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Examining Pedagogical Content Knowledge and Instructional Challenges of Key Stage 1 Mathematics Teachers: Evidence from Catanduanes, Philippines

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Jandel Bon T. Pereyra[1], ORCID No. 0009-0000-6391-502X
Engr. Johnmar F. Cordial[2], PhD, ORCID No. 0000-0003-4151-19341

[1]Teacher, Mind Champs Learning Center, Bato, Catanduanes, Philippines
[2]Faculty Member, Catanduanes State University–Panganiban Campus, Panganiban, Catanduanes, Philippines

Abstract

Pedagogical content knowledge (PCK) is a key determinant of instructional effectiveness in early mathematics education, particularly in geographically isolated and resource-constrained contexts. This study examined the PCK and instructional challenges of Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes, Philippines, during the School Year 2025–2026. It specifically assessed teachers' content knowledge, pedagogical knowledge, and assessment literacy; identified instructional challenges; analyzed differences based on demographic and professional variables; and developed an evidence-based instructional enhancement plan. A quantitative descriptive–comparative research design was employed, involving 105 teachers selected through stratified random sampling from a population of 142. Data were collected using a validated researcher-developed questionnaire (Cronbach's alpha = 0.975) and analyzed using frequency, percentage, weighted mean, t-test, and ANOVA. Findings revealed that respondents were generally experienced and professionally engaged in advanced studies and training. Teachers demonstrated a very high level of PCK across content, pedagogy, and assessment domains, indicating strong instructional competence. However, instructional challenges persisted, particularly in content delivery, alongside pedagogical and assessment-related difficulties. Significant differences were observed when grouped by age, educational attainment, teaching experience, and professional development participation, indicating that teacher characteristics influence both competence and instructional challenges. Despite strong pedagogical competence, contextual and instructional barriers continue to affect effective teaching in isolated settings. An evidence-based enhancement plan was developed, emphasizing content mastery, learner-centered pedagogy, assessment literacy, mentoring, and collaborative professional learning. The study contributes localized evidence and offers practical implications for improving mathematics instruction and learner outcomes in underserved educational contexts.

Keywords: pedagogical content knowledge, mathematics instruction, instructional challenges, Key Stage 1 teachers, instructional enhancement plan, Philippines

INTRODUCTION

Pedagogical content knowledge (PCK) remains a central construct in mathematics education, emphasizing the integration of subject matter expertise and pedagogical strategies necessary for effective teaching, particularly in the early years of schooling (Krauss et al., 2020). In Key Stage 1, where learners develop foundational numeracy skills, teachers' capacity to transform mathematical concepts into developmentally appropriate and meaningful learning experiences is critical to long-term academic success (Darling-Hammond et al., 2017; Organization for Economic Co-operation and Development [OECD], 2019).

Empirical evidence consistently shows that strong PCK enables teachers to anticipate misconceptions, employ responsive instructional approaches, and implement assessment practices that promote conceptual understanding rather than rote learning (Baumert et al., 2010). Accordingly, the quality of

early mathematics instruction is closely tied to the depth and application of teachers' pedagogical content knowledge.

Globally, concerns about the quality of primary mathematics instruction persist, particularly in developing contexts where systemic constraints such as limited resources, uneven teacher preparation, and restricted access to sustained professional development shape classroom practices (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020; World Bank, 2018). In the Philippines, national assessments continue to reveal gaps in learners' mathematics proficiency, underscoring the need to strengthen instructional quality at the foundational level (Department of Education, 2022; TIMSS & PIRLS International Study Center, 2020). Although policy reforms and teacher development initiatives have been implemented, variations in instructional effectiveness remain evident, suggesting that both teachers' PCK and the contexts in which they operate significantly influence learning outcomes (Avalos, 2011; Kraft et al., 2018). These conditions highlight the need to examine not only teachers' pedagogical competence but also the challenges that shape its enactment in practice.

Instructional challenges in early mathematics education are inherently multifaceted, encompassing issues related to content delivery, pedagogical decision-making, and assessment design. Teachers frequently encounter difficulties in aligning instruction with diverse learner needs, managing classroom dynamics, and developing assessments that accurately capture conceptual understanding (Tomlinson, 2017; Black & Wiliam, 2018). At the same time, teacher-related factors such as educational attainment, teaching experience, and participation in professional development are shown to influence both PCK and the capacity to address these challenges effectively (Darling-Hammond et al., 2017; Kraft & Papay, 2014). This interplay suggests that teacher characteristics function not merely as background variables but as critical determinants of instructional quality, warranting a more integrative examination of their relationships with PCK and instructional challenges.

Despite the expanding literature on PCK, important gaps remain. A contextual gap persists in geographically isolated and resource-constrained settings, such as island divisions in the Philippines, where educational conditions differ markedly from urban environments (OECD, 2019; UNESCO, 2020). In Catanduanes, teachers operate under distinct constraints, including limited access to professional development, logistical barriers, and resource scarcity, that may shape both the development and enactment of PCK (Darling-Hammond et al., 2017; World Bank, 2018). A theoretical gap is evident in the reliance on generalized PCK models that insufficiently account for context-specific adaptations in rural and peripheral systems (Baumert et al., 2010). Methodologically, the predominance of descriptive approaches and the limited application of integrative or multivariate analyses constrain deeper understanding of the relationships among teacher characteristics, PCK, and instructional outcomes (Kraft et al., 2018). Furthermore, a conceptual gap exists as PCK and instructional challenges are often examined independently, with limited attention to their interaction in localized early-grade contexts (Black & Wiliam, 2018). An empirical gap also persists in the scarcity of evidence linking teacher profile variables, such as educational attainment, experience, and professional training, to both PCK and instructional challenges within a unified framework (Avalos, 2011). Finally, a research-to-practice gap is evident in the limited translation of empirical findings into context-responsive instructional models that directly inform classroom practice in disadvantaged settings (Department of Education, 2022).

Addressing these gaps, the present study investigates the pedagogical content knowledge of Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes, and examines the instructional challenges they encounter across

content, pedagogy, and assessment domains. It further explores the influence of teachers' demographic and professional characteristics on both PCK and instructional challenges within an integrated analytical framework. By situating the analysis within a localized and resource-constrained context, the study contributes nuanced empirical insights to the literature on early mathematics education. Ultimately, the findings inform the development of an evidence-based instructional enhancement plan that supports teachers in improving the quality of mathematics instruction for young learners, particularly in geographically isolated and underserved educational settings.

Statement of the Problem. This study aimed to examine the level of pedagogical content knowledge (PCK) of teachers teaching mathematics to Key Stage 1 learners in schools in Zone 2, Division of Catanduanes, Philippines. It also sought to identify the challenges encountered in mathematics instruction and to develop an evidence-based instructional enhancement plan.

Specifically, this study addressed the following research questions:

1. What is the demographic profile of Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes, in terms of:
   1.1 age;
   1.2 educational attainment;
   1.3 years of teaching experience; and
   1.4 relevant trainings and seminars attended?

2. What is the level of pedagogical content knowledge (PCK) of the respondents in terms of:
   2.1 content knowledge;
   2.2 pedagogical knowledge; and
   2.3 assessment knowledge?

3. What challenges are encountered by teachers in teaching mathematics to Key Stage 1 learners across the domains of content, pedagogy, and assessment?

4. Is there a significant difference in the pedagogical content knowledge of teacher teaching mathematics in key stage 1 when grouped according to profile variables?

5. Is there a significant difference in the challenges encountered by key stage 1 when grouped according to profile variables?

6. What instructional enhancement plan can be proposed to improve the teaching of mathematics among Key Stage 1 learners based on the findings of the study?

Null Hypotheses. The following null hypotheses were tested at a 0.05 significance level:

Ho_1. There is no significant difference in the pedagogical content knowledge of Key Stage 1 mathematics teachers when grouped according to profile variables.

Ho_2. There is no significant difference in the challenges encountered by Key Stage 1 mathematics teachers when grouped according to profile variables.

Scope of the Study. This study was conducted in Zone 2, Division of Catanduanes, Philippines, during the School Year 2025–2026, focusing on Key Stage 1 mathematics teachers in public elementary schools. It examined the level of pedagogical content knowledge (PCK) in terms of content, pedagogy, and assessment, as well as the instructional challenges encountered across these domains. It also considered teachers' demographic and professional characteristics (age, educational attainment, years of teaching experience, and relevant trainings and seminars attended) and analyzed differences in PCK and instructional challenges when grouped according to these variables using descriptive and inferential approaches. The findings provided the basis for developing a context-responsive instructional enhancement plan aimed at improving early mathematics instruction in geographically isolated and resource-constrained settings.

Theoretical and Conceptual Framework. This study is anchored on the Pedagogical Content Knowledge (PCK) Theory developed by Shulman (1986), as cited by Ling and Mahmud (2023), which emphasizes the integration of content knowledge and pedagogical knowledge as essential components of effective teaching and meaningful learning. Fundamentally, the theory posits that teachers must not only possess mastery of the subject matter but also demonstrate the ability to transform such knowledge into appropriate instructional strategies that respond to learners' needs, abilities, and contextual realities. In this regard, content knowledge refers to teachers' understanding of concepts, principles, and subject-specific competencies, whereas pedagogical knowledge pertains to instructional methods, classroom management practices, teaching strategies, and assessment approaches utilized in facilitating learning.

More importantly, the intersection of these domains' forms pedagogical content knowledge, which enables teachers to deliver instruction more effectively, simplify complex concepts, and foster higher-order thinking and problem-solving skills among learners. Furthermore, Mabonga (2021) emphasized that strong pedagogical content knowledge significantly enhances instructional effectiveness and improves student achievement through learner-centered and context-responsive teaching practices. Consequently, the PCK theory provides a strong theoretical lens for understanding how teachers' professional competencies influence classroom instruction and educational outcomes.

In connection with this theoretical foundation, Figure 1 presents the conceptual paradigm of the study, illustrating the relationship among teacher profile variables, pedagogical content knowledge (PCK), instructional challenges, and the proposed evidence-based instructional enhancement plan. Specifically, the framework posits that teachers' age, educational attainment, years of teaching experience, and trainings or seminars attended significantly influence their content knowledge, pedagogical knowledge, and assessment knowledge, which collectively determine instructional effectiveness.

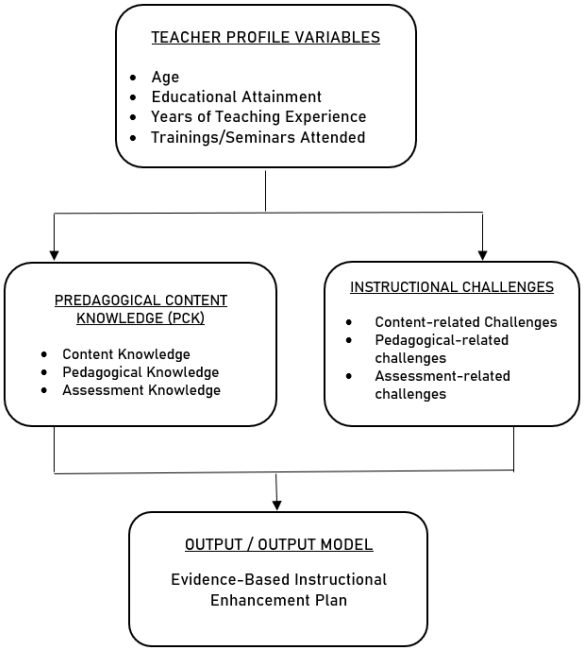

Figure 1
Structural Flow of Teacher Profile, Knowledge, and Challenges Toward Evidence-Based Instructional Outcomes

At the same time, the paradigm recognizes that teachers encounter various instructional challenges categorized into content-related, pedagogical-related, and assessment-related challenges that may hinder the delivery of quality instruction. Hence, the model assumes that the interaction between teacher characteristics, pedagogical content knowledge, and instructional challenges provides essential empirical bases for identifying instructional gaps, instructional limitations, and professional development needs. Moreover, the framework highlights the importance of examining both teacher competence and contextual instructional barriers in understanding the complexities of classroom teaching. Ultimately, the findings of the study serve as the basis for developing an evidence-based instructional enhancement plan aimed at strengthening teachers' pedagogical competencies, addressing instructional challenges, and improving overall teaching and learning outcomes.

LITERATURE REVIEW

Mathematics instruction in the early grades remains a major focus of contemporary educational reforms because of its critical role in developing learners' foundational numeracy, analytical thinking, and long-term academic achievement. In Key Stage 1 education, teachers' pedagogical content knowledge (PCK) is widely regarded as a key factor influencing instructional quality and learner performance. Effective mathematics teaching requires the integration of content knowledge, pedagogical competence, and assessment literacy to promote conceptual understanding and problem-solving skills among young learners. In geographically isolated and resource-limited contexts such as Zone 2, Division of Catanduanes, examining teachers' pedagogical competencies and the instructional challenges they encounter is essential for developing evidence-based interventions that enhance mathematics instruction and learner outcomes.

Pedagogical Content Knowledge in Mathematics Instruction. Recent studies consistently recognize pedagogical content knowledge (PCK) as a critical determinant of effective mathematics instruction in elementary education. PCK is conceptualized as the integration of subject matter knowledge and pedagogical understanding that enables teachers to transform content into comprehensible forms for learners (Hill et al., 2008). In mathematics education, PCK is widely regarded as a multidimensional construct that supports teachers in linking content representation, instructional strategies, and learner understanding in meaningful ways (Ball et al., 2008; Baumert et al., 2010). In classroom practice, strong PCK enables teachers to explain abstract mathematical ideas, diagnose learners' misconceptions, and apply developmentally appropriate instructional strategies that enhance conceptual understanding and learner engagement (Hill et al., 2008; Baumert et al., 2010). Furthermore, research emphasizes that teacher professional development is a key mechanism for strengthening PCK, particularly through structured learning experiences such as training programs, mentoring, and collaborative professional learning communities (Desimone, 2009; Darling-Hammond et al., 2017). In the Philippine educational context, national reforms such as Republic Act No. 10533 reinforce the need to strengthen teacher competencies to improve foundational literacy and numeracy outcomes among learners (Republic of the Philippines, 2013).

Despite extensive research on pedagogical content knowledge, significant gaps remain in studies focusing on Key Stage 1 mathematics instruction in geographically isolated and resource-constrained contexts. Existing literature largely emphasizes general teacher knowledge or secondary mathematics instruction, with limited empirical focus on early-grade mathematics teachers in rural Philippine settings. Moreover, prior studies rarely examine the integrated relationship between content knowledge, pedagogical knowledge, assessment literacy, and instructional challenges in relation to teachers' demographic and professional profiles. There is also a limited body of research translating PCK-related findings into localized, context-responsive instructional enhancement plans tailored to elementary schools in remote divisions such as Catanduanes. Hence, the present study addresses these gaps by examining the pedagogical content knowledge of Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes, identifying instructional challenges, and developing an evidence-based instructional enhancement plan to strengthen mathematics teaching effectiveness.

Instructional Challenges in Teaching Mathematics to Key Stage 1 Learners. Recent literature consistently shows that mathematics teachers continue to encounter instructional challenges that negatively affect teaching effectiveness and learner achievement despite ongoing curriculum reforms and professional development efforts. Empirical studies highlight persistent difficulties in content delivery, learner diversity, limited instructional

resources, and weak assessment practices as major barriers in elementary mathematics instruction (Darling-Hammond et al., 2017; OECD, 2019; UNESCO, 2020). Teachers frequently experience challenges in translating abstract mathematical concepts into understandable forms, differentiating instruction for diverse learners, and addressing persistent misconceptions in mathematics (Tomlinson, 2014; Hill et al., 2008). Additionally, overcrowded classrooms, insufficient learning materials, and limited access to instructional technologies further constrain meaningful learner engagement and conceptual understanding, particularly in under-resourced and geographically isolated school contexts. Collectively, these conditions reflect enduring systemic and pedagogical constraints that limit effective mathematics instruction at the foundational level.

Assessment-related challenges remain equally significant in mathematics education. Black and Wiliam (1998) emphasized that formative assessment is central to improving learning outcomes; however, many teachers continue to struggle in designing valid, reliable, and learner-centered assessment strategies aligned with curriculum standards. Similarly, Popham (2009) noted that limited assessment literacy affects teachers' ability to use assessment results to inform instruction and improve learner performance. In the Philippine educational system, DepEd Order No. 8, s. 2015 institutionalized standards-based and formative assessment practices under the K to 12 curriculum, while Republic Act No. 9155 underscores the need to strengthen instructional supervision and teacher support mechanisms. Despite these policy directions, studies by Abellera (2020), David and Roger (2021), and Mabonga (2021) reveal that many elementary teachers still experience difficulties aligning assessment practices with competency-based and learner-centered instruction. Nevertheless, limited empirical research has systematically examined instructional challenges across content, pedagogy, and assessment domains among Key Stage 1 mathematics teachers in geographically isolated contexts such as Catanduanes. Hence, this study addresses this gap by investigating these instructional challenges and using the findings as basis for a context-responsive, evidence-based instructional enhancement plan.

Teacher Characteristics, Professional Development, and Contextualized Instructional Enhancement. Recent empirical literature consistently demonstrates that teachers' demographic and professional characteristics are significantly associated with pedagogical content knowledge (PCK), instructional competence, and classroom effectiveness. Research indicates that variables such as age, educational attainment, teaching experience, and engagement in professional learning activities contribute to variations in teaching quality and instructional outcomes (Kini & Podolsky, 2016; Toropova et al., 2021; Kraft & Papay, 2014). Teachers with greater experience tend to exhibit stronger classroom management, adaptive instructional strategies, and deeper contextual understanding, while those with higher qualifications and sustained professional learning engagement demonstrate stronger instructional planning, assessment literacy, and learner-centered pedagogical practices (Darling-Hammond et al., 2017; Desimone, 2009). Collectively, these findings underscore that teacher-related characteristics are critical determinants of pedagogical content knowledge development and instructional effectiveness, particularly in mathematics education.

Contemporary policy and research further emphasize the importance of continuous professional development and contextualized instructional enhancement in improving teaching quality and learner achievement. The Department of Education institutionalized school-based professional learning through the Learning Action Cell (LAC) via DepEd Order No. 35, s. 2016, while DepEd Order No. 24, s. 2020 reinforced competency-based professional development aligned with national teaching standards. International frameworks also highlight that effective professional learning

must be sustained, collaborative, and context-responsive to improve instructional practice (OECD, 2019; UNESCO, 2020). In addition, studies by Avalos (2011), Darling-Hammond et al. (2017), and Kraft et al. (2018) confirm that high-quality, sustained professional development significantly enhances teacher effectiveness and student learning outcomes, particularly in under-resourced and rural school contexts. Nevertheless, despite these advances, limited research has simultaneously examined the interaction of teacher profile variables, pedagogical content knowledge, and instructional challenges among Key Stage 1 mathematics teachers in geographically isolated contexts such as Zone 2, Division of Catanduanes. Hence, this study addresses this gap by generating localized empirical evidence that may serve as a basis for a context-responsive instructional enhancement plan aimed at strengthening early-grade mathematics instruction.

METHODS

Research Design. This study employed a quantitative descriptive–comparative research design to examine the pedagogical content knowledge (PCK) of Key Stage 1 mathematics teachers, identify their instructional challenges, and determine differences when grouped according to selected profile variables. The descriptive component was used to systematically describe teachers' levels of PCK in terms of content knowledge, pedagogical knowledge, and assessment knowledge, as well as the nature of instructional challenges encountered in mathematics teaching (Creswell & Creswell, 2018; Snyder, 2019). Meanwhile, the comparative component was applied to test for significant differences in PCK and instructional challenges across teacher profile groups, consistent with inferential approaches in educational research (Fraenkel, Wallen, & Hyun, 2019; Saunders et al., 2019). This design is appropriate for generating evidence on existing conditions and group variations in teacher characteristics and instructional practices, supporting data-driven conclusions for educational improvement (König et al., 2022; Gess-Newsome, 2015).

Population, Samples and Sampling Technique. The study population consisted of 142 teachers handling Grades 1 to 3 in selected elementary schools across the municipalities of Baras, Bato, Gigmoto, and San Miguel during the academic year 2025–2026. A sample of 105 respondents was determined using Slovin's formula with a 5% margin of error, ensuring a statistically adequate and reliable representation of the population while maintaining a balance between precision and feasibility. To ensure proportional representation across the four municipalities, stratified random sampling using proportional allocation was employed, wherein respondents were grouped according to school or municipal affiliation and subsequently selected through random procedures within each stratum. This method minimized sampling bias and enhanced the representativeness, external validity, and generalizability of the study findings, consistent with established methodological recommendations in educational research (Etikan et al., 2016; Taherdoost, 2017).

Instrumentation. The study utilized a researcher-developed structured questionnaire as the primary data-gathering instrument to assess the level of pedagogical content knowledge (PCK) and the challenges encountered by teachers. The instrument consisted of three parts. Part I elicited the demographic and professional profile of respondents. Part II measured the level of PCK across key domains of content knowledge, pedagogical knowledge, and assessment practices. Part III examined the challenges encountered in relation to these domains, including difficulties in content mastery, instructional delivery, and assessment implementation. Responses were recorded using a 4-point Likert scale, where higher scores indicated stronger agreement, higher levels of PCK, or greater extent of challenges encountered.

To establish face and content validity, the instrument underwent expert evaluation by a panel of specialists in education and research. Reliability was determined through pilot testing involving 30 respondents, and internal consistency was computed using Cronbach's alpha, which yielded a coefficient of 0.975, indicating excellent reliability. These procedures ensured that the instrument was both contextually appropriate and methodologically sound for data collection in educational research settings (Creswell & Creswell, 2018; Mertens, 2022). The evaluation and scoring scheme is presented in Table 1.

Table 1

Evaluation and Scoring of Pedagogical Content Knowledge and Challenges Encountered

Assigned Points	Numerical Range	Level of PCK	Challenges Encountered
4	3.25–4.00	Strongly Agree / Very High	Strongly Agree / Highly Encountered
3	2.50–3.24	Agree / High	Agree / Encountered
2	1.75–2.49	Disagree / Low	Disagree / Less Encountered
1	1.00–1.74	Strongly Disagree / Very Low	Strongly Disagree / Least Encountered

Note: All variables were measured using a 4-point Likert scale, where higher scores denote higher levels of pedagogical content knowledge and greater extent of challenges encountered across content, pedagogy, and assessment domains.

Data Analysis. The study used descriptive and inferential statistics to examine teachers' PCK and instructional challenges in teaching mathematics among Key Stage 1 learners. Frequency and percentage were used for demographic profiling, while weighted means determined the levels of PCK and challenges across content, pedagogical, and assessment domains. Ranking was applied based on weighted means to identify relative positions of indicators. Independent samples t-test and one-way ANOVA were used to test differences across groups. Prior to analysis, Shapiro–Wilk and Levene's tests confirmed normality and homogeneity of variance, indicating that parametric tests were appropriate. Where assumptions were not met, Welch's t-test/Welch's ANOVA and Mann–Whitney U/Kruskal–Wallis tests were considered as alternatives. These procedures ensured the validity and robustness of the results (Creswell & Creswell, 2018; Field, 2020).

Ethical Considerations. Ethical standards were rigorously upheld throughout the conduct of the study. Prior to data collection, informed consent was obtained from all teacher-participants to ensure voluntary participation and a clear understanding of the study's objectives, procedures, and their rights, including the option to withdraw at any stage without penalty. Confidentiality and anonymity were strictly maintained by safeguarding all data and excluding any identifying information in the reporting of results. All responses were treated with utmost confidentiality and were utilized solely for academic and research purposes. Furthermore, the researcher ensured that findings were presented with honesty, accuracy, and transparency, avoiding any form of data manipulation or misrepresentation. These ethical safeguards reinforced the integrity of the research process, protected the welfare and rights of participants, and enhanced the credibility and trustworthiness of the study outcomes (Mertens, 2020; Israel & Hay, 2021).

RESULTS

This section presents the findings of the study on the pedagogical content knowledge (PCK) and instructional challenges of Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes. It includes the respondents' demographic profile, level of PCK, challenges encountered in mathematics instruction, significant differences based on profile variables, and the proposed instructional enhancement plan derived from the findings.

Demographic Profile of Key Stage 1 Mathematics Teachers in Zone 2, Division of Catanduanes. Table 2 presents the demographic profile of the 105 Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes. The findings reveal that most respondents were aged 40–59 years, indicating a mature and experienced teaching workforce. In terms of educational attainment, the majority had bachelor's degrees with master's units, suggesting active engagement in graduate studies and professional advancement. The data further show that most teachers had 15

years and above teaching experience, reflecting substantial exposure to classroom instruction and curriculum implementation. Moreover, a large proportion of respondents attended 15 or more trainings and seminars, indicating strong participation in professional development activities. Overall, the profile suggests that the respondents possess considerable teaching experience and continuous professional learning relevant to mathematics instruction in Key Stage 1 education.

Table 2

Demographic Profile of Key Stage 1 Mathematics Teachers in Zone 2, Division of Catanduanes (n = 105)

Profile Variable	Category	Frequency (f)	Percentage (%)
Age	Below 30 years old	2	1.91
	30–39 years old	25	23.81
	40–49 years old	38	36.19
	50–59 years old	39	37.14
	60 years old and above	1	0.95
Total		**105**	**100.00**
Educational Attainment	Bachelor's Degree	7	6.67
	Bachelor's Degree with Master's Units	82	78.09
	Master's Degree	11	10.48
	Master's Degree with Doctoral Units	4	3.81
	Doctoral Degree Holder	1	0.95
Total		**105**	**100.00**
Years in Teaching	Below 5 years	3	2.86
	5–9 years	9	8.57
	10–14 years	19	18.09
	15 years and above	74	70.48
Total		**105**	**100.00**
Trainings/ Seminars Attended	5–9 trainings	17	16.19
	10–14 trainings	12	11.43
	15 and above trainings	76	72.38
Total		**105**	**100.00**

Level of Pedagogical Content Knowledge (PCK) of Key Stage 1 Mathematics Teachers. Table 3 reveals that the respondents demonstrated a very high level of pedagogical content knowledge (PCK) in teaching mathematics to Key Stage 1 learners, as reflected by the overall weighted mean of 3.54. Among the domains, content knowledge obtained the highest mean of 3.56, indicating that teachers possess strong understanding of mathematical concepts, principles, and subject matter relevant to early-grade instruction. Knowledge of assessment and pedagogical knowledge both garnered weighted means of 3.53, suggesting that the respondents are also highly competent in selecting appropriate teaching strategies and utilizing assessment practices to support learner understanding. The relatively low standard deviation values indicate consistency in the respondents' perceptions. Overall, the findings imply that the teachers exhibit strong instructional competence necessary for effective mathematics teaching in Key Stage 1 classrooms.

Table 3

Composite Table on Level of Pedagogical Content Knowledge as Perceived by the Respondents (n = 105)

Variable	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation	Rank
Content Knowledge	3.56	0.41	Strongly Agree / Very High	1
Knowledge of Pedagogical	3.53	0.43	Strongly Agree / Very High	3
Knowledge of Assessment	3.53	0.42	Strongly Agree / Very High	2
Overall Weighted Mean	3.54	0.42	Strongly Agree / Very High	

Note: 3.25-4.00 -Strongly Agree/Very High; 2.50-3.24 -Agree/High; 1.75-2.49 -Disagree/Fine; 1.00-1.74 -Strongly Disagree/Very Low

Challenges Encountered by Teachers in Teaching Mathematics to Key Stage 1 Learners. Table 4 indicates that the respondents encountered instructional challenges in teaching mathematics to Key Stage 1 learners, as reflected by the overall weighted mean of 2.62 interpreted as "Agree/Encountered." Among the domains, challenges related to content knowledge obtained the highest weighted mean of 2.64, suggesting that teachers experienced difficulties in explaining mathematical concepts, simplifying lessons, and addressing learners' misconceptions. Knowledge of assessment ranked second with a weighted mean of 2.62, implying challenges in designing and implementing appropriate assessment strategies aligned with learners' needs.

Meanwhile, pedagogical knowledge obtained the lowest mean of 2.61, although still interpreted as encountered, indicating concerns related to instructional strategies and classroom management. The close standard deviation values further suggest consistency in the respondents' perceptions regarding the instructional challenges experienced in mathematics teaching.

Table 4

Composite Table on Challenges Encountered in Content Knowledge, Pedagogical Knowledge (PCK) (n = 105)

Variable	Weighted Mean	Standard Deviation (SD)	Verbal Interpretation	Rank
Content Knowledge	2.64	0.48	Agree / Encountered	1
Knowledge of Pedagogy	2.61	0.46	Agree / Encountered	3
Knowledge of Assessment	2.62	0.47	Agree / Encountered	2
Overall Weighted Mean	**2.62**	**0.47**	Agree / Encountered	—

Note: 3.25-4.00 -Strongly Agree/Very High; 2.50-3.24 -Agree/High; 1.75-2.49 -Disagree/Fine; 1.00-1.74 -Strongly Disagree/Very Low

Difference in the Pedagogical Content Knowledge of Teachers When Grouped According to Profile Variables. Prior to conducting the inferential analyses, the assumptions of normality and homogeneity of variance were evaluated. Results of the Shapiro–Wilk test indicated that the distributions of pedagogical content knowledge and instructional challenge scores across groups did not significantly deviate from normality (p > .05). Likewise, Levene's test revealed no significant violations of the homogeneity of variance assumption for the variables examined (p > .05). Consequently, one-way ANOVA was considered appropriate for determining differences across respondent groups.

Table 5 reveals significant differences in the pedagogical content knowledge (PCK) of Key Stage 1 mathematics teachers when grouped according to profile variables. Age showed significant differences across all domains; content, pedagogical, and assessment knowledge (p < .001) with post hoc results indicating that teachers aged 40 and above generally obtained higher PCK scores than younger teachers. Educational attainment likewise showed significant differences across all domains, with post hoc analysis revealing that teachers with master's units or master's degrees outperformed those with only bachelor's degrees. Years in teaching significantly influenced pedagogical and assessment knowledge (p < .001), with teachers having 15 years or more experience scoring higher than less experienced groups. Trainings and seminars attended significantly affected content knowledge (p < .001), where those with 15 or more trainings performed better, while no significant differences were found in pedagogical and assessment knowledge.

Table 5

Differences in the Pedagogical Content Knowledge of Key Stage 1 Mathematics Teachers by Profile Variables (n = 105)

Profile Variable	Content Knowledge	Pedagogical Knowledge	Assessment Knowledge
Age	F = 108.08, p < .001 ✓	F = 189.07, p < .001 ✓	F = 192.56, p < .001 ✓
Educational Attainment	F = 10.71, p < .001 ✓	F = 16.55, p < .001 ✓	F = 29.21, p < .001 ✓
Years in Teaching	F = 2.75, p = .060 ✗	F = 44.54, p < .001 ✓	F = 46.18, p < .001 ✓
Trainings/ Seminars Attended	F = 7.23, p < .001 ✓	F = 3.11, p = .060 ✗	F = 2.40, p = .110 ✗

Note: ✓ = significant at α = .05; ✗ = not significant. Significant ANOVA results were subjected to post hoc multiple comparisons presented in the supplementary tables.

Difference in the Challenges Encountered by Teachers When Grouped According to Profile Variables. Table 6 shows significant differences in the instructional challenges experienced by Key Stage 1 mathematics teachers when grouped according to profile variables. Age significantly affected all domains of challenges (p < .001), with post hoc results indicating that younger teachers generally reported more difficulties than older teachers. Educational attainment also showed significant differences across all domains, where teachers with lower qualifications experienced greater challenges compared to those with master's units or master's degrees. Years in teaching significantly influenced all challenge domains (p < .001), with less experienced teachers reporting higher levels of difficulty than those with longer teaching experience. Trainings and seminars attended were likewise significant, with teachers having fewer trainings experiencing more challenges than those with greater professional development exposure. Overall, instructional challenges tend to decrease with higher education, greater experience, and increased training.

Table 6

Differences in the Challenges Encountered by Key Stage 1 Mathematics Teachers by Profile Variables (n = 105)

Profile Variable	Content Knowledge	Pedagogical Knowledge	Assessment Knowledge
Age	F = 36.346, p < .001 ✓	F = 12.678, p < .001 ✓	F = 502.164, p < .001 ✓
Educational Attainment	F = 8.181, p < .001 ✓	F = 5.036, p < .001 ✓	F = 5.398, p < .001 ✓
Years in Teaching	F = 219.737, p < .001 ✓	F = 271.567, p < .001 ✓	F = 46.251, p < .001 ✓
Trainings/ Seminars Attended	F = 9.955, p < .001 ✓	F = 5.163, p = .020 ✓	F = 18.598, p < .001 ✓

Note: ✓ = significant at α = .05; ✗ = not significant. Significant ANOVA results were subjected to post hoc multiple comparisons presented in the supplementary tables.

Proposed Instructional Enhancement Plan for Improving the Teaching of Mathematics Among Key Stage 1 Learners

Rationale. This Instructional Enhancement Plan is developed based on the findings of the study on the pedagogical content knowledge (PCK) and instructional challenges of Key Stage 1 mathematics teachers. The plan responds to identified gaps in content knowledge application, pedagogical strategies, and assessment practices, aiming to strengthen instructional effectiveness and improve learner numeracy outcomes in early-grade mathematics education.

General Objective. To enhance the pedagogical content knowledge and instructional effectiveness of Key Stage 1 mathematics teachers through targeted capacity-building interventions that address content delivery, pedagogical strategies, and assessment practices.

DISCUSSION

The findings of the study provide important insights into the pedagogical content knowledge (PCK), instructional challenges, and professional characteristics of Key Stage 1 mathematics teachers in Zone 2, Division of Catanduanes. Overall, the results highlight the significant role of teacher-related characteristics and continuous professional development in shaping instructional competence and effective mathematics teaching practices in early-grade education.

The demographic profile indicates that most Key Stage 1 mathematics teachers were aged 40–59 years, possessed bachelor's degrees with master's units, had 15 years and above teaching experience, and actively participated in professional development activities. These findings suggest a professionally mature and experienced teaching workforce capable of demonstrating stronger instructional competence and adaptive pedagogical practices. Moreover, the respondents' active engagement in graduate studies and training programs reflects their commitment to professional growth and instructional improvement. Prior studies emphasize that experienced teachers tend to exhibit deeper pedagogical content knowledge, improved classroom management, and more effective instructional decision-making (Kini & Podolsky, 2016; Kraft & Papay, 2014). Similarly, sustained participation in professional learning activities enhances instructional quality, assessment literacy, and learner-centered teaching practices (Darling-Hammond et al., 2017).

Furthermore, the findings revealed that Key Stage 1 mathematics teachers demonstrated a very high level of pedagogical content knowledge, particularly in content knowledge, pedagogical knowledge, and assessment literacy. This suggests that the respondents possess the instructional competence necessary for effective mathematics teaching in early-grade classrooms. In particular, the teachers demonstrated the ability to integrate mathematical understanding with appropriate teaching strategies and assessment practices to support learner comprehension and engagement. Consistent with previous studies, strong PCK enables teachers to explain mathematical concepts clearly, address learners' misconceptions, and employ developmentally appropriate instructional approaches that improve learner achievement (Hill et al., 2008; Ball et al., 2008; Baumert et al., 2010). Additionally, sustained professional development significantly contributes to strengthening teachers' pedagogical competence and instructional effectiveness in mathematics education (Desimone, 2009).

Table 7
Enhancement Plan Matrix

Key Area	Specific Objective	Strategies / Activities	Persons Involved	Time Frame	Expected Output / Outcome	Success Indicators
Content Knowledge Enhancement	Strengthen teachers' mastery of foundational mathematics concepts	Mathematics content mastery workshops; error analysis; misconception diagnosis sessions; problem-solving drills	Mathematics teachers, Master Teachers, Math coordinators	Quarterly	Improved conceptual understanding of basic mathematics content	Increased post-test scores; improved lesson delivery accuracy
Pedagogical Development	Enhance learner-centered and effective teaching strategies	Differentiated instruction training; demonstration teaching; peer observation and feedback cycles	Teachers, School Heads, Instructional Supervisors	Quarterly / LAC sessions	Improved instructional delivery and classroom engagement	Higher classroom observation ratings; improved learner participation
Assessment Literacy Improvement	Improve design and use of formative and summative assessments	Workshops on assessment design; performance-based assessment development; formative feedback training	Teachers, Assessment focal persons	Semi-annual	Valid, reliable, and learner-centered assessment tools	Improved assessment quality and alignment with competencies
Instructional Challenge Mitigation	Address classroom difficulties affecting mathematics instruction	Classroom management training; inclusive education strategies; contextualized learning material development	Teachers, School Heads, SPED coordinators	Ongoing	Reduced instructional barriers in mathematics teaching	Fewer reported classroom issues; improved learner comprehension
Professional Development & Collaboration	Strengthen continuous teacher development and collaboration	Learning Action Cell (LAC) strengthening; mentoring/coaching programs; Professional Learning Communities (PLC)	Teachers, Master Teachers, School Heads	Continuous / Monthly	Sustained professional growth and collaboration	Active LAC participation; documented mentoring activities
Monitoring and Evaluation	Assess effectiveness of the enhancement plan	Pre- and post-assessment; classroom observation; teacher self-evaluation; learner performance tracking	School Heads, Supervisors, Researchers	Ongoing	Evidence-based evaluation of program impact	Measurable improvement in teacher and learner performance

Despite the respondents' high pedagogical competence, the study also revealed that teachers encountered notable instructional challenges in content knowledge, pedagogy, and assessment. Specifically, the highest challenge was associated with content knowledge, indicating difficulties in simplifying mathematical concepts, addressing learners' misconceptions, and facilitating conceptual

understanding among young learners. Likewise, challenges related to assessment practices and instructional strategies suggest limitations in implementing learner-centered and competency-based approaches effectively. These findings align with previous studies emphasizing that mathematics teachers frequently struggle with content delivery, differentiated instruction, and assessment literacy, particularly in geographically isolated and resource-constrained contexts (Hill et al., 2008; Tomlinson, 2014; OECD, 2019). Moreover, inadequate instructional resources and limited contextual support may further constrain effective mathematics instruction and learner engagement (Darling-Hammond et al., 2017).

In addition, the findings showed that significant differences existed in the pedagogical content knowledge of teachers when grouped according to age, educational attainment, teaching experience, and participation in trainings and seminars. This implies that teacher-related characteristics substantially influence instructional competence, particularly in content delivery, pedagogical strategies, and assessment practices. Older and more academically qualified teachers tended to demonstrate stronger PCK, possibly due to greater professional exposure, reflective practice, and continuous learning experiences. Correspondingly, previous studies noted that teaching experience and sustained professional development enhance classroom effectiveness, assessment literacy, and learner-centered instructional practices (Kini & Podolsky, 2016; Darling-Hammond et al., 2017). Likewise, professional learning opportunities contribute significantly to the development of adaptive teaching strategies and deeper pedagogical understanding in mathematics instruction (Desimone, 2009; Toropova et al., 2021; Darling-Hammond et al., 2017).

Similarly, the findings revealed significant differences in the instructional challenges encountered by teachers when grouped according to age, educational attainment, years in teaching, and trainings or seminars attended. This indicates that teacher-related characteristics substantially influence the extent of difficulties experienced in content delivery, pedagogy, and assessment practices. Teachers with varying levels of professional preparation and experience may differ in their ability to manage learner diversity, simplify mathematical concepts, and implement effective assessment strategies. Consistent with prior studies, instructional challenges in mathematics are often shaped by professional competence, contextual teaching conditions, and access to sustained professional development opportunities (Darling-Hammond et al., 2017; OECD, 2019). Moreover, continuous training and collaborative professional learning significantly strengthen teachers' adaptive instructional practices and assessment literacy, particularly in resource-constrained educational settings (Desimone, 2009; UNESCO, 2020).

Finally, the proposed instructional enhancement plan was developed to address the identified gaps in pedagogical content knowledge and instructional challenges encountered by Key Stage 1 mathematics teachers. The plan emphasizes strengthening content mastery, learner-centered pedagogical strategies, assessment literacy, and collaborative professional development to improve instructional effectiveness and learner numeracy outcomes. The inclusion of mentoring programs, Learning Action Cell (LAC) sessions, classroom observations, and contextualized instructional interventions reflects the importance of sustained and context-responsive professional learning in enhancing teaching quality. Consistent with previous studies, continuous professional development significantly improves teachers' pedagogical competence, assessment practices, and classroom effectiveness, particularly in under-resourced educational settings (Desimone, 2009; Darling-Hammond et al., 2017). Likewise, collaborative learning communities and evidence-based instructional support promote reflective practice, adaptive teaching strategies, and improved learner achievement in mathematics education (Avalos, 2011).

Overall, the study concludes that while Key Stage 1 mathematics teachers possess high pedagogical competence, they continue to experience instructional challenges influenced by demographic and professional characteristics. Hence, sustained and context-responsive professional development programs should be strengthened to enhance teachers' content delivery, pedagogical practices, and assessment literacy. It is therefore recommended that school administrators, instructional supervisors, and education stakeholders institutionalize continuous capacity-building initiatives, mentoring programs, collaborative professional learning communities, and localized instructional support mechanisms to further improve mathematics instruction and learner outcomes in Key Stage 1 education.

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