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Id: samsul_maarif

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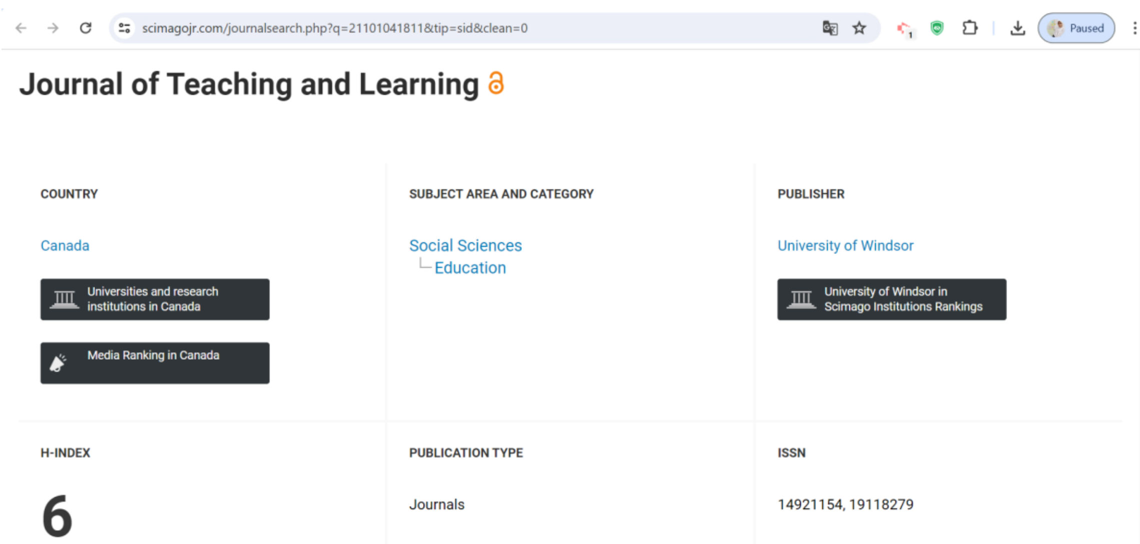

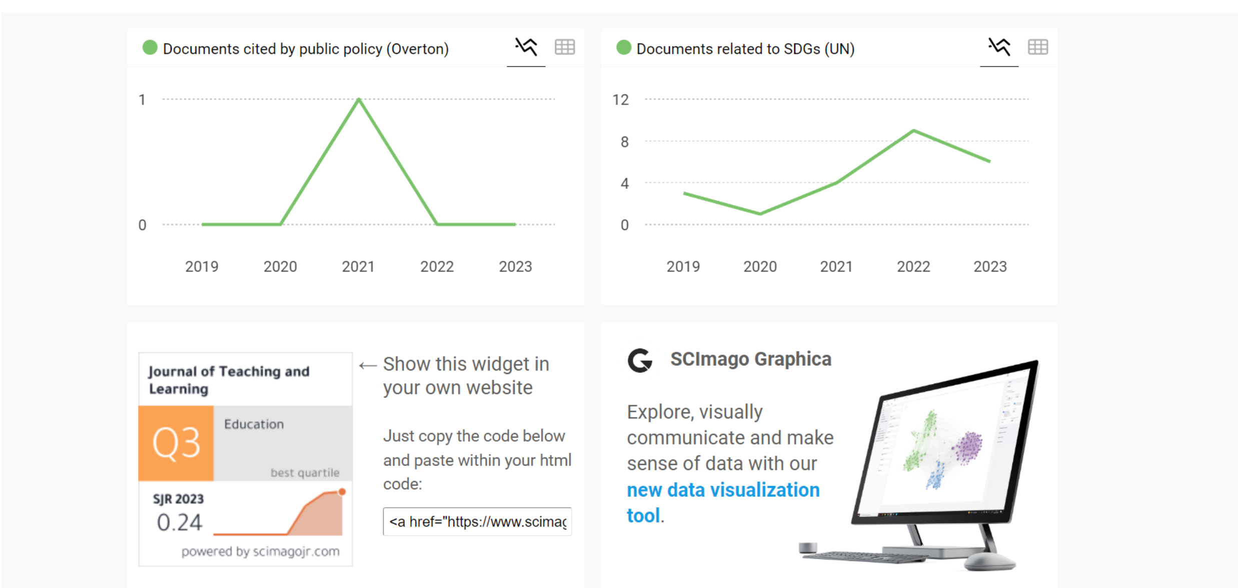

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[JTL] Article Review Request

External Inbox ×

April King via University of Windsor Journal Publishing <no_reply@scholarsportal.info>

to me

Wed, Jun 5, 11:55 PM (4 days ago)

Samsul Maarif Samsul:

Thank you for your willingness to review for the Journal of Teaching and Learning. I believe that, given your expertise, you would serve as an excellent reviewer of the manuscript, "Examining the Van Hiele Model's Effects on Student Attitudes and Achievement in Geometry Content of Senior Secondary Mathematics." The submission's extract is inserted below, and I hope that you will consider undertaking this important task for us.

Please log into the journal web site by 2024-06-12 to indicate whether you will undertake the review or not, as well as to access the submission and to record your review and recommendation.

The review itself is due 2024-07-03.

Submission URL: https://jtl.uwindsor.ca/index.php/jtl/reviewer/submission?submissionId=8734&reviewId=4821&key=Nh7qLa

Thank you for considering this request.

April King
king92@uwindsor.ca

Journal of Teaching and Learning

← Back to Submissions

Review:Examining the Van Hiele Model's Effects on Student Attitudes and Achievement in Geometry Content of Senior Secondary Mathematics

1. Request 2. Guidelines 3. Download & Review 4. Completion

Request for Review

You have been selected as a potential reviewer of the following submission. Below is an overview of the submission, as well as the timeline for this review. We hope that you are able to participate.

Article Title

Examining the Van Hiele Model's Effects on Student Attitudes and Achievement in Geometry Content of Senior Secondary Mathematics

Abstract

This research examines the impact of the Van Hiele instructional model on geometry education for senior secondary students in the Nsukka Education Zone of Enugu State, Nigeria. A quasi-experimental study with a non-equivalent group pretest-posttest design involved 128 students from four co-educational secondary schools. Classes were randomly assigned as the experimental group, receiving Van Hiele model instruction, or the control group, using traditional teaching methods. Data were collected using the validated Geometry Attitude Scale (GAS) and Geometry Achievement Test (GAT), with reliability coefficients of 0.81 and 0.85, respectively. The study assessed the influence of these instructional strategies on students' attitudes towards geometry and their performance. ANCOVA analysis revealed a significant improvement in mean achievement scores for students taught with the Van Hiele model compared to traditional methods. Additionally, there

https://jtl.uwindsor.ca/index.php/jtl/reviewer/step/8734?step=1 ...nt gender differences in achievement scores and no significant interaction between instructional methods and gender. The

Abstract

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Review Type

Anonymous Reviewer/Anonymous Author

View All Submission Details

Review Schedule

2024-06-05	2024-06-12	2024-07-03
Editor's Request	*Response Due Date*	*Review Due Date*

Review:Examining the Van Hiele Model's Effects on Student Attitudes and Achievement in Geometry Content of Senior Secondary Mathematics

1. Request | 2. Guidelines | 3. Download & Review | 4. Completion

Review Files Search

24480	2021 - JTL Article Press Template-OTH-1.docx	June 5, 2024	Article Text
24481	TABLES.docx	June 5, 2024	Research Results

JTL Review Form

Reviewers are invited to use the on-line review form when reviewing submitted manuscript assessments.

The problem/topic: its relevance to the interests of our readership and/or mandate of JTL. *

- 1. Of little relevance
- 2. Of some relevance
- 3. Of significant relevance

Comments:

The research carried out is relevant to readers, namely the application of the van Hiele model in learning geometry. The research gap is also visible, although the gap regarding afficacy needs to be explained further, why there is an efficacy gap in learning using the Van Hiele method, because from several studies that have been presented there are those that study attitudes using the Van Hiele model. So what differentiates the research conducted from previous research will be clearer.

Theoretical framework. *

- 1. Not well established.
- 2. Somewhat established.
- 3. Well established

Comments:

The theoretical framework is good although it needs some improvements, including: - Paragraph 1: The statement "This model offers an organized framework for understanding the development of students' geometric thinking and directs learning methods to increase their understanding and interest in geometry" shows that the Van Hiele method is very suitable for use in learning to improve understanding of geometric concepts. Maybe it is necessary to add attitude to learning geometry

Methodology/Data Sources. *

- 1. Not well established.
- 2. Somewhat established.
- 3. Well established.

Comments:

7. Method:

- For the Geometry Attitide instrument, it is necessary to explain the indicators used, thereby strengthening the content validity of the instrument.

- It is necessary to explain the indicators of the GAT instrument. Mathematical achievement is still general because it includes affective, cognitive and psychomotor aspects, but why is it also a research question in other areas, namely about attitude which is still in

Argument/Conclusions. *

- 1. Not well supported.
- 2. Somewhat supported.
- 2. Well supported.

Contribution to the Field. *

- 1. Routine.
- 2. Important, but not novel.
- 3. Significant/innovative/insightful

Comments:

The contribution is good, but the novelty of the research carried out needs to be explored in more depth and several notes corrected, including:

10. Conclussions:
- Conclusions must refer to the research questions that have been asked

Overall Recommendation *

- Accept as written
- Accept with minor revisions
- Revise and resubmit for review
- Reject manuscript (please explain why)

Reviewer's Comments and Suggestions for Improvement.

There are several things that need to be revised in this article:

1. Abstract:
- Add one sentence stating the importance or novelty of the research that has been conducted. So, readers will decide that the research that has been carried out is of interest to read and study

Upload

Upload files you would like the editor and/or author to consult, including revised versions of the original review file(s).

Reviewer Files Search

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Comments:

7. Method:
- For the Geometry Attitide instrument, it is necessary to explain the indicators used, thereby strengthening the content validity of the instrument.

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Argument/Conclusions. *

- 1. Not well supported.
- 2. Somewhat supported.
- 2. Well supported.

Comments:

- Conclusions must refer to the research questions that have been asked

9. Discussions:

- In the discussion section, it is necessary to describe each hypothesis proposed. This is an important part because this research is quantitative research in the form of an experiment so hypothesis testing is the aim of the research carried out. There are 6 hypotheses

Comments:

- Conclusions must refer to the research questions that have been asked

9. Discussions:

- In the discussion section, it is necessary to describe each hypothesis proposed. This is an important part because this research is quantitative research in the form of an experiment so hypothesis testing is the aim of the research carried out. There are 6 hypotheses

Coherence and Organization. *

1. Not coherent.
2. Somewhat coherent.
3. Very coherent.

Comments:

1. Abstract:

- Add one sentence stating the importance or novelty of the research that has been conducted. So, readers will decide that the research that has been carried out is of interest to read and study
- In a quasi-experimental sample, it is not possible to carry out random sampling, perhaps it is necessary to review the determination of samples using non-actual randomness so that it is more appropriate, for example, cluster random sampling to determine the experimental class and control class.

Journal of Teaching and Learning

← Back to Submissions

Review:Examining the Van Hiele Model's Effects on Student Attitudes and Achievement in Geometry Content of Senior Secondary Mathematics

1. Request | 2. Guidelines | 3. Download & Review | 4. Completion

Review Submitted

Thank you for completing the review of this submission. Your review has been submitted successfully. We appreciate your contribution to the quality of the work that we publish; the editor may contact you again for more information if needed.

Review Discussions | Add discussion

Name	From	Last Reply	Replies	Closed
No Items				

Artikel Hasil Reviu

Journal of Teaching and Learning
Vol. xx, No. xx (2020), pp. xx–##
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Examining the Van Hiele Model's Effects on Student Attitudes and Achievement in Geometry Content of Senior Secondary Mathematics

Abstract

This research examines the impact of the Van Hiele instructional model on geometry education for senior secondary students in the Nsukka Education Zone of Enugu State, Nigeria. A quasi-experimental study with a non-equivalent group pretest-posttest design involved 128 students from four co-educational secondary schools. Classes were randomly assigned as the experimental group, receiving Van Hiele model instruction, or the control group, using traditional teaching methods. Data were collected using the validated Geometry Attitude Scale (GAS) and Geometry Achievement Test (GAT), with reliability coefficients of 0.81 and 0.85, respectively. The study assessed the influence of these instructional strategies on students' attitudes towards geometry and their performance. ANCOVA analysis revealed a significant improvement in mean achievement scores for students taught with the Van Hiele model compared to traditional methods. Additionally, there were no significant gender differences in achievement scores and no significant interaction between instructional methods and gender. The findings highlight the Van Hiele instructional model's potential to enhance students' understanding and attitudes towards geometry, advocating for its integration into the curriculum. The study also emphasizes the need for comprehensive training programs for teachers on the Van Hiele model, including workshops and in-service training sessions.

Introduction

Mathematics education is a cornerstone of academic learning, equipping students with essential skills and competencies for navigating an increasingly complex world (Egara & Mosimege, 2023a). Within this domain, geometry is pivotal, offering insights into spatial relationships, structural properties, and geometric patterns that underpin diverse fields of study and professional endeavors (Osakwe et al., 2022). At the heart of geometry education lies the dual objectives of fostering students' conceptual understanding and promoting their attainment of mathematical proficiency (Bora & Ahmed, 2019). Central to achieving these objectives are students' attitudes towards mathematics and their academic achievement in geometry content (Karamert & Kuyumcu Vardar, 2021). Attitudes towards mathematics encompass students' beliefs, perceptions, and

Commented [SM1]: Add one sentence stating the importance or novelty of the research that has been conducted. So, readers will decide that the research that has been carried out is of interest to read and study

Commented [SM2]: In a quasi-experimental sample, it is not possible to carry out random sampling, perhaps it is necessary to review the determination of samples using non-actual randomness so that it is more appropriate, for example, cluster random sampling to determine the experimental class and control class.

Commented [SM3]: In quasi experimental research, a model should be compared with an equivalent model, but the researcher decided to compare the Van Hiele Model with a traditional method. The scope of a method is narrower than a model

Commented [SM4]: Traditional methods seem to theoretically not exist. What exists is learning using methods commonly used today. Although researchers try to define the methods that are widely used by teachers today, for example, usually they are expository methods or direct learning. This is important to strengthen the comparison class from the experimental class. So, we don't just justify learning that previously was lagging behind or traditional.

Commented [SM5]: Is there a validity testing process on the instruments that have been used? If possible, a statement may be given in the abstract section that the instrument has been tested for validity, thus strengthening the reliability of the test.

Commented [SM6]: Instructional strategies or models? This must be clear because there are different meanings between a strategy and a model in learning emotional dispositions, influencing their engagement, motivation, and learning outcomes (Recber et al., 2017).

Extensive literature highlights the alarming trend of poor attitudes and achievements among secondary school students, particularly in the realm of geometry (Bora & Ahmed, 2019; Dan'inna, 2016; Doz et al., 2022; Kundu, 2018; Pavlovicova & Zahorska, 2015; Wakhata et al., 2022; Yea-Ling Tsao & Wei-Shin Tung, 2022). Analysis of the WAEC Chief Examiner's Reports from 2015 to 2020 underscores the prevalence of students' underperformance in mathematics, with geometry emerging as a particularly challenging area (Osakwe et al., 2022). This trend has been attributed, in part, to students' negative attitudes towards geometry topics, which can adversely affect their learning outcomes and retention of key concepts (Egara & Mosimege, 2023b; Karigi et al., 2015). Furthermore, the traditional teacher-centred teaching methods commonly employed in classrooms have exacerbated students' difficulties in geometry (Nzeadibe et al., 2020). These methods often limit students' active participation in the learning process, hindering their ability to develop a deeper understanding of geometric principles and fostering negative attitudes towards the subject (Bora & Ahmed, 2019; Kundu, 2018).

In response to these challenges, educators have increasingly sought effective teaching and learning methods that promote students' engagement and achievement in geometry (Nzeadibe et al., 2020; Osakwe et al., 2022). One such approach is the Van Hiele model, renowned for its student-centered approach to geometry instruction and fostering deeper conceptual understanding among learners (Naufal et al., 2021; Santos et al., 2022; Usman et al., 2020; Yalley et al., 2021). Developed by Dina and Pierre van Hiele in the 1950s, the Van Hiele model delineates distinct levels of geometric thought development, providing a roadmap for students' progression from basic shape recognition to rigorous geometric reasoning (Santos et al., 2022). By scaffolding instruction according to students' developmental levels, mathematics teachers can tailor learning experiences to promote active exploration, collaborative problem-solving, and reflective discourse, thereby enhancing students' attitudes towards geometry and their achievement in geometry content (Usman et al., 2020). Through a comprehensive examination of the effects of the Van Hiele model on students' attitudes and achievement in geometry content, this research endeavors to inform mathematics educators, curriculum developers, and policymakers about strategies for promoting deeper engagement and understanding of geometric concepts among senior secondary school students.

Theoretical Framework

The theoretical basis for this study is rooted in the Van Hiele Model, formulated by Dina and Pierre van Hiele in 1986. This model offers an organized framework for comprehending the progression of geometric thinking in students and directing instructional methods to improve their understanding and interest in geometry (Santos et al., 2022).

The Van Hiele Model delineates five levels of geometric thought processes: Visualization, Analysis, Abstraction, Deduction, and Rigor (Usman et al., 2020). Students engage in concrete experiences with geometric shapes and figures at the visualization stage, developing an intuitive grasp of spatial relationships and properties. Progressing to the analysis level, students begin to recognize patterns and classify geometric objects based on their attributes. The abstraction level involves identifying common properties and relationships among geometric elements, facilitating the transition from concrete to abstract reasoning. Subsequently, students advance to the deduction level, employing logical reasoning and formal proofs to justify geometric conclusions. Finally,

Commented [SM7]: Kalimat ini tidak memiliki koherensi dengan kalimat sebelumnya, sepertinya perlu menambahkan satu paragraph tentang bagaimana pentingnya attitude dalam pembelajaran geometri.

Commented [SM8]: It is necessary to explain what traditional methods are like, because, every lesson must use learning methods in accordance with theory, usually what is meant by traditional method is the expository method or direct learning.

Commented [SM9]: It is necessary to explain why the Van Hile Method was chosen to be the solution to the various geometry learning problems mentioned previously. For example, in the previous paragraph we mentioned difficulties in learning geometry. Can you describe the difficulties, is it understanding theorems? Do you understand the concept? What are the difficulties in the procedure for solving geometric problems? So it will be relevant to Van Hiele's learning theory. This means that when a learning problem is in line with the drug or learning treatment chosen with characteristics that suit the problem being experienced.

Commented [SM10]: Perlu dijelaskan secara langsung bagaimana van hiele dapat meningkatkan pembelajaran geometri dari sisi proses berpikir dan treatmen pembelajaran. Sehingga dapat menyimpulkan bahwa van hiele method dapat mengembangkan kurikulum bahkan penentuan kebijakan.

Commented [SM11]: This statement shows that the Van Hiele Method is very suitable for learning to improve understanding of geometric concepts. Maybe it is necessary to add an attitude in learning geometry students engage in rigorous mathematical argumentation at the rigor level, demonstrating mastery of geometric concepts through precise definitions and proofs (Santos et al., 2022).

In designing and implementing geometry instruction for this study, the Van Hiele Model served as a guiding framework. The mathematics teachers scaffolded learning experiences to align with students' developmental levels, incorporating hands-on activities, collaborative problem-solving tasks, and reflective discourse to promote deeper engagement and comprehension of geometric concepts. While the primary focus remains on assessing the effectiveness of the Van Hiele Model in enhancing students' attitudes and achievement in geometry, complementary insights from Socio-Constructivist principles, rooted in the works of scholars such as Lev Vygotsky and Jean Piaget, are also acknowledged. Socio-Constructivist Theory emphasizes the social nature of learning and the importance of providing students with meaningful, real-world tasks to promote engagement and understanding.

Reviewed Studies

Several studies have explored the effectiveness of the Van Hiele instructional model in teaching geometry, demonstrating its impact on students' achievement and attitudes towards the subject. A study in Ghana examined the impact of the Van Hiele model on students' performance in Circle Geometry at Daffiama Senior High School (Yalley et al., 2021). Employing purposive and simple random sampling methods, 75 students were split into experimental and control groups. The experimental group was instructed using the Van Hiele model, whereas the control group received traditional teaching methods. The quasi-experimental design employed tests, interviews, and classroom observations for data collection. Findings indicated that participants taught using the Van Hiele model outperformed their counterparts taught using the traditional method.

In the Philippines, a similar quasi-experimental study with 92 Grade 8 students assessed the effectiveness of the Van Hiele model in teaching geometry (Santos et al., 2022). Pre-test and post-test performance comparisons between control and experimental groups revealed significant mean gain differences, with the experimental group performing better. Despite challenges encountered by teachers and students, most students enjoyed the activities and found learning geometry through the model's phases interesting. The study concluded that the Van Hiele model is an effective teaching strategy for students with diverse learning needs.

In Malaysia, additional research focused on creating activities aligned with Van Hiele's phases of learning geometry, utilizing Geometer's Sketchpad software within a learning kit called Geo-V (Abdullah et al., 2014). Over a six-week period, 94 secondary school students were assigned to either control or treatment groups. Their performance and attitudes towards geometry were evaluated through an Achievement Test and an Attitude towards Geometry Survey. MANOVA test results showed significant differences in geometric achievement between the groups, although attitudes towards geometry did not differ significantly. This suggests that Van Hiele-based activities can be a valuable reference for varying teaching methods in geometry.

In Jordan, another study investigated the Van Hiele model's effect on primary school students' acquisition of geometric concepts, attitudes towards geometry, and learning transfer (Al-ebous, 2016). Sixty students were randomly divided into control and experimental groups in the quasi-experimental study. Instruments included a teacher's guide, a geometric concepts test, an attitude scale towards geometry, and a learning transfer test. ANCOVA analysis revealed significant differences favouring the experimental group in geometric concept acquisition, attitudes towards geometry, and learning transfer. This study underscored the effectiveness of the

Van Hiele model in enhancing geometric understanding and fostering positive attitudes towards the subject.

Lastly, a study examined the infusion of metacognition into the Van Hiele model to improve secondary school students' geometric thinking levels (Naufal et al., 2021). Conducted over six weeks with 90 students divided into two groups, the quasi-experimental study used the Van Hiele Geometry Test (vHGT) before and after the intervention. Analysis using the Mann-Whitney U test revealed a significant difference in geometric thinking levels, demonstrating that the Van Hiele model enhanced with metacognitive strategies is more effective than the standard Van Hiele learning phases. This suggests that integrating metacognitive approaches into the Van Hiele model can significantly improve students' geometric thinking abilities.

These studies highlight the significant benefits of using the Van Hiele instructional model in teaching geometry, including improved geometric thinking levels, better achievement, and positive attitudes towards the subject. Despite extensive research on the Van Hiele model, several gaps remain, particularly in its application to senior secondary mathematics. Few studies have specifically focused on this age group, and there is a limited exploration of the model's impact on student attitudes towards geometry. Additionally, the influence of gender differences on achievement and attitudes has not been thoroughly examined, with no studies to date investigating the gender effect using the Van Hiele model. This study also addresses a significant geographical gap as it will be the first conducted in Nigeria.

To address these gaps, there is a pressing need to explore the efficacy of the Van Hiele model in improving secondary school students' attitudes and achievements in geometry and examine its potential role in addressing gender disparities in geometry education. Against this backdrop, this study's central question emerges: Would the Van Hiele model help improve secondary school students' attitudes and achievements in geometry? By addressing this question, the study aims to contribute empirical insights to the ongoing dialogue surrounding effective pedagogical methods in geometry education and offer guidance on strategies for fostering deeper engagement and comprehension of geometric concepts among secondary school students.

Research Questions

The following research questions were posed, which guided the study.

1. What is the mean attitude score of students taught geometry using Van Hiele's model and those taught without?
2. What is the influence of gender on students' attitudes towards geometry?
3. What is the interaction effect of instructional models and gender on students' attitude scores in geometry?
4. What is the mean achievement score of students taught geometry using Van Hiele's model and those taught without?
5. What is the influence of gender on students' achievement scores in geometry?
6. What is the interaction effect of instructional models and gender on students' mean achievement scores in geometry?

Hypotheses

The following null hypotheses were formulated for the study and tested at a 0.05 significance level.

Commented [SM12]: This statement shows the possibility that gender differences in mathematics learning need to be studied again. Is this really a part that has never been studied by other researchers? So it will strengthen the research gap that has been determined

Commented [SM13]: The gap regarding afficacy needs to be explained further, why is there an efficacy gap in learning using the Van Hiele method, because from several studies that have been presented, some have examined attitudes using the Van Hiele model. So what differentiates the research conducted from previous research will be clearer.

Commented [SM14]: According to the reviewer, mathematical achievement is still general because it includes affective, cognitive and psychomotor aspects, but why is it also a research question in other areas, namely about attitude which is still in the affective aspect? This must be explained by using mathematics learning achievement. Maybe it could be directed at understanding geometric concepts or other mathematical hard skills.

Commented [SM15]: Can attitudes be averaged? Maybe it would be better not to use the average parameter but rather the proportion of each student's attitude. So what proportion of students' attitudes are good after learning is not the average. Statistically, it is true that attitude scores can be found and calculated using statistical tests. However, how do we find the average of two students' attitudes, one good and one bad? Can we find the average of good and bad attitudes?

1. There is no significant difference in the mean attitude score of students taught geometry using Van Hiele's model and those taught without.
2. There is no influence of gender on students' attitudes towards geometry.
3. There is no significant interaction effect of instructional models and gender on students' attitude scores in geometry.
4. There is no significant difference in the mean achievement score of students taught geometry using Van Hiele's model and those taught without.
5. There is no significant influence of gender on students' achievement scores in geometry.
6. There is no significant interaction effect of instructional models and gender on students' mean achievement scores in geometry.

Commented [SM16]: Can attitudes be averaged? Maybe it would be better not to use the average parameter but rather the proportion of each student's attitude. So what proportion of students' attitudes are good after learning is not the average. Statistically, it is true that attitude scores can be found and calculated using statistical tests. However, how do we find the average of two students' attitudes, one good and one bad? Can we find the average of good and bad attitudes?

Methodology

The study employed a quasi-experimental research design, specifically the non-equivalent group pretest-posttest design, as intact classes were used, and random assignment was impossible. This design was chosen due to practical constraints, allowing for comparing groups receiving different instructional methods while controlling for initial differences. The study took place in the Nsukka Education Zone of Enugu State, Nigeria, which includes three Local Government Areas (LGAs). The research population consisted of 3,400 Senior Secondary II (SSII) students—1,522 males and 1,878 females—enrolled in public secondary schools within the Nsukka Education Zone during the 2022/2023 academic year, as reported by the Post-Primary Schools Management Board, Nsukka, in December 2022. SSII students were chosen for this study because the geometry content taught was found in the SSII scheme of work for the second term, derived from the SSII Mathematics curriculum.

The study sample consisted of 128 (69 males and 59 females) SSII students drawn from the Nsukka Education Zone. The sampling procedure involved a multistage process. First, one LGA was randomly selected from the three LGAs in the Zone using simple random sampling. In the second stage, four co-educational secondary schools were purposively selected from the chosen LGAs to ensure the inclusion of schools where both male and female students were in the same classes. In the third stage, one intact class of SSII students was randomly chosen from each of these four schools. The two instructional approaches (the Van Hiele model and conventional methods) were then randomly assigned to these four intact classes using simple random sampling with replacement.

The researcher developed two instruments, namely the Geometry Attitude Scale (GAS) and the Geometry Achievement Test (GAT), for data collection. The GAS was divided into two sections: Section A gathered personal information from the students, and Section B contained 19 items designed to evaluate students' attitudes towards geometry using a modified four-point Likert scale. The GAT had two sections: Section A elicited personal information. Section B included 50 multiple-choice questions created by the researcher, based on SSII Geometry curriculum content. These questions spanned various cognitive levels as outlined by Anderson and Krathwohl's updated version of Bloom's taxonomy. Additionally, the researcher developed two lesson plans for each instructional approach, ensuring consistency in content, objectives, duration, and evaluation while varying instructional methods.

The Geometry Achievement Test (GAT) was subjected to content validation. A test blueprint was prepared for the GAT based on the modified Bloom's taxonomy. Various weights were assigned to various geometry contents. Also, various weights were assigned to the level of Bloom's cognitive objectives. Questions for the test were drawn according to the contents and the

Commented [SM17]: For the Geometry Attitide instrument, it is necessary to explain the indicators used, thereby strengthening the content validity of the instrument.

Commented [SM18]: It is necessary to explain the indicators of the GAT instrument. Mathematical achievement is still general because it includes affective, cognitive and psychomotor aspects, but why is it also a research question in other areas, namely about attitude which is still in the affective aspect? This must be explained by using mathematics learning achievement. Maybe it could be directed at understanding geometric concepts or other mathematical hard skills.

weights assigned to the contents and cognitive domain. Furthermore, the instruments (GAS and GAT), the study's objectives, research questions, hypotheses, and the two sets of lesson plans underwent face validation by five experts. These specialists were asked to carefully review the instruments to ensure alignment with the study's objectives, research questions, and hypotheses, as well as to evaluate the lesson plans. They were also requested to ensure appropriateness, suitability, clarity of language, and structure of items and to make suggestions for improvement of the instruments and the study as a whole. Based on the corrections, suggestions, and recommendations of the validators, five items (items 3, 6, 15, 18, and 30) in the GAS were discarded because they did not seem to measure attitude as commented by validators. Items of the GAT were corrected accordingly as recommended by the validators.

Construct validity was also established for the Geometry Attitude Scale (GAS). To do this, 50 copies of each instrument were printed and administered to 50 SSII students from two public secondary schools in Obollo Education Zone that share characteristics similar to those of the study area. After administering and retrieving the questionnaires, the students' responses were subjected to factor analysis on SPSS (Statistical Package for Social Sciences) version 28 using the Principal Component Analysis (PCA). In running the analysis, two factors were extracted based on the Scree Plot generated by the SPSS software. The varimax rotational technique was adopted. In selecting the valid items using the "Rotated Component Matrix" generated from the analysis, the researcher adopted Meredith's (1969) benchmark value of 0.35 and above for valid items. As recommended by Meredith, only factor loadings of 0.35 and above on one factor should be considered substantive and valid for an item.

Based on the above criterion, out of the 25 items in the GAS that survived face validation, the valid items after construct validation include items 1, 2, 3, 4, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23 and 25 that loaded on factor I. These items were adjudged factorially pure because each had a factor loading of 0.35 and above on one factor. There was no factorially pure item on factor II. Items 5, 6, 16 and 20 loaded 0.35 and above on the two extracted factors; thus, the items were considered factorially complex and consequently deleted. Likewise, items 11 and 24 were considered factorially impure because they loaded below 0.35 on both factors; hence, they were discarded. Consequently, the final version of the Geometry Attitude Scale (GAS) contains 19 items, which were renumbered serially. Construct validity was established for the GAS because attitude is a latent variable or a psychological construct since it cannot be observed directly but is inferable through its indicators.

Commented [SM19]: What validity tests are used to justify the items of the instrument. Determine the criteria for the statistical test used so that it is clear which items are valid or invalid. Is the validity test just by looking at the factor loading without looking at the AVE?

The reliability of the GAS and the GAT were determined after trial testing 30 copies of each of the two instruments on 30 SSII students from one school that was not part of the actual study. The internal consistency of the GAS was established using the Cronbach Alpha. This is because the instrument was polytomously scored. The reliability coefficient obtained was 0.81. The internal consistency of the GAT was determined using the Kuder-Richardson 20 (KR-20) method, appropriate for dichotomously scored items. The GAT achieved a reliability coefficient of 0.85. Establishing the internal consistency of the instruments demonstrated the degree to which the items reliably measured the variables in the study. In addition, the instruments were re-administered (re-trial-tested) after two weeks on the same respondents. This was done to establish the reliability index for the coefficient of stability of the instruments' items. Data from the first and second trial test sets were analyzed using Pearson's Product Moment Correlation Coefficient to determine their correlation. The stability coefficients obtained for GAS and GAT were 0.82 and 0.86, respectively. This was done to establish the extent to which responses or scores generated by the items of the instruments were consistent over time.

Commented [SM20]: Determine the criteria for reliability testing, so that readers can easily confirm that the instrument is reliable

Experimental Procedure

Commented [SM21]: What is the procedure for control classes? It also needs to be described so that the differences between the experimental class treatment and the control class are clear

Intact SSII classes from the four selected schools were randomly allocated to different treatment groups. Four regular SSII Mathematics teachers from these schools were recruited as research assistants. The selection criteria required each teacher to hold at least a Bachelor's Degree (B.Ed) or an equivalent qualification in Mathematics and to have a minimum of three years of teaching experience post-qualification.

The researcher conducted training sessions for the research assistants covering various aspects:

- Objective clarification: The research assistants were briefed on the study's objectives.
- Instructional models: Detailed discussions were held on each instructional model, including the corresponding lesson plans.
- Lesson presentation: The research assistants received thorough instructions on presenting lessons conducting micro-teaching sessions in the presence of other assistants and the researcher.
- Instrument administration: Training was provided on administering research instruments for data collection.
- Training assessment: The research assistants' proficiency was evaluated through micro-teaching practices to gauge the effectiveness of the training.

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Application of Van Hiele Model in Teaching Geometry Concepts

In this study, the Van Hiele model was utilized as a guiding framework for instructing the experimental group in three key areas of geometry: Circle geometry, Plane geometry, and Coordinate geometry.

Circle Geometry:

Level 1: Visualization - Students began by visually recognizing the basic properties of circles, such as radius, diameter, and circumference. For example, they used compasses and rulers to draw circles of different sizes and visually identified the radius and diameter of each circle.
Level 2: Analysis - Building upon visual recognition, students progressed to analyzing properties of circles, such as central and inscribed angles, arc length, and sector area. For instance, they measured angles formed by intersecting chords and applied the properties of circles to solve problems involving arc lengths and sector areas.
Level 3: Deduction - At this stage, students deduced geometric relationships and properties of circles through deductive reasoning. They constructed proofs of circle theorems, such as the inscribed angle theorem and the tangent-chord angle theorem. For example, they proved that the measure of an inscribed angle is half the measure of the intercepted arc.
Level 4: Abstraction - At this level, students abstracted common properties of circles, such as symmetry and cyclic quadrilaterals. For example, they recognized that opposite angles in a cyclic quadrilateral are supplementary and applied this property to solve problems involving cyclic quadrilaterals.
Level 5: Rigor - Students engaged in rigorous mathematical argumentation in this stage, constructing formal proofs of advanced circle theorems. For example, they proved the converse of the inscribed angle theorem, which states that if an angle subtends a semicircle, it is a right angle.

Plane Geometry:

Level 1: Visualization - Students visualized basic geometric shapes in the plane, such as triangles, quadrilaterals, and polygons. They used manipulatives like pattern blocks to explore the visual properties of plane figures and classify them based on their characteristics.
Level 2: Analysis - Students progressed to analyzing properties of plane figures, including angles, side lengths, and relationships between different parts of the figures. They applied geometric formulas to solve problems involving triangles, quadrilaterals, and other polygons. For example, they used the Pythagorean theorem to find the lengths of sides in right triangles.
Level 3: Deduction - Students deduced geometric properties and relationships of plane figures through deductive reasoning at this stage. They constructed proofs of geometric theorems, such as the triangle congruence theorems. For instance, they proved that two triangles are congruent if their corresponding sides and angles are equal.
Level 4: Abstraction - Students generalized geometric properties of plane figures, abstracting common principles to solve more varied and complex problems in plane geometry. For example, it recognizes the relationship between the angles formed by parallel lines and a transversal and applies this property to prove theorems about angle relationships.
Level 5: Rigor - Students engaged in rigorous mathematical argumentation, constructing formal proofs and logical arguments to justify geometric conclusions with precision and accuracy. They apply advanced concepts and techniques to tackle challenging problems in plane geometry, such as proving theorems about similar triangles and using similarity to solve real-world problems.

Coordinate Geometry:

Level 1: Visualization - Students visually represented geometric figures on the coordinate plane, including points, lines, and shapes. They graphed geometric figures and explored their visual properties in the Cartesian coordinate system.
Level 2: Analysis - Students analyzed geometric relationships and properties using coordinate geometry techniques, such as distance formula, midpoint formula, and slope of a line. They applied coordinate geometry to solve problems involving lines, circles, and polygons on the coordinate plane.
Level 3: Deduction - Students deduced geometric properties and relationships using coordinate geometry principles and deductive reasoning at this stage. They proved geometric theorems and propositions using coordinate geometry techniques, such as a line equation's distance formula and slope-intercept form.
Level 4: Abstraction - Students abstract common properties and concepts in coordinate geometry, such as transformations and conic sections. They analyze how transformations affect the coordinates of points and equations of geometric objects. For example, students explored how translations, reflections, rotations, and dilations transform geometric figures on the coordinate plane, applying these concepts to solve symmetry and transformation problems.
Level 5: Rigor - Students engage in rigorous mathematical argumentation in this stage, constructing formal proofs and justifications for advanced coordinate geometry concepts and theorems. They rigorously prove the properties of conic sections and transformations. For example, students constructed a formal proof to demonstrate that the locus of points equidistant from the foci of an ellipse forms the ellipse. They used algebraic techniques and geometric reasoning to justify their conclusion.

After receiving a week of training under the researchers' supervision, the research assistants began the teaching phase. Prior to instruction, the assistants administered the pre-GAS and pre-

GAT to the students simultaneously to assess their initial attitudes and achievements in geometry. This was done to ensure the students were comparable in their geometry knowledge and attitudes before starting the treatments. The teaching spanned four weeks, consisting of three lessons per week for a total of twelve lessons, aligning with the standard Nigerian senior secondary school Mathematics timetable. This approach maintained the regular schedule and kept the students unaware of their participation in an experiment. Following the teaching period, a week was dedicated to revision. The research assistants then administered the post-tests for GAS and GAT to evaluate changes in students' attitudes and achievements in geometry, using the same instruments as the pre-tests but with reshuffled items.

Commented [SM23]: For the Van Hiele Teaching Model application, you can complete the number of meetings for each material

Method of Data Analysis

The retrieved copies of the GAS and GAT were cross-checked for completeness of response before analysis. The SPSS was used for data analysis. The mean and standard deviation obtained were used to answer the research questions. Since the data collected fulfilled the assumptions or conditions for using ANCOVA, the F statistic obtained was used to test all the null hypotheses at a .05 significance level. The decision rule for hypothesis testing was as follows: Reject the null hypothesis if the p-value associated with the test statistics is less than 0.05 ($p < 0.05$); if the p-value is 0.05 or higher, do not reject the null hypothesis.

Commented [SM24]: In the data analysis section, it is necessary to explain the statistical hypothesis for each hypothesis proposed. So that the parameters proposed for each hypothesis are clear. Especially for Geometric Attitude, because it is not suitable to use average parameters.

Ethical Consideration

The study received ethical approval from the Post Primary Management Board, Nsukka Education Zone, on May 10, 2022 (Ref. No. PPSMB/23/0147). School principals granted permission for the research, and informed consent was obtained from all participants, ensuring adherence to ethical standards throughout the process.

Findings

The results are presented in line with the research questions and the null hypotheses that guided the study.

Research Question 1

What are the mean attitude scores of students taught geometry using Van Hiele's model and those taught without?

[Insert Table 1 here]

Table 1 presents the pre-test and post-test mean attitude scores of students in the experimental group (taught using Van Hiele's model) and the control group (taught using conventional methods). The pre-test mean score for students taught using Van Hiele's model was 66.16 (SD = 6.08), and their post-test mean score was 86.46 (SD = 8.34), resulting in a mean difference of 20.3. For students taught using conventional methods, the pre-test mean score was 65.45 (SD = 5.76), and the post-test mean score was 72.40 (SD = 6.46), resulting in a mean difference of 6.95. These results suggest that students taught geometry using Van Hiele's model experienced a greater improvement in their attitude scores compared to those taught using conventional methods.

Hypothesis 1

There is no significant difference in the mean attitude score of students taught geometry using Van Hiele's model and those taught without ($p < 0.05$).

Commented [SM25]: Can attitudes be met on average?

[Insert Table 2 here]

The ANCOVA results in Table 2 indicate that there is a significant difference in the mean attitude scores of students taught geometry using Van Hiele's model compared to those taught using the conventional method ($F(1, 123) = 111.747$, $p < .05$, $\eta p^2 = .476$). This suggests that Van Hiele's model significantly positively affects students' attitudes towards geometry. The effect size for the group variable is substantial, with 47.6% of the variance in students' attitudes explained by the instructional method (Van Hiele's model) used. Therefore, we reject the null hypothesis, concluding that there is a significant difference in the mean attitude scores of students taught geometry using Van Hiele's model compared to those taught using the conventional method.

Research Question 2

What is the influence of gender on students' attitudes towards geometry?

[Insert Table 3 here]

Table 3 presents male and female students' pre-test and post-test mean attitude scores towards geometry. The pre-test mean score for male students was 66.58 (SD = 4.70), and their post-test mean score was 79.12 (SD = 11.12), resulting in a mean difference of 12.54. For female students, the pre-test mean score was 64.95 (SD = 7.03), and the post-test mean score was 80.75 (SD = 9.22), resulting in a mean difference of 15.80. These results suggest that male and female students improved their attitude scores towards geometry. The mean differences indicate that female students experienced a slightly larger gain in attitude scores than male students.

Commented [SM26]: Can attitudes be met on average?

Hypothesis 2

Commented [SM27]: Need to explain whether the data analysis uses normalized gain or ordinary gain?

There is no influence of gender on students' attitudes towards geometry.

The result in Table 2 also shows ANCOVA analysis of the significant influence of gender on students' attitudes towards geometry. The ANCOVA results indicate that gender does not significantly influence students' attitudes towards geometry ($F(1, 123) = 2.295$, $p = .132$). This suggests no significant difference in attitude scores between male and female students. Therefore, we fail to reject the null hypothesis, concluding that gender does not significantly influence students' attitude towards geometry."

Research Question 3

What is the interaction effect of instructional models and gender on students' attitude scores in geometry?

[Insert Table 4 here]

Table 4 presents male and female students' pre-test and post-test mean attitude scores under two instructional models: Van Hiele's and conventional models. For Van Hiele's model, the pre-test mean score for male students was 66.78 (SD = 3.82), and their post-test mean score was 86.14 (SD = 9.13), resulting in a mean difference of 19.36. Female students in the same group had a pre-test mean score of 65.47 (SD = 7.91) and a post-test mean score of 86.81 (SD = 7.49), resulting in a mean difference of 21.34. For the conventional method, the pre-test mean score for male students was 66.36 (SD = 5.56), and their post-test mean score was 71.45 (SD = 7.46), resulting in a mean difference of 5.09. Female students in this group had a pre-test mean score of 64.33 (SD = 5.91) and a post-test mean score of 73.56 (SD = 4.88), resulting in a mean difference of 9.23. These results suggest that both instructional methods improved attitude scores for both male and female students. However, Van Hiele's model appears to have had a more substantial positive effect on students' attitudes towards geometry, regardless of gender. To test for the interaction effect of instructional methods and gender on students' attitude scores in geometry, see hypothesis three.

Hypothesis 3

There is no significant interaction effect of instructional methods and gender on students' attitude scores in geometry.

Results in Table 2 also show ANCOVA analysis of the interaction effect of instructional methods and gender on students' attitude scores in geometry. The ANCOVA results indicate no significant interaction effect of instructional methods and gender on students' attitude scores in geometry ($F(1, 123) = 0.423$, $p = .517$). This suggests that the combined effect of instructional methods and gender does not significantly influence students' attitudes towards geometry. Therefore, we fail to reject the null hypothesis, concluding that there is no significant interaction effect of instructional methods and gender on students' attitude scores in geometry.

Research Question 4

What is the mean achievement score of students taught geometry using Van Hiele's model and those taught without?

[Insert Table 5 here]

Table 5 presents the pre-test and post-test mean achievement scores of students in the experimental group (taught using Van Hiele's model) and the control group (taught using the conventional method). For Van Hiele's model group, the pre-test mean score was 62.53 (SD = 7.45), and the post-test mean score was 88.60 (SD = 9.08), resulting in a mean difference of 26.07. For the conventional group, the pre-test mean score was 63.22 (SD = 5.97), and the post-test mean score was 76.80 (SD = 6.71), resulting in a mean difference of 13.58. These results suggest that both instructional methods improved students' achievement scores in geometry. However, students taught using Van Hiele's model showed a larger increase in achievement scores than those taught using the conventional method.

Hypothesis 4

There is no significant difference in the mean achievement score of students taught geometry using Van Hiele's model and those taught without.

[Insert Table 6 here]

Table 6 shows ANCOVA analysis of the difference in the mean achievement score of students taught geometry using Van Hiele's model and those taught using the conventional method. The ANCOVA results indicate that there is a significant difference in the mean achievement scores of students taught geometry using Van Hiele's model compared to those taught using the conventional method ($F(1, 123) = 67.759$, $p < .05$, $\eta p^2 = .355$). This suggests that Van Hiele's model has a significantly positive effect on students' achievement in geometry. The effect size for the group variable is substantial, with 35.5% of the variance in students' achievement explained by the instructional method (Van Hiele's model) used. Therefore, we reject the null hypothesis, concluding that there is a significant difference in the mean achievement scores of students taught geometry using Van Hiele's model compared to those taught using the conventional method.

Research Question 5

What is the influence of gender on students' achievement scores in geometry?

[Insert Table 7 here]

Table 7 presents the pre-test and post-test mean achievement scores for male and female students in geometry. Male students (N = 69) had a pre-test mean score of 61.96 (SD = 7.73) and a post-test mean score of 83.62 (SD = 10.21), resulting in a mean difference of 21.66. Female students (N = 59) had a pre-test mean score of 63.90 (SD = 5.33) and a post-test mean score of 82.42 (SD = 9.73), resulting in a mean difference of 18.52. This data indicates that while male and female students improved their achievement scores, the mean difference was slightly higher for male students.

Commented [SM28]: If you look at the increase data, this uses the gain principle. But in the methodology section it has not been explained that the scores analyzed use normalized gain or ordinary gain

Hypothesis 5

There is no significant influence of gender on students' achievement scores in geometry.

The result in Table 6 also shows ANCOVA analysis of the significant difference in the mean achievement score of male and female students in geometry. The ANCOVA results indicate that gender does not significantly influence students' achievement scores in geometry ($F(1, 123) = 1.206$, $p = .274$). Therefore, we fail to reject the null hypothesis, concluding that gender does not significantly influence students' geometry achievement.

Research Question 6

What is the interaction effect of instructional models and gender on students' mean achievement scores in geometry?

[Insert Table 8 here]

Table 8 presents the pre-test and post-test mean achievement scores for male and female geometry students using two different instructional methods: Van Hiele's model and the conventional method. Male students taught with the Van Hiele's model (N = 36) had a pre-test mean score of 60.08 (SD = 8.37) and a post-test mean score of 89.50 (SD = 8.26), resulting in a mean difference of 29.42. Female students taught with the Van Hiele's model (N = 32) had a pre-test mean score of 65.28 (SD = 5.11) and a post-test mean score of 87.59 (SD = 9.95), resulting in a mean difference of 22.31. Male students taught with the conventional method (N = 33) had a pre-test mean score of 64.00 (SD = 6.50) and a post-test mean score of 77.21 (SD = 8.10), resulting in a mean difference of 13.21. Female students taught with the conventional method (N = 27) had a pre-test mean score of 62.26 (SD = 5.20) and a post-test mean score of 76.30 (SD = 4.58), resulting in a mean difference of 14.04. This data indicates that both instructional methods positively affected students' achievement scores, with Van Hiele's model showing a more substantial improvement. To test for the interaction effect of instructional methods and gender on students' achievement scores in geometry, see hypothesis six.

Hypothesis 6

What is the interaction effect of instructional models and gender on students' mean achievement scores in geometry?

Results in Table 6 also show ANCOVA analysis of the interaction effect of instructional methods and gender on students' achievement scores in geometry. The ANCOVA results indicate no significant interaction effect between instructional models and gender on students' mean achievement score in geometry ($F(1, 123) = 0.334$, $p = .564$). Therefore, we fail to reject the null hypothesis, concluding that there is no significant interaction effect of instructional models and gender on students' achievement scores in geometry.

Discussion

This study examined the effects of the Van Hiele instructional model on students' attitudes and achievements in geometry, with special attention to gender differences. The findings align with the existing body of research on the effectiveness of the Van Hiele model in enhancing students' geometric understanding and attitudes towards the subject. Our study found that students taught geometry through the Van Hiele model had significantly higher mean attitude scores compared to those who received traditional instruction. This result is consistent with findings from Yalley et al. (2021) in Ghana, where students taught using the Van Hiele model outperformed their counterparts in Circle Geometry. The significant difference in attitude scores suggests that the Van Hiele model improves students' performance and positively influences their attitudes towards geometry, making the learning experience more engaging and enjoyable.

Similarly, our study found a significant improvement in the mean achievement scores of students taught using the Van Hiele model compared to those taught with conventional methods. This aligns with Santos et al. (2022) in the Philippines, where the experimental group displayed significant gains in geometry achievement. The consistent positive outcomes across different studies indicate the robustness of the Van Hiele model in enhancing geometric understanding.

The results of our study showed no significant influence of gender on students' attitudes towards geometry or on their achievement scores. These findings suggest that the Van Hiele model is equally effective for both male and female students, promoting gender equity in geometric learning. This aligns with Abdullah et al. (2014), who found no significant difference in attitudes towards geometry based on gender. However, their study reported significant geometric achievement differences, favoring the Van Hiele model. Our study also examined the interaction effect of instructional models and gender on students' attitudes and achievement scores in geometry. The results indicated no significant interaction effect on attitude scores or achievement scores. This lack of interaction effect suggests that the effectiveness of the Van Hiele model is consistent across genders, further supporting the model's broad applicability and effectiveness.

The reviewed studies consistently highlight the effectiveness of the Van Hiele model in improving students' geometric achievement and attitudes. For instance, among primary school students, Al-ebous (2016) demonstrated significant gains in geometric concept acquisition and attitudes towards geometry. Moreover, Naufal et al. (2021) showed that incorporating metacognitive strategies into the Van Hiele model can further enhance students' geometric thinking levels, indicating the model's adaptability and potential for further improvement.

Our findings contribute to this body of literature by providing additional evidence of the Van Hiele model's effectiveness in a different educational context. The significant improvements in attitude and achievement scores among students taught using the Van Hiele model underscore its value as an instructional strategy in geometry education.

Commented [SM29]: In the discussion section, it is necessary to describe each hypothesis proposed. This is an important part because this research is quantitative research in the form of an experiment so hypothesis testing is the aim of the research carried out. There are 6 hypotheses proposed and tested. So each hypothesis must be discussed in depth and compared with previous research.

For example, there is an interaction between gender and model. This has not been discussed in depth. Why the contribution of the Van Hiele Model to providing interactions with gender needs to be explained with various theories and previous research results. Thus validating and strengthening the research findings

If necessary, there is data from observations, supporting data can be used to justify the findings from hypothesis testing

Conclusion

In conclusion, the Van Hiele instructional model significantly enhances students' attitudes and achievement in geometry, with no significant differences based on gender. These findings support the widespread adoption of the Van Hiele model in geometry instruction to improve students' engagement and performance.

Commented [SM30]: Conclusions must refer to the research questions that have been asked

Limitations

This study has several limitations. Firstly, the intervention period was short, which might not capture long-term effects. Longitudinal studies would be beneficial in understanding the lasting impact of the instructional model. Secondly, the study was conducted in a specific geographical and cultural context, which may influence the applicability of the findings to other regions. Cross-cultural studies are needed to assess the model's effectiveness in diverse educational settings.

Commented [SM31]: It is explained how long the time will be used so that it can be used as a basis for the limitations of the research carried out

Educational Implications

The significant improvement in students' attitudes and achievement scores when using the Van Hiele model suggests its integration into geometry curricula can enhance learning outcomes and engagement. Educators should consider adopting this model to make geometry instruction more effective. Mathematics teachers need thorough training in the model's principles and phases for successful implementation. Professional development programs should focus on equipping teachers with the necessary skills. Curriculum developers should incorporate the Van Hiele model into educational frameworks, creating lesson plans and instructional materials that align with the model's structured approach. The study's findings also highlight the potential of this model to promote gender equity in geometry education, providing equal learning opportunities for all students.

Commented [SM32]: The proposed implications should also be discussed in the discussion section, so that they can be used as a basis for the implications section. Because the implications of research must refer to research findings and not just normative, but actually from the phenomena discovered from the research results.

Recommendations

Longitudinal studies are recommended to investigate the long-term impact of the Van Hiele model on students' attitudes and achievement in geometry. Additionally, cross-cultural studies should be conducted to explore the model's effectiveness in different geographical and cultural contexts. Comprehensive training programs for teachers on the Van Hiele model are essential, including workshops and in-service training sessions. Lastly, advocating for curriculum reforms incorporating the Van Hiele model, supported by instructional materials and resource development, can improve the quality of geometry education.

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