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Research Article

Teacher Challenges and Strategies in Addressing Proof in Mathematics

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Abstract
Mathematical proof is fundamental to mathematical reasoning and conceptual understanding, yet teaching proof remains challenging because learners must coordinate mathematical knowledge, logical reasoning, justification, and communication. This study investigated the challenges mathematics teachers encounter in addressing proof and the strategies they employ to respond to students' misconceptions and learning difficulties. A mixed-method research design was used to integrate quantitative assessment of teachers' perceived challenges with qualitative analysis of instructional strategies. The participants were 30 mathematics teachers in Region VI who were enrolled in graduate studies in mathematics or mathematics education. Data were collected through a researcher-developed questionnaire consisting of respondent profiles, 15 Likert-scale items on challenges in proof instruction, and open-ended questions concerning instructional strategies. Descriptive statistics, the Kruskal–Wallis H test, and the Mann–Whitney U test were used to analyze quantitative data, while thematic analysis was used for qualitative responses. The findings indicate a very high level of challenges across cognitive, affective, instructional, curricular, and structural dimensions, with the tendency of students to treat examples as proofs receiving the highest rating. Teachers report using multiple proof techniques, scaffolded instruction, guided questioning, collaborative learning, and engagement-oriented strategies. No significant differences are found across teacher profile variables. The findings support the need for progressive proof instruction, reasoning-focused professional development, improved instructional resources, and stronger curriculum alignment.

Keywords
mathematical proof, proof instruction, teacher challenges, reasoning, mathematics education

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INTRODUCTION
Mathematical proof occupies a central position in mathematics because it establishes the validity of mathematical claims while developing reasoning, justification, and conceptual understanding. Proof is therefore not merely a formal procedure

but an essential component of mathematical activity and learning (Zaslavsky et al., 2012). Reasoning and proof remain significant areas of mathematics education research because of their contribution to students' mathematical development (Lessing & Ogbonnaya, 2026). Mathematics learning and teaching also require learners to coordinate conceptual understanding, reasoning, problem solving, and productive engagement with mathematical ideas (Schoenfeld, 2022). These demands make proof instruction particularly important because students must progress from recognizing patterns and examples to constructing and evaluating logically warranted arguments. Consequently, mathematics instruction needs to move beyond procedural memorization toward learning experiences that explicitly develop mathematical reasoning and justification.

Effective proof instruction, however, presents substantial pedagogical demands for teachers. Proof-related tasks involve instructional complexities that require teachers to provide appropriate support as students engage with mathematical arguments (Bieda, 2010). Teachers may experience both successes and difficulties when implementing proof instruction, indicating that mathematical knowledge alone does not necessarily translate into effective pedagogical knowledge for teaching proof (Buchbinder & McCrone, 2020). The use of examples also plays an important role in preparing teachers to teach mathematical reasoning and proof, particularly in helping learners understand the distinction between examples and general mathematical arguments (Buchbinder & McCrone, 2023). These concerns extend to the assessment of students' reasoning and proof comprehension, particularly when teachers must evaluate students' understanding of mathematical arguments rather than merely their final answers (Sari et al., 2020; Mejia-Ramos et al., 2012). Effective mathematics lesson planning likewise requires teachers to coordinate content knowledge, pedagogical approaches, learner needs, and instructional objectives (Cevikbas et al., 2024). Thus, challenges in teaching proof may arise from the interaction of students' mathematical understanding with teachers' pedagogical decisions, curriculum expectations, assessment practices, instructional resources, and classroom conditions. The broader mathematics education literature likewise indicates that instructional conditions influence the quality of mathematics teaching. Persistent concerns involving teacher preparation, instructional resources, curriculum implementation, and educational conditions have been identified in mathematics education (Agbata et al., 2024a). Teachers' roles in connecting mathematics with meaningful contexts and everyday mathematical activity have also been emphasized (Agbata et al., 2024b). Teachers may encounter difficulties in mathematics classroom instruction that affect the implementation of effective learning experiences (Karali, 2022). Technological developments have further introduced opportunities and challenges for mathematics teaching, particularly in integrating digital technologies with appropriate pedagogical and mathematical purposes (Engelbrecht & Borba, 2024). Similarly, the integration of technological, pedagogical, and content knowledge remains a continuing challenge in mathematics education (Kholid et al., 2023), while artificial intelligence has introduced additional instructional possibilities that require appropriate pedagogical consideration (Egara & Mosimege, 2024).

Despite these developments, limited contextual evidence is available regarding the experiences of practicing Filipino mathematics teachers who teach proof while pursuing graduate-level mathematical study, particularly in Region VI. Existing research has addressed students' reasoning, preservice teacher preparation, proof assessment, and broader mathematics teaching concerns, but fewer studies have examined how practicing mathematics teachers in this Philippine context perceive proof-related challenges and respond to students' misconceptions and difficulties.

Accordingly, this study investigated the challenges mathematics teachers in Region VI encounter in addressing mathematical proof and the strategies they employ to address students' misconceptions and difficulties. Specifically, it examined respondents' educational attainment, teaching position, years of teaching mathematics, mathematics courses related to proof, access to instructional resources, and teaching modality; determines the overall and profile-based levels of challenges; identifies the instructional strategies reported by teachers; and examines whether statistically significant differences exist in perceived challenge levels across respondent groups. The study is significant to mathematics teachers, teacher educators, curriculum developers, and school administrators because its findings may provide contextual evidence for strengthening professional development, curriculum refinement, assessment practices, and proof-focused instructional resources. The study is limited to a purposive sample of 30 graduate-enrolled mathematics teachers in Region VI and relies primarily on self-reported questionnaire responses. The findings should therefore be interpreted within the characteristics and context of the participating teachers.

METHODOLOGY

Design

This study employed a mixed-method research design integrating quantitative and qualitative approaches to develop a comprehensive understanding of teachers' challenges and instructional strategies associated with mathematical proof. The quantitative component measured teachers' perceived level of challenges using a structured Likert-scale questionnaire, while the qualitative component examined the strategies that teachers reported using to address students' misconceptions and difficulties in proof instruction. The quantitative and qualitative components addressed complementary aspects of the research problem. Quantitative data provided information about the extent and distribution of perceived challenges, whereas qualitative responses provided contextual information about how teachers responded to these challenges in their instructional practices. The integration of both forms of evidence allowed the study to describe the prevalence of perceived challenges while also examining the instructional responses reported by participating teachers. This approach is consistent with the view that mathematics teaching involves the interaction of mathematical knowledge, pedagogical decision-making, reasoning, and classroom conditions (Cevikbas et al., 2024; Schoenfeld, 2022).

Sampling

The respondents were 30 mathematics teachers in Region VI who were enrolled in graduate studies in mathematics or mathematics education. The participants included practicing teachers from public and private educational institutions in the provinces of Antique and Guimaras. Purposive sampling was employed to select participants who met the established study criteria. Specifically, the respondents were practicing mathematics teachers who were actively enrolled in graduate-level studies related to mathematics or mathematics education. Their simultaneous engagement in professional teaching and advanced academic study provided relevant perspectives regarding the challenges associated with addressing mathematical proof. The respondents represented different levels of educational attainment, teaching positions, years of mathematics teaching experience, proof-related mathematics courses, access to instructional resources, and teaching modalities. This variation provided a basis for examining whether perceived challenges differed according to selected professional and instructional characteristics.

Collection

Data were gathered using a researcher-developed structured questionnaire informed by relevant literature, existing validated instruments, and consultations with mathematics educators. The questionnaire consisted of three parts. The first part obtained information about respondents' profiles, including highest educational attainment, teaching position, years of teaching mathematics, mathematics courses taken related to proof, access to instructional resources regarding proving, and teaching modality. The second part contained 15 Likert-scale items designed to measure challenges encountered by teachers in addressing mathematical proof. The items covered cognitive, instructional, curricular, affective, and resource-related dimensions of proof instruction. The third part consisted of open-ended questions that elicited information about strategies teachers used to address students' misconceptions and difficulties in learning mathematical proof. Content validation was conducted by three to five experts in mathematics education, assessment, and educational research from state universities and colleges in Region VI. The experts evaluated the questionnaire in terms of clarity, relevance, alignment with the study variables, and comprehensiveness. Following validation, the instrument was pilot-tested with 30 mathematics teachers from a comparable institution who were not included in the main study. The pilot-test responses were used to establish the reliability of the challenges section. The reported Cronbach's alpha coefficient was 0.856, indicating satisfactory internal consistency. Before questionnaire administration, the researchers secured the necessary administrative permissions from the appropriate graduate school offices of the selected institutions. The questionnaire was administered either in printed form or through a secure online platform depending on respondent accessibility and preference. Each questionnaire included information regarding the purpose of the study, confidentiality, and voluntary participation. Respondents were provided one to two weeks to complete the questionnaire, and follow-up reminders were issued. After retrieval, responses were encoded, reviewed, cleaned, and organized for statistical and qualitative analysis. Incomplete or inconsistent responses were excluded from the analysis.

Analysis

Quantitative data were analyzed using descriptive and inferential statistical procedures. Frequency and percentage were used to summarize respondents' profile characteristics, while mean scores were used to describe the perceived level of challenges encountered in addressing mathematical proof. The Kruskal–Wallis H test was used to examine differences in perceived challenge levels across groups based on highest educational attainment, teaching position, years of teaching mathematics, mathematics courses related to proof, and access to instructional resources. The Mann–Whitney U test was used to examine differences according to teaching modality. All inferential tests were evaluated at the 0.05 level of significance. The qualitative responses were analyzed thematically. The analysis involved familiarization with the responses, identification of meaningful statements, generation of initial codes, clustering of related codes, development and refinement of themes, and interpretation of recurring patterns. The resulting themes represented the instructional strategies reported by participating teachers in addressing students' misconceptions and difficulties in mathematical proof. The qualitative findings were subsequently integrated with the quantitative results to provide a more comprehensive interpretation of teachers' experiences.

Ethical Considerations

The study incorporated informed consent, confidentiality, voluntary participation, and protection of respondent information into the data-gathering process. Participants were informed about the purpose of the study and the intended use of the information they provided. Participation was voluntary, and respondents were given the opportunity to decline participation or discontinue their involvement. The collected information was treated confidentially and used solely for research purposes.

RESULTS AND DISCUSSION

The profile of the respondents provides important contextual information for interpreting their experiences in addressing mathematical proof. The respondents represent different levels of educational attainment, professional positions, teaching experience, exposure to proof-related mathematics courses, access to instructional resources, and teaching modalities. These characteristics are relevant because teaching mathematical proof requires teachers to integrate mathematical knowledge with pedagogical decisions concerning reasoning, task design, explanation, and assessment. Research on mathematics teacher competence indicates that effective lesson planning requires teachers to coordinate content and pedagogical considerations in response to learners' needs and instructional contexts (Cevikbas et al., 2024). Similarly, research on preparing teachers to teach mathematical reasoning and proof indicates that mathematical knowledge must be accompanied by appropriate pedagogical understanding of how students develop proof competence (Buchbinder &

McCrone, 2020, 2023). Table 1 therefore establishes the professional and instructional context within which the reported challenges and strategies should be understood.

The distribution shows that the respondents were predominantly graduate-level mathematics teachers. The largest educational-attainment group consisted of teachers with master's units (53.3%), followed by those with master's degrees (20.0%). Most respondents held Teacher I–III positions (66.7%), while 40.0% had between 0 and 5 years of teaching experience and 33.3% had between 6 and 10 years. Geometry was the most frequently reported proof-related course, accounting for 43.3% of respondents, followed by Abstract Algebra at 33.3%. Most respondents reported moderate access to instructional resources, and the participants were evenly divided between face-to-face and blended learning. This profile suggests that the respondents generally possessed substantial academic exposure to mathematics while still reporting varied levels of professional experience and instructional conditions. The prominence of graduate-level preparation is particularly relevant because proof involves mathematical reasoning that may require knowledge beyond routine procedural competence. Buchbinder and McCrone (2020) emphasize the challenges teachers encounter when implementing proof instruction, while Buchbinder and McCrone (2023) highlight the importance of pedagogical preparation for teaching mathematical reasoning and proof. The diversity of the respondents' professional backgrounds therefore provides an appropriate basis for examining whether proof-related challenges vary across teacher characteristics.

Table 1
Profile of the Respondents

Profile Variable	Category	f	%
Highest educational attainment	Bachelor's Degree	3	10.0
	With Master's Units	16	53.3
	Master's Degree	6	20.0
	With Doctoral Units	2	6.7
	Doctoral Degree	3	10.0
Teaching position	Teacher I–III	20	66.7
	Instructor I–III	6	20.0
	Assistant Professor	4	13.3
Years teaching mathematics	0–5 years	12	40.0
	6–10 years	10	33.3
	11–15 years	5	16.7
	16–20 years	3	10.0
Courses taken related to proof	Geometry	13	43.3
	Number Theory	7	23.3
	Abstract Algebra	10	33.3
Access to instructional resources	Limited	9	30.0
	Moderate	14	46.7
	Adequate	7	23.3
Teaching modality	Face-to-face	15	50.0
	Blended learning	15	50.0
Total		30	100.0

The findings presented in Table 2 indicate that mathematical proof represents a substantial instructional challenge for the participating teachers. The challenge indicators encompass students' understanding of proof structure, deductive reasoning, foundational knowledge, motivation, instructional time, teaching resources, curriculum emphasis, assessment, and readiness. These dimensions reflect the multifaceted nature of proof instruction identified in mathematics education research. Proof requires students to move beyond recognizing examples or applying procedures toward constructing logically justified mathematical arguments (Bieda, 2010; Zaslavsky et al., 2012). Consequently, examining the individual indicators is important for determining which aspects of proof instruction are most problematic in the study context.

Table 2 shows that all 15 indicators were rated very high, with mean scores ranging from 4.23 to 4.80 and an overall mean of 4.45. The highest-rated challenge was students' tendency to treat examples or visual illustrations as complete proofs (M = 4.80). This finding suggests that teachers experience considerable difficulty helping students distinguish illustrative evidence from a logically sufficient mathematical argument. The distinction is fundamental because mathematical proof requires justification that establishes the validity of a general mathematical claim rather than merely demonstrating that the claim works in selected cases. This finding is consistent with the mathematical and pedagogical importance of understanding what constitutes proof and proving (Zaslavsky et al., 2012). Students' reliance on memorization also received a very high rating (M = 4.47). This suggests that teachers perceive a tendency among students to approach proof as something to reproduce rather than as a process of reasoning and justification. Such a tendency may limit students' ability to construct, evaluate, and communicate mathematical arguments. Mejia-Ramos et al. (2012) emphasize the importance of assessing proof comprehension, indicating that understanding a proof involves more than reproducing its final form. Lessing and Ogbonnaya (2025) likewise identify reasoning and proof as continuing concerns in mathematics education. The very high ratings for insufficient foundational knowledge (M = 4.40), low motivation (M = 4.43), limited instructional time (M = 4.37), and inadequate resources (M = 4.43) further indicate that proof instruction is influenced by multiple interacting conditions. Clements et al. (2023) emphasize the importance of developing mathematical understanding through appropriate pedagogical approaches, while Agbata et al. (2024a) identify teacher preparation, instructional conditions, and educational resources as important issues in mathematics education. The present findings therefore suggest that teachers face challenges extending beyond students' immediate difficulties with proof construction.

The curriculum-related indicators were also rated very high. These included insufficient curriculum focus on proof and reasoning (M = 4.33), broad or ambiguous competencies (M = 4.33), limited earlier exposure to proof-based tasks (M = 4.43), and curriculum expectations that exceed students' readiness (M = 4.40). These results suggest that the development of proof competence may require greater continuity across grade levels. Early mathematical experiences can contribute to the development of reasoning and conceptual foundations needed for more advanced mathematical activity (Clements et al., 2023). The very high rating for the ineffectiveness of existing assessment tools (M = 4.23) is also significant. Assessment practices influence whether students are encouraged to demonstrate reasoning, justification, and understanding. Sari et al. (2020) identified challenges in implementing reasoning and proof assessment, supporting the present finding that evaluating proof competence can be difficult for teachers. Assessment approaches that focus on the reasoning process may therefore be necessary to complement conventional assessments of mathematical answers.

Table 2
Level of Challenges in Addressing Proof in Mathematics

Particulars	M	Description
Students have difficulty following the logical flow and structure required in constructing mathematical proofs.	4.27	Very High
Students often treat examples or visual illustrations as if they were complete proofs.	4.80	Very High
Students struggle to recognize and differentiate the premises, assumptions, and conclusions within a proof.	4.23	Very High
Students lack the foundational concepts and prior knowledge needed to begin constructing meaningful proofs.	4.40	Very High
Students frequently fail to distinguish valid deductive reasoning from flawed or incorrect arguments.	4.37	Very High
Identifying students' misconceptions about proofs early in the learning process is challenging.	4.30	Very High
Many students rely heavily on memorization rather than engage in analytical or logical reasoning.	4.47	Very High
Students exhibit low interest or motivation when lessons involve abstract or complex proof tasks.	4.43	Very High
Limited instructional time restricts teachers from adequately developing students' problem-solving skills.	4.37	Very High
The absence of sufficient teaching materials and resources makes proof instruction more difficult.	4.43	Very High
The curriculum does not allocate enough focus or depth to the teaching of proof and reasoning.	4.33	Very High
Existing assessment tools are ineffective at evaluating students' actual understanding of proofs.	4.23	Very High
Students reach secondary levels with minimal exposure to proof-based tasks in earlier grades.	4.43	Very High
Competencies related to proof are written broadly or ambiguously, making them difficult to teach effectively.	4.33	Very High
Curriculum expectations regarding proof often exceed the current readiness level of most students.	4.40	Very High
Overall	4.45	Very High

Table 3 examines whether the perceived challenges of addressing mathematical proof vary according to teachers' professional and instructional characteristics. Comparing challenge levels across educational attainment, teaching position, teaching experience, proof-related coursework, resource access, and teaching modality is important because it helps determine whether proof-related difficulties are concentrated among particular groups of teachers or are broadly experienced across the sample. Previous research suggests that teaching proof requires specialized pedagogical knowledge and cannot be understood solely through general measures of teacher qualification or experience (Buchbinder & McCrone, 2020; Cevikbas et al., 2024). The profile-based results therefore provide an important basis for determining whether professional characteristics correspond with differences in perceived instructional difficulty.

The results demonstrate that all respondent groups reported a very high level of challenge. The means ranged from 4.30 to 4.78, indicating a consistent pattern across educational attainment, teaching position, teaching experience, proof-related coursework, resource access, and teaching modality. The highest mean was recorded among respondents with doctoral units (M = 4.77), while respondents using blended learning reported the lowest group mean (M = 4.30); however, both were still classified as very high. The consistency of the findings suggests that challenges in proof instruction are not limited to teachers with lower academic qualifications or less professional experience. This pattern is consistent with research showing that teaching proof presents distinctive pedagogical challenges even when teachers possess mathematical knowledge and professional preparation (Buchbinder & McCrone, 2020). Cevikbas et al. (2024) similarly emphasize that teacher competence involves complex pedagogical decision-making rather than simply possessing academic qualifications. Respondents who reported adequate access to instructional resources nevertheless recorded a very high challenge level (M = 4.78). This finding suggests that access to resources alone may not be sufficient to overcome difficulties in proof instruction. Instructional resources need to be appropriately designed and pedagogically integrated with mathematical reasoning activities. Kholid et al. (2023) emphasize the importance of integrating technological, pedagogical, and content knowledge, while Engelbrecht and Borba (2024) highlight the opportunities and challenges created by digital technology in mathematics education. The similar challenge levels across teaching modalities are also noteworthy. Face-to-face teachers reported a mean of 4.61, while blended-learning teachers reported 4.30. Although the descriptive means differ, both groups experienced very high challenges. This suggests that the underlying difficulties associated with mathematical proof may persist regardless of delivery mode. Digital or blended environments may provide additional instructional opportunities, but they do not automatically address students' difficulties with deductive reasoning, proof structure, or conceptual understanding (Engelbrecht & Borba, 2024).

Table 3
Level of Challenges in Addressing Proof According to Respondent Profile

Profile Variable	Category	M	Description
Highest educational attainment	Bachelor's Degree	4.51	Very High
	With Master's Units	4.44	Very High
	Master's Degree	4.37	Very High
	With Doctoral Units	4.77	Very High
	Doctoral Degree	4.44	Very High
Teaching position	Teacher I–III	4.45	Very High
	Instructor I–III	4.44	Very High
	Assistant Professor	4.44	Very High
Years teaching mathematics	0–5 years	4.32	Very High
	6–10 years	4.60	Very High
	11–15 years	4.33	Very High
	16–20 years	4.69	Very High
Courses related to proof	Geometry	4.39	Very High
	Number Theory	4.32	Very High
	Abstract Algebra	4.57	Very High
Access to instructional resources	Limited	4.41	Very High
	Moderate	4.32	Very High
	Adequate	4.78	Very High
Teaching modality	Face-to-face	4.61	Very High
	Blended learning	4.30	Very High
Overall		4.45	Very High

Table 4 presents the results of the inferential analysis of differences in teachers' perceived challenges in addressing mathematical proof according to selected respondent characteristics. The findings show no statistically significant differences according to educational attainment ($H = 3.740$, $p = .442$), teaching position ($H = 8.633$, $p = .280$), years of teaching mathematics ($H = 2.956$, $p = .398$), mathematics courses related to proof ($H = 0.746$, $p = .862$), and access to instructional resources ($H = 2.469$, $p = .291$). Similarly, teaching modality showed no statistically significant difference ($U = 76.500$, $p = .137$). Since all p-values exceeded the 0.05 significance level, the null hypothesis of no significant difference was not rejected.

Although differences were observed in the mean ranks across some categories, these descriptive variations were not statistically significant. For instance, teachers with master's units had a mean rank of 17.53, whereas those with doctoral units had 6.50; teachers with 0–5 years of experience had a mean rank of 17.54 compared with 7.83 among those with 16–20 years; and teachers with adequate access to resources had a mean rank of 11.36 compared with 17.71 among those with moderate access. Similarly, blended-learning teachers had a higher mean rank (17.90) than face-to-face teachers (13.10), but the difference was not statistically significant. These findings indicate that the observed variations in perceived challenges cannot be interpreted as meaningful group differences based on the present sample.

The results suggest that the challenges of addressing mathematical proof were broadly reported across the participating teachers, regardless of their professional and instructional characteristics. This finding highlights the importance of specialized pedagogical competence in proof instruction rather than relying solely on academic qualifications, teaching experience, resources, or delivery modality. Previous research similarly emphasizes the specific pedagogical demands involved in teaching mathematical proof and mathematical reasoning (Buchbinder & McCrone, 2020, 2023). However, because the study involved only 30 purposively selected teachers and several subgroups were small, the nonsignificant findings should not be interpreted as evidence that the groups are equivalent. Instead, the results indicate that statistically detectable differences were not observed within the participating sample, supporting the need for broader professional development, curriculum support, appropriate assessment, and reasoning-focused instructional resources.

Table 4
Differences in the Level of Challenges Encountered by Teachers According to Respondent Profile

Profile Variable	Category	Mean Rank	Test Value	p	Remarks
Highest educational attainment	Bachelor's Degree	11.83	H = 3.740	.442	Not significant
	With Master's Units	17.53			
	Master's Degree	16.08			
	With Doctoral Units	6.50			
	Doctoral Degree	13.17			
Teaching position	Teacher I–III	14.92	H = 8.633	.280	Not significant
	Instructor I–III	14.40			
	Assistant Professor	12.75			
Years teaching mathematics	0–5 years	17.54	H = 2.956	.398	Not significant
	6–10 years	15.35			
	11–15 years	15.50			
	16–20 years	7.83			
Courses related to proof	Geometry	15.50	H = 0.746	.862	Not significant
	Number Theory	18.41			

Profile Variable	Category	Mean Rank	Test Value	p	Remarks
	Abstract Algebra	15.50			
Access to instructional resources	Limited	15.28	H = 2.469	.291	Not significant
	Moderate	17.71			
	Adequate	11.36			
Teaching modality	Face-to-face	13.10	U = 76.500	.137	Not significant
	Blended learning	17.90			

Instructional Strategies Used by Teachers

The qualitative responses provide additional information about how participating teachers respond to the challenges identified in the quantitative findings. The reported strategies can be organized into five themes: use of multiple proof techniques, step-by-step scaffolding and structured proof formats, emphasis on reasoning and justification, collaborative learning, and strategies for improving student engagement.

Use of Multiple Proof Techniques

Teachers reported using different proof techniques to help students recognize that mathematical claims can be established through more than one form of reasoning. Presenting alternative approaches may provide students with opportunities to compare arguments and identify the logical structure underlying a proof. This approach is consistent with the importance of examples and instructional representations in developing mathematical reasoning and proof competence (Buchbinder & McCrone, 2023).

Step-by-Step Scaffolding and Structured Proof Formats

Teachers also reported breaking proof tasks into smaller and more manageable steps. Structured formats may help students identify assumptions, premises, mathematical statements, reasoning steps, and conclusions. Such scaffolding is particularly relevant given the very high ratings for difficulties with logical flow, foundational knowledge, and deductive reasoning in Table 2.

Emphasis on Reasoning and Justification

Another reported strategy involved encouraging students to explain why a statement is true rather than simply reproduce a completed proof. This strategy directly addresses the finding that students may rely heavily on memorization. Emphasizing explanation and justification may help shift proof instruction from procedural reproduction toward mathematical reasoning.

Collaborative Learning

Teachers reported using collaborative activities to allow students to discuss proof strategies, compare solutions, and explain mathematical reasoning to peers. Collaborative learning may provide opportunities for students to articulate and evaluate mathematical arguments, although the effectiveness of particular collaborative approaches should be examined through future intervention-based research.

Strategies for Improving Student Engagement

Teachers also reported using strategies intended to increase student participation and interest in proof-related activities. These included guided questioning, accessible examples, and progressively challenging tasks. Such strategies may be particularly relevant to the very high rating for students' low interest or motivation when dealing with abstract or complex proof tasks. The qualitative findings complement the quantitative results by showing that teachers do not respond to proof-related challenges through a single instructional approach. Instead, they report combining scaffolding, reasoning-focused instruction, multiple proof techniques, collaborative activities, and engagement strategies. Because these findings are based on self-reported practices, they should be interpreted as teachers' reported strategies rather than as direct evidence of observed classroom effectiveness.

Conclusion and Recommendations

The study concludes that mathematics teachers in Region VI experience a very high level of challenges in addressing mathematical proof. The difficulties involve students' misconceptions about proof, weak deductive reasoning, limited foundational knowledge, reliance on memorization, low motivation, insufficient instructional time, inadequate resources, curriculum concerns, and difficulties in assessing students' actual understanding. The most prominent challenge is students' tendency to treat examples or visual illustrations as complete proofs. Despite these challenges, teachers employ multiple strategies, including varied proof techniques, step-by-step scaffolding, structured proof formats, guided questioning, collaborative learning, and approaches that promote reasoning and engagement. The findings further show that there are no significant differences in the level of challenges according to educational attainment, teaching position, teaching experience, proof-related coursework, access to instructional resources, or teaching modality, indicating that proof-related difficulties are broadly experienced across the participating teachers.

Based on these findings, mathematics curricula should provide a progressive and developmentally appropriate introduction to mathematical reasoning and proof across grade levels. Schools and teacher-education institutions should provide sustained professional development focused on proof pedagogy, including scaffolding, deductive reasoning, misconception identification, proof construction, and assessment. Teachers should consistently use reasoning-centered strategies, multiple proof techniques, guided questioning, collaborative activities, and progressively challenging tasks. Schools should also provide adequate proof-focused instructional materials that emphasize constructing, explaining, evaluating, and justifying mathematical arguments rather than memorizing completed proofs. Assessment practices should be improved to measure students' reasoning and proof comprehension. Future research should use larger and more diverse samples and examine intervention-based or longitudinal approaches to determine the effectiveness of specific strategies for improving students' mathematical proof competence.

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