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Research Article

Multilevel Analysis of Academic Factors Influencing Academic Outcomes in Mathematics

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ABSTRACT

Mathematics skill is a significant indicator of a school's quality as well as a nation's competitive edge globally. Despite its significance, academic achievement gaps among nations and school settings remain prominent. The current study investigated how institutional and teacher-related factors predict mathematics proficiency among secondary students in junior high schools in Region XI, Philippines. A quantitative multilevel approach was employed to analyse data from 114 licensed junior high school mathematics teachers across 30 public and private junior high schools in five city divisions of the region. A 70-item researcher-developed instrument was used to assess institutional factors (professional development engagement, supportive school administration, and availability and use of school resources) and teacher-related factors (pedagogical content knowledge, mathematics teaching self-efficacy, teaching practices, and students' classroom engagement). Students' mathematics proficiency was measured using their quarterly grades from the end of the second academic year.

This study applies hierarchical linear models (HLM) to examine student, teacher, and school-level predictors of mathematics proficiency. Findings reveal that both pedagogical content knowledge and teacher self-efficacy are strong predictors of student achievement. Moreover, findings suggest that teacher practices and student engagement are significant predictors of mathematics proficiency. At the institutional level, findings show that supportive school leadership and professional development engagement are significant predictors of teacher practices and mathematics student proficiency. Notably, findings indicate that the availability and use of school and classroom resources predict mathematics student proficiency, but only slightly ($\beta = 0.12$, $p = .182$), and that the direct effects of these resources are

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largely mediated by other variables, serving as enabling conditions. In additional analyses, findings show that leadership strengthens the effect of teacher self-efficacy on student achievement.

This study develops the ISICE (Institutional Support–Instructional Support for Broad and Specific Instructional Capacity–Engagement) Model of instructional improvement, which posits that support for instruction (enhancing instructional capacity) increases student engagement, which, in turn, improves mathematics proficiency for all students. The findings contribute to multilevel educational theories of change and provide a theoretical basis supporting particular professional development approaches for strengthening mathematics instruction, as well as particular roles for instructional leaders and school-level improvement initiatives.

Keywords: *Instructional capacity, Multilevel modeling, Pedagogical expertise, School leadership, Secondary education*

Introduction

Despite advancements in mathematics education in Philippine secondary schools, persistent problems persist in students' acquisition of essential mathematical knowledge and applications. This is even true in Region XI (Davao Region), where teachers at all levels employ strategies to facilitate students' acquisition of mathematical proficiency despite the variations in school settings. The study focused on five divisions of Digos, Davao, Panabo, Tagum, and Mati, describing, documenting, and analyzing the teaching strategies and challenges encountered by teachers in selected secondary schools with varying school conditions and resources. Findings revealed that while some schools have access to technology and sufficient textbooks, most classrooms, including those with minimal resources, use improvised strategies to enhance the teaching and learning of mathematics.

Mathematics is fundamental to general cognitive development and problem-solving. Understanding and applying mathematical concepts, as well as their applications, are especially significant for students enrolled in a science, technology, engineering, and mathematics (STEM) program because these subjects are interconnected. Mathematics is an important aspect of living in any modern society. Not only does it empower individuals to make informed decisions based on the large amounts of data collected every day, but it also enables them to interpret these figures accordingly (Wang et al.,

2016). The OECD (2019) and Mullis & Martin (2019) have argued that mastering mathematics is vital for cognitive development, problem-solving, and understanding numerous sciences, in addition to numerous applications in daily life.

Student performance in mathematics, however, is deemed to be woefully inadequate. National assessments indicate that students, on average, perform below Level 2 for various mathematical competencies, thereby failing to achieve expectations in mathematics (Department of Education [DepEd], 2023). While some Philippine students have excelled in mathematics, they are predominantly confined to certain regions, most probably due to unequal access to adequate mathematical instruction and resources.

This report documents teachers' practices in handling large, diverse classes and delivering quality instruction amid many other competing obligations in some secondary schools in Region XI. Teaching practices, instructional quality, and student outcomes are influenced by both student and teacher backgrounds. Teacher knowledge for teaching mathematics, for example, and the overall instructional quality in a classroom are affected by and in turn affect the quality of the school's learning environment. How these factors interact is seen as contextual. Furthermore, student achievement is influenced by a complex mix of students' entering skills, the teacher's knowledge of teaching, and the school's support characteristics.

Previous studies have identified factors at different levels that explain mathematics performance. Teacher-level factors, like pedagogical content knowledge (PCK) and teacher self-efficacy, are essential for effective mathematics instruction (Baumert et al., 2010; Tschannen-Moran & Hoy, 2001). Institution-level factors, like leadership, professional development, and school resources, create an environment that can support or hinder teaching and learning (Leithwood et al., 2017; Schleicher, 2019). Yet most research approaches these factors one-dimensionally and does not account for their interactions, which is how they actually unfold in practice.

Given that the data were collected in Region XI, a very diverse region with many different school settings (public and private, regular and special, elementary and secondary, etc.), it was important to examine the relationships among these contexts. As noted in the theoretical framework, educational settings are inherently hierarchical, and thus, students are nested in classrooms within schools. Thus, analyses must account for this when describing how outcomes are produced (Cheema & Kitsantas, 2014; Lee & Shute, 2021).

This study examined the relationships between institutional factors, teacher variables, and third-year secondary students' mathematics performance in selected regular public and private secondary schools in Region XI, particularly in the Davao Region. The study sought to explain differences in students' mathematics proficiency through a multilevel analysis, taking into account both local teaching contexts and educational conditions, and to develop a multilevel model.

Theoretical Framework

This study utilized an integrated theoretical framework of Shulman's Pedagogical Content Knowledge (PCK), Bandura's Social Cognitive Theory, and Bronfenbrenner's Ecological Systems Theory to account for the differences in mathematics performance of students from public elementary schools in Region XI (Davao Region).

Pedagogical Content Knowledge (PCK) of Mathematics as Enacted in Regular Classrooms in Region XI. The role of Pedagogical Content

Knowledge (PCK) as conceptualized by Shulman (1986, 1987) goes beyond the simple notion that teachers must be proficient in the subject matter that they are expected to teach. This proficiency must be translated into forms meaningful to students, and this process of transformation involves many other aspects of teaching, such as addressing pupils' misconceptions, using representations, and employing other instructional strategies. In regular classrooms, learners' experiences and abilities vary; therefore, teachers need to consider these differences when meeting the needs of learners who lack the requisite understanding and have different levels of prior knowledge. This study explores how PCK is enacted by elementary teachers in regular classrooms that typically include students with diverse learning styles and varying levels of entry behaviors, reflecting differences in prior knowledge and experiences. Findings show that implementing PCK is not a straightforward task, as it depends on many instructional conditions, such as classroom size, available time, class session, and learning resources.

From a broader perspective, teacher self-efficacy may also influence teaching practices through the lens of Bandura's (1997) Social Cognitive Theory. Teacher self-efficacy has been shown to affect how teachers handle student problems, adopt best practices in the classroom, and engage students in learning. In many secondary schools in Region XI, teachers are burdened with heavy workloads and struggle to access relevant professional development programs. These contextual factors can potentially influence teachers' efficacy in delivering quality instruction to their students.

This study incorporates Bronfenbrenner's (1979) Ecological Systems Theory by viewing teaching and learning as a complex process influenced by several levels of factors. These factors begin with the immediate classroom and extend to school-level instructional processes, school institutional policies and procedures, and the level of resources and funding allocated to schools. The study applies this framework to a sample of elementary and middle school students from disadvantaged backgrounds in Region XI, Philippines. The specific learning environments vary across schools because of

differences in school administration, instructional materials, and access to professional development programs for mathematics teaching. The learning environments also vary across teachers because teacher-level factors interact with other levels to shape how teachers teach and how students learn.

Previous theoretical approaches posited that students' mathematics performance could be predicted by a range of antecedents, including teachers' instructional knowledge for mathematics (Shulman, 1987), their self-efficacy for teaching mathematics (Bandura, 2004), and the schools in which they teach (Shulman, 1987; Bronfenbrenner, 1979). These theories, which portray mathematics proficiency as the result of multiple factors operating at different levels of analysis, can be viewed as an 'umbrella' for comprehending the complex phenomena of mathematics proficiency observed in this study. Moreover, these theories can be viewed as operating at different levels of the teaching and learning process, which are addressed in this study at three hierarchical levels: student-level, teacher-level, and school-level. Specifically, students are nested within teachers and teachers are nested within schools (Cheema & Kitsantas, 2014; Lee & Shute, 2021).

The study also draws upon relevant theoretical perspectives, including the ISICE Model,

to provide a deeper understanding of the determinants and consequences of mathematics proficiency. Specifically, the study develops an ISICE Model of mathematics proficiency that posits that mathematics proficiency is a result of a set of interrelated processes. Institutional support—namely, leadership, professional development, and resources—sets the stage for the development of mathematics proficiency by providing the necessary enabling conditions for instructional capacity. Instructional capacity, namely, teachers' pedagogical content knowledge, self-efficacy, and instructional practices, then translates into effective classroom instruction, which in turn generates optimal levels of student engagement, which is the immediate mechanism through which learning occurs.

Unlike previous approaches that treat mathematics performance as a function of a single factor, the ISICE model treats mathematics performance as a function of three interacting factors: institutional conditions, teacher capabilities, and student engagement. Improving mathematics performance in Region XI thus requires a nuanced approach that considers the complex interactions among these factors at different levels of the educational system and accounts for how they are shaped by the broader institutional environment.

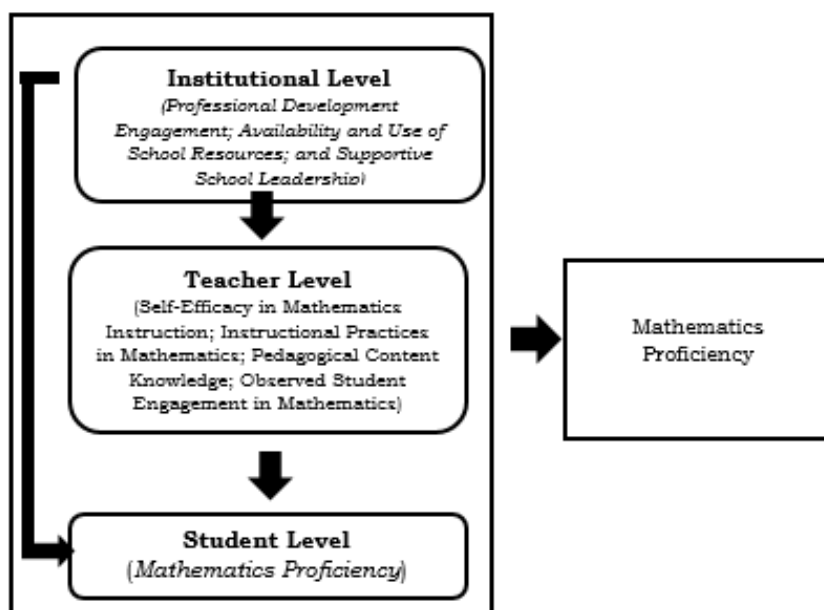


Figure 1. The conceptual framework of the study

This study, therefore, examined (a) the levels of institutional-related and teacher-related factors, (b) the level of students' mathematics proficiency, (c) the relationships among these variables, (d) the significant predictors of mathematics proficiency, and (e) the multilevel model that best explains their interaction.

Materials and Methods

Research Design

This study applies a quantitative multilevel approach using Hierarchical Linear Modeling (HLM) to examine the influence of both institutional-related and teacher-related factors on students' mathematics proficiency. The multilevel approach is necessary because the educational data contain dependence among observations and therefore require appropriate modeling to partition the variance and obtain reliable, unbiased estimates of model parameters (Bryk, Raudenbush, & Congdon, 2010; Cheema & Kitsantas, 2014).

In the first step, an unconditional (null) model was estimated to assess the proportion of variance in mathematics proficiency that could be explained by student-, teacher-, and school-level differences. Thereafter, teacher-level predictors were entered into the model to examine their impact on student outcomes. For the third step, institutional-level predictors were included to determine their direct and indirect effects on student performance. Finally, cross-level interactions were tested to determine whether institutional factors moderated the relationship between teacher-level variables and student mathematics proficiency. Significance was determined at $p < .05$.

Research Locale and Participants

The study was conducted in Region XI (Davao Region), Philippines, with a focus on five City Schools Division Offices: Digos City, Davao City, Panabo City, Tagum City, and Mati City. The study attempted to capture the unique settings—public and private secondary schools—within the various divisions.

There were 114 junior high school mathematics teachers participated in the study at the teacher level. They were all licensed by the Professional Regulation Commission and had at least 1 year of teaching experience in m

athematics at the junior high school level. The study used stratified random sampling in selecting participants from public and private schools. The total population of potential teachers from the assigned divisions was 282.

At the student level, we use a random sample from each teacher's classroom to capture variation in mathematics performance. Students' mathematics skills are measured via their mathematics grades as recorded in their academic records provided by the schools.

Research Instrument

A 70-item questionnaire was used to collect data from teachers, covering institutional and teacher-related variables. A five-point Likert scale (Never: 1 to Always: 5) was used.

These observed constructs were pedagogical content knowledge, self-efficacy in mathematics instruction, instructional practices, observed student engagement, supportive school leadership, availability and use of school resources, and professional development engagement. The observed constructs were informed by theoretical frameworks such as Shulman's (1986) Pedagogical Content Knowledge and Bandura's (1997) social cognitive theory. Students' mathematics proficiency was measured through their Mathematics grades.

Instrument Validation and Reliability

Content validity was established through specialized content reviews by mathematics education and educational leadership specialists. A pilot test containing the Instruments was administered to a separate sample of 50 students to assess reliability and construct validity. Item internal consistency for this sample was strong for the mathematics assessment (Cronbach's alpha = .834).

An exploratory factor analysis was performed in order to assess construct validity. Maximum likelihood extraction and a Promax rotation were used, given the possibility that variables might correlate with multiple factors. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was excellent (KMO = .913). Bartlett's Test of Sphericity was found to be statistically significant, $\chi^2 (1176) = 9710.389$, $p < .001$, supporting the use of factor analysis. The seven extracted factors accounted for 60.55%

of the total variance. Loadings of .40 and greater were considered significant (Hair et al., 2019).

Data Collection Procedure

Consent from Schools Division Offices and school administrators, as well as informed consent from teachers, was obtained prior to data collection. Teachers were approached through formal school channels and provided with an informed consent form that explained the purpose of the study, confidentiality and anonymity procedures, and the voluntary nature of the study and the right to withdraw at any stage without reason or consequence.

Participants' survey responses were managed electronically. Students' mathematics grades from the official school records were gathered with the administrative assistance and made anonymous before the analysis. The digital data was stored in password-protected files.

Statistical Analysis

This study used hierarchical linear modeling (HLM) to predict students' mathematics proficiency. The analyses were conducted using HLM software version 7 (Bryk et al., 2010). An unconditional model was first estimated to derive intraclass correlation coefficients (ICCs) and determine the proportion of variance at each level of the hierarchy that explained student outcomes. Subsequent models included teacher-level variables such as pedagogical content knowledge, teacher self-efficacy, instructional practices, and student engagement in the lesson. Institutional-level variables, including supportive school leadership, adequate school resources, and PD engagement, were also incorporated into the models. Cross-level interactions were examined to determine whether institutional variables moderated teacher-level predictors of student mathematics proficiency.

Model fit was assessed using deviance statistics and tests of significance for reductions in the minus two log-likelihood. We evaluated the relative contribution of fixed, random, and residual effects, as well as variance components at different levels of the hierarchy. We report

descriptive statistics and correlation coefficients for study-level variables.

Ethical Considerations

Ethical research practices were adhered to throughout the study. Participants were made aware that their participation was voluntary and that they were free to withdraw at any time. Participants were also assured of confidentiality. Survey responses were anonymized and stored in digital or physical form. Digital records were encrypted and stored on a secure, password-protected database. Physical records were stored in a locked cabinet. Data will be retained for 5 years following completion of the study, then destroyed permanently.

Result and Discussion

Level of Institutional-Related and Teacher-Related Factors and Their Relationship to Mathematics Proficiency

Aims to identify some institutional-related and teacher-related factors affecting the mathematics proficiency of students and to investigate their relationships with each other. Findings suggest that, at both the institutional and teacher levels, indicators of supportive practices in mathematics were perceived as somewhat high and positively related to students' mathematics proficiency. Despite these general findings, differences emerged in the degree of association between these supportive practices and the mathematics proficiency in actual classrooms.

At the individual teacher level, the strongest correlation for attendance in PD was with mathematics proficiency ($r = .301^*$, $p < .001$), followed by use of school resources ($r = .251^{**}$, $p < .001$), and perception of supportive school leadership ($r = .233^{**}$, $p < .001$). Many secondary schools in Region XI have good classrooms and learning spaces, but they lack instructional materials such as manipulatives, mathematical models, videos, educational software, and other learning resources for mathematics lessons. In many classrooms, mathematics lessons are mostly traditional board work and textbook readings. Teachers rarely explore and discuss new concepts and ideas in mathematics because these activities require more than

textbooks. This correlation between use of school resources and math proficiency is reasonable given that the way students learn mathematics requires adequate resources, and having these is key to supporting learning, according to Schleicher (2019).

Engagement in professional development activities also correlated with mathematics proficiency. Opportunities for sustained professional development may not be available to the same extent in all schools in Region XI due to school schedule, teacher load, school culture, and leadership support. Teachers who engaged in professional development used more instructional strategies and practices in their mathematics classrooms than their less engaged counterparts. Desimone and Garet (2015) noted that “sustained, content-focused PD” is a critical feature of instructional improvement efforts.

Supportive school leadership showed a slightly lower correlation but remained a significant factor. While the correlation was less direct than with the teacher survey variables, it was more closely related to creating appropriate instructional conditions than to student achievement outcomes. In the surveyed schools, supportive leadership was evident, particularly through instructional supervision, the provision of tools and support for teaching and learning, and the promotion of teacher professional development. This aligns with findings by Leithwood et al. (2017) that school leadership primarily affects student learning through its impact on teachers and the school work environment.

The correlation between observed teacher support of student engagement and mathematics proficiency at the teacher level was .631 ($p < .001$). In Region XI, student engagement in mathematics classes was influenced by factors such as the teaching and learning approach, the quality of available resources, and the relevance and task demands of the tasks. When students are engaged, both cognitively and behaviourally, in mathematical activity, they can achieve a deeper understanding of the content and sustain their interest in mathematics. This finding supports that of Middleton et al. (2017), which found that engagement is a determinant of academic success.

Correlation with Self-efficacy in mathematics instruction was moderate and positive ($r = 0.355^{**}$, $p < .001$). Classroom data showed that teachers' self-efficacy in teaching mathematics to students with difficulties was influenced by teaching experience, the quality of peer and supervisor support, classroom quality, and the quality of the student-teacher relationship. Teachers with high levels of self-efficacy expectations for achieving teaching outcomes were able to modify their teaching practices, adopt instructional adaptability, and address students' difficulties on an ongoing basis. Teacher efficacy, defined as a belief in one's own capacities as a teacher, corresponds to teacher effectiveness and behavior in the school environment (Bandura, 1997; Caprara et al., 2006).

This finding is consistent with previous research on teachers' knowledge for teaching mathematics (e.g., 44) in finding that both pedagogical content knowledge and instructional practices for teaching mathematics predict teachers' own mathematical proficiency ($r = 0.245$; $p = .009$ for pedagogical content knowledge for mathematics and $r = 0.236$; $p < .001$ for instructional practices for teaching mathematics). However, putting several effective instructional strategies into practice daily in her crowded urban classroom, where resources are scarce, is no easy task for this teacher. Teachers' pedagogical content knowledge for teaching mathematics—the knowledge that enables teachers to teach mathematics well (Shulman, 1986) is the key to effective instructional practice. However, other aspects of the classroom are also implicated in the effective practice of this knowledge.

The average overall mathematics proficiency of the students in this study was at the Proficient level ($M = 85.61$, $SD = 2.74$). Although students have established a strong foundation from which to begin, assessment data also show a strong correlation between mathematics proficiency and two categories of students' engagement and resources. These findings indicate there is room for growth in these two areas.

Both school- and teacher-level factors were significantly related to mathematics proficiency. School and teacher engagement in mathematics, and the availability of

mathematics resources in the school and the teacher's classroom, were the school- and teacher-level variables with the strongest bivariate associations with mathematics proficiency. However, because correlation analysis does not account for the hierarchical data

structure or interactions among variables, we used hierarchical linear modeling to examine the direct and indirect effects of school- and teacher-level variables on mathematics proficiency.

Table 1. Descriptive Statistics and Correlation of Institutional and Teacher-Related Factors with Mathematics Proficiency

Variable	Mean	SD	r-value	p-value	Decision
Supportive School Leadership	4.21	0.48	0.289	.002	Significant
Professional Development Engagement	4.08	0.52	0.433	< .001	Significant
Availability and Use of School Resources	3.94	0.57	0.599	< .001	Significant
Pedagogical Content Knowledge	4.32	0.44	0.245	.009	Significant
Self-Efficacy in Mathematics Instruction	4.27	0.46	0.355	< .001	Significant
Instructional Practices	4.19	0.49	0.236	< .001	Significant
Observed Student Engagement	3.98	0.53	0.631	< .001	Significant
Mathematics Proficiency	85.61	2.74			

Note. N = 114. Significance level set at $\alpha = .05$.

Variance Decomposition and Intraclass Correlation

The unconditional multilevel model showed significant variation in mathematics proficiency across students, teachers, and schools. The ICCs indicated that 18.6% of the variance in mathematics proficiency occurred between teachers, 9.4% between schools, and 72.0% between students.

A substantial portion of the variation in mathematics performance is attributable to teacher- and school-level factors. This analysis finds that differences in instructional practices (such as how math is taught and managed in the classroom) and teacher-level factors (such as teacher quality or competence) drive stu-

dent performance in mathematics once students are assigned to a school. Subsequent variations in the learning environment are then influenced by differences in school-level conditions, such as leadership support and school resources. The analysis is focused on Region XI in the Philippines.

At higher levels, there is considerable variation in the relation between mathematics proficiency beyond student characteristics, potentially reflecting the roles of settings, schools, or program characteristics (Raudenbush & Bryk, 2002). Nevertheless, there remains sufficient variation at the lower levels to justify the use of hierarchical linear modeling on these data (Bryk et al, 2010; Cheema & Kitsantas, 2014).

Table 2. Variance Components and Intraclass Correlation Coefficients

Source of Variance	Variance Component	ICC (%)
Student Level	5.21	72.0
Teacher Level	1.35	18.6
School Level	0.68	9.4

Multilevel Predictors of Mathematics Proficiency

When teacher-predictor variables were introduced into the multilevel model to investigate which teacher variables account for variation in mathematics proficiency. The best teacher-predictor of mathematics proficiency was pedagogical content knowledge (PCK), or

teacher knowledge for teaching the specific subject matter for which they have responsibility, plus the knowledge, effort, creative genius and manner of organizing that the teacher brings to his or her work, and the extent to which that knowledge, effort, creativity and organization translates into meaningful and

effective lessons for his or her learners. In typical mathematics classrooms in Region XI, for instance, each set of students comes to instruction with vastly different mathematical knowledge. Teaching these students would therefore require teachers to have strong PCK, namely the ability to address students' possible misconceptions, monitor their knowledge gains, and deliver content worth learning that is connected to learners' prior knowledge. In support of the fundamental role of pedagogical content knowledge posited by Shulman (1986, 1987), teacher knowledge, or knowledge for teaching, also emerged as the strongest predictor of student achievement in earlier research (Baumert et al., 2010).

One other factor that influenced student performance was self-efficacy in mathematics instruction ($\beta = 0.36, p < .001$). Many secondary schools in Region XI cater to large enrolments of students from diverse backgrounds. Teachers at these schools face the challenge of managing large classes and handling multiple tasks simultaneously. This is where self-efficacy in teaching comes in, as it affects teachers' continuation of effort, strategic behavior, cognitive and somatic states, and instructional strategies. This construct also aligns with Bandura's social cognitive theory (1997). According to Caprara et al. (2006), teacher self-efficacy positively affects student academic achievement.

In addition to levels of pedagogical content knowledge (PCK), features of the instructional practices and observed levels of student engagement were identified as strong predictors of mathematics proficiency. The findings show that both instructional practices ($\beta = 0.28, p = .006$) and student engagement ($\beta = 0.24, p = .011$) predicted mathematics proficiency. The impact of engagement on mathematics proficiency was less than that of PCK but may have been enhanced by effective instructional practices and the classroom environment (Middleton et al., 2017).

The results from the teacher-level analysis show that supportive school leadership and teachers' engagement in professional development are strong predictors of teachers' mathematics proficiency. Both supportive school leadership practices, such as observational and coaching practices, and engagement in

professional development predict teachers' mathematics proficiency, above and beyond prior mathematics knowledge and experience. This finding is consistent with the argument that institutional support enhances instructional capacity by furnishing teachers with the guidance, supervision, and professional development opportunities needed to improve their mathematics teaching. In Region XI, differences in leadership practices and professional development opportunities between and within schools may explain variation in instructional quality and mathematics proficiency among teachers. Leithwood et al. (2017) found that leadership can positively affect student achievement by focusing on teaching practices. Desimone and Garet (2015) also argued that high-quality, sustained professional development organized around specific teaching practices can improve instructional quality.

In contrast, the availability and use of school resources did not appear to be a strong predictor of mathematics proficiency ($\beta = 0.12, p = .182$). This stands in contrast to the bivariate correlation analysis for this variable ($r = .243$).

Correlation analysis establishes the strength of the relationship between two variables, whereas multilevel models control for the relationships among multiple predictors across levels of the hierarchy (Cheema & Kitsantas, 2014, p. 25). Therefore, it can be concluded that resources do influence mathematics proficiency; however, this influence is not independent and operates through other variables. Resource availability can facilitate instructional practices and enhance student engagement in mathematics achievement. While instructional materials are available in many of the Region XI classrooms observed, these need to be better integrated into teachers' practices to support student mathematics achievement. Resources are useful only if they are well used in the teaching process.

Also, it found a 34.2% reduction in unexplained teacher-level variance and a 46.8% increase in explained total variance for mathematics proficiency. Importantly, the inclusion of teacher-level predictors of student mathematics proficiency substantially reduced model deviance, $\chi^2(2, N = 1320) = 62.13, p < .001$.

Using multilevel modeling was successful in modeling complex educational data (Bryk, Kerry, & Schneider, 2010; Cheema & Kitsantas, 2014).

Table 3. Final Multilevel Model Predicting Mathematics Proficiency

Predictor	β	SE	p
Pedagogical Content Knowledge	0.41	0.08	< .001
Self-Efficacy in Mathematics Instruction	0.36	0.09	< .001
Instructional Practices	0.28	0.10	.006
Observed Student Engagement	0.24	0.09	.011
Supportive School Leadership	0.27	0.11	.018
Professional Development Engagement	0.23	0.10	.026
Availability and Use of School Resources	0.12	0.09	.182

Cross-Level Interaction

The cross-level interaction between supportive school leadership and teacher self-efficacy for teaching mathematics predicted student mathematics proficiency. Results indicate that teacher self-efficacy positively predicted student mathematics proficiency, and this effect was stronger in schools with more supportive school leadership ($\beta = 0.19$, $p = .008$). Thus, teachers are better able to translate their confidence in teaching mathematics into students' proficiency when working in schools with effective leadership.

The findings have implications for understanding how individual differences interact with varying levels of contextual influences, as suggested by Bronfenbrenner's (1979) ecological systems theory (EST). The results further support the claim that contextual conditions can greatly enhance the effects of instruction (Lee & Shute, 2021).

Conclusion

Mathematics proficiency at the secondary level in Region XI is a function of institutional and teacher characteristics. However, the study found that teacher-level variables are the most salient predictors of student performance in mathematics. Among these teacher-level variables, pedagogical content knowledge and self-efficacy emerged as the strongest predictors of students' performance in mathematics. Other instructional practices and teacher-student interaction, which reflect students' engagement in mathematics, also predicted mathematics performance.

The between-level analyses showed that, at the institutional level, supportive school leadership and school resources (professional development) were associated with students' mathematics proficiency. However, the analyses showed that the school resource domain (school resource availability and use) does not directly predict student mathematics proficiency. This domain is best predicted through the mediator of instructional practices and student engagement. The effect sizes for supportive school leadership and school resources were moderate in magnitude (ranging from 0.27 to 0.23) and statistically significant. This means that, on average, a 1-standard-deviation increase in supportive school leadership and professional development would result in a 0.27- and 0.23-standard-deviation increase in mathematics proficiency, respectively. The effect size for school resources was very small and not statistically significant, indicating that a 1-standard-deviation increase in school resources would result in minimal to no increase in mathematics proficiency.

The findings support the application of the ISICE (Institutional Support–Instructional Capacity–Engagement) Model, which posits that institutional support will lead to increased instructional capacity, which will result in students' engagement in mathematical and/or scientific investigations and improved mathematics proficiency for those students. The findings support the hypothesis that school-centered support for teachers and their schools is most effective when it is targeted and focused on developing links between school support for teaching and specific instructional practices.

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