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Research paper

Mathematics Teachers' Competence and Instructional Quality in Senior High Schools in The Province of Laguna

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Abstract

This study explored the relationship and effects of teachers' competence to their instructional quality in public senior high schools in the Philippines. Employing a descriptive-correlational design, the study surveyed 129 mathematics teachers from seven schools' divisions of Laguna Province. Stratified random sampling ensured equitable representation. Teachers' instructional quality was assessed through cognitive activation, student support and classroom management with a reliability coefficient of 0.865. Meanwhile, teachers' competence was measured across five domains such as mathematics content knowledge (MCK), pedagogical content knowledge (MPCK), general pedagogi-cal knowledge (GPK), affective-motivation characteristics, and situation-specific skills with a reliability coefficient of 0.931. Multiple re-gression analysis was used to determine statistical correlations and its effect. Findings revealed very high instructional quality, while accom-plished levels were observed in teacher competence aspects. A strong positive correlation was found between overall teacher competence and all aspects of instructional quality. Specifically, MCK positively influenced cognitive activation, while both MCK and situation-specific skills impacted on student support. Classroom management was significantly affected only by situation-specific skills. These results under-scored the multifaceted nature of teacher competence in driving effective mathematics instruction, informing the development of a Mathemat-ics Teachers' Instructional Quality Framework. Future research with a larger sample is recommended to further explore these complex rela-tionships.

Keywords: *Mathematics Competence; Instructional Quality; Senior High School Teachers; Framework.*

1. Introduction

The underperformance in mathematics among Filipino students was a significant issue that raised questions about the effectiveness of the educational system. The consistent low performance levels were emphasized by both national and international assessments, which indicated a deeper systemic problem that demanded careful examination. Despite the country's implementation of the K to 12 educational reforms and the introduction of numerous policies and programs to improve education quality and student achievement, recent results from the Programme for International Student Assessment [1 - 3]and the National Achievement Test (NAT) [4] indicated that students still performed poorly in mathematics. These results served as a starting point for urgent exploration to identify and tackle the core challenges that prevented students from receiving quality mathematics education.

The PISA results clearly illustrated this challenge. In 2018, the Philippines ranked second to last among 79 participating nations, with an average score of 353 points, a staggering 136 points below the OECD average. A particularly concerning 80.70% of Filipino students performed below Level 2 in mathematical literacy, indicating a severe deficit in foundational skills, with a small fraction 0.01% demonstrating advanced mathematical thinking. While the 2022 PISA results showed a marginal 2-point increase to 355, placing the country 76th out of 81, this minimal improvement did not signal substantial progress. The average score remained significantly below the OECD average of 472, and despite ongoing educational initiatives, 84% of Filipino students continued to perform below Level 2 proficiency in mathematics, with none reaching the advanced Levels 5 or 6.

This pattern of underperformance was further corroborated by the National Achievement Test (NAT) results for Grade 12 students. Data for Academic Year 2022-2023 in the CALABARZON region revealed consistently low mathematics proficiency, with subtests in problem-solving (29.75 MPS), information literacy (37.03 MPS), and critical thinking (44.33 MPS) all fell significantly below the Department of Education's (DepEd) 75% proficiency standard. This indicated profound struggles with strategic problem identification and information organization. Nationwide, the 2023-2024 NAT results for Grade 12 also echoed this trend, showing generally low mathematics proficiency with a national average of 41.12. Although CALABARZON's average score of 43.85 was slightly higher, it remained within the low proficiency range. This persistent weakness, consistently observed across both national and international assessments, highlighted an urgent and critical challenge within the Philippine education system that necessitated immediate, targeted attention to identify and address the core obstacles to quality mathematics education.

Despite considerable efforts, including teacher training programs, policy changes, and the introduction of initiatives like the MATATAG curriculum and the National Mathematics Program (NMP), students in the Philippines continued to exhibit poor mathematics proficiency. This consistent underperformance, clearly reflected in low scores on both international (PISA) and national (NAT) assessments, strongly suggested that the issues were not superficial, but rather deep-rooted and fundamental problems within the Philippine education system itself. This raised serious concerns about whether current interventions were truly effective or comprehensive enough.

A significant concern was that teachers often lacked adequate subject matter expertise and effective teaching skills [5]. This meant that their own understanding of mathematics might not have been sufficient, or they might not have had the most effective methods to convey it. There were difficulties in developing the pedagogical skills necessary for 21st-century competencies, indicating that teachers may not have been prepared to foster critical thinking, problem-solving, and other essential modern skills [6]. A general lack of preparedness for their roles was noted, with specific challenges including insufficient training and inadequate preparation for new teachers [6][7]. Teachers and students alike perceived these competency gaps in teaching. Furthermore, there was a significant shortage of essential learning materials, technology, and infrastructure, particularly prevalent in public and rural schools [8]. This scarcity directly hindered effective curriculum implementation and negatively impacted the fairness and effectiveness of assessments, creating an uneven playing field for learning. Historically, mathematics instruction may have overemphasized rote memorization rather than actively fostering critical thinking and problem-solving skills. This traditional approach failed to build deep conceptual understanding, which is vital for true mathematical proficiency. Both teachers and students perceived gaps in competency, especially in teaching, which suggested a disconnect between current practices and desired outcomes [7].

The persistence of these issues despite interventions indicated that past efforts may have missed these fundamental underpinnings. To truly address this, a comprehensive, evidence-based approach was needed. This meant going beyond superficial fixes and deeply diagnosing these root causes by combining data from assessments (like PISA and NAT), teacher training effectiveness, and resource distribution to get a holistic picture. Designing solutions that directly addressed the identified root causes, rather than applying generic solutions. Without directly confronting these multifaceted issues especially the foundational gaps in teacher competence, the lack of essential resources, and the need to shift from rote learning to critical thinking, the Philippines would likely continue to struggle with improving student mathematics proficiency.

This study was launched to address the persistent low performance of students in mathematics by focusing directly on teacher competence and instructional quality as the key solutions. The core idea is that highly effective teachers, those with strong content knowledge (MCK), teaching expertise (MPCK/GPK), skills, and beliefs—directly lead to high-quality instruction and, ultimately, better student achievement. Critically, while international literature establishes the link between teacher competence and student outcomes, there was a significant research gap concerning the precise, localized predictive relationships between specific facets of mathematics teacher competence (MCK, MPCK, GPK, Affective-Motivation, Situation-Specific Skills) and specific dimensions of instructional quality (Cognitive Activation, Student Support, Classroom Management) within the Senior High School system of Laguna Province. This study specifically aimed to fill that gap by providing a comprehensive, empirical framework tailored to the local context.

2. Literature Review

Moving beyond fragmented theories of teaching, the study was anchored in a powerful theoretical architecture that merges the Multidimensional Adapted Process (MAP) model [9] with the Three Basic Dimensions (TBD) framework [10]. This literature review is essential for accurately mapping how latent teacher competence translates into observable instructional quality.

Instructional quality is defined as the effectiveness, efficiency, and engagement of teaching practices, reflecting observable classroom behavior that directly promotes student learning and development [11]. Research frameworks, particularly in the German context, commonly define instructional quality by three essential, observable dimensions: Cognitive Activation, Student Support, and Classroom Management. Cognitive Activation refers to the degree to which students are challenged with tasks requiring higher-level thinking. Student Support involves fostering a positive atmosphere and providing personalized, differentiated instruction to address learning needs. Classroom Management refers to the effective use of time, prevention of disruptions, and establishment of clear rules [12]. Developing valid measures for these dimensions is crucial, as they provide the necessary theoretical foundation to understand and enhance teaching practices that influence student achievement.

The field of research on teacher professional competence has matured through a crucial synthesis, moving from two separate historical perspectives to a unified, dynamic model. For two decades, the dominant view treated teacher competence as stable knowledge traits (like MCK, MPCK, GPK) consistent across all classroom situations. However, a more recent, situated perspective shifted focus to the context-specific, moment-to-moment skills of teaching, theorized around the concept of "noticing" a teacher's ability to quickly discern and act upon noteworthy classroom events. The goal of this situated work was to find competence facets more directly tied to observed instructional quality. The Blömeke et al. [9] model successfully integrated these cognitive and situated approaches by conceptualizing teacher competence as a continuum. In this framework, competence is a multi-dimensional construct comprising two main parts: dispositions (the teacher's potential, including knowledge and affective-motivational beliefs) and situation-specific cognitive skills.

The structural foundation of teacher competence is defined by three interacting knowledge bases. Mathematics Content Knowledge (MCK) provides a deep understanding of mathematical concepts and procedures necessary to effectively address student misconceptions [13]. Mathematics Pedagogical Content Knowledge (MPCK) operationalizes this content, encompassing knowledge of curriculum, planning, and enacting subject-specific instruction [13]. On the other hand, General Pedagogical Knowledge (GPK) is essential for subject-generic tasks, such as classroom management, student motivation, and assessment strategies [14]. This cognitive potential is intrinsically linked to affective-motivational characteristics, with teachers' beliefs—subjective assumptions categorized as either constructivist or transmissive—acting as a core component and the lens through which they interpret and respond to teaching situations, thus profoundly shaping instructional practices [15]. Crucially, since knowledge alone is insufficient for high-quality instruction, teachers require situation-specific cognitive skills to effectively translate their knowledge and beliefs into action. These skills, defined by the ability to Perceive, Interpret, and Decide (PID), represent the necessary cognitive processes for adapting to the dynamic classroom environment, enabling teachers to diagnose student behavior and make informed, immediate instructional choices [9].

Empirical studies delineated the differential influence of teacher competence facets on the three dimensions of instructional quality: Cognitive Activation, Student Support, and Classroom Management. Mathematics Content Knowledge (MCK), or a teacher's deep subject mastery, held a unique and primary influence on Cognitive Activation. Teachers with solid MCK were better equipped to explain complex concepts and articulate the connections between them [16]. This depth of knowledge was crucial because it directly influenced the selection and framing of materials, determining the necessary complexity for students to think critically and solve novel problems [17]. For instance, complex teaching methods like incorporating historical context or real-life problems [18] [19] demanded an MCK that moved beyond simple procedures into Specialized Content Knowledge (SCK). Teachers with this expertise were able to design activities that went beyond rote memorization [20], resulting in fewer errors and richer, more insightful explanations [21]. Essentially, profound subject knowledge was what enabled a teacher to effectively challenge students and guide them toward genuine understanding. While MCK was the key driver for setting intellectual rigor, its primary influence was not on the managerial or relational aspects of teaching (e.g., Classroom Management or general Student Support). For example, GPK and Situation-Specific Skills were typically needed to manage behavior or provide emotional support, whereas MCK's strength lay in setting the intellectual ceiling of the lesson. Furthermore, MCK alone was insufficient; teachers also needed to know how to teach effectively. The evidence confirmed that both MCK and MPCK primarily drove the quality of instruction that led to Cognitive Activation [22]. This highlighted that to truly foster critical thinking, a teacher's knowledge base had to be both deep (MCK) and strategically applicable to teaching the specific subject matter (PCK).

Moreover, the study clearly established that a teacher's professional knowledge (like strong MCK and MPCK) did not directly improve student learning [23]. Instead, this deep knowledge acted only as a high-potential resource. Its ultimate realization into observable, high-quality instruction across all areas (Cognitive Activation, Student Support, and Classroom Management) had to first pass through the teacher's real-time adaptive skills, known as Situation-Specific Skills (SSS). The effect chain was clear: the teacher's ability to quickly Perceive a student's difficulty, Interpret the root conceptual error, and Decide on a targeted, real-time response was what actualized the potential of their deep knowledge [23]. While skills were the active agent, the quality of the instruction depended entirely on the knowledge base being activated. Teachers with strong MCK were better prepared to guide students in exploration [24]. This knowledge allowed them to provide clearer explanations, ask more probing questions, and better anticipate difficulties [25]. However, insufficient MCK could hinder the effective use of teaching methods (MPCK), leading to poor evaluation of student responses and weak feedback [26]. While MCK was crucial, it alone was not enough. Teachers also needed PCK to design effective experiences [25] [26]. Teachers with strong PCK were better able to identify and address student misconceptions, adapt instruction to individual needs, and provide targeted interventions, which were vital for sustaining student motivation [20] [27]. In conclusion, effective teaching required all competence dimensions, but the research confirmed that the real-time adaptive skill (SSS) was the critical mechanism that translated deep knowledge (MCK, PCK, GPK) into tangible support and high-level challenge for students.

The research consistently supported the significant role of Situation-Specific Skills (SSS) in effective classroom management, particularly noting its value for novice teachers [28]. This was crucial because SSS represented not just what a teacher knew (knowledge), but their ability to adapt to real-time situations. In its advanced application, SSS extended beyond mere organizational efficiency to support culturally responsive classroom management [29]. This meant SSS was the mechanism that allowed a teacher to notice and respond effectively to varied student contributions, which was fundamental to creating inclusive learning environments. Essentially, SSS ensured that management was adaptive and sensitive, not rigid and procedural, making it essential for handling complex classroom dynamics and maintaining a conducive learning environment [30].

The research conclusively established that effective teaching relied on a dynamic chain where a teacher's knowledge acted only as a high-potential resource, requiring real-time skills to transform it into high-quality instruction. Mathematics Content Knowledge (MCK) was the essential driver for Cognitive Activation, as deep subject mastery—moving beyond simple procedures—uniquely equipped teachers to design complex, engaging activities and give insightful explanations, setting the intellectual ceiling of the lesson. However, MCK alone was insufficient; teachers also needed Pedagogical Content Knowledge (PCK) to understand how students learn, allowing them to adapt instruction, address misconceptions, and provide targeted support. Critically, this foundational knowledge did not directly improve student learning. Instead, its potential was actualized by Situation-Specific Skills (SSS), the ability to Perceive student struggles, Interpret errors, and Decide on an immediate response. SSS was the critical mechanism that drove high-quality instruction across all areas, and was particularly significant for Classroom Management, where it enabled teachers to be adaptive, manage complex dynamics, and ensure the learning environment was inclusive and responsive rather than just orderly. In short, effective teaching requires deep knowledge to challenge students and adaptive skills to deliver that challenge successfully in the moment.

3. Methodology

3.1. Study design

This study employed a descriptive-correlational design to investigate the relationship between mathematics teachers' competence and the quality of their instruction. As Creswell and Creswell [31] noted, this design was well-suited for describing variables and quantifying the natural relationships between them, often using statistical tools like the Pearson r correlation.

The descriptive component of the study detailed teachers' instructional quality across three constructs: cognitive activation, student support, and classroom management. It also described teacher competence in terms of mathematics content knowledge (MCK), mathematics pedagogical content knowledge (MPCK), general pedagogical knowledge (GPK), affective-motivation characteristics, and situation-specific skills. The correlational aspect then assessed how these facets of mathematics competence related to the observed quality of teachers' instruction. This combined approach was crucial for establishing the foundation of the proposed Mathematics Teachers' Instructional Quality Framework.

3.2. Participants of the study

The participants in this study were the public Senior High School Mathematics teachers in Laguna Province. To determine the sample respondents, the researcher utilized RAOSOFT, an online sample size calculator, at a 5% margin of error. Out of one hundred ninety-two (192) total respondents, one hundred twenty-nine (129) were identified as the total sample respondents of the study.

To ensure representative sampling and address the heterogeneity of the study population, stratified proportional sampling was employed. The population was divided into seven strata based on the Schools Divisions Office: Biñan City (12), Cabuyao City (8), Calamba City (32), Laguna Province (Sta. Cruz, 47), San Pablo City (13), San Pedro City (7), and Sta. Rosa City (10). The sample size for each subgroup was proportional to its size within the larger population. This ensured that each subgroup was represented in the sample in a way that reflected its actual size in the population. By allocating sample sizes proportionally to the size of each stratum, this method guaranteed that all divisions were adequately represented in the study, enhancing the generalizability of the findings. To finally select the specific participants for the study, simple random sampling was then employed within each school division. This sampling method effectively captured the variety within the teacher population and ensured sufficient representation from all the different divisions.

3.3. Research instrument

This study employed two instruments: the Teachers Instructional Quality Questionnaire and the Mathematics Competence Questionnaire. The instructional quality was assessed using an adapted construct by Praetorius et al. [32]. This instrument measured three key domains: cognitive activation (11 items focusing on challenging students' thinking), student support (12 items focusing on the level of support, including individual needs and a positive learning environment), and classroom management (6 items focusing on how well teachers managed their time, handled student behavior, and created a supportive environment for learning).

Meanwhile, the teachers' mathematics competence was evaluated across five dimensions: Mathematics Content Knowledge (MCK), Mathematics Pedagogical Content Knowledge (MPCK), General Pedagogical Knowledge (GPK), affective-motivation characteristics, and situation-specific skills. Adapted questionnaires from the SEI-DOST & MATHTED [33] framework were used to assess MCK (13 items), MPCK (28 items), GPK (14 items), and situation-specific skills (15 items). Affective-motivation characteristics, specifically their beliefs about teaching, were assessed using a 40-item questionnaire adapted from Schmeisser et al. [34].

The adapted research instruments underwent a thorough and systematic process to guarantee their validity and reliability. This involved three key stages: content validation, pilot testing, and reliability analysis. For content validation, the instruments were reviewed by a panel of five internal validators (members of the research team) and three external validators. The external experts included an Education Program Supervisor (EPS) and two Public Schools Division Supervisors (PSDS) in mathematics from the Division of Calamba City. Their collective feedback and suggestions were incorporated to revise the questionnaires. Following these revisions, the questionnaires were pilot tested with 30 public senior high school mathematics teachers from provinces outside Laguna. This approach ensured an independent sample for testing. Finally, Cronbach's alpha coefficient was used to assess the instruments' internal consistency reliability. The instructional quality questionnaire showed good reliability (α=0.865), while the mathematics teachers' competence questionnaire demonstrated excellent reliability (α=0.931).

3.4. Data collection procedure

The data were collected in alignment with the study's objectives and in strict adherence to established ethical research protocols. The participants were informed about the study's objectives, the significance of their contribution, and the voluntary nature of their participation. An electronic questionnaire via Google Forms was administered to gather pertinent data from the participants. All responses were carefully gathered, reviewed, and analyzed to ensure accuracy and relevance to the variables under investigation.

3.5. Statistical treatment

The researchers used the free software statistical package to calculate the results. The following were the statistical tools used in the study. The distribution of teachers' instructional quality levels, specifically cognitive activation, student support, and classroom management, was analyzed using frequency counts and percentages. The same statistical methods were applied to evaluate the distribution of teachers' competence levels, covering MCK, MPCK, GPK, affective-motivation characteristics, and situation-specific skills. To numerically determine the levels of teachers' mathematics competence and instructional quality, weighted mean and standard deviation were used as statistical tools. Pearson-r was used to statistically determine the strength and direction of the relationship between teachers' mathematics competence and their instructional quality. This coefficient quantified the linear association between two continuous variables. Multiple regression analysis was employed to examine the effect of teachers' self-reported competence, specifically MCK, MPCK, GPK, affective-motivation characteristics, and situation-specific skills, on their instructional quality, as measured by cognitive activation, student support, and classroom management. This analysis aimed to identify statistically significant effects among these constructs.

4. Results and Discussion

This section presents the findings of the study. The data analysis was organized to address the research objectives, facilitating a clear and logical flow of information. The results were presented, analyzed, and interpreted to provide insights into the research questions.

4.1. Teacher's level of instructional quality

Instructional quality describes how effective, efficient, and engaging teaching practices are. In this study, this referred specifically to the teachers' instructional practices, which included cognitive activation, student support, and classroom management.

Cognitive Activation. In math education, this refers to engaging students in deep thinking and thorough conceptual understanding. It means explaining techniques clearly, giving constructive feedback, addressing mistakes effectively, and creating challenging tasks that link new ideas with what students already know.

Table 1: Level of SHS Mathematics Teacher's Instructional Quality in Terms of Cognitive Activation

Level	Frequency	Percentage
Very High	78	60.5
High	50	38.8
Low	1	0.8
Total	129	100

Mean=3.53 (Very High); SD=0.334; Max=3.61 (Very High); Min=3.47 (High).

The research confirmed a notably high standard for teaching quality in Laguna Province, particularly in Cognitive Activation, meaning teachers were successfully getting students to think deeply and critically. This was evidenced by the fact that a significant majority of teachers (60.5%) frequently used methods that promoted higher-order thinking, a finding strongly validated by a mean score of 3.53 (SD=0.334), which placed this strategy at a very high level. This success was more than just a positive result; it was a powerful, empirically proven method for overcoming the problem of rote memorization, showing students were actively making sense of ideas and forging connections, aligning perfectly with the Philippine Professional Standards for Teachers (PPST) emphasis on mastery and challenging tasks [35] [36]. This widespread, high-level instruction carried profound implications: to eliminate rote learning completely, the successful practices of these top teachers must be immediately formalized and scaled. By creating a library of their effective lessons and using them as the non-negotiable, concrete standard for all instruction, and by shifting professional development (PD) from theoretical talk to practical demonstration, the school system can systematically transition all teachers to implement truly challenging and engaging curriculum, proving that deep learning is achievable locally.

Student Support. Student support in teaching involves various actions teachers take to boost student learning and success. This means closely observing how students learn, offering them tailored feedback, and adapting teaching methods to meet individual student needs.

Table 2: Level of SHS Mathematics Teacher's Instructional Quality in Terms of Student Support

Level	Frequency	Percentage
Very High	95	73.6
High	34	26.4
Total	129	100

Mean=3.61 (Very High); SD=0.351; Max.=3.66 (Very High); Min=3.57 (Very High).

The research revealed that Student Support was a consistent, high-level priority for SHS mathematics teachers in the province, far exceeding a simple optional practice. The data confirmed this with an overwhelming 73.6% of teachers demonstrating exceptional support, backed by a high composite mean score of 3.61 (SD=0.351). This signified a crucial shift in the teaching role, where teachers moved beyond merely delivering content to become proactive, responsive facilitators of the student learning journey. This high-level support was rooted in a deep, personalized approach based on careful observation and diagnostic skills. Teachers were dedicated to identifying each student's unique styles, struggles, and strengths, which crucially empowered them to adjust their instruction, materials, and activities, accordingly, abandoning the "one-size-fits-all" model. The findings strongly suggested that effective teaching was fundamentally an act of adaptation and responsiveness, not just content display, directly supporting the idea that teachers must not only provide feedback but also cultivate feedback motivation by teaching students to monitor their own learning and view mistakes as data [37]. This success validated the importance of Situation-Specific Skills, training teachers to use frequent diagnostic checks and meticulous observation to understand how students approach problems. This deep knowledge allowed teachers to tailor precise interventions and empowered them to be flexible, dynamically adjusting lessons to ensure no student was left behind in the pursuit of mathematical mastery.

Classroom Management. Refers to a teacher's ability to maximize classroom time by minimizing interruptions and conflicts among students. It also encompasses the teacher's skill in establishing clear rules and routines to ensure smooth transitions between learning activities.

Table 3: Level of SHS Mathematics Teacher's Instructional Quality in Terms of Classroom Management

Level	Frequency	Percentage
Very High	98	76.0
High	29	22.5
Low	2	1.6
Total	129	100

Mean=3.67 (Very High); SD=0.441; Max.=3.71 (Very High); Min=3.65 (Very High).

The research unequivocally demonstrated a notably high level of skill in Classroom Management among SHS mathematics teachers in the province. This was confirmed by a dominant 76% of teachers exhibiting maximized practice, supported by a strong composite mean score of 3.67 (SD=0.441). This success signified that most teachers were masters of their learning environments, consistently creating structured, orderly, and productive spaces that were essential for focused mathematical instruction. Their practice was primarily proactive, focusing on designing the entire classroom system to maximize instructional time by rigorously preventing time-wasting behaviors and logistical chaos. This high level of practice aligned directly with principles in the Philippine Professional Standards for Teachers (PPST) and frameworks emphasizing structure and consistency [38], confirming that strong management was crucial for maximizing learning by minimizing disruptions [39] and boosting teacher confidence [40]. This finding had direct implications: training must shift to viewing management as an instructional act, emphasizing the proactive design of physical space and the establishment of clear, repeatable routines. By mastering management, teachers gained the confidence and instructional freedom to employ more complex, cognitively activating tasks without fearing a loss of control. Ultimately, the goal is to foster self-discipline within a supportive, predictable environment, ensuring that consistency and clear expectations provide the necessary safety for students to engage in the challenging process of learning complex mathematics.

4.2. Teachers' level of mathematics competence

Teacher competence is a multifaceted construct, encompassing a wide range of subject-specific and generic knowledge, beliefs, and skills related to mathematics teaching. For this study, competence specifically refers to Senior High School (SHS) mathematics teachers' Mathematics Content Knowledge (MCK), Mathematics Pedagogical Content Knowledge (MPCK), General Pedagogical Knowledge (GPK), Affective-Motivation Characteristics, and Situation-Specific Skills as they apply to their teaching practices.

Mathematics Content Knowledge (MCK). MCK refers to teachers deep understanding of mathematical ideas, how to perform calculations, and various ways to solve problems across topics like numbers, algebra, geometry, and data analysis. Having strong MCK helps teachers teach math effectively and correct student misunderstandings.

Table 4: Level of SHS Mathematics Teacher's Competence in Terms of Mathematics Content Knowledge

Level	Frequency	Percentage
Expert	69	53.5
Accomplished	57	44.2
Emerging	3	2.3
Total	129	100

Mean=3.46 (Accomplished); SD=0.361; Max.=3.51 (Expert); Min=3.39 (Accomplished).

The research strongly indicated a high overall level of Mathematics Content Knowledge (MCK) among SHS mathematics teachers in the province, with a combined 97.7% of teachers categorized at either the expert or accomplished level, resulting in an overall accomplished composite mean score of 3.46 (SD=0.361). This meant teachers possessed a solid, logical grasp of core mathematical concepts and, crucially, were empowered to present information coherently, adapt multiple solution strategies, and guide students through deep exploration rather than just teaching single-method problem-solving. This finding strongly reinforced the established theoretical consensus [41][42] that deep subject matter knowledge formed the indispensable foundation for all other teaching skills. Strong MCK enabled teachers to logically present information, explain complex ideas clearly, correct misconceptions, and promote deep conceptual understanding [43], thereby fostering critical thinking and improved student outcomes [44]. While this accomplished level was highly positive, the findings carried specific implications: given MCK's strong link to Cognitive Activation, teachers must use their deep knowledge not as an end, but as a tool to design non-routine, challenging tasks that push students toward synthesis and productive struggle, aiming for the "expert" level. Professional development should focus on advanced conceptual coherence—the deeper connections between disparate math topics, to further reduce instructional errors [45] and empower teachers to actively model multiple solution pathways in the classroom [46], ensuring instruction can be instantly tailored without sacrificing rigor.

Mathematics Pedagogical Content Knowledge (MPCK). MPCK is a complex idea that combines several important elements. It includes knowing the math curriculum well, understanding how to effectively plan math lessons, and having the skill to teach mathematics in the classroom.

Table 5: Level of SHS Mathematics Teacher's Competence in Terms of Mathematics Pedagogical Content Knowledge

Level	Frequency	Percentage
Expert	66	51.2
Accomplished	60	46.5
Emerging	3	2.3
Total	129	100

Mean=3.43 (Accomplished); SD=0.380; Max.=3.51 (Expert); Min=3.34 (Accomplished).

The data indicated a high level of Mathematics Pedagogical Content Knowledge (MPCK) among SHS mathematics teachers in the province, with a combined 97.7% of teachers reaching the accomplished or expert level, resulting in an overall accomplished mean score of 3.43 (SD=0.380). This finding suggested that teachers were highly skilled in the 'how-to' of teaching math, effectively designing engaging activities, utilizing comprehensive assessment, adapting instruction based on student knowledge, and adeptly identifying and correcting common student misconceptions. This strong MPCK aligned with research confirming that such skill was crucial for conveying complex ideas and boosting student performance [47]. Strong PCK was emphasized as crucial because it enabled teachers to effectively convey complex mathematical ideas [48], craft lessons that truly captured student interest [49] [50] and proactively address common student difficulties and misconceptions [51]. However, despite this high score, the lack of a significant link between MPCK and Cognitive Activation demanded strategic attention: teachers must continually fuse this strong planning skill (MPCK) with their deep content mastery (MCK) to ensure their methods lead to truly deep conceptual exploration. Training should now focus on translating specific, complex mathematical concepts into highly challenging activities, ensuring the pedagogy serves the depth of the content. Crucially, teachers should formalize their knowledge of common student difficulties—an MPCK strength—to proactively design lessons that prevent learning obstacles [52], maximizing instructional time. This widespread competence also created a valuable resource pool for peer coaching, where teachers can refine lesson plans and assessment strategies to ensure their instructional adaptation is truly diagnostic and effective.

General Pedagogical Knowledge (GPK). GPK refers to the essential teaching knowledge that applies regardless of the specific subject being taught. This type of knowledge goes beyond the subject matter itself, focusing instead on broader teaching responsibilities such as managing the classroom, supporting students, and implementing effective assessment methods.

Table 6: Level of SHS Mathematics Teacher's Competence in Terms of General Pedagogical Knowledge

Level	Frequency	Percentage
Expert	64	49.6
Accomplished	63	48.8
Emerging	2	1.6
Total	129	100

Mean=3.44(Accomplished); SD=0.376; Max.=3.49 (Accomplished); Min=3.35 (Accomplished).

The research indicated that SHS mathematics teachers possessed a high level of General Pedagogical Knowledge (GPK) with a composite mean score of 3.44 (SD = 0.376). This meant that they mastered the fundamental principles and mechanics of effective teaching in a broad sense. This expertise allowed them to consistently maintain organized, productive learning environments, skillfully understand and respond to diverse student needs, and competently design and use various assessment tools not just for grading, but crucially, for diagnosing student learning gaps and providing constructive feedback. This strong GPK acted as a critical and universally valuable component for effective teaching [33], enabling differentiation [53], improving classroom management [49], and contributing to a focused learning atmosphere. However, despite this high proficiency, the data suggested that GPK alone did not independently guarantee high-level math instruction, indicating that teachers were excellent at the mechanics of teaching like organization and assessment but needed to consciously integrate these general skills with their specific mathematical goals. Therefore, training must emphasize that teachers use their strong assessment design skills (GPK) to create formative tasks that specifically measure deep conceptual understanding (MCK), thereby ensuring their general competence always serves the goal of deep mathematics mastery. This powerful GPK-based skill in assessment must be maximized by shifting focus to rapid diagnostic checks and using the data to provide timely, differentiated support. Ultimately, the predictable, positive classroom atmosphere fostered by strong GPK is the necessary prerequisite that grants students the emotional safety required to engage in the "productive struggle" of Cognitive Activation for mastering complex mathematics.

Affective-Motivation Characteristics. In math teaching, this refers to a teacher's beliefs about how math should be taught. This ranges from believing they should simply transmit knowledge to students (a transmissive view) to believing students should actively build their own understanding (a constructivist view).

Table 7: Level of SHS Mathematics Teacher's Competence in Terms of Affective-Motivation Characteristics

Level	Frequency	Percentage
Expert	66	51.2
Accomplished	62	48.1
Emerging	1	0.8
Total	129	100

Mean=3.46 (Accomplished); SD=0.339; Max=3.56 (Expert); Min=3.36 (Accomplished).

The data confirmed a very strong collective competence in Affective-Motivation Characteristics among SHS mathematics teachers in the province, with nearly all teachers achieving expert (51.2%) or accomplished (48.1%) levels, resulting in an overall accomplished mean score of 3.46 (SD=0.339). This high finding meant math teachers possessed a sophisticated, balanced philosophical approach to teaching: they were not rigid, but instead strategically integrated both direct instruction and active discovery methods. They were masters of the instructional pivot, knowing precisely when to efficiently deliver foundational information and when to switch to facilitating students' active construction of deep understanding, which was crucial for greater student involvement and improved results. While this high philosophical commitment was an immense asset, its non-significant role in predicting overall student outcomes suggested that teachers must be strategic in their application. They need to continually refine their diagnostic skills to ensure their choice of teaching method is driven by student data, not by habit, by analyzing when a student is ready for self-discovery versus when they need explicit instruction to close a knowledge gap. By leveraging this high competence, teachers should use professional learning communities to refine the nuances of instructional timing, allowing the "accomplished" to learn from the "expert" group on precisely when the pedagogical pivot from "telling" to "facilitating" is most effective for optimizing learning.

Situation-Specific Skills. Refers to the mathematics teachers' skills in managing the classroom, such as effectively handling resources, student behavior, and instructional time to create a supportive learning environment.

Table 8: Level of SHS Mathematics Teacher's Competence in Terms of Situation-Specific Skills

Level	Frequency	Percentage
Expert	70	54.3
Accomplished	57	44.2
Emerging	2	1.6
Total	129	100

Mean=3.48 (Accomplished); SD=0.355; Max.=3.54 (Expert); Min=3.43 (Accomplished).

The data revealed a high degree of proficiency in Situation-Specific Skills among SHS mathematics teachers, with a combined 98.5% of teachers reaching the accomplished or expert level, leading to an overall accomplished mean score of 3.48 (SD=0.355). This signified that teachers were highly skilled at managing and orchestrating their classroom environment to directly support learning. Their capability went beyond simple control; it involved proactively establishing clear expectations and routines and, critically, the ability to skillfully perceive and interpret complex classroom events in real-time [54]. This meant they were not just hearing student answers, but actively trying to understand underlying thoughts, feelings, and potential misconceptions, allowing them to propose preventive strategies and synthesize multiple factors like student needs and subject complexity to make informed, effective choices instantly [55]. This strong presence of Situation-Specific Skills was the backbone of instructional success because it highly predicted both effective Student Support and Classroom Management. Therefore, professional development must prioritize the refinement of perceptual skills through training like case simulations to ensure teachers can translate their quick perceptions into precise, tailored interventions, for instance selecting the perfect alternative explanation immediately. Furthermore, these adaptive skills empower teachers to proactively set up challenging, complex pedagogical methods like group work or mathematical modeling that require student risk-taking, knowing their situational awareness will prevent chaos and maintain a safe, encouraging learning atmosphere.

4.3 Relationship between teachers' mathematics competence and their instructional quality

To provide valuable insights into the degree of correlation between teachers' competence and their instructional quality, Tables 9-11 explored the connection between the two variables.

Table 9: Relationship between Teachers' Mathematics Competence and their Instructional Quality in terms of Cognitive Activation

Competence Domain	Computed r-values	Degree	p-values	Decision on H_0	Interpretation
MCK	.642	Strong Positive	<.001	Reject	Significant
MPCK	.616	Strong Positive	<.001	Reject	Significant
GPK	.597	Strong Positive	<.001	Reject	Significant
Affective motivation	.625	Strong Positive	<.001	Reject	Significant
Situation-Specific Skills	.615	Strong Positive	<.001	Reject	Significant

The data presented a compelling picture of the relationship between teachers' mathematics competence and their instructional quality, specifically in terms of Cognitive Activation. The assessment of teachers' cognitive activation across all domains of mathematics competence such as MCK (r=.642; p<.001), MPCK (r=.616; p<.001), GPK (r=.597; p<.001), Affective-Motivation Characteristics (r=.625; p<.001), and Situation-Specific Skills (r=.615; p<.001) yielded significant p-values, indicating a strong positive relationship. This implied that teachers who frequently employed cognitively engaging teaching methods tended to possess higher levels of mathematical competence, especially in their subject matter depth and their philosophical/motivational orientation toward teaching. The findings further explained that a teacher's strong grasp of mathematics translated into teaching practices that pushed students beyond rote memorization, encouraging genuine understanding and critical thinking.

The research firmly corroborated earlier findings [56] that highly competent mathematics teachers consistently delivered instruction that effectively motivated students and stimulated active engagement. This engagement, in turn, facilitated the mastery of critical, foundational concepts which, once truly understood, unlocked a much deeper, more holistic mathematical comprehension. Furthermore, this high level of competence enabled teachers to move beyond merely procedural teaching—showing students "how" to do something—to foster true insight and reasoning, guiding students to understand the "why" behind mathematics [57]. These strong findings offered clear direction for enhancing instructional quality by urging teachers to strategically pivot their practice. To achieve true understanding, lesson planning had to shift from focusing on procedural steps to emphasizing conceptual mastery, requiring teachers to explicitly highlight foundational principles. Teachers must enhance cognitive activation by replacing simple recall with higher-order questioning that led students to analyze and create. Finally, continuous professional development in advanced mathematical concepts was vital, as deeper subject knowledge equipped teachers to anticipate struggles, provide insightful explanations, and bridge the gap between merely doing math and genuinely understanding it.

Table 10: Relationship between Teachers' Mathematics Competence and Their Instructional Quality in Terms of Student Support

Competence Domain	Computed r-values	Degree	p-values	Decision on H_0	Interpretation
MCK	.664	Strong Positive	<.001	Reject	Significant
MPCK	.653	Strong Positive	<.001	Reject	Significant
GPK	.661	Strong Positive	<.001	Reject	Significant
Affective motivation	.675	Strong Positive	<.001	Reject	Significant
Situation-Specific Skills	.722	Strong Positive	<.001	Reject	Significant

Table 10 illustrates the relationship between teachers' mathematics competence and their instructional quality in terms of student support. The results indicated a significant positive correlation between teachers' mathematics competence and the quality of their instruction, especially the level of teacher support offered. Across all domains of mathematics competence such as MCK (r=.664, p<.001), MPCK (r=.653, p<.001), GPK (r=.66, p<.001), Affective-Motivation Characteristics (r=.675, p<.001) and Situation-Specific Skills (r=.722, p<.001), yielded significant p-values indicating a strong positive relationship. This meant that as teachers grew more skilled and knowledgeable in their profession, they were more likely to offer extensive support to their students. This support, in turn, contributed to a higher quality of instruction within the classroom. Essentially, the more capable a teacher was, the more effectively they could assist students, resulting in better overall instruction.

The study's findings strongly supported the notion [58] that more experienced and knowledgeable teachers tended to implement instructional practices that better supported student learning. This included crucial strategies like scaffolding complex tasks, providing differentiated instruction to meet diverse needs, and offering formative feedback to guide progress. Similarly, other research [59] emphasized that skilled teachers were more adept at employing cognitively engaging methods and providing personalized support, both of which significantly improved instructional quality. These findings, therefore, provided clear, actionable steps for teachers to elevate their practice and professional development. Teachers must recognize that deepening their competence is the essential prerequisite for effectively supporting students. Practically, this meant teachers embedded high-leverage support strategies into every lesson by scaffolding complex tasks into manageable steps and delivering timely, constructive formative feedback that diagnosed why errors occurred. Furthermore, teachers differentiated instruction using their subject mastery to design varied tasks, and participating in Professional Learning Communities (PLCs) was crucial to share successful support strategies and collectively integrate the best practices of their most capable colleagues.

Table 11: Relationship between Teachers' Mathematics Competence and Their Instructional Quality in Terms of Classroom Management

Competence Domain	Computed r-values	Degree	p-values	Decision on H_0	Interpretation
MCK	.665	Strong Positive	<.001	Reject	Significant
MPCK	.684	Strong Positive	<.001	Reject	Significant
GPK	.620	Strong Positive	<.001	Reject	Significant
Affective motivation	.657	Strong Positive	<.001	Reject	Significant
Situation-Specific Skills	.677	Strong Positive	<.001	Reject	Significant

The table presents the relationship between teachers' mathematics competence and their instructional quality in terms of classroom management. Result revealed a significant positive correlation between teachers' mathematics competence and the quality of their instruction, particularly in terms of classroom management. Across all domains of mathematics competence such as MCK (r=.665, p<.001), MPCK (r=.684, p<.001), GPK (r=.620, p<.001), Affective-Motivation Characteristics (r=.657, p<.001) and Situation-Specific Skills (r=.677, p<.001), yielded significant p-values indicating a strong positive relationship. This implied that teachers who possessed strong mathematical competence were more likely to effectively manage their classrooms. This was not just about subject knowledge; it highlighted that a broad foundation of both general teaching skills and subject-specific expertise contributed significantly to a teacher's ability to maintain an orderly and productive learning environment. This, in turn, underscored the critical role of effective classroom management in successful teaching.

Research from Kunter et al. [13] and Kraft et al. [60] showed that a mathematics teacher's professional competence, which encompassed both their subject mastery and their teaching knowledge, equipped them to anticipate student difficulties, provide clear explanations, and keep students cognitively engaged. All these factors inherently supported classroom order and significantly reduced behavioral problems. When students were intellectually stimulated and understood the material, they were less likely to become disengaged and disruptive, making the teacher's management tasks smoother and more effective. This observed link between teacher competence and effective classroom management indicated that teachers viewed subject mastery as a primary management tool. They recognized that deepening their mathematical competence was a direct strategy for reducing classroom disruption, as compelling, clear, and conceptually strong instruction naturally minimized student confusion and disengagement. Consequently, teachers must leverage their Pedagogical Content Knowledge (PCK) to proactively anticipate where students commonly struggled, and by addressing these cognitive roadblocks before frustration arose, they prevented off-task behavior. Furthermore, teachers should plan and deliver lessons with a high level of cognitive activation, understanding that activities demanding critical thinking and problem-solving inherently kept students intellectually stimulated and on-task. Finally, teachers must utilize their expert knowledge to create clear explanations and routines, maximize instructional time, improve classroom flow, and significantly reduce the need for constant discipline.

4.4. Effect of the teachers' mathematics competence on their instructional quality

A multiple regression analysis was conducted to determine which specific teacher competence areas affected Cognitive Activation. The overall model was statistically significant ($R^2 = 0.675$, F = 20.587, p-value<.001), explaining a substantial 67.5% of the total variability of the respondents' cognitive activation could be explained by their teachers' mathematics competence. The analysis indicated that among all competence dimensions, only Mathematics Content Knowledge (MCK) was a statistically significant predictor of Cognitive Activation (β=.336; t=2.589; p<.05). This finding strongly suggested that a deeper knowledge of mathematics concepts (MCK) directly enabled teachers to implement more cognitively challenging and activating tasks in the classroom. This rigorous content foundation was critical, as it empowered teachers to create genuinely engaging learning environments that promoted critical thinking and problem-solving, which ultimately led to improved student outcomes [22] [44].

Table 12: Effect of Teachers' Mathematics Competence on Their Instructional Quality in Terms of Cognitive Activation

Variables	B	p-values	t-values	Interpretation
(Constant)	1.179	.000	4.940	Significant
Mathematics Content Knowledge	.336	.011	2.589	Significant
Mathematics Pedagogical Content Knowledge	.018	.904	0.121	Not Significant
General Pedagogical Knowledge	-.042	.780	-0.280	Not Significant
Affective-Motivation	-.166	.243	-1.172	Not Significant
Situation Specific skills	.212	.113	1.596	Not Significant

Dependent variable: Cognitive activation R-square: 0.675 Computed F-value=20.587 p-value: <.001.

Moreover, the final regression analysis provided precise unstandardized coefficients to detail the magnitude and direction of the relationships with Cognitive Activation. The model indicated that for every one-unit increase in MCK, MPCK, and Situation-Specific Skills, a corresponding positive change in Cognitive Activation of 0.336, 0.018, and 0.212 units were predicted, respectively. Conversely, the model showed that for a one-unit decrease in GPK and Affective-Motivation Characteristics, Cognitive Activation was predicted to decrease by 0.042 and 0.166 units, respectively. However, while all variables contributed to the overall predictive power of the equation, the statistically significant Constant ($\beta = 1.179$; $t = 4.94$; $p<.001$) and the individual significance tests confirmed that only MCK held a reliable, non-zero predictive influence on Cognitive Activation. The significant Constant further suggested that even when all measured teacher competence variables were theoretically held at zero, a baseline level of Cognitive Activation score of 1.179 was still predicted. This latter finding strongly reinforced the notion that other, unmeasured variables not included in the model are also influencing the quality of cognitive activation in the classroom.

Table 13: Effect of Teachers' Mathematics Competence on Their Instructional Quality in Terms of Student Support

Variables	B	p-values	t-values	Interpretation
Constant	.931	.000	4.094	Significant
Mathematics Content Knowledge	.258	.039	2.085	Significant
Mathematics Pedagogical Content Knowledge	-.005	.969	-0.039	Not Significant
General Pedagogical Knowledge	.029	.840	0.203	Not Significant
Affective-Motivation	.001	.996	0.004	Not Significant
Situation Specific skills	.490	.000	3.864	Significant

Dependent variable: Student's support R-square: 0.784 Computed F-value=30.378 p-value: <.001.

Table 13 utilized multiple regression analysis to move past finding simple links between teacher competence and Student Support. The overall model was highly effective ($R^2 = 0.784$, $F = 30.378$, p-value<.001), accounting for a substantial 78.4% of the variance in Student Support. This powerfully demonstrated that the competence variables were extremely effective predictors of a teacher's ability to offer personalized help. The analysis identified two major, highly significant drivers of Student Support. Situation-Specific Skills emerged as the most crucial factor ($\beta=.490$; $t=3.864$; $p<.001$). This indicated that a teacher's real-time ability to perceive, interpret, and instantly respond to student needs was the single most important factor for providing quality support. Specifically, a one-unit increase in these adaptive skills predicted a 0.490 unit increase in Student Support. Further, Mathematics Content Knowledge (MCK) also significantly influenced student support ($\beta=.258$; $t=2.085$; $p<.05$). This suggested that a teacher's deep conceptual knowledge was vital, likely because it enabled them to better diagnose the root cause of student errors and offer precise, clear conceptual remediation.

While other variables like General Pedagogical Knowledge (GPK) ($\beta=.029$) and Affective Motivation ($\beta=.001$) predicted a slight positive increase in support, and Mathematics Pedagogical Content Knowledge (MPCK) ($\beta=.005$) predicted a slight decrease, their effects were marginal compared to the top two predictors. The analysis also found a significant baseline support level ($\beta = 0.931$; $t = 4.094$; $p<.001$), implying that other unmeasured factors contributed to a teacher's support effectiveness. The evidence clearly showed that to maximize Student Support, training must prioritize the development of real-time adaptive skills and deep content knowledge.

Table 14: Effect of Teachers' Mathematics Competence on Their Instructional Quality in Terms of Classroom Management

Variables	B	p-values	t-values	Interpretation
Constant	.427	.149	1.452	Not Significant
Mathematics Content Knowledge	.279	.084	1.744	Not Significant
Mathematics Pedagogical Content Knowledge	.331	.071	1.822	Not Significant
General Pedagogical Knowledge	-.161	.384	-.873	Not Significant
Affective-Motivation	.029	.903	.122	Not Significant
Situation Specific skills	.457	.006	2.785	Significant

Dependent variable: Classroom Management R-square: 0.726 Computed f-value=27.385 p-value: <.001.

Table 14 employed multiple regression analysis to precisely isolate which teacher competence dimensions had a genuine, measurable impact on Classroom Management. The overall model was highly effective and statistically significant ($R^2 = 0.726$, $F = 27.385$, p-value<.001), showing that 72.6% of the total variability of the respondents' Classroom Management can be explained by their teachers' mathematics competence. However, the analysis revealed that only Situation-Specific Skills ($\beta=.457$; $t=2.785$; $p<.01$) was a statistically significant predictor of effective Classroom Management. This strong positive effect suggested that a teacher's adaptive capacity and real-time judgment—their ability to perceive a situation and respond instantly—were the most reliable competence factors for effective control and smooth instruction. While the model predicted slight increases in Classroom Management from MCK ($\beta=0.279$), MPCK ($\beta=0.331$), and Affective Motivation ($\beta=0.029$), and a slight decrease from GPK ($\beta=-0.161$), these individual variables were not statistically significant predictors. The evidence, therefore, clearly indicated that to achieve superior classroom control, the most crucial focus should be on honing a teacher's real-time adaptive skills, as these are the primary drivers of an orderly and focused learning environment.

4.5. Framework for senior high school mathematics teachers' instructional quality

The final Mathematics Teachers' Instructional Quality Framework was developed as a critical diagnostic tool, specifically targeting the documented failures in Senior High School (SHS) mathematics instruction highlighted by dismal NAT and PISA results in Laguna Province. The framework's theoretical foundation was rooted in the Multidimensional Adapted Process (MAP) model and the Three Basic Dimensions (TBD) framework, which collectively guided the operationalization of the broad concept of Teachers' Mathematics Competence into two distinct, measurable constructs. The first, Mathematics Content Knowledge (MCK), directly aligned with the theoretical knowledge dimension, focusing explicitly on the teacher's deep, declarative understanding of mathematical concepts, procedures, and their interconnections. The second construct, Situation-Specific Skills, captured the dynamic and practical elements, representing the theoretical frameworks' beliefs/motivational and situational/performance dimensions. This construct effectively measured a teacher's adaptive capacity, their ability to perceive, interpret, and make effective decisions in real-time, especially when managing instructional situations and overcoming real-world constraints like resource scarcity—thereby capturing the enactment and application of competence in a dynamic classroom setting.

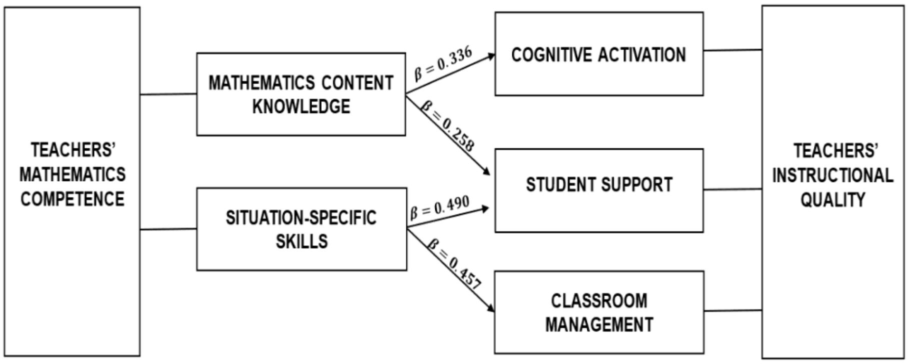

Fig. 1: Instructional Quality Framework for Senior High School Mathematics Teachers.

To validate the model's structural integrity, the researchers utilized Multiple Regression Analysis to simultaneously test the predictive relationships, a process supported by a rigorous content validation phase involving eight expert validators and a pilot study (N=30) that established high instrument reliability (Instructional Quality α=0.865; Competence α=0.931).

In testing the structural model, the initial framework hypothesized paths connecting the competence constructs to all instructional dimensions, but only the statistically significant pathways, evidenced by their standardized path coefficients, were retained in the final model (Figure 1), confirming their direct and unique predictive contribution to Instructional Quality. Specifically, Mathematics Content Knowledge (MCK) significantly influenced cognitive activation, suggesting that teachers with a deeper conceptual understanding were better equipped to design cognitively demanding and challenging tasks for students. MCK also significantly predicted student support, implying that strong content knowledge enhanced teacher confidence, enabling more effective student assistance. Meanwhile, Situation-Specific Skills exerted a stronger influence on both student support and classroom management, revealing that a teacher's adaptive capacity and skill in responding appropriately to students' dynamic needs and varying classroom situations were crucial determinants of both a supportive learning environment and effective management.

The newly developed framework emerged as a valuable, multi-faceted tool designed to immediately benefit both teacher self-reflection and systemic professional development. By employing the framework for self-assessment, teachers were empowered to accurately gauge their individual strengths and weaknesses across both mathematics competence and instructional quality, thus effectively guiding their professional growth. This pinpointed self-diagnosis allowed teachers to identify the specific areas where targeted training and support, such as deepening content knowledge or enhancing situation-specific skills, would yield the highest returns. Ultimately, addressing these needs promised to enhance overall teacher competence, enabling them to better meet the diverse learning needs of their students and foster more positive and effective learning experiences.

To fundamentally transform mathematics education and achieve widespread, sustained improvement, the researchers proposed a decisive, two-pronged strategy for the Department of Education (DepEd). First, DepEd should mandate the official adoption and integration of the Mathematics Teachers' Instructional Quality Framework as the research-backed standard for the evaluation and professional guidance of every teacher, thereby establishing a uniform, high-quality benchmark for instructional practice. Second, DepEd must launch a Strategic Professional Development (PD) Initiative designed to dismantle the documented systemic failures, such as inadequate subject matter expertise, teaching preparedness, and insufficient training. This initiative rigorously prioritized deepening teachers' Mathematics Content Knowledge (MCK) while concurrently equipping them with high-leverage, Situation-Specific Skills seminars to innovatively navigate real-world constraints, including the scarcity of learning materials. By decisively strengthening these targeted competencies, DepEd will elevate the professional capacity of its teachers, serving as the essential catalyst to shift classroom instruction from mere rote compliance to the cultivation of true intellectual mastery and deep student competence.

To truly apply these research findings, the focus must shift immediately to practical teacher training. First, teachers need intense training to use their deep math knowledge (MCK), not just to check answers, but to diagnose why students are confused (conceptual errors) and give them precise, helpful explanations. Second, training must include real-life practice using scenarios, videos, and simulations to quickly practice their adaptive skills, the ability to Perceive what's happening, Interpret the problem, and Decide what to do instantly in a busy classroom. Teachers must also learn to be creative, using their adaptive skills to innovate and adjust lessons when they face local constraints, like having few learning materials. To ensure this training actually reaches every classroom, the school system must empower Master Teachers to become primary trainers, giving them specialized instruction on these new techniques so they can coach and mentor others. Finally, existing internal school groups, like In-Service Training (INSET) and School Learning Action Cells (SLACs), must stop covering generic topics and dedicate their time to directly applying these new framework principles through peer observation and practice, focusing on balancing challenging math tasks with timely, situation-specific help.

Beyond its utility for individual growth, the framework's distinct structure maintained a critical alignment with the broader educational priorities of the Department of Education (DepEd) and the Department of Science and Technology – Science Education Institute (DOST-SEI). While featuring unique dimensions compared to existing curricula, it strongly affirmed their shared emphasis on cultivating critical thinking and problem-solving skills. Furthermore, it underscored the enduring significance of mathematical content mastery, cognitive demands, and the development of cognitive values in effective education.

5. Conclusion and Future Work

The study painted a very positive picture, confirming a very high level of instructional quality among Senior High School (SHS) mathematics teachers, consistent in engaging students in deep thinking (Cognitive Activation), providing support (Student Support), and maintaining orderly environments (Classroom Management). This excellence stemmed from a high degree of teacher competence across all professional areas, including deep subject mastery (MCK), teaching methods (MPCK), and their real-time adaptive skills (Situation-Specific Skills). Crucially, the research established a strong link where increased teacher competence directly led to higher instructional quality. Specifically, MCK was key to deepening student thinking and effective support, while Situation-Specific Skills were essential for providing timely help and maintaining classroom order. The main outcome is the new Instructional Quality Framework, a structured tool designed to guide teachers and policymakers toward improving math education. However, future research is needed to understand the complex factors that might weaken this link, such as whether poor school resources or large class sizes prevent knowledgeable teachers from applying their expertise, or if a teacher's self-belief (self-efficacy) is a necessary step that turns knowledge into high-level teaching.

5.1. Limitations

The study's findings, while valuable, cannot be broadly generalized because the research was strictly limited to SHS mathematics teachers in Laguna Province (N=129), meaning the results may not apply to teachers in other subjects, regions, or educational levels. Furthermore, the reliance on self-report questionnaires gathered online introduces the risk of social desirability bias, where teachers might overstate their skills, and the data lacks the depth needed to fully understand how competence translates to effective teaching due to the quantitative methodology. Finally, the study was confined to specific measures of competence (MCK, MPCK, GPK, Affective-Motivation, Situation-Specific Skills) and instructional quality (Cognitive Activation, Student Support, Classroom Management), meaning it did not capture the full, complex range of teaching quality or teacher professionalism.

5.2. Future directions

Future research should focus on investigating the complex factors that influence the relationship between teacher competence and instructional quality, moving beyond simple correlation. Specifically, studies should explore potential moderation and mediating variables. For instance, research should determine if the scarcity of school resources (like technology or materials) acts as a ceiling effect, preventing knowledgeable teachers (MCK) from implementing Cognitive Activation. Additionally, it should be investigated whether a teacher's self-efficacy (belief in their teaching ability) acts as a mediator, determining if strong MCK first boosts confidence, which then enables higher Cognitive Activation. Lastly, studies should examine if the complexity of classroom ecology (large class size or high student diversity) negatively impacts a teacher's ability to translate Situation-Specific Skills (SSS) into effective Student Support. To enhance the applicability of the findings, researchers should also test the developed framework using a larger and more diverse sample size, including teachers from other subject areas, to strengthen the generalizability across the broader educational system.

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