

Research Article

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Exploring the Challenges of Geometric Reasoning in Middle School: An Analysis of Teachers' Perceptions and Pedagogical Perspectives

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Abstract

Background/purpose. Geometric reasoning is essential for students' cognitive development, yet middle school learners in Morocco face major difficulties in this area. This study investigates the challenges perceived by teachers and aims to identify effective pedagogical strategies to enhance students' geometric reasoning skills.

Materials/methods. This research adopted a quantitative methodology based on a structured questionnaire administered to 90 middle school mathematics teachers across various regions of Morocco. The survey explored perceived student difficulties, instructional methods, and the integration of digital technologies. Data analysis included descriptive statistics and Chi-square tests using SPSS.

Results. Students mainly struggle with geometric problem-solving (59.94%) and logical reasoning and proofs (39.96%), while basic skills like figure visualization are generally mastered. Most teachers use problem-solving approaches (83.25%) and rely on traditional assessments (100%). Digital tools are underused, with only 42.18% using GeoGebra and 57.72% using no technology. The lack of resources (76.59%) is the main barrier to digital integration. All teachers believe current assessments only partially reflect students' reasoning abilities, and 92.13% see value in alternative evaluation methods.

Conclusion. This study highlights the persistent challenges in teaching geometric reasoning in Moroccan middle schools, particularly in problem-solving and logical proofs. While traditional methods dominate, the limited use of digital tools and diversified assessments hinders deeper learning. Enhancing teacher training, integrating alternative evaluation methods, and promoting tools like mind maps could significantly improve students' reasoning skills in geometry.

1. Introduction

Geometric reasoning occupies a central place in the learning of mathematics in middle school, as it enables students to develop spatial, logical, and analytical skills that are essential for their academic and professional careers. In particular, deductive reasoning, defined as the ability to link logical propositions based on established facts in order to reach a valid conclusion, constitutes a fundamental pillar in the resolution of geometric problems (Duval, 1998).

In Morocco, teaching geometry has crucial importance. Nevertheless, numerous reports and studies have revealed that students encounter significant difficulties in geometric reasoning (Nachit et al., 2021; El Idrissi, 2016). Traditional teaching methods often exacerbate these difficulties, focused more on memorization than on the active construction of knowledge (Talbi, 2020). Added to this is a lack of suitable didactic resources and teacher training, both initial and ongoing, that do not give sufficient attention to teaching strategies centered on geometric reasoning. In addition, the Higher Council for Education, Training and Scientific Research has pointed out that Moroccan students have difficulty assimilating and applying fundamental mathematical concepts, particularly in geometry (PNEA, 2008).

Morocco's modest performance in international assessments such as PISA, TIMSS, and OIM can be attributed to several structural and pedagogical factors. Teaching methods often remain focused on rote memorization at the expense of understanding and reasoning. Moreover, the lack of continuous professional development for teachers, along with the limited availability of didactic and digital resources, hinders pedagogical innovation. Lastly, the absence of a problem-solving culture and the insufficient development of transversal skills also contribute to these concerning outcomes.

In this context, it is crucial to explore teachers' perceptions of these challenges, as their role is decisive in implementing appropriate pedagogical practices. As intermediaries between disciplinary content and students, their perspectives directly influence the strategies they choose to teach (Shulman, 1987).

Thus, this study aims to analyze the obstacles perceived by Moroccan teachers in teaching geometric reasoning at the middle school level, while proposing innovative pedagogical perspectives to overcome these difficulties.

2. Literature Review

2.1. Overview of Recent Findings on Mathematics Education in Morocco

Despite the clarifications provided regarding the role of mathematics education, serious problems persist within educational systems. When analyzing students' performance, academic failure is often rightly or wrongly attributed to the specific characteristics of the mathematics discipline. It is therefore absolutely necessary to identify the sources likely to effectively improve teaching and pedagogical practices for the benefit of mathematics learning. It is precisely in the face of these major challenges that the need for in-depth scientific research in this field becomes evident.

The effectiveness of an educational system is measured by students' results in various international assessments. Among these assessments is the TIMSS (Trends in Mathematics and Science Study), conducted by the International Association for the Evaluation of Educational Achievement (IEA), which evaluates the performance of primary and lower secondary students in mathematics (number, geometry, algebra, etc.) and science. The assessment also focuses on three cognitive domains: knowledge, application, and reasoning. The data collected allows for comparisons between the educational systems of different countries. According to the results of the 2019 edition of TIMSS, Moroccan lower secondary students scored 388 points in mathematics, one of the lowest scores among participating countries, and well below the international average of 500 points

(Education and Training Evaluation Commission, 2021; Nhaili, 2021). These results highlight significant gaps in the teaching and learning of mathematics in Morocco.

The International Mathematical Olympiad (IMO) is another assessment framework that evaluates students' performance in mathematics on a global scale. It is an annual competition intended for high school and middle school students, held each year in a different country. Regarding Morocco, the results obtained between 2010 and 2020 reflect a relatively low ranking: the country consistently ranked between 67th and 90th place out of over 100 participating countries during that period (International Mathematical Olympiad, 2020).

A third and final program for evaluating students' learning outcomes is the PISA (Programme for International Student Assessment). Unlike TIMSS, which assesses an entire grade level, PISA is based on a random sample of 15-year-old students. Led by the OECD (Organisation for Economic Co-operation and Development), this evaluation aims to measure how well students are prepared to face complex real-life situations. To do so, PISA assesses competencies in three main areas: reading comprehension, mathematical literacy, and scientific literacy. In mathematics, the assessment examines students' ability to formulate, use, and interpret mathematical concepts in various contexts. This includes their ability to describe, explain, and predict phenomena, while recognizing the role of mathematics in society. These skills are essential to developing engaged, critical citizens who are capable of making informed decisions (OECD, 2004; Levasseur, 2006). According to the national PISA 2018 report, Morocco participated for the first time alongside 78 countries, ranking 75th with a score of 368 points, compared to the OECD average of 489 points (Bourqia, 2021).

Thus, Morocco's results reveal a general underperformance. The gaps recorded compared to the OECD average are considerable. The PISA findings show that there is still a long way to go in order to achieve, by 2030, the global objectives related to quality education as defined in the United Nations Sustainable Development Goals for education.

2.2. Challenges and Issues of Geometric Reasoning in the Moroccan School Context

Geometric reasoning is a fundamental skill in mathematics, involving the ability to manipulate spatial concepts, visualize figures, and apply mathematical properties to solve problems (Battista, 2007). According to Duval (1998), this type of reasoning relies on three interdependent semiotic registers: visualization, construction, and deduction, whose articulation often presents difficulties for students, hindering their overall understanding.

In Morocco, studies such as those by El Idrissi (2016) and Talbi (2020) have highlighted the persistent difficulties encountered by middle school students in mastering basic geometric concepts, particularly the properties of shapes and congruence theorems. These challenges are often linked to a teaching approach that emphasizes memorization at the expense of reasoning.

Moreover, the teaching of geometry faces structural challenges: abstract concepts that require strong visualization skills (Battista, 2007), overloaded curricula, a lack of suitable teaching resources, and the absence of ongoing teacher training (El Idrissi, 2016). These constraints are compounded by socio-economic factors such as overcrowded classrooms and the limited integration of educational technologies (Talbi, 2020).

In addition, the use of a language of instruction that students do not fully master constitutes a further barrier to learning. Finally, recent studies (Benali et al., 2018; Laajan, 2024) emphasize the persistence of transmissive teaching approaches in Moroccan schools, which limit students' active participation and their engagement in authentic geometric reasoning.

2.3. Teacher Perceptions and Pedagogical Perspectives

Teachers' perceptions play a key role in how they approach the teaching of geometry. According to Shulman (1987), pedagogical content knowledge is essential for adapting teaching methods to meet students' needs. However, in Morocco, many teachers lack in-depth training in mathematics didactics, which affects their ability to effectively teach geometry (El Idrissi, 2016).

To overcome these challenges, many researchers recommend the use of innovative pedagogical methods, such as problem-based learning, the use of dynamic geometry software like GeoGebra, and the implementation of contextualized problem situations (Battista, 2007; Talbi, 2020). These approaches promote more intuitive and interactive learning, while also enhancing student engagement and the development of geometric reasoning.

3. Methodology

3.1. Study Design

This study adopts a quantitative approach to explore teachers' perceptions of the challenges related to geometric reasoning at the middle school level. Data were collected through a survey designed as a structured questionnaire, allowing for both descriptive and inferential analysis of responses.

3.2. Participants

A total of 90 middle school mathematics teachers participated in this study, from different regions of Morocco, thus ensuring a diversity of teaching contexts. The selection of teachers was carried out using a non-probability sampling method, based on their availability and consent to answer the questionnaire.

The choice of a non-probability sampling method (convenience sampling) was primarily driven by the logistical and geographical constraints associated with accessing teachers across multiple regions. Given the exploratory nature of the study and the aim to gather in-depth insights into teachers' perceptions, this sampling approach was deemed appropriate for ensuring voluntary participation and maximizing the diversity of teaching contexts. Although this method does not allow for statistical generalization to the entire population of Moroccan middle school teachers, it provides valuable descriptive insights that are consistent with the objectives of this research.

3.3. Data Collection Tools

The questionnaire used was designed to assess teachers' perceptions of several aspects of geometric reasoning:

- The difficulties encountered by students, as perceived by teachers.
- The pedagogical methods currently used.
- The perceived needs in terms of further training or teaching resources.

Responses were collected in two formats:

Paper form: distributed in schools.

Google Forms: enabling digital data collection and automatic consolidation.

3.4. Data Analysis Methods

Descriptive Analysis

The collected data were first subjected to a descriptive analysis to identify general trends and frequencies. This analysis includes the frequency distribution, which indicates the number and percentage of responses for each question category.

An inferential analysis was conducted using the following statistical tests to explore the relationships between different variables:

Chi-Square Test:

Used to examine relationships between categorical variables.

Software Used

Microsoft Excel was used for the initial organization of the data and the creation of descriptive charts. SPSS (Statistical Package for the Social Sciences) was used to perform statistical tests such as the Chi-Square and Pearson's correlation coefficient.

3.5. Validity and Reliability

Questionnaire Validity:

The questionnaire was validated by experts in mathematics education to ensure the relevance and clarity of the questions.

Data Reliability:

The internal consistency of the questionnaire was assessed using Cronbach's alpha (α), with a target value above 0.7 indicating good reliability.

3.6. Limitations of the Methodology

The use of non-probability sampling may limit the generalizability of results to all Moroccan teachers.

Data collection using paper forms and Google Forms may introduce biases linked to voluntary participation.

4. Results

For presenting and analyzing results, here's a structured approach, including detailed steps and suggestions for organizing data in a clear and informative way:

4.1. Global Descriptive Statistics

Before turning to the specific sections of the form, here are some general statistics:

- Total number of participants: 90 middle school mathematics teachers.
- Distribution by professional experience:

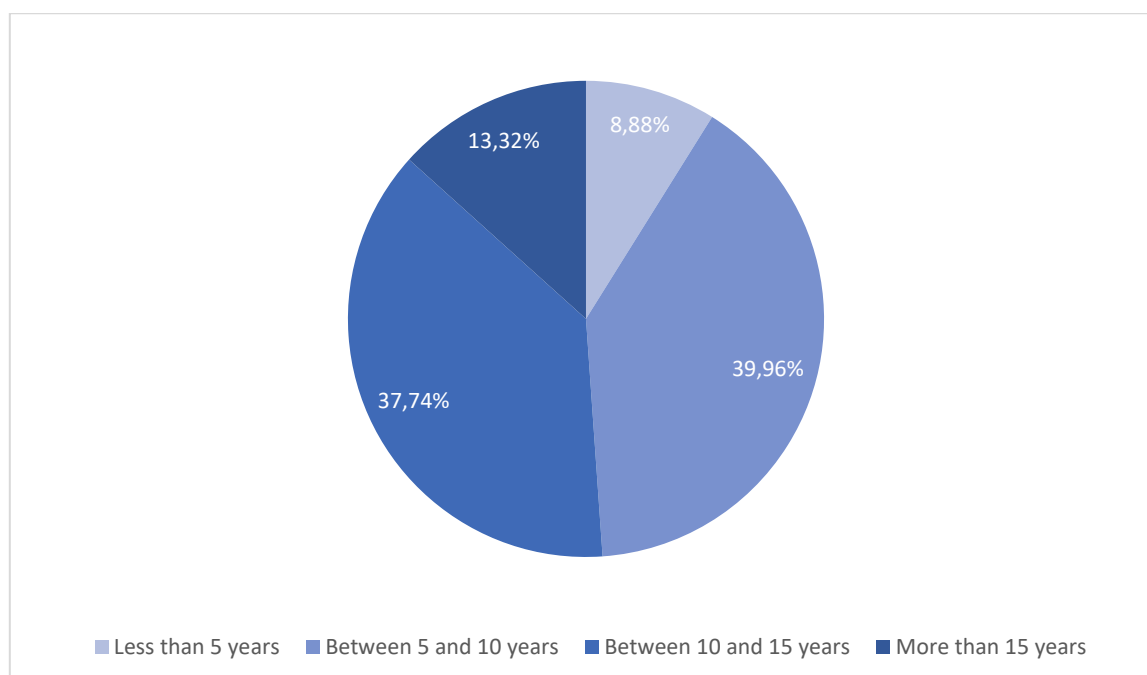


Figure 1. Distribution by Teachers' Experience

4.2. Results by Form Section

4.2.1 Teachers' General Perceptions of Geometry Difficulties

Table 1. Challenging Aspects of Geometry for Students

Answers	Percentage %
Visualization of figures	0
Solving geometric problems	59.94
Use of mathematical language (e.g., theorems, axioms)	0
Logical reasoning and demonstration	39.96

The results reveal that students' main difficulties in geometry concern geometric problem solving (59.94%) and logical reasoning and demonstrations (39.96%). These figures highlight a gap in learners' ability to apply geometric concepts in problematic contexts and to structure deductive reasoning. On the other hand, no notable difficulties were reported in visualizing figures (0%) or using mathematical language (0%), suggesting sufficient mastery in these skills. These observations point to the need to reinforce practical application activities and logical reasoning exercises to improve students' skills.

Table 2. Mastering Deductive Reasoning Among Middle School Students

Answers	Less than 25%	Between 25% and 50%	Between 50% and 75%	More than 75%
Percentage %	1.11	98.79	0	0

The results show that the vast majority of all teachers (98.79%) estimate that only 25% to 50% of students had mastered deductive reasoning in geometry by the end of middle school. Very few teachers (1.11%) believe that less than 25% of students reach this level, and no teacher reported a

mastery above 50%. These data point to significant difficulties in the acquisition of this key skill, indicating the need for pedagogical reinforcement focused on the progressive development of deductive reasoning through adapted activities and ongoing teacher training to better support students.

4.2.2. Teaching Methods Used

Table 3. Geometry Exercises Most Effective for Developing Geometric Reasoning

Answers	Percentage %
Demonstration exercises (proofs)	83,25
Geometric construction exercises	0
Real-world problem solving	16,65
Practical activities with digital tools	0

The results show that teachers largely consider exercises through demonstration (proofs) to be the most useful for developing students' geometric reasoning, with a high proportion of 83.25%. In contrast, geometric construction exercises and practical activities using digital tools are not perceived as effective (0% each), while 16.65% of teachers emphasize concrete problem solving. These results reflect a strong preference for formal, proof-oriented approaches, but they also reveal an underuse of practical methods and digital tools, which could diversify teaching strategies and better meet students' needs.

Table 4. Pedagogical Approaches Used to Help Students Overcome Difficulties in Geometry

Answers	Problem-solving approach	Project-based learning (e.g., 3D-figure modeling)	Lectures	Group work
Percentage %	83,25	0	0	16,65

The results show that a large number of teachers (83.25%) favor the problem-solving approach to help students overcome their difficulties in geometry. In contrast, other pedagogical approaches, such as project-based learning (0%), lectures (0%), and group work (16.65%), are rarely used. These data reveal a strong focus on practical problem-solving activities, but also an underuse of interactive or collaborative methods, such as group work, which could enrich students' learning experience and foster a deeper understanding of geometric concepts.

4.2.3. Use of Digital Tools

Table 5. Use of Digital Tools in Geometry Teaching

Answers	Percentage %
Yes, GeoGebra	42,18
Yes, dynamic geometry software	0
Yes, tablet applications (e.g., Khan Academy)	0
No	57,72

The results reveal that a significant proportion of teachers (42.18%) use GeoGebra to teach geometry, while none of them use other digital tools such as dynamic geometry software or tablet

applications. The majority of teachers (57.72%) report not using digital tools. These figures highlight a partial adoption of technology in geometry teaching, with an almost exclusive reliance on GeoGebra. This points to an untapped potential for diversifying the use of digital tools, which could enhance learning and better meet the needs of struggling students.

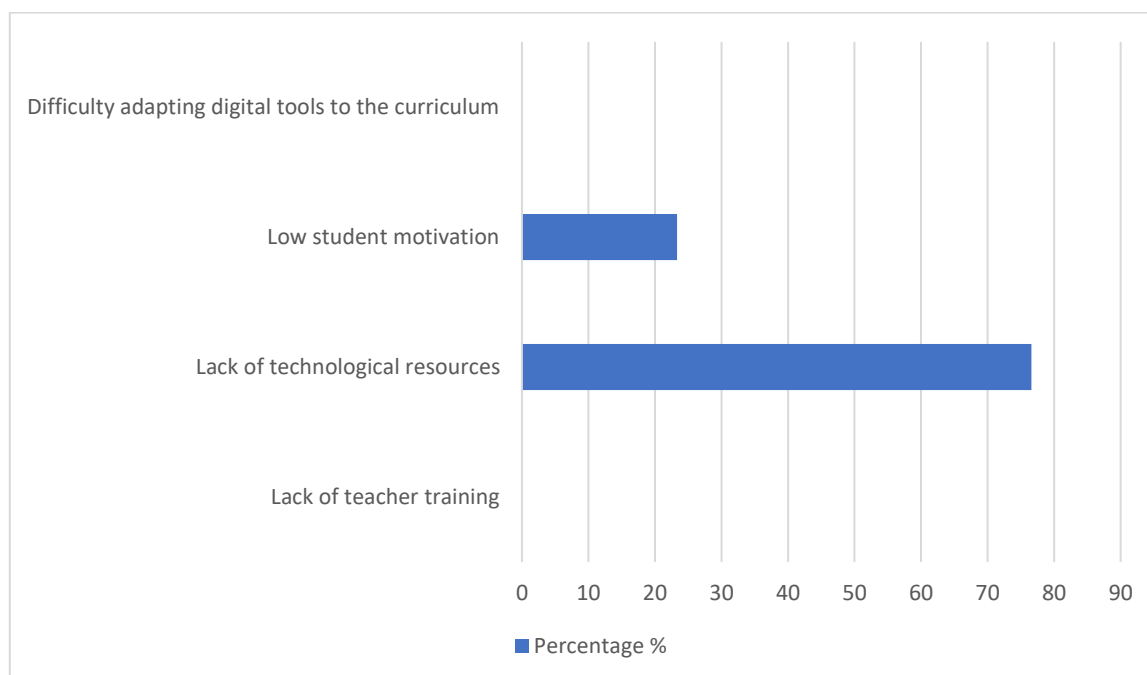


Figure 2. Challenges to the Integration of Technology in Geometry Education

The results show that the main obstacle to integrating digital technologies into geometry teaching is the lack of technological resources, identified by 76.59% of teachers. A smaller proportion (23.31%) mentioned low student motivation as a barrier. On the other hand, no teacher reported a lack of training or difficulty in adapting digital tools to the curriculum as obstacles. These results suggest that material constraints are the major challenge, requiring increased investment to equip schools and support the integration of technology into geometry teaching.

4.2.4. Student assessment in geometry

Table 6. Assessing Students' Progress in Geometric Reasoning

Answers	Percentage %
Regular tests with demonstration exercises	100
Assessment based on practical projects	0
Individuals work on geometric construction exercises	0
Written tests with reflection questions	0

The results show that 100% of teachers assess their students' progress in terms of geometric reasoning exclusively through regular tests with demonstration exercises. No teacher mentioned other assessment methods, such as practical projects, individual work on geometric construction exercises, or written tests with reflective questions. These data highlight a focus on a formal, traditional method of assessment, centered on proofs and demonstrations, while alternative approaches, such as practical projects or creative work, remain untapped despite their potential to diversify assessment and enhance student understanding.

Table 7. Teachers' Perceptions of the Accuracy of Geometry Assessments

Answers	Yes	No	Partially	Don't know
Percentage %	0	0	100	0

The results indicate that 100% of teachers feel that current geometry assessments partially reflect students' reasoning skills. No teacher responded with a "Yes" or "No" or selected the "Don't know" option. These responses suggest that, while assessments measure some aspects of geometric reasoning, they do not fully capture all dimensions of this skill, including students' ability to apply their knowledge in practical or creative contexts. This highlights the need to broaden assessment tools and approaches to better reflect students' overall skills.

Table 8. Importance of Alternative Assessment Methods in Evaluating Geometry Skills

Answers	Very important	Moderately important	Slightly important	Not important
Percentage %	7,77	92,13	0	0

The results show that the majority of teachers (92.13%) consider the introduction of alternative assessment methods, such as formative assessments and self-assessments, to be moderately important, while a small proportion (7.77%) consider it to be very important. No teacher rated these methods as unimportant or not at all important. These data suggest that, although teachers recognize the value of alternative approaches to measuring geometry skills, they are not perceived as a top priority. This may reflect a preference for traditional assessments or a lack of familiarity with these methods, despite their potential to offer a more comprehensive assessment of students' skills.

4.3. Inferential Results

Table 9. Relationship Between Geometry Challenges and Effective Exercise Types

	Value	Degree of Freedom	Asymptotic (bilateral) significance
Pearson's chi-squared	212,789 ^a	9	,000
Likelihood ratio	53,590	9	,000

Given that the p-value is well below the significance threshold of 0.05, the results reveal a statistically significant association between the two variables studied. In other words, the aspects of geometry perceived as complex by students are significantly related to the types of exercises they consider conducive to the development of their geometric reasoning.

This association highlights the relevance of a pedagogical adaptation based on identified difficulties, by prioritizing targeted exercises likely to strengthen students' logical and proof-related skills.

Table 2. Effectiveness of Evaluation Methods in Assessing Students' Geometric Reasoning

	Value	Degree of Freedom	Asymptotic (bilateral) significance	Exact (bilateral) significance
Pearson's chi-squared	279,000a	9	,000	,000
Likelihood ratio	33,098	9	,000	,000
Fisher's exact test	51,580			,000

The chi-square analysis ($p < .001$), supported by the likelihood ratio test and Fisher's exact test ($p = .000$), reveals a highly significant association between the aspects of geometry perceived as complex by students and the types of exercises they consider effective in developing their geometric reasoning.

In other words, students' perceived difficulties are not independent from the instructional approaches they find beneficial. These findings highlight the relevance of pedagogical adaptation based on identified learning obstacles. For instance, when students report specific difficulties in logical reasoning or proof, the targeted use of proof-based exercises may be particularly effective in enhancing their deductive logic, abstraction skills, and overall proficiency in geometric reasoning.

4.4. General results analysis

The results of this study reveal several important trends in geometry teaching at the middle school level. Firstly, teachers perceive students' major difficulties in two main areas: geometric problem solving (59.94%) and logical reasoning and demonstrations (39.96%). On the other hand, no significant difficulties were reported in visualizing figures or using mathematical language, suggesting that students master these basic skills. In terms of pedagogical approaches, a significant majority of teachers (83.25%) favored the problem-solving approach, while other strategies, such as group work (16.65%), are used less frequently. No mention was made of project-based learning or lectures.

In terms of integrating digital tools, 42.18% of teachers use GeoGebra, while 57.72% report they are not using digital technologies. The main obstacles identified are a lack of technological resources (76.59%) and, to a lesser extent, low student motivation (23.31%). Student assessment is based almost exclusively on regular tests with demonstration exercises (100%), reflecting a strong preference for traditional approaches. Finally, all teachers feel that current assessments partially reflect geometric reasoning skills, and a majority (92.13%) consider that the introduction of alternative assessment methods, such as formative assessments or self-assessments, would be moderately important.

5. Discussion

The results highlight a reliance on traditional teaching and assessment methods in geometry, with limited use of digital technologies and innovative pedagogical approaches. The lack of technological resources is identified as the main obstacle to ICT integration, which is consistent with the findings of previous studies on ICT integration in education in Morocco (Omar & Benjelloun, 2013).

On the other hand, the focus on demonstration tests to assess geometric reasoning may not fully capture students' skills. The introduction of alternative assessment methods, such as portfolios or authentic assessments, could offer a more holistic view of students' skills.

Some of the results obtained, particularly those showing near-unanimous responses, warrant a more critical examination. For instance, the fact that 100% of teachers report using demonstration-

based tests to assess geometric reasoning reflects a highly uniform assessment culture. While this may suggest a shared understanding of the importance of proof in geometry, it may also point to a limited diversification of assessment practices, potentially influenced by institutional norms or exam-oriented teaching.

Such uniformity might not only reflect pedagogical consensus but also indicate systemic constraints: a lack of training on alternative evaluation strategies, time limitations, or the pressure to prepare students for national exams that prioritize formal demonstration over exploratory reasoning. This rigid focus on traditional methods could hinder the development of students' creative, reflective, and spatial reasoning capacities, key components of geometric thinking (Duval, 1998; Rahmani et al., 2024).

Similarly, the widespread acknowledgment that current assessments only partially reflect students' reasoning abilities (100% of teachers) suggests a collective awareness of existing limitations, but also raises questions about the gap between diagnostic insight and classroom implementation. If teachers recognize the limitations of current practices but are not adopting alternatives (e.g., authentic tasks, formative assessments), it may indicate a need for professional support structures and curricular flexibility to encourage pedagogical innovation.

In this light, the uniformity of certain responses should not be interpreted as evidence of best practice alone, but as a signal of structural rigidity and the need for institutional change.

In summary, it is essential to diversify pedagogical approaches and assessment methods in geometry while strengthening the integration of digital technologies in order to better meet students' needs and foster the development of their geometric reasoning skills.

Beyond the descriptive trends observed in the data, several sociocultural and structural factors may help explain the persistence of difficulties in geometric reasoning among Moroccan students.

From a structural standpoint, many schools continue to face material constraints, such as insufficient access to technological equipment, overcrowded classrooms, and an overloaded curriculum. These conditions significantly limit the implementation of innovative pedagogical approaches, including the use of digital tools or collaborative learning strategies, which are known to support students' cognitive engagement and reasoning development (Omar & Benjelloun, 2013; El Mokhtari et al., 2024).

Moreover, teacher professional development remains fragmented and often lacks a sustained focus on didactic strategies tailored to geometry. The absence of continuous, subject-specific training restricts the capacity of educators to update their practices and to incorporate tools like dynamic geometry software or formative assessments effectively (Talbi, 2020).

On the sociocultural level, linguistic challenges, particularly when the language of instruction differs from students' home language, may hinder the assimilation of abstract mathematical concepts. Additionally, the widespread use of transmissive teaching practices, rooted in traditional educational cultures, limits student participation and reinforces a passive approach to learning. These practices are often reinforced by societal expectations that prioritize exam performance over the development of critical and deductive reasoning skills (Benali et al., 2018 ; Shulman, 1987).

Taken together, these factors suggest that addressing geometric reasoning difficulties requires more than pedagogical adjustments; it calls for a systemic approach, involving curriculum reform, investment in infrastructure, and culturally responsive teaching strategies that account for the local realities of Moroccan classrooms.

6. Conclusion

This study has shed light on teachers' perceptions of the challenges associated with geometric reasoning in middle school, as well as the associated teaching practices and assessment methods. The results show that Moroccan students mainly encounter difficulties in geometric problem solving, logical reasoning and demonstrations, while basic skills such as visualizing figures are generally mastered. The dominant pedagogical approach remains problem-solving, although a more varied integration, including collaborative work and the use of digital tools, is little exploited.

As far as assessment is concerned, reliance on traditional tests limits the ability to fully measure geometric reasoning skills. All teachers recognize that these assessments only partially reflect students' skills and consider that alternative methods, such as formative assessments, could enrich this process (Rahmani et al., 2024). However, the integration of digital technologies remains hampered by material constraints and a lack of resources, despite their potential to transform geometry teaching (El Mokhtari et al., 2024).

The structure of this article is based on a mind map developed to logically organize the various elements of the analysis, from teachers' perceptions to proposed solutions. The mind map, as a pedagogical tool, was not limited to structuring this research: it also illustrates its direct impact on reasoning (MENOUER et al., 2024). Defined by Tony Buzan as "a graphical representation that reflects the natural way the brain processes and structures information, by organizing ideas around a central concept using hierarchical branches" (Buzan & Buzan, 2006). By visualizing relationships between concepts and issues, the mind map stimulates logical and deductive thinking. It is thus a valuable tool for teachers and students in the development of geometric reasoning, fostering a more global and organized approach to learning.

In conclusion, this research contributes to a better understanding of the practices and challenges associated with geometric reasoning in the Moroccan context and proposes concrete avenues for reinforcing the learning of this essential skill in middle school. The use of mind maps, as a tool for organization and reasoning, could be integrated into teaching practices to enhance understanding and effectiveness in geometry teaching.

7. Suggestion

Based on the results of this study, several recommendations are proposed to enhance the teaching and assessment of geometric reasoning at the middle school level. First, instructional strategies should be diversified to move beyond traditional proof-based methods. Educators are encouraged to adopt a variety of pedagogical approaches, such as collaborative learning, contextual problem-solving, and project-based activities, which can deepen students' conceptual understanding and engagement. The use of mind maps as cognitive tools is also recommended, as they help structure thinking, reinforce connections between geometric concepts, and foster logical reasoning.

Secondly, greater integration of digital technologies is essential. Schools should support the use of dynamic geometry software like GeoGebra and other interactive tools to strengthen spatial reasoning and increase student motivation. This requires addressing technological limitations and ensuring equitable access to digital resources. Finally, assessment practices should be expanded to include formative assessments, self-assessment techniques, and authentic tasks. These alternative methods provide a more holistic view of students' reasoning abilities and promote critical reflection, ensuring that evaluation processes are more closely aligned with learning objectives.

8. Limitation

Like any empirical investigation, this study presents several limitations that should be acknowledged to ensure an accurate interpretation of its findings.

Firstly, the use of a non-probability sampling method (convenience sampling) limits the generalizability of the results. The participating teachers were primarily drawn from a limited number of institutions located in a specific region of Morocco, which does not allow for national-level representativeness.

Secondly, the data collected were based on self-reported perceptions obtained through a questionnaire. Such a method may introduce subjective bias (e.g., social desirability, personal interpretation of items) and does not necessarily reflect actual classroom practices.

Moreover, the study focused solely on difficulties related to the teaching of geometry at the lower secondary level, without considering other mathematical domains or incorporating students' perspectives. This represents a limitation in providing a more comprehensive understanding of mathematics education challenges.

Lastly, the absence of longitudinal data or direct classroom observations restricts the ability to establish causal relationships or assess the evolution of teaching practices over time.

Declarations

Author Contributions. All authors have read and approved the final version of the article.

Conflicts of Interest. The authors declare no conflict of interest.

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