On the practices of teachers to mathematics achievement of high school students

Wilberto Maputol Peligro[1], Juanita Moya Costillas[2],
Melbert Odo Hungo[2], Leomarich Fortugaliza Casinillo[3*]

[1]Department of Education, Maasin City, Philippines
[2]Southern Leyte State University, Southern Leyte, Philippines
[3]Visayas State University, Baybay City, Philippines
[*]Corresponding author: leomarichcasinillo02011990@gmail.com

ARTICLE INFO

DOI:10.46223/HCMCOUJS.soci.en.15.6.3308.2025

Received: March 16th, 2024

Revised: May 02nd, 2024

Accepted: May 20th, 2024

Keywords:

assessment; development; instructional strategy; manipulatives; practices; professional; technology

ABSTRACT

This study emphasizes the pivotal role of mathematics as a foundational prerequisite for diverse scientific and engineering disciplines. Its primary aim is to evaluate the teaching practices of mathematics in four national high schools, exploring elements such as professional development, technology integration, manipulative use, instructional strategies, and assessment methods. Employing a descriptive-normative methodology, the study engages mathematics educators and students from four national high schools in Bontoc District, Bontoc, and Southern Leyte, utilizing absolute, stratified, and simple random sampling techniques for data collection. The analysis employs various statistical measures, revealing notable practices, such as a focus on professional development, frequent use of instructional technology, and consistent application of instructional strategies. Most teachers are Mathematics majors with 06 - 15 years of teaching experience, while students predominantly achieve standard ratings. The study establishes a moderate correlation between professional development and students' mathematics achievement, with the instructional strategy applied to be notably significant while teaching experience differences are not. Finally, mathematics teachers exhibit a dedicated commitment to enhancing professional development and serving as effective facilitators in the classroom. The study underscores the significance of a comprehensive approach, integrating diverse practices to optimize student outcomes and cultivate a dynamic and effective educational environment. Recommendations include integrating educational practices, fostering professional development, advocating for technology, promoting manipulative use, implementing assessments, and supporting teachers.

1. Introduction

The foundational role of mathematics in science and engineering is widely acknowledged (Khamidov & Akhadova, 2023). Mathematics serves as a prerequisite, providing a framework for scientific and engineering endeavors, facilitating calculations based on measured data, and enabling the determination of unmeasured quantities (Diekman et al., 2019). The cognitive demands of mathematical thinking, distinguished by unique thought patterns incongruent with daily experiences, contribute to a specialized and innovative approach (Hong & Choi, 2019).

Mathematics, as an educational cornerstone, equips individuals with problem-solving skills applicable across diverse disciplines (Szabo et al., 2020). Unlike professions confined to specific domains, mathematicians possess the versatility to transition into various fields (Radek et al., 2023). Despite the inherent assumption of mathematics as a fundamental skill, its true value, particularly in management, is often underestimated by employers (Sawant et al., 2019). This perspective, derived from extensive experience with a major employer, underscores the broader contributions mathematicians can make beyond traditional arithmetic.

The pivotal role of a mathematical background in overcoming challenges within her profession. Notably, the application of mathematics in developing software for generating 3D images from 2D patterns exemplifies its pervasive influence in computer science (Hakimi et al., 2024). The convergence of values and features between mathematics and science, such as the pursuit of order, honesty, and openness, highlights the symbiotic relationship between the two disciplines (Goldanloo & Gharehchopogh, 2022). Mathematics serves as a precise language for scientific discourse, enabling the description of objects, characterization of variable relationships, and logical argumentation (Jayasree et al., 2023). Additionally, advancements in science and technology often stimulate mathematical innovation by presenting novel problem-solving opportunities.

Mathematical thinking is a logical process involving conjecture formulation, sense-making, and judgment formation. Such behaviors, crucial for problem-solving and analytical reasoning, are integral to the professional evolution of individuals in computer science and academia (Peterson et al., 2023). The lamentable performance of Filipino students in international assessments raises concerns about the nation's mathematical proficiency. Various factors, including societal influences, teacher education, learning styles, and curriculum deficiencies, contribute to this academic challenge (Velez et al., 2023). The need for a reformed mathematics education emphasizing problem-solving, reasoning, and independent learning is evident, aligning with global educational trends (Brantuo et al., 2023).

Exploring facets like professional development, technology integration, manipulative use, instructional strategies, and assessment methods may encounter obstacles due to limited resources and varying access to technology and manipulatives across schools (Alam & Mohanty, 2023). Investigating profiles of mathematics teachers, including specialization and years of experience, faces challenges in gathering accurate and up-to-date information (Simamora & Saragih, 2019). Additionally, considering disparities based on teachers' specialization and experience may be challenging. The research aims to contribute valuable insights to enhance mathematics education, yet generalizing findings to the broader educational context may be difficult. To address these challenges, the study proposes suggestions such as developing standardized evaluation criteria, collaborating with schools for resource management, implementing continuous data monitoring, ensuring comprehensive data collection, conducting multifaceted analyses using advanced statistical methods, and offering contextualized recommendations tailored to the regional context. Through these efforts, the research aims to investigate the practices of Mathematics teachers in four national high schools within Bontoc District, Bontoc, and Southern Leyte, focusing on professional development, technology integration, manipulative use, instructional strategies, and assessment methods. Additionally, it explores the teachers' profiles regarding specialization and years of teaching experience in Mathematics. Furthermore, it examines student achievement in Mathematics and analyzes the relationship between student achievement and teacher practices, as well as any differences in teacher practices based on specialization and years of teaching experience. The study seeks to contribute valuable insights for the enhancement of mathematics education in the specified region.

2. Theoretical basis

This study is rooted in Social Cognitive Theory, as proposed by Albert Bandura, which highlights the intricate interplay of observational learning, self-efficacy, and reciprocal determinism in shaping human behavior (Mujahidah & Yusdiana, 2023). Within the realm of evaluating teaching practices in mathematics, this theoretical framework asserts that teachers' behaviors and practices are influenced not only by their personal experiences and beliefs but also by observing the practices of their peers, mentors, and colleagues (Zhu & Kaiser, 2022). For instance, educators may adopt specific instructional strategies or integrate technology into their teaching methods after witnessing their effectiveness in other educational contexts. Moreover, the degree of self-efficacy, or belief in one's ability to successfully implement these practices, significantly impacts their adoption and implementation (Casinillo et al., 2024; Degerstedt et al., 2020). The application of Social Cognitive Theory in this study is pertinent as it allows for an in-depth exploration of how observational learning, self-efficacy beliefs, and environmental factors interact to shape teaching practices across various high schools. It provides a theoretical framework to understand the complexities of educators' decision-making processes and instructional behaviors (Ma et al., 2020). Furthermore, the significance of professional development for mathematics teachers cannot be overstated, as it serves as a foundational pillar for enhancing instructional practices. Scholars such as Shirrell et al. (2019) emphasize the critical role of ongoing training and development in equipping educators with the pedagogical skills and content knowledge necessary for delivering high-quality instruction. Kilag et al. (2023) further contribute to this discourse by highlighting the importance of effective teacher development in improving student outcomes. Additionally, the integration of technology into mathematics teaching represents a dynamic frontier, as demonstrated by Marbán and Sintema (2021), who explore its role in secondary education and emerging trends. Manipulatives also emerge as indispensable tools for fostering conceptual understanding, as evidenced by Ondog et al. (2023), Byrne et al. (2023), who investigate virtual manipulatives. Instructional strategies, as delineated in the National Council of Teachers of Mathematics Principles and Standards for School Mathematics, provide a guiding framework for effective teaching practices, with support from the works of Haji (2019). Furthermore, assessment methods outlined in the National Council of Teachers of Mathematics "Principles to Actions," as elucidated by Haji (2019), play a crucial role in gauging student progress and informing instructional decision-making. The multifaceted scholarly inquiry into the interplay between teacher practices, intervening variables such as specialization and years of teaching experience, and student achievement in mathematics offers valuable insights into the complex dynamics of mathematics education. Investigating differences in teacher practices based on these variables not only sheds light on factors shaping instructional approaches but also informs the development of tailored professional development initiatives aimed at enhancing student achievement and fostering academic success.

3. Research method

3.1. Research design

The present study utilized a descriptive-normative methodology to thoroughly examine the instructional practices of mathematics educators and to comprehend their professional profiles in terms of specialization and tenure in teaching the subject. Furthermore, this approach was instrumental in delineating the academic achievements of students in the domain of Mathematics. Employing a correlational research approach, the study also explored into potential associations between students' mathematical achievements and the instructional strategies implemented by teachers. Additionally, the comparative method was employed to rigorously

assess the significance of variances in the instructional practices of mathematics educators, with a particular focus on their areas of specialization and years of experience in teaching.

3.2. Population sampling and locale of the study

This study centered on mathematics educators and students hailing from four national high schools situated in Bontoc District, Bontoc, and Southern Leyte. All mathematics teachers, constituting 100% of the cohort, actively participated, while a representative sample of students, randomly selected at 10%, was included to ensure a balanced representation amidst resource constraints. This methodological approach facilitates a thorough examination of all math teachers' practices while maintaining a manageable yet significant sample size for analysis. The selection of teacher respondents was executed through absolute sampling, whereas stratified and simple random sampling techniques were employed to identify student respondents based on their year level and section. The study was conducted at Paku National High School, Divisoria National High School, Bontoc National High School, and Hilaan National High School, strategically chosen within the Bontoc District, Southern Leyte. The selection of these institutions holds significance as they collectively serve as focal points for the investigation, providing a distinct geographical and administrative context. The overarching research goal is to attain a comprehensive understanding of the educational landscape within the specified region. Table 1 furnishes an overview of the total population, encompassing 1,916 students and 11 teachers. Table 2, conversely, delineates the distribution of student respondents across four academic levels within the identified schools, totaling 192 participants from the broader population of 1,916 students. These meticulous sampling strategies and demographic representations form the cornerstone of ensuring the comprehensive coverage and representativeness of the study's participant pool.

Table 1

Distribution of Population and Sample of Respondents

Respondents	Population	Percent of Sample	No. of Respondents
Students	1916	10%	192
Teachers	11	100%	11
Total	**1927**	**10.53%**	**203**

Source. Authors' construction (2024)

Table 2

Distribution of Student Respondents

School	Year Level									
	Population				Total	Sample				Total
	I	II	III	IV		I	II	III	IV	
Paku NHS	166	133	131	126	556	16	13	13	13	55
Divisoria NHS	109	102	104	67	382	11	10	10	7	38
Bontoc NHS	154	168	164	137	623	15	17	17	14	63
Hilaan NHS	135	83	76	61	355	14	8	8	6	36
TOTAL	**564**	**486**	**475**	**391**	**1916**	**56**	**48**	**48**	**40**	**192**

Source. Authors' construction (2024)

3.3. Research instruments

The inventory instrument utilized in this study is derived from the Education Alliance 1-866-314KIDS, employed specifically to assess teachers' best practices within the realm of mathematics education. These practices are categorized based on the level of professional development, proficiency in integrating technology, utilization of manipulatives, application of instructional strategies, and the types of assessments employed. Each category comprises 10 distinct indicators, thereby contributing to a comprehensive evaluation of teachers' best practices, all assessed through a 5-point scale. Furthermore, the study incorporates a Questionnaire on the Profile of Mathematics Teachers to systematically gather information on professional specialization and teaching tenure. This survey instrument facilitates the detailed profiling of participating educators, thereby providing valuable context for the interpretation of research findings. In addition to these instruments, the study integrates an Achievement Test, consisting of four sets tailored to the academic requirements of each year level, aligning meticulously with the competencies identified for each tier. Derived from the standardized Division Achievement Test in Mathematics, this assessment ensures a systematic evaluation of students' mathematical aptitude in accordance with educational benchmarks for each academic year. To ensure the validity and reliability of these instruments, a panel of three expert reviewers conducted a rigorous evaluation, aligning the instruments with the research objectives. Meticulous pilot testing was then undertaken to gauge feasibility, followed by subsequent item analysis to assess the psychometric properties, thereby refining the instruments for methodological robustness. The insights gleaned from these analyses informed necessary adjustments, thereby ensuring the integrity of the instruments. The finalized versions of the instruments, validated through expert scrutiny, pilot testing, and item analysis, are now deemed ready for implementation in the substantive study. This systematic validation process not only enhances the credibility of the research but also underscores the integrity of the instruments for data collection and analysis, thereby bolstering the overall rigor and reliability of the study.

Table 3

Inventory of the Practices of Mathematics Teachers

Scale	Interpretation
1 (1.00 - 1.80)	Never
2 (1.81 - 2.61)	Sometimes
3 (2.62 - 3.42)	Don't Know
4 (3.43 - 4.23)	Oftentimes
5 (4.24 - 5.00)	Always

Source. The data are from "Factor analysis and psychometric evaluation of the mathematical modeling attitude scale for teachers of mathematics" by R. S., Asempapa and G. P. Brooks, 2022, *Journal of Mathematics Teacher Education, 25*(2), pp. 131-161

Table 4

The Student's Achievement in Mathematics

Score	Description
23 - 30	Exemplary
15 - 22	Standard
07 - 14	Apprentice
01 - 06	Novice
0	No Achievement

Source. The data are from "Impact of formative assessment instructional approach on students' mathematics achievement and their metacognitive awareness" by R. N. Wafubwa and C. Csíkos, 2022, *International Journal of Instruction, 15*(2), pp. 119-138

3.4. Research procedures and ethics

Before initiating the study, essential preliminary preparations were diligently undertaken. This encompassed the acquisition of requisite permits from the School's Division Superintendent and the District Supervisor, facilitated through an official letter of permit to conduct the study. Following the receipt of necessary permissions, immediate efforts were directed towards the preparation of study materials and the establishment of a meticulously structured study schedule. Subsequently, meticulous attention was devoted to the preparation of research instruments, involving critical evaluation and subsequent revisions to ensure methodological robustness. The deployment of these instruments was conducted systematically, with the researcher personally administering them to participants. Upon the culmination of data collection, the gathered information underwent a systematic organization and presentation in tabular forms, facilitating ease of analysis. Expert consultation was sought for the purpose of data analysis and interpretation, thereby ensuring methodological rigor and accuracy in the analytical process. Based on the findings derived from the study, recommendations were thoughtfully formulated and grounded in the evidence presented within the research. These recommendations contribute to the scholarly discourse within the field of study, offering insights and implications for future research endeavors and educational practices.

3.5. Statistical treatment of data

Various statistical tools were employed for the meticulous analysis and interpretation of data in this study. Frequency counts, percentages, weighted mean, and arithmetic mean were leveraged to provide a comprehensive description of the profile of mathematics teachers and their instructional practices. These statistical measures were also instrumental in depicting the academic achievements of students in Mathematics. Additionally, the Chi-square + Eta Correlation was applied to ascertain the significance of the relationship between students' Mathematics achievement and the practices of their mathematics teachers. The strength of this relationship was elucidated based on the correlation coefficient, with interpretation guided by the scale outlined by Yates et al. (2019). Before the application of the F-test, a Normality Test was rigorously conducted to ensure adherence to the assumptions of normal distribution. Subsequently, the F-test was employed to determine the presence of statistically significant differences in the practices of mathematics teachers based on their specialization and the number of years dedicated to teaching mathematics subjects. This methodological approach facilitated a thorough examination of the data, enabling robust conclusions to be drawn regarding the relationships and variances observed within the study parameters.

4. Results and discussions

4.1. Teachers' practices

Table 5 displays teachers' practices regarding professional development, offering a comprehensive overview with mean scores, standard deviations, and interpretations for each activity. Teachers exhibit a high commitment to continuous professional development, evident in consistently elevated mean scores. Notably, activities like attending school-directed seminars score highest at 4.91, reflecting a prevalent dedication. The overall average mean of 3.80 underscores teachers' substantial inclination toward professional development, indicating a positive commitment to ongoing educational growth. Regarding technology adaptation, mean scores, standard deviations, and interpretations illuminate each practice. Teachers exhibit a keen interest in enhancing their tech proficiency, evident in the highest mean score of 4.82 for practices like wanting to learn how to use technology tools and emphasizing students' competitiveness through tech. The 4.14 overall mean underscores teachers' noteworthy proclivity to adapt to technology, indicating moderate variability in responses, capturing diversity in attitudes and practices. Concerning manipulative use in math instruction, teachers display a positive inclination, evident in the high mean score of 4.09 for practices like utilizing aids aligned with mathematical concepts. However, challenges in preparation, financial constraints, and limited training reflect lower scores for activities such as difficulty in preparing materials and infrequent manipulative use. The 3.98 overall mean implies a prevalent tendency among teachers to integrate manipulatives.

Regarding teachers' instructional practices, mean scores, standard deviations, and interpretations highlight a strong commitment to effective strategies. Consistently high mean scores, notably for focusing on standard-based concepts and developing basic computational skills (4.55), indicate a steadfast dedication to aligning instruction with standards. The 4.27 overall mean underscores teachers' prevailing commitment to consistently apply instructional strategies in mathematics classes. Teachers' commitment to assessment practices in mathematics education is evident in mean scores, standard deviations, and interpretations. The highest mean score of 4.82 showcases a strong dedication to aligning assessments with taught concepts, ensuring congruence between assessments and instructional content. Elevated mean scores for practices like administering examinations and utilizing various test types emphasize a comprehensive approach to assessment. The 4.24 overall mean highlights a prevalent commitment to employing assessments as integral components of the instructional process. The investigation into teachers' professional development practices, assessed through mean scores and standard deviations (West, 2021), provides nuanced insights into their attitudes and behaviors. The overall mean score, indicative of frequent engagement in professional development activities, highlights a positive inclination towards competency enhancement. However, the emergence of diverse practices necessitates targeted interventions (Didion et al., 2020; Huynh et al., 2023). While laudable, variations in individual practices underscore the need for focused strategies and motivational approaches (Adarkwah, 2021). The prevalence of traditional teaching methods signals resistance to change, emphasizing the imperative of cultivating an innovative culture in education (Adarkwah, 2021; West, 2021). Tailored professional development programs are thus essential to address diverse teacher practices and foster a culture of innovation effectively. The examination of teachers' practices in adapting to technology, notably with consistently high mean scores across various areas, underscores a strong inclination toward technology integration (O'Neil & Krause, 2019). The overall average

mean indicates widespread adaptation to technology, showcasing its growing significance in education, with positive implications for teaching methodologies (Ferri et al., 2020).

Furthermore, there is substantial potential for leveraging technology to enhance teaching effectiveness and student engagement in mathematics education significantly. Exploring teachers' practices with manipulatives reveals a favorable inclination toward incorporating hands-on materials, underlining their potential effectiveness (Sidek et al., 2022). Despite commendable overall mean scores, identified challenges underscore the need for support mechanisms and streamlined preparation approaches, offering valuable insights for stakeholders to enhance the quality of mathematics education (Li, 2023; Sidek et al., 2022). Additionally, it emphasizes the importance of providing adequate support and resources for the effective integration of manipulatives into mathematics instruction to optimize student learning outcomes. The examination of teachers' instructional strategies, encompassing learner-centered teaching and real-life situation integration, showcases a steadfast dedication to effective methodologies (Bonitez, 2021). The overall average mean indicates the consistent application of these strategies, contributing substantively to discussions on learner-centered, standards-based, and practical approaches in mathematics education (Ruiz, 2024; Sabando, 2022). Moreover, there is immense potential for fostering deeper student understanding and engagement through the continued utilization of innovative instructional strategies. The exploration of teachers' assessment practices reflects a robust commitment to effective assessment, with consistently high mean scores across various metrics (Lucey et al., 2020). The overall average mean indicates teachers' steadfast use of various effective assessment practices, significantly enriching the discourse on education assessment (Lucey et al., 2020). The study underscores a commendable commitment to best practices in assessment, with identified variations reflecting a thoughtful and student-centered approach (Lucey et al., 2020). Furthermore, there is vast potential for enhancing student learning outcomes through the continued utilization of effective assessment practices and the exploration of innovative assessment approaches.

Table 5

Teachers' Practices in Teaching Mathematics

Teachers' practices	Mean	Standard deviation	Overall interpretation
Professional Development Practices	3.80	0.828	Oftentimes
Adaptation of Technology Practices	4.14	0.856	Oftentimes
Use of Manipulative Practices	3.98	0.826	Oftentimes
Applied Instructional Strategy Practices	4.27	0.848	Always
Assessment Used Practices	4.24	0.79	Always

Source. Authors' calculation (2024)

4.2. Teachers' field of specialization and number of years of teaching

Table 6 offers a detailed overview of teacher-respondents based on their fields of specialization, presenting frequencies and percentages. The majority, comprising 81.82% of respondents, specialize in Mathematics, emphasizing a predominant focus on the subject. English and Technology and Livelihood Education are also represented, each accounting for 9.09%, while there are no respondents specializing in Filipino or Social Science. With a total of 11 teacher-respondents, the table provides insight into the distribution of specialization fields,

highlighting a strong concentration in Mathematics. Examining teaching experience, the breakdown offers a nuanced perspective on the diverse range of tenures within the surveyed group. A majority, 54.54%, falls within the 06 to 15 years of teaching experience range, with 27.27% in both the 06 - 10 and 11 - 15 year brackets. Other categories include 9.09% each for 5 and below, 16 - 20, 21 - 25, and 26 and above year brackets. This distribution showcases a balanced representation of teaching experience, indicating varied tenures within the surveyed teacher-respondents. With a total count of 11 teacher-respondents, the table encapsulates the collective years of teaching experience, offering valuable insights into the diverse professional backgrounds of the study participants.

The investigation into teacher-respondents' fields of specialization holds significant implications for educational research, as noted by Unver et al. (2023), Ray et al. (2018), Bronson et al. (2021). The prominence of Mathematics specialization among respondents implies a concentrated focus within the group, which could potentially influence research findings and educational practices. However, the underrepresentation of fields such as English and Technology and Livelihood Education raises concerns regarding the generalizability of study outcomes, as noted by Ray et al. (2018), Bronson et al. (2021). The absence of respondents in areas like Filipino and Social Science underscores unique challenges specific to those disciplines, highlighting the necessity for tailored interventions to address these gaps in teacher expertise and instructional support, as emphasized by Unver et al. (2023), Ray et al. (2018), Bronson et al. (2021).

In examining the number of years of teaching among respondents, as discussed by Bhatti et al. (2019), Roberts et al. (2020), Lim et al. (2022), Traini et al. (2021), valuable insights emerge regarding experience distribution within the teaching cohort. The presence of a substantial percentage with ten years or less of experience implies a significant portion of the teaching population may still be in the formative stages of their careers, potentially influencing reported practices and professional development preferences, as highlighted by Bhatti et al. (2019). However, the limited representation of teachers with longer tenures raises concerns about capturing diverse perspectives and experiences, indicating the necessity for a broader participant pool to ensure comprehensive insights into teaching practices and professional growth trajectories, as noted by Roberts et al. (2020). Additionally, the representation of mid-range experience levels underscores the importance of exploring teaching evolution over this critical period, while focusing on a single representation bracket offers valuable insights into the specific challenges and developmental needs characteristic of that career phase, as suggested by Lim et al. (2022), Traini et al. (2021).

Table 6

Distribution of Teacher-Respondents as to the Field of Specialization and Number of Years of Teaching

Field of specialization	**Frequency**	**Percentage**
Mathematics	9	81.82
English	1	9.09
Filipino	0	0.00
Social Science	0	0.00
Technology and livelihood education	1	9.09

Field of specialization	**Frequency**	**Percentage**
Total	**11**	**100.00**
Number of years in teaching		
05 and below	1	9.09
06 - 10	3	27.27
11 - 15	3	27.27
16 - 20	2	18.18
21 - 25	1	9.09
26 and above	1	9.09
Total	**11**	**100.00**

Source. Authors' calculation (2024)

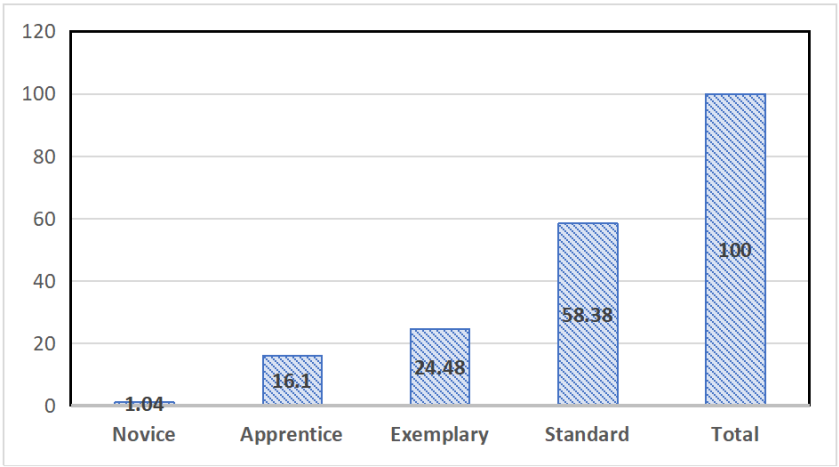
4.3. Achievement of the students in mathematics

Student achievement, assessed through the Division Test in Mathematics (2006 - 2007), categorizes them as novice, apprentice, standard, or exemplary. The figure reveals that the majority (58.38%) falls into the standard category, scoring 15 - 22 out of 30 items. Notably, 24.48% demonstrate exemplary achievement, securing 23 - 30 out of 30 items, while 15.10% are classified as apprentices, scoring 07 - 14 out of 30 items. Additionally, a small percentage (1.04%) of students are novices, scoring 01 - 06 out of 30 items. This distribution provides insights into the diverse levels of mathematics achievement among student-respondents, forming a comprehensive understanding of their performance in the specified academic year (Hungo et al., 2024). Categorizing students into novice, apprentice, standard, and exemplary levels yields significant implications for educational practices, with potential effects on teaching strategies and student outcomes.

The majority of students falling into the standard category implies a substantial portion achieving at an acceptable level, as noted by Hitt and Player (2019). However, the presence of students in the apprentice and novice categories indicates the necessity for targeted interventions to support those facing challenges in mathematics, thereby potentially improving their academic performance and overall learning experiences. Conversely, a significant proportion of students achieving exemplary scores showcase commendable proficiency, highlighting successful mastery of mathematical concepts and skills, as evidenced by Hisgen et al. (2020). The identification of novices and apprentices underscores the need for targeted strategies to address specific learning challenges and facilitate their progression toward higher levels of proficiency. Moreover, the data's significance lies in informing educational stakeholders about the varied achievement levels among students, thereby contributing to a nuanced interpretation of teaching effectiveness and the need for tailored instructional approaches to meet diverse learning needs effectively. Ultimately, the categorization of students based on their proficiency levels in mathematics enables educators to identify areas of strength and weakness within their student population, allowing for more targeted and personalized instructional interventions. This approach not only supports struggling students but also challenges high achievers, fostering a more inclusive and effective learning environment overall.

Figure 1

Distribution of Achievement of Students in Mathematics



Source. Authors' calculation (2024)

4.4. Correlation between achievement of students and practices of teachers

Table 7 presents a comprehensive examination of the correlation coefficients and significance values, shedding light on the relationships between students' achievement and diverse teaching practices. The correlation coefficients serve to measure the strength and direction of these connections, with corresponding significance values assessing their reliability. Notably, the professional development of teachers demonstrates a statistically significant and moderately positive correlation (r = 0.499*, p-value = 0.011) with students' achievement, underscoring its potential impact on academic outcomes. Conversely, correlations pertaining to the adaptation of technology, use of manipulatives, instructional technology utilization, and assessment practices, although positive, do not attain statistical significance and, hence, do not influence the students' achievement. The correlation coefficients and significance values between student achievement and teacher practices provide a nuanced understanding, contributing significantly to educational research. Lee et al. (2021) reveal a moderate positive correlation between Professional Development practices and student achievement, indicating the positive impact of continuous learning for teachers on student outcomes. However, the non-significant correlations for Adaptation of Technology, Use of Manipulatives, Instructional Technology Used, and Assessment Used imply no clear statistical association with student achievement in the studied context, highlighting areas where further investigation and improvement may be needed. The significance values underscore the importance of fostering a culture of continuous learning among teachers for positive student outcomes, as noted by Alkhawaldeh and Khasawneh (2023). Furthermore, the examination of mathematics teachers' practices, focusing on specialization variables with Levene's Test, unveils instructional nuances that can inform tailored pedagogical strategies. These significance values serve as a statistical lens, indicating trends in professional development, technology adaptation, manipulative use, instructional strategies, and assessment practices across diverse areas. These findings underscore the need for deeper exploration and research, shaping future pedagogical strategies tailored to teachers in distinct specializations. Similarly, the analysis of math teachers' practices based on teaching experience challenges assumptions about its impact, implying a need for broader instructional competency-focused professional development programs. These nuanced insights contribute to the ongoing discourse on effective mathematics pedagogy, informing educational policies and practices aimed at enhancing student achievement and teacher effectiveness.

Table 7

Correlation Coefficient and Significance Values between Achievement of Students and Practices of Teachers

Practices	Correlation coefficient (r)	Significance value	Interpretation
Professional development	0.499*	0.011	Moderate
Adaptation of technology	0.393 ns	0.768	Not significant
Use of manipulatives	0.504 ns	0.305	Not significant
Instructional technology used	0.514 ns	0.796	Not significant
Assessment used	0.344 ns	0.535	Not significant

Note. *-significant at 5% level.
Source. Authors' calculation (2024)

4.5. Comparison of practices of mathematics teachers in terms of specialization

Table 8 provides a comprehensive analysis of mathematics teachers' practices, considering different specializations and years of teaching experience. Levene's Test and t-tests are utilized to gauge differences in significance across these categories. Regarding specializations, there's no substantial difference in the variances of Professional Development and Adaptation to Technology practices, indicated by non-significant Levene's Tests (p-value = 0.390 and p-value = 0.623) and t-test results (t =1.856ns and t = 2.076ns). However, in the Instructional Strategy Applied, significant differences emerge (Levene's Test p-value = 0.053, t-test t = 2.342*, p-value < 0.05). Conversely, the Use of Manipulatives and Assessment Used show no statistically significant differences across specializations. This analysis contributes valuable insights into the nuanced variations in teaching practices among different specialized educators.

The statistical analysis undertaken scrutinizes the disparities in practices among mathematics teachers, delving into various specialization variables such as professional development, adaptation to technology, use of manipulatives, instructional strategy applied, and assessment used (Phusavat et al., 2019). The examination of the results reveals a nuanced landscape: while most specialization variables exhibit no significant differences in practice variability, evident through non-significant p-values from Levene's test, a notable exception arises in instructional strategies applied, where statistically significant differences emerge from t-tests. This finding implies that mathematics teachers' choices regarding instructional methods diverge based on specialization, indicating potential influences from factors such as pedagogical training, subject expertise, and teaching philosophy on instructional decision-making processes. These insights carry substantial implications for teacher training and support programs, emphasizing the imperative for tailored professional development initiatives to address the diverse instructional needs of mathematics teachers across different specializations. By recognizing and responding to these differences, educational institutions and policymakers can better equip teachers with the requisite skills and strategies to enhance their effectiveness in the classroom. Moreover, acknowledging and embracing pedagogical diversity among mathematics educators can foster collaboration and knowledge-sharing, ultimately enriching the overall quality of mathematics teaching and learning experiences. This holistic approach not only supports individual teacher growth but also contributes to the collective advancement of mathematics education as a whole.

Table 8

Differences of the Practices of Mathematics Teachers in terms of Specialization

Variables	Levene's test for equality of variance (p-value)	t-test	p-value
Professional development	0.390	1.856ns	0.096
Adaptation to technology	0.623	2.076ns	0.068
Use of manipulatives	0.055	1.836ns	0.099
Instructional strategy applied	0.053	2.342*	0.044
Assessment used	0.662	1.254ns	0.241

Note: ns-not significant; *-significant at 5% level
Source. Authors' calculation (2024)

4.6. Comparison of practices of mathematics teachers in terms of number of years in teaching

Examining years of teaching experience, the analysis indicates no significant differences in variances for Professional Development (Levene's Test p-value = 0.166, F-test = 1.123ns), Adaptation to Technology (Levene's Test p-value = 0.246, F-test = 0.594ns), Use of Manipulatives (Levene's Test p-value = 0.437, F-test = 0.748ns), Instructional Strategy Applied (Levene's Test p-value = 0.121, F-test = 0.092ns), and Assessment Used (Levene's Test p-value = 0.428, F-test = 0.918ns). These findings imply that, across different experience levels, observed differences in teaching practices are not statistically significant. The comparison of mathematics teachers' practices based on teaching experience yields insights into consistent approaches across variables, with Levene's Test results implying no significant differences, as observed by Hitt and Player (2019). This stability, regardless of tenure, underscores the robustness of instructional practices within the teaching cohort. While statistical tests may lack sensitivity to nuanced differences, implications emerge for individual teaching methods and student outcomes, as highlighted by Phusavat et al. (2019). Although overall practices may not vary significantly, teachers may exhibit nuanced differences based on experience, implying potential variations in instructional approaches that warrant further exploration (Hitt & Player, 2019). The study emphasizes the need to explore deeper into how instructional practices impact student achievement, irrespective of teachers' experience levels.

These implications extend beyond individual classrooms to inform policymakers, curriculum developers, and professional development initiatives, guiding interventions tailored to meet diverse educator needs. Recognizing the stability of instructional practices prompts cohesive initiatives aimed at enhancing instruction and ultimately improving student learning outcomes. Despite statistical insignificance, the implications underscore the ongoing necessity for research and reflection on effective mathematics teaching practices, ensuring continuous improvement and innovation in mathematics education. This comprehensive approach fosters a culture of inquiry and adaptation, ultimately enriching the quality of mathematics instruction and student learning experiences.

Table 9

Differences in Practices of Mathematics Teachers in terms of the Number of Years in Teaching

Variables	Levene's test for equality of variance (p-value)	F-test	p-value
Professional development	0.166	1.123ns	0.451
Adaptation to technology	0.246	0.594ns	0.709
Use of manipulatives	0.437	0.748ns	0.621
Instructional strategy used	0.121	0.092ns	0.990
Assessment used	0.428	0.918ns	0.536

Note: ns-not significant
Source. Authors' calculation (2024)

5. Conclusion

Mathematics teachers enhance professional development, which is crucial for effective mentorship and classroom facilitation, impacting student learning. This study accentuates not only the influence of professional development on Mathematics achievement but also the positive contributions of leveraging instructional technology, employing manipulatives, and emphasizing appropriate instructional strategies. Despite challenges like resource constraints or resistance to change, a holistic approach integrating these practices optimizes teaching effectiveness, forming a comprehensive framework. This nuanced understanding emphasizes diverse teaching practices collectively enriching the learning environment and fostering dynamic and interactive learning. Educators can refine methods for enhanced engagement, while policymakers can shape balanced pedagogical frameworks. Hence, it's concluded that findings highlight the importance of professional development, technology use, manipulative application, and instructional strategies for teachers. Math majors' prevalence and the correlation between teacher experience, student achievement, and teaching practices underscore their impact on learning outcomes. Consistent teaching practices emphasize the need for sustained emphasis on professional development and effective strategies in mathematics education. Recommendations aim to enhance conditions by integrating educational practices, fostering continuous professional development, promoting technology use, encouraging manipulative utilization, implementing assessments, supporting master's studies, providing funded opportunities, motivating teachers, suggesting a parallel study, and creating a portfolio showcasing math teachers' best practices.

References

Abd Rahman, H., Khalid, Z. M., Ismail, N. M., Kamisan, N. A. B., Norrulashikin, S. M., Nor, S. R. M., Shabri, A., & Hamdan, M. F. (2022). Statistical analysis on students' evaluation and students' final exam marks in undergraduate mathematical courses at Universiti Teknologi Malaysia. *International Journal of Advanced Research in Future Ready Learning and Education, 27*(1), 1-8.

Adarkwah, M. A. (2021). "I'm not against online teaching, but what about us?": ICT in Ghana post Covid-19. *Education and Information Technologies, 26*(2), 1665-1685. https://doi.org/10.1007/s10639-020-10331-z

Alam, A., & Mohanty, A. (2023). Cultural beliefs and equity in educational institutions: Exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics. *International Journal of Adolescence and Youth, 28*(1), 576-599. https://doi.org/10.1080/02673843.2023.2270662

Alkhawaldeh, M. A., & Khasawneh, M. A. S. (2023). The influence of cognitive load and learning styles on personalized learning outcomes: An untapped variable perspective. *Migration Letters*, *20*(S4), 1231-1240. https://doi.org/10.59670/ml.v20iS4.4472

Al-Shaboul, Y., Al-Azaizeh, M., & Al-Dosari, N. (2021). Differentiated instruction between application and constraints: Teachers' perspective. *European Journal of Educational Research*, *10*(1), 127-143.

Asempapa, R. S., & Brooks, G. P. (2022). Factor analysis and psychometric evaluation of the mathematical modeling attitude scale for teachers of mathematics. *Journal of Mathematics Teacher Education*, *25*(2), 131-161.

Bhatti, M. A., Alshagawi, M., Zakariya, A., & Juhari, A. S. (2019). Do multicultural faculty members perform well in higher educational institutions? Examining the roles of psychological diversity climate, HRM practices and personality traits (big five). *European Journal of Training and Development*, *43*(1/2), 166-187.

Bonitez, A. G. (2021). Effectiveness of science strategic intervention material in elevating the performance level of grade seven students. *International Journal of Advanced Research in Education and Society*, *3*(2), 18-31.

Brantuo, W. A., Atta, S. A., Klu, T. K., & Amoako-Atta, S. O. (2023). Viability problem-solving approach in teaching mathematics at this era: Retrospection of the six decades of mathematics education in Ghana. *Mathematics Letters*, *9*(1), 1-7. https://doi.org/10.11648/j.ml.20230901.11

Bronson, K., Devkota, R., & Nguyen, V. (2021). Moving toward generalizability? A scoping review on measuring the impact of living labs. *Sustainability*, *13*(2), 1-16. https://doi.org/10.3390/su13020502

Byrne, E. M., Jensen, H., Thomsen, B. S., & Ramchandani, P. G. (2023). Educational interventions involving physical manipulatives for improving children's learning and development: A scoping review. *Review of Education*, *11*(2), 1-42. https://doi.org/10.1002/rev3.3400

Casinillo, L. F., Hungo, M., & Hermano, R. (2024). Predictors of students' SQ3R in learning statistics during distance education: An ordinal logit modeling. *JPI (Jurnal Pendidikan Indonesia)*, *13*(1), 192-201.

Degerstedt, Å., Alinaghizadeh, H., Thorstensson, C. A., & Olsson, C. B. (2020). High self-efficacy - A predictor of reduced pain and higher levels of physical activity among patients with osteoarthritis: an observational study. *BMC Musculoskeletal Disorders*, *21*(380), 1-13. https://doi.org/10.1186/s12891-020-03407-x

Didion, L., Toste, J. R., & Filderman, M. J. (2020). Teacher professional development and student reading achievement: A meta-analytic review of the effects. *Journal of Research on Educational Effectiveness*, *13*(1), 29-66. https://doi.org/10.1080/19345747.2019.1670884

Diekman, A. B., Clark, E. K., & Belanger, A. L. (2019). Finding common ground: Synthesizing divergent theoretical views to promote women's STEM pursuits. *Social Issues and Policy Review*, *13*(1), 182-210. https://doi.org/10.1111/sipr.12052

Ferri, F., Grifoni, P., & Guzzo, T. (2020). Online learning and emergency remote teaching: Opportunities and challenges in emergency situations. *Societies*, *10*(4), 1-18. https://doi.org/10.3390/soc10040086

Goldanloo, M. J., & Gharehchopogh, F. S. (2022). A hybrid OBL-based firefly algorithm with symbiotic organisms search algorithm for solving continuous optimization problems. *The Journal of Supercomputing*, *78*(3), 3998-4031. https://doi.org/10.1007/s11227-021-04015-9

Haji, S. (2019). NCTM's principles and standards for developing conceptual understanding in mathematics. *Journal of Research in Mathematics Trends and Technology, 1*(2), 52-60.

Hakimi, M., Fazil, A. W., Khaliqyar, K. Q., Quchi, M. M., & Sajid, S. (2024). Evaluating the impact of e-learning on girl's education in Afghanistan: A case study of Samangan University. *International Journal of Multidisciplinary Approach Research and Science, 2*(1), 107-120. https://doi.org/10.59653/ijmars.v2i01.368

Hisgen, S., Barwasser, A., Wellmann, T., & Grünke, M. (2020). The effects of a multicomponent strategy instruction on the argumentative writing performance of low-achieving secondary students. *Learning Disabilities: A Contemporary Journal*, *18*(1), 93-110.

Hitt, D. H., & Player, D. W. (2019). Identifying and predicting effective leader practices: Examining principal experience and prior roles. *Leadership and Policy in Schools*, *18*(1), 97-116. https://doi.org/10.1080/15700763.2017.1384502

Hong, D. S., & Choi, K. M. (2019). Challenges of maintaining cognitive demand during the limit lessons: understanding one mathematician's class practices. *International Journal of Mathematical Education in Science and Technology*, *50*(6), 856-882. https://doi.org/10.1080/0020739x.2018.1543811

Hungo, M. O., Casinillo, L. F., Jacobe, G., Getes, J., Jusay, P. J. M., & Bagtindon, R. (2024). Factors affecting the academic performance of elementary learners under nuclear, extended, and single families. *Canadian Journal of Family and Youth/Le Journal Canadien de Famille et de la Jeunesse*, *16*(3), 92-114. https://doi.org/10.29173/cjfy30040

Huynh, D. T. T., Mai, T. P., & Tran, M. T. (2023). An Investigation into the benefits and challenges of international student exchange programs: Perspectives from student teachers. *International Journal of Learning, Teaching and Educational Research*, *22*(7), 258-280.

Jayasree, S., Subramaniam, K., & Ramanujam, R. (2023). Coherent formalisability as acceptability criterion for students' mathematical discourse. *Research in Mathematics Education*, *25*(2), 135-153. https://doi.org/10.1080/14794802.2022.2041469

Juniati, D., & Budayasa, I. K. (2020, October). The mathematics anxiety: Do prospective math teachers also experience it? In *Journal of physics: Conference series* (Vol. 1663, No. 1, pp. 01-08). IOP Publishing.

Khamidov, J., & Akhadova, K. (2023). The role of mathematics in the formation of design competence of future architects and building engineers. *Science and innovation*, *2*(A1), 97-102.

Kilag, O. K., Tokong, C., Enriquez, B., Deiparine, J., Purisima, R., & Zamora, M. (2023). School leaders: The extent of management empowerment and its impact on teacher and school effectiveness. *Excellencia: International Multi-Disciplinary Journal of Education (2994-9521)*, *1*(1), 127-140.

Lee, Y., Lee, G., Kim, J., & Lee, M. (2021). Equity in career development of high school students in South Korea: The role of school career education. *Education Sciences*, *11*(1), 1-20. https://doi.org/10.3390/educsci11010020

Li, S. (2023). Application of embodied learning in middle school mathematics education. *Journal of Education, Humanities and Social Sciences*, *22*(1), 452-459. https://doi.org/10.54097/ehss.v22i.12498

Lim, F. V., Chia, A., & Nguyen, H. T. T. (2022). "From the beginning, I think it was a stretch"-Teachers' perceptions and practices in teaching multiliteracies. *English Teaching: Practice & Critique*, *21*(4), 379-396.

Lucey, C. R., Hauer, K. E., Boatright, D., & Fernandez, A. (2020). Medical education's wicked problem: achieving equity in assessment for medical learners. *Academic Medicine*, *95*(12S), S98-S108. https://doi.org/10.1097/acm.0000000000003717

Ma, Q., Chan, A. H., & Teh, P. L. (2020). Bridging the digital divide for older adults via observational training: Effects of model identity from a generational perspective. *Sustainability*, *12*(11), 1-24. https://doi.org/10.3390/su12114555

Marbán, J. M., & Sintema, E. J. (2021). Pre-service teachers' TPACK and attitudes toward integration of ICT in mathematics teaching. *International Journal for Technology in Mathematics Education*, *28*(1), 37-46. https://doi.org/10.1564/tme_v28.4.03

Mujahidah, N., & Yusdiana, Y. (2023). Application of Albert Bandura's social-cognitive theories in teaching and learning. *Edukasi Islami: Jurnal Pendidikan Islam*, *12*(2), 2131-2146.

O'Neil, K., & Krause, J. M. (2019). Physical education teacher education faculty self-efficacy toward educational technology. *Physical Educator*, *76*(5), 1287-1305.

Ondog, J., Kilag, O. K., Padilla, J., & Abendan, C. F. (2023). Understanding numerical intuition: An analysis of junior high school students' innate mathematical abilities and number sense competencies. *Excellencia: International Multi-disciplinary Journal of Education (2994-9521)*, *1*(5), 391-402.

Peterson, T. L., Ferreira, R., & Vardi, M. Y. (2023). Abstracted power and responsibility in computer science ethics education. *IEEE Transactions on Technology and Society*, *4*(1), 96-102.

Phusavat, K., Hidayanto, A. N., Kess, P., & Kantola, J. (2019). Integrating design thinking into peer-learning community: Impacts on professional development and learning. *Journal of Workplace Learning*, *31*(1), 59-74.

Radek, M., Pietraszek, A., Kozień, A., Radek, K., & Pietraszek, J. (2023). Matching computational tools to user competence levels in education of engineering data processing. *Materials Research Proceedings*, *22*(7), 453-459.

Ray, B., Babb, J., & Wooten, C. A. (2018). Rethinking SETs. *Composition Studies*, *46*(1), 34-56.

Roberts, A. M., LoCasale-Crouch, J., Hamre, B. K., & Jamil, F. M. (2020). Preschool teachers' self-efficacy, burnout, and stress in online professional development: A mixed methods approach to understand change. *Journal of Early Childhood Teacher Education*, *41*(3), 262-283. https://doi.org/10.1080/10901027.2019.1638851

Ruiz, A. M. (2024). Instructional capacity and emotional quotient as predictors of teaching as efficacy among educators in region XI HEIs: A convergent design. *Ignatian International Journal for Multidisciplinary Research*, *2*(1), 551-632. https://doi.org/10.5281/zenodo.10594872

Sabando, N. (2022). Intervention strategies utilized by elementary mathematics teachers and their perceived effectiveness in enhancing learners' performance. *Psychology and Education: A Multidisciplinary Journal*, *5*(4), 281-292. https://doi.org/10.5281/zenodo.7244162

Sawant, D. V., Yano, H., Chikina, M., Zhang, Q., Liao, M., Liu, C., Callahan, D. J., Sun, Z., Sun, T., Tabib, T., Pennathur, A., Corry, D. B., Luketich, J. D., Lafyatis, R., Chen, W., Poholek, A. C., Bruno, T. C., Workman, C. J., & Vignali, D. A. (2019). Adaptive plasticity of IL-10+ and IL-35+ Treg cells cooperatively promotes tumor T cell exhaustion. *Nature Immunology*, *20*(6), 724-735. https://doi.org/10.1038/s41590-019-0346-9

Shirrell, M., Hopkins, M., & Spillane, J. P. (2019). Educational infrastructure, professional learning, and changes in teachers' instructional practices and beliefs. *Professional Development in Education, 45*(4), 599-613. https://doi.org/10.1080/19415257.2018.1452784

Sidek, R., Halim, L., & Buang, N. A. (2022). Pedagogical approaches to inculcate scientific creativity among secondary students. *Creative Education, 13*(5), 1779-1791. https://doi.org/10.4236/ce.2022.135112

Simamora, R. E., & Saragih, S. (2019). improving students' mathematical problem solving ability and self-efficacy through guided discovery learning in local culture context. *International Electronic Journal of Mathematics Education*, *14*(1), 61-72.

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills. *Sustainability*, *12*(23), 1-28. https://doi.org/10.3390/su122310113

Traini, H. Q., Stewart, J., & Velez, J. J. (2021). Navigating the social landscape of school-based agricultural education: A hermeneutic phenomenology. *Journal of Agricultural Education*, *62*(1), 61-76. https://eric.ed.gov/?id=EJ1297980

Unver, A. O., Okulu, H. Z., Muslu, N., Yilmaz, Y. O., Senler, B., Arabacioglu, S., & Bektaş, O. (2023). The readiness of stakeholders in the scientific inquiry-supported mentoring project. *International Journal of Education in Mathematics, Science and Technology*, *11*(1), 37-55. https://doi.org/10.46328/ijemst.2651

Velez, A. J., Dayaganon, D. G., Robigid, J., Demorito, J., Villegas, J., & Gomez, D. (2023). Difficulties and coping strategies in understanding mathematical concepts in a private higher education in Tagum City, Davao del Norte, Philippines. *Davao Research Journal*, *14*(1), 45-54. https://doi.org/10.59120/drj.v14i1.10

Wafubwa, R. N., & Csíkos, C. (2022). Impact of formative assessment instructional approach on students' mathematics achievement and their metacognitive awareness. *International Journal of Instruction, 15*(2), 119-138.

West, J. J. (2021). Is music teacher professional development becoming more effective? Evaluating practice and policy in the United States, 1993-2012. *Journal of Research in Music Education*, *69*(3), 321-342. https://doi.org/10.1177/0022429420982525

Yates, M. C., Fraser, D. J., & Derry, A. M. (2019). Meta-analysis supports further refinement of eDNA for monitoring aquatic species-specific abundance in nature. *Environmental DNA*, *1*(1), 5-13. https://doi.org/10.1002/edn3.7

Zhu, Y., & Kaiser, G. (2022). Impacts of classroom teaching practices on students' mathematics learning interest, mathematics self-efficacy and mathematics test achievements: A secondary analysis of Shanghai data from the international video study Global Teaching InSights. *ZDM-Mathematics Education, 54*(3), 581-593. https://doi.org/10.1007/s11858-022-01343-9