International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Overlooked Logic: A Narrative Inquiry into Why Geometry Teachers Avoid Teaching Proofs

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Abstract

Mathematical proofs are fundamental to developing logical reasoning, yet many geometry teachers avoid teaching them. This study explores the reasons behind this avoidance through a narrative inquiry, examining the perspectives of secondary school teachers. Grounded in Constructivist Learning Theory and Shulman's Pedagogical Content Knowledge (PCK) Framework, the study identifies key challenges that contribute to the omission of proofs in geometry instruction.

Findings reveal that teacher-related factors—such as lack of preparation, low confidence, and negative past experiences—significantly impact teachers' willingness to teach proofs. Curriculum and institutional constraints, including time limitations and an emphasis on procedural problem-solving over reasoning, further discourage proof instruction. Additionally, student-related factors, such as perceived difficulty and resistance to logical reasoning, contribute to teachers' reluctance. The study also highlights a strong need for professional development, with teachers expressing interest in training programs and innovative teaching strategies to make proofs more engaging and accessible.

These findings align with existing literature, emphasizing that teachers require both content knowledge and pedagogical strategies to effectively teach proofs. The study suggests curriculum reforms, professional development initiatives, and instructional innovations as potential solutions. Addressing these barriers can help reintegrate proofs into geometry education, fostering critical thinking and mathematical reasoning skills among students.

Ultimately, this study underscores the importance of strengthening teachers' pedagogical knowledge and institutional support to ensure that proofs remain a core component of mathematical learning, bridging the gap between computational skills and conceptual understanding.

Keywords: Overlooked logic, Geometry teachers, Proof avoidance, Geometry proofs

1. Introduction

Teaching geometry proofs is vital in math education to foster students' critical thinking and reasoning skills. Yet, many teachers avoid or underemphasize proofs, potentially hindering students' preparedness for advanced mathematical concepts. As proofs are explicitly designated as fundamental learning goals in the K-12 curriculum, this avoidance poses a major obstacle for students' mathematical development.

Various challenges that teachers experience when teaching geometric proofs are highlighted in the existing literature. For instance, Jones and Herbst (2012) emphasize how socio-mathematical norms and the lack of time make it difficult for teachers to focus on proofs. Stylianides (2007) discusses the interplay of

teacher actions and student responses, identifying students' struggle with abstract reasoning as a significant barrier. Heinze and Reiss (2009) explore how standardized testing pressures lead to the neglect of proof teaching. Martin and McCrone (2009) note that teachers often feel unprepared to teach proofs due to insufficient professional development. Lastly, Herbst and Miyakawa (2008) focus on the importance of variation in teaching, suggesting that teachers' lack of diverse pedagogical strategies limits their ability to effectively teach geometric proofs.

It is essential to comprehend the reasons why teachers refrain from teaching proofs in order to address this gap in mathematics education. By identifying the challenges and barriers, educational stakeholders can implement targeted interventions, ensuring that students receive a well-rounded mathematical education. This study aims to provide insights into the reasons behind the avoidance of teaching proofs and to propose practical solutions to overcome these challenges.

The primary objective of this research is to investigate the viewpoints and experiences of geometry teachers in connection to their avoidance or reluctance to give proofs. It specifically seeks to give answers to the following questions:

1. What particular difficulties do teachers have while teaching students in geometric proofs?
2. How do teachers view student's ability to comprehend and formulate arguments?
3. What factors influence teachers' decisions to avoid or minimize proofs in their lessons?
4. What strategies do teachers propose for improving proof instruction?

2. Methodology

This study employed a qualitative narrative inquiry approach to capture the personal experiences and perspectives of geometry teachers regarding the teaching of proofs. The narrative inquiry method was chosen to provide an in-depth understanding of teachers' experiences and the contextual factors influencing their instructional practices. Specifically, this approach allowed the study to explore why some teachers skip or avoid teaching geometric proofs.

According to Cresswell (2013), as cited by Adhikari (2021), narrative research is particularly suited for capturing the detailed stories of individuals or small groups. Similarly, Lane (2023) highlights that the goal of a researcher in narrative inquiry is to elicit and explore participants' stories. In line with this, the use of narrative inquiry in this study facilitated an in-depth evaluation of participants' experiences and contextualized insights. Through their narratives, participants provided valuable perspectives on their personal experiences in learning and teaching geometric proofs.

Ten secondary school geometry teachers with varying levels of teaching experience participated in the study. They were selected based on their willingness to share their experiences with teaching geometric proofs.

Data were collected through semi-structured interviews using a pre-designed instrument. The interviews focused on teachers' experiences, challenges, instructional strategies, and their perceptions of students' responses to proofs. Each interview lasted approximately 40 minutes and was recorded and transcribed for analysis.

Key themes were identified, and findings were presented with supporting quotations from participants. Thematic analysis was employed to identify recurring patterns in the teachers' responses. Data were initially coded manually, and themes were refined through an iterative review process and discussion. Sample responses were extracted to illustrate key findings.

3. Results and Discussions

The study identified several key challenges that teachers encounter when teaching geometric proofs, which were categorized into themes. The results are presented and discussed in relation to the study's four research questions. Additionally, a tabular summary of the thematic analysis highlights teachers' responses regarding their avoidance of teaching proofs in geometry.

Table 1: Thematic Analysis of Teachers' Responses

Factors/Categories	Themes	Codes/Descriptions
Teacher-Related Factors	▪ Perceived Irrelevance of Proofs	Teachers view proofs as too abstract, not practically useful.
	▪ Lack of Preparation and Confidence ▪ Negative Personal experiences	Insufficient training, lack of confidence in teaching proofs. Teachers struggled with proofs as students and avoid them in teaching.
Curriculum and Institutional Factors	▪ Time Constraints	Pressure to cover curriculum guide leads to skipping proofs.
	▪ Lack of Curriculum Emphasis on Proofs ▪ Policy and Assessment Expectations	Teachers struggled with proofs as students and avoid them in teaching. Standardized tests focus on computations rather than proof-based reasoning.
Student-Related Factors	▪ Student Resistance to Proofs	Students find proofs difficult and disengage.
	▪ Perceived Difficulty of Logical Reasoning ▪ Low Engagement with Abstract Concepts	Logical reasoning seen as complex and intimidating. Students prefer concrete, numerical problems over abstract reasoning.
Professional Development Needs	▪ Need for Training and Support ▪ Need for Engaging Teaching Strategies	Teachers express a need for workshops or training on teaching proofs. Teachers seek innovative methods to make proofs more accessible.

The findings of this study highlight several factors contributing to the avoidance of teaching proofs in geometry classrooms. These factors align with existing literature and theoretical perspectives, particularly Constructivist Learning Theory (Piaget, 1972; Vygotsky, 1978) and Pedagogical Content Knowledge

(PCK) Framework (Shulman, 1986). The major themes identified include teacher-related challenges, curriculum and institutional constraints, student-related difficulties, and the need for professional development.

Teacher-Related Factors

One of the main reasons teachers avoid proofs is their perceived irrelevance, which aligns with Knuth's (2002) study, where secondary school teachers viewed proofs as unnecessary for students who are not pursuing advanced mathematics. One participant expressed this sentiment: *"I know proofs are important, but when I'm pressed for time, I focus more on problem-solving techniques that students will actually use in exams."*

This perspective indicates a misalignment between mathematical reasoning and exam-oriented teaching, which is reinforced by the education system's emphasis on procedural problem-solving over logical reasoning.

Additionally, lack of preparation and confidence was a recurring theme. Teachers admitted feeling unprepared due to minimal exposure to proofs during their training: "*We barely touched on proofs in my teacher training program. When I entered the classroom, I didn't have the confidence to teach them well."*

This supports Stylianides (2007), who found that teachers with limited formal training in proof-based instruction often avoid it altogether. Shulman's (1986) PCK framework also suggests that effective teaching requires both content knowledge (understanding proofs) and pedagogical knowledge (how to teach them effectively). The lack of PCK in proof instruction makes teachers feel ill-equipped, leading to avoidance.

Curriculum and Institutional Factors

Another significant factor is time constraints, as teachers feel pressured to cover the syllabus quickly, leaving little room for teaching proofs. One teacher explained: *"With the number of topics we need to cover, spending time on proofs feels like a luxury. I have to choose what's most important for my students to pass."*

This finding is consistent with Cirillo (2009), who noted that curriculum structures often prioritize computational techniques over reasoning, discouraging teachers from integrating proofs. The lack of emphasis on proofs in standardized tests further reinforces this avoidance: *"Most of the exams don't even ask for formal proofs. So why spend so much time on something students won't be tested on?"*

This response aligns with Harel and Sowder (1998), who argued that without assessment-driven motivation, teachers often neglect proof instruction. Constructivist Learning Theory suggests that meaningful learning occurs when students are actively engaged, yet institutional constraints prevent teachers from fostering such engagement with proofs.

Student-Related Factors

A major challenge is student resistance to proofs, as students often perceive them as difficult and abstract. One teacher described their struggle: "*The moment I introduce proofs, my students tune out. They see it as something only 'math geniuses' can do."*

This supports Blanton and Stylianou (2014), who found that students struggle with proofs because they lack familiarity with formal reasoning. Teachers also noted the perceived difficulty of logical reasoning, as students prefer numerical computations over abstract thinking: *"My students are comfortable solving equations, but when I ask them to explain why a theorem works, they get frustrated."*

This aligns with Constructivist Learning Theory, which suggests that students need scaffolding to develop reasoning skills. Without proper guidance, students struggle to make sense of proofs, reinforcing their res-

istance.

Need for Professional Development

Finally, teachers expressed a strong need for professional development to improve their ability to teach proofs. One teacher shared: *"I'd love to attend a workshop on making proofs more engaging. I feel like I need new strategies to make it work."*

This supports Cirillo's (2009) argument that targeted teacher training is essential for fostering proof-based reasoning. Additionally, teachers seek engaging teaching strategies to make proofs more accessible: *"If there were better resources and interactive ways to teach proofs, I think more of us would incorporate them."*

This highlights the need for innovative instructional approaches that align with PCK principles, ensuring that teachers can bridge the gap between content knowledge and effective pedagogy.

4. Conclusion

The study reveals various reasons why geometry teachers hesitate to teach proofs, highlighting the complex relationship between challenges faced by teachers, institutions, and students. Teachers often avoid proof instruction due to a lack of confidence, limited time, curriculum constraints, and students' difficulties with abstract reasoning. These insights underscore the pressing need for professional development programs that provide teachers with both the necessary content knowledge and effective teaching strategies.

To improve proof instruction, educational institutions should adopt supportive policies that emphasize logical reasoning in addition to procedural problem-solving. By incorporating engaging and interactive teaching methods, student interest and understanding of proofs can be significantly enhanced. Ultimately, creating a culture that appreciates proof-based reasoning will aid in students' overall mathematical growth, equipping them with the critical thinking skills essential for tackling advanced mathematics and real-world challenges.

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