – 7 categories of knowledge

- Content knowledge
- General pedagogical knowledge
- Pedagogical contents knowledge (PCK)
- Curriculum knowledge
- Knowledge of learners and their characteristics
- Knowledge of educational context
- Knowledge of educational ends, purpose, and value and their philosophical and historical grounds

Content Strand NUMBER

- Whole numbers
- Counting numbers
- Digits
- Numerals
- Fractional
- Decimal
- Composite
- Prime
- Even
- odd

Content Strand MEASUREMENT

- Length
- Capacity
- Mass/weight
- Time
- Volume
- Area
- money

Content Strand GEOMETRY

- 2-D
- 3-D

Nets
Area
Perimeter
Volume

Content Strand STATISTICS

- .....

- Find missing values
- Use symbols to replace values

Content Strand PROBABILITY

- Given a total number whats the possibility?

Content Strand

PROBABILITY

Predicting Outcomes
What if ,,,,,,Chances

- Possible
- Impossible
- Certain
- Uncertain
- Lucky
- Unlucky
- Always
- Sometimes
- Never
- More likely
- Less likely
- Equally likely
- Fair
- Random

Think about a concept in any of the content strand you or a colleague had challenges teaching

Discuss it as a group. How do you teach the concept?

In your groups decide on a method that you experience to be more impactful for students. Use the materials provided to create aids then be prepared to demonstrate the lesson to class.

End of Day 2

Please complete evaluation of the day's activities before you leave

Day 3

Mathematics Process Strand

Process Strand

- words
- diagrams
- pictures
- symbols

Communication

Finding ways to express mathematical ideas with

Process Strand

Real World Connections

- Home
- School
- Church
- Sports
- Celebrations
- Places

CONNECTIONS

Mathematics relates to things we do in the real world everyday

MAKING CONNECTIONS THROUGH

- ICT, role play, demonstration

Process Strand

Ask questions such as which everyday activity would require you to use this?

CONNECTIONS

Benefits of linking mathematics to experience

- Provokes interest
- Promotes critical thinking
- Provides a context for using mathematics to solve problems

Process Strand

REASONING AND PROOF

Logical Reasoning
- Comparing
- Classifying/sorting
- Using patterns
- Making connections
- Explaining
- checking
- Visual and Creative thinking
- Visual patterns/spatial reasoning

Reasoning is used to think through a question and come up with a useful answer. It is the major part of problem solving.

Proof is where you check to ensure that your answer is correct or make sense.

Process Strand

REPRESENTATION

- Semi- concrete
- Pictorial

- Using objects to model mathematical ideas
- Using models/pictures/ drawings to organize, record and communicate mathematical ideas
- Using representation to solve mathematical problems

Process Strand

PROBLEM SOLVING

- Use objects/act it out
- Draw a picture
- Use logical reasoning
- Try/check
- Look for a pattern
- Make an organized list
- Make a graph

This is the key in being able to do mathematics. It provides the avenue to think, reason and solve problems

End of Day 3
Evaluation

Strenghts of the Workshop:

Weaknesses:

Most impactful:

What can be improved next time:

How likely am I to recommend this workshop to other colleagues?

How has my MPCK been impacted?

Schedule and Activities

Day 1

Presentation of the Research Findings and Workshop Design

Time	Topic	Method
9:00–9:30am	Registration & Welcome	Registration Sheets
9:30–9:45am	Icebreaker/Get to Know You Activity	Slide show mathematics riddles
9:45–10:00 am	Learning Outcomes & Purpose of PD	PD trainer
10:00–10:15	Water Break	
10:15–12:00 noon	Purpose of the Study & General Findings	PowerPoint Presentation, PD Trainer
12 noon–1:00pm	Lunch	
1:00–2:20pm	Customizing the PD Workshop using research findings	PowerPoint Presentation, Discussion
2:20–2:30	End of Day Reflection	Provide participants with question for reflection.

Building Bridges in Mathematics

DAY 1- SESSION 1
NOTE TAKING AND REFLECTION SHEET

Notes:

1. What went well today?

2. What could be improved?

3. What did I learn today or what am I reflecting on?

Appendix B: Interview Protocol

Part 1: Participant Demographics

1. What degree and/or endorsement do you hold?
2. Are you currently teaching mathematics at the Grade 6?
3. How long have you been teaching at this grade level?

Thank you for taking the time to participate in this study. The purpose of the study is to explore primary teachers' perspective on mathematics pedagogical content knowledge and students' underperformance in mathematics. Before we get started let me remind you that your participation in this study is completely voluntary. Any response given will be kept strictly confidential. Please let me know if any of the questions cause you to be uncomfortable. May I have your permission to audio record? With your permission could I also write notes based on your responses? Would you like to ask any questions before we begin? Should you have any questions after the interview you are free to contact me with any questions or concerns regarding your consent form or your participant rights

Part 3: Semistructured Interview

RQ1: What are primary teachers' perspective regarding the value of teachers' MPCK in improving students' performance in mathematics?

1. What is your perspective on teachers' mathematics pedagogical content knowledge?

2. What is your view of the connection between teachers' MPCK and students' performance in mathematics?

RQ2: What kind of support, knowledge, and skills do teachers feel is essential to experience MPCK growth?

3. What factors do you believe most significantly contribute to teachers' pedagogical content knowledge growth?

4. What factors do you believe most significantly hamper teachers' mathematics pedagogical content knowledge growth?

5. What factors do you believe most significantly contribute to students' performance in mathematics?

6. What factors do you believe most significantly hamper students' performance in mathematics?

7. What support do teachers and students need to increase mathematics performance?

8. Is there anything else you like to tell me about teachers' mathematics pedagogical content knowledge and students' underperformance in mathematics?