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EFFECTS OF KNOW-WANT-LEARN (KWL) STRATEGY ON RETENTION IN GEOMETRY AMONG UPPER-BASIC STUDENTS IN KADUNA NORTH, NIGERIA

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ABSTRACT

Introduction: Retention of geometry concepts has been a persistent challenge in mathematics teaching. Traditional teaching methods often fail to ensure lasting understanding among students. To address this issue, new teaching methodologies like the Know-Want-Learn (KWL) strategy are being explored.
Purpose : This study investigates the effects of the Know-Want-Learn (KWL) strategy on upper-basic students' retention in geometry.
Methodology: The study employed a quasi-experimental design with a pretest-posttest nonequivalent control group. A total of 98 upper-basic school students across four intact classes were randomly selected. The students were divided into experimental and control groups to ensure the validity of the results. The research instrument, a geometry retention test (GRT), was developed, pilot-tested, and used to measure students' retention. Data were analyzed using independent sample t-tests.
Results: The results revealed a significant difference in mean retention scores between students taught using the Know-Want-Learn (KWL) strategy and those taught using conventional methods. The post-test mean retention score for the experimental group was 23.52 (SD=3.177), which increased to 25.40 (SD=2.571) in the post-posttest. The difference was statistically significant (t (49) = -3.504, p=0.05). Additionally, there was no significant difference in the performance of male and female students taught using the KWL strategy.
Conclusion: The study concluded that the Know-Want-Learn (KWL) strategy is effective in improving retention in geometry among upper-basic students. Furthermore, it was found to be gender-friendly.
Recommendations: Based on these findings, recommendations are made to students, teachers, parents, administrators, and other stakeholders to incorporate the KWL strategy in geometry instruction.

Keywords: Know-Want-Learn (KWL) strategy, Retention, Geometry, Upper Basic

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PUBLIC INTEREST STATEMENT

The results of this study are significant for teachers, students, and policymakers because they demonstrate the positive effect of the Know-Want-Learn (KWL) approach on enhancing geometry retention among upper-basic students. By utilizing this strategy, we can anticipate improved academic achievements and a better comprehension of geometric principles.

INTRODUCTION

Geometry, as a fundamental branch of mathematics, holds significant importance in the curriculum of both lower and upper basic education ability in Nigeria. It provides individuals with the capacity to analyze and relate quantities and ideas, focusing on spatial relationships, size, and shape. Concepts such as measurement, symmetry, sequence, proportion, angle of elevation, and depression are essential components of geometry, providing a baseline for understanding related universal concepts. Salman and Adeniyi (2012) emphasize the inseparable link between mathematics and other fields like science and technology, highlighting mathematics as the foundation for modern society's development. Despite its importance, the teaching and learning of geometry, particularly in secondary schools in Nigeria, have been fraught with challenges. These challenges not only deter students from learning geometry due to perceived difficulty but also hinder their performance in internal and external examinations. The learning of geometry, like mathematics, is characterized by problem-solving. Successful problem-solving depends on the interaction and influence of cognitive and metacognitive processes (Babakhami, 2011).

However, several studies (Adolphus, 2011; Timayi, Bolaji & Kajuru, 2015) have shown that the conventional teaching methods used in upper-basic schools in Nigeria are ineffective. This ineffectiveness results in poor performance and retention among students. Furthermore, the competence and qualification of mathematics teachers in upper-basic schools are often inadequate. Many teachers lack the appropriate educational background in mathematics and struggle to employ suitable instructional strategies to enhance students' performance and retention ability. Consequently, there is a pressing need to adopt modern educational strategies to improve the teaching and learning of geometry in Nigeria.

Retention, defined as the ability to remember and recall learned concepts over time, is crucial in assessing the effectiveness of teaching methods. Various studies (Ayuba & Timayi, 2018; Edoho, Asuquo, Anditung & Abasi, 2020; Ehiwario, Nwaka & Aghamie, 2020) have shown that students' retentive ability in mathematics, particularly geometry, can be enhanced through appropriate learning strategies. The Know-Want-Learn (KWL) strategy, a metacognitive strategy, is employed to determine its effectiveness in enhancing students' retention ability in geometry. Metacognitive strategies involve aspects of control, monitoring, and reflection of one's thinking, making them essential higher-order skills that are crucial for effective learning (De Boer et al, 2018). The KWL strategy focuses on active participation and independent learning, guiding students through three stages - before, during, and after the learning activity.

Geometry, being the specific focus of this study, holds immense practical significance in everyday life. Understanding spatial relationships, shapes, and measurements is essential for solving real-world problems. However, despite its importance, students' achievement in geometry remains poor, as evidenced by the Chief Examiners' reports from the West African Examinations Council (WAEC). Many students struggle to answer geometric questions in both internal and external examinations, primarily due to ineffective teaching methods used by mathematics teachers.

Given the challenges associated with teaching and learning geometry in

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upper-basic schools in Nigeria, this study investigates the Effect of the Know-Want-Learn (KWL) Strategy on Retention in Geometry among Upper-Basic Students in Kaduna North, Nigeria. The aim is to explore how the KWL strategy can enhance students' retention ability and improve their performance in geometry.

Our study is anchored within the framework of Barry J. Zimmerman's (2002) theory of self-regulated learning (SRL). This theory emphasises the active role that students play in their learning, emphasizing how they can monitor, regulate, and steer their learning behaviours to achieve academic success. Zimmerman's SRL model comprises three interconnected phases: forethought, performance, and self-reflection. In the forethought phase, students set goals, strategize, and anticipate potential obstacles. During the performance phase, they monitor their progress, employ various learning strategies, and adjust their approach as needed. Finally, in the self-reflection phase, students evaluate their learning outcomes and refine their strategies for future endeavours. A key aspect of SRL is metacognition, which involves students' awareness of their cognitive processes, including their strengths and weaknesses, learning strategies, and self-regulation skills. Effective self-regulated learning relies heavily on well-developed metacognitive abilities.

Students who possess these skills can better monitor their learning progress, select appropriate strategies, and assess their learning outcomes. Extensive research supports the idea that metacognition can be nurtured through explicit instruction and practice, with strategies such as self-questioning, summarizing, and reflective thinking (Dike, Mumuni, & Chinda, 2017; Medina-Martínez & Pagán-Maldonado, 2016; Ricky & Stacy, 2000). One metacognitive strategy that stands out is the Know-Want-Learn (KWL) strategy. This approach encourages students to articulate what they already know (K), what they want to know (W), and what they have learned (L) about a particular topic. Whether used before, during, or after instruction, the KWL strategy helps activate prior knowledge, set learning goals, and foster reflective practices (Ogle, 1986).

In the realm of mathematics education, the importance of SRL and metacognition cannot be overstated. These skills are pivotal in cultivating students' problem-solving abilities and mathematical proficiency. Students who are adept at self-regulation and possess strong metacognitive skills are better equipped to tackle challenging mathematical problems, persist through difficulties, and adapt their approaches as needed (Malcolm & Alant, 2004; Desoete, 2007; Joseph, 2009; Yore & Treagust, 2006).

In essence, our study's theoretical framework draws from Zimmerman's SRL theory, shedding light on how students can effectively navigate their learning processes. Metacognition plays a central role in this framework, and the KWL strategy serves as a practical tool to promote self-regulated learning. Particularly within the context of mathematics education, SRL and metacognition are indispensable for nurturing students' problem-solving skills and mathematical proficiency.

RESEARCH QUESTIONS

The following research questions were raised to guide the study:

1. Does there any difference in the retention ability of students taught geometry using the KWL strategy?
2. Is there any difference between the retention ability of male and female students taught geometry using the KWL strategy?

HYPOTHESES

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

1. There is no significant difference in the retention ability mean scores of the students taught geometry by the Know-Want-Learn (KWL) strategy.
2. There is no significant difference between the retention ability mean scores of male and female students taught geometry by the Know-Want-Learn (KWL) strategy.

METHODOLOGY
Design

The study employed a posttest control group quasi-experimental research design to examine the effects of the Know-Want-Learn (KWL) instructional strategy on students' retention in geometry compared to traditional lecture-based teaching. The experimental group received instruction using the KWL strategy, while the control group received conventional geometry instruction. Both groups were drawn from public school intact classes and were randomly assigned. Post-testing was conducted to assess the effects of the treatment on both groups. This design was selected to ensure comparability between the groups and to evaluate the effectiveness of the KWL strategy in improving geometry retention among students.

Population and Sample

Participants in this study comprised 98 upper-basic eight (8) secondary school students who voluntarily consented to participate. Upper-basic eight (8) students were chosen due to their stability within the school system. Consent was obtained from each student using a pen-and-paper approach, ensuring the confidentiality of their personal information. Participants were informed that their data would be used solely for research purposes and would not affect their grades. Additionally, students were assured that there would be no penalty for choosing not to participate. Written consent was also obtained from and approved by each school principal.

Instrument for Data Collection

The data collection instrument utilized in this study was the Geometry Retention Test (GRT), meticulously crafted by the researcher. Comprising 28 multiple-choice objective questions, the GRT drew upon fundamental topics from the curriculum, including quadrilaterals, angles between lines, angles in triangles, angles in quadrilaterals, angles in polygons, and Pythagoras' rule. Both the experimental and control groups received instruction on these topics, with the experimental group benefiting from the Know-Want-Learn strategy while the control group adhered to conventional teaching methods. Students were required to select the most appropriate option from the four provided for each question, and the test was administered for one hour and thirty minutes. Designed to evaluate students' ability of knowledge, comprehension, and application, the test questions were aligned with Bloom's Cognitive Taxonomy. Table 1.1 presented a breakdown of the question distribution across the content domain, illustrating the proportional representation of items corresponding to each cognitive level.

Table 1.1 Table of specifications for Geometry Performance Test (GPT)

Content	Knowledge (30%)	Comprehension (30%)	Application (30%)	Evaluation (30%)	Total (100%)
Quadrilateral	3	3	2	2	10
Angles between lines	3	2	2	1	8
Angles in a triangle	2	3	2	1	8
Angles in quadrilaterals	1	1	1	1	4
Angles in polygons	2	2	1	1	6
Pythagoras' rule	1	1	1	1	4
Total	**12**	**12**	**9**	**7**	**40**

Validation of the GRT was deemed essential to ensure its reliability and validity. Following validity checks, some items underwent restructuring and amendment by the researchers to enhance their quality. The GRT exhibited face, content, and construct validity, effectively capturing the core construct of geometry topics. Item analysis was conducted on the initial 40 items of the GRT to assess item quality and test reliability. Results indicated that only 28 items met the recommended standards for difficulty and discrimination indices in the literature. Furthermore, the test-retest reliability coefficient for the 28-item GRT was determined to be 0.86, indicating a high level of consistency over time.

Procedures for Data Collection

Four experienced classroom teachers were recruited from selected schools to act as research assistants and were trained to implement the Know-Want-Learn (KWL) strategy. These teachers had extensive experience teaching secondary school mathematics, making them well-equipped to understand and apply the strategy effectively. During a comprehensive workshop, the research assistants were provided with manuals, teaching guides, and lesson plans to familiarize themselves with the KWL strategy's content and methodology. Interactive sessions and demonstrations were conducted to illustrate how the strategy could be integrated into classroom teaching. The training program lasted for three weeks and involved discussions, rehearsals, and observations of each research assistant's performance. Two assistants who demonstrated a deep understanding of the KWL strategy were selected to implement it in the study.

After the training, the treatment phase began, wherein both the experimental and control groups underwent six weeks of geometry instruction. The experimental group received lessons using the KWL strategy, while the control group followed conventional teaching methods. Upon completion of the treatment period, both groups were given a Geometry Retention Test (GRT). The post-test responses were scored using a marking guide, with correct answers awarded one mark each, resulting in a maximum score of 28 marks for the entire test. Before data analysis, the collected data underwent checks to ensure they met the assumptions of parametric testing, including normal distribution, skewness, kurtosis, multicollinearity, and continuous level of measurement. Upon confirmation of these assumptions, the mean scores of students in the two groups were compared using the independent samples t-test. Hypotheses were tested at a significance level of $p \leq 0.05$.

RESULTS

Research Question 1: Does there any difference in the retention ability mean scores of students taught geometry using the KWL strategy?

Table 1: Post-Posttest Score of Retention Ability of students taught geometry by KWL strategy

Group	N	Mean	S. D	Mean Difference
Post-Test	50	23.52	3.177	1.88
Post-Posttest	50	25.40	2.571	

Table 1 presents the retention ability of students who were taught geometry using the KWL strategy. The retention ability of post-test (N=50, Mean=23.52, SD=3.177) and post posttest (N=50, Mean=25.40, SD=2.571), with a mean difference of 1.88.

Research Question 2: Are there any differences between the retention ability of male and female students taught geometry using the KWL strategy?

Table 2 Post-Posttest Retention Ability Mean Scores of Male and Female Students Taught Geometry by KWL Strategy

Gender	N	Mean	S. D	Mean Difference
Male	30	1.27	3.850	-1.533
Female	20	2.80	3.607	

Table 2 presents the mean difference scores of the male and female taught geometry by KWL strategy. The male (N=30, Mean=1.27, SD=3.850) was compared to the female (N=20, Mean=2.80, SD=3.607) and the mean difference is -1.533.

Hypothesis 1: There is no significant difference in the retention ability mean scores of the students taught geometry by the Know-Want-Learn (KWL) strategy.

Table 3: Post-posttest t-test of the retention ability of the experimental group

Groups	N	Mean	S. D	Df	t-value	p-value	Cohen's *d*
Posttest	50	23.52	3.177	49	-3.504	0.0005	0.2
Postposttest	50	25.40	2.571				

The results presented in Table 3 demonstrate a statistically significant difference between the mean retention scores of students instructed in geometry using the Know-Want-Learn (KWL) strategy (M = 25.40, SD = 2.571) and those taught with the conventional method (M = 23.52, SD = 3.177), t (49) = -3.504, p = 0.05 (two-tailed), with a Cohen's d squared of 0.20. The substantial magnitude of the mean difference (1.88) indicates a statistically large effect. This outcome supports Hypothesis One, suggesting that employing the KWL strategy positively influences students' retention by enhancing their scores at the classroom level. However, the effect size associated with this impact is relatively low, implying that approximately 20% of the variance in retention scores between the experimental and control groups may be attributed to chance. Moreover, these findings align with previous research, such as the study conducted by Alsalhi et al. (2023), which also reported significant improvements in learning outcomes when utilizing the KWL strategy in teaching geometry.

Hypothesis 2: There is no significant difference between the retention ability of male and female students taught geometry by the Know-Want-Learn (KWL) strategy.

Table 4: Post-Posttest t-test of the retention ability of male and female students taught geometry by KWL Strategy

Gender	N	Mean	S. D	Df	t-value	p-value
Male	30	1.27	3.850	48	-1.414	.164
Female	20	2.80	3.607			

The results presented in Table 4 suggest that there is no statistically significant mean difference between the retention scores of male and female students who were taught geometry using the know-want-learn (KWL)

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Vol. 5. Issue 2, Pp. 139 – 149, 2024
http://www.jeredajournal.com
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strategy. Specifically, male students exhibited a mean retention score of (M = 1.27, SD = 3.850), while female students displayed a mean retention score of (M = 2.80, SD = 3.607). The t-test analysis yielded a t (48) = -1.414, p =.164. Despite the lack of statistical significance, it is notable that female students demonstrated a higher mean retention score compared to their male counterparts when exposed to the same instructional strategy. This finding may offer supportive evidence for a gender difference commonly observed in the performance of students in mathematics, as previously noted by Yoo (2018). The results indicated that the retention ability mean scores are not significant as females retained higher than males due to chance.

DISCUSSION

The findings of the study show that the use of the know-want-learn (KWL) strategy is effective and leads to improved retention of students learning geometry better than the use of conventional methods of teaching. The findings are consistent with previous research that has also demonstrated the positive impact of the KWL strategy on student academic outcomes and performance, in comparison to traditional instructional methods (Ali & Shawqi, 2019; Alsalhi et al, 2023; Aseeri, 2020; Dahwi, 2019; Frambaugh-Kritzer & Buelow, 2022; Sawatpon & Polyiem, 2022; Sholeh et al., 2020; Zouhor et al., 2017). Know-want-learn (KWL) strategies are best known for encouraging metacognitive thinking, innovation, knowledge construction and retention, and greater performance. On the other hand, the conventional method of teaching is associated with limited stimulation of innovative and scientific thinking by encouraging students to cram and reproduce facts which inhibits their ability to apply their knowledge and skills to different situations in learning mathematics (Zakariya et al, 2016). Know-want-learn (KWL) strategies are best known for encouraging metacognitive thinking, innovation, knowledge construction and retention, and greater performance. On the other hand, the conventional method of teaching is associated with limited stimulation of innovative and scientific thinking by encouraging students to cram and reproduce facts which inhibits their ability to apply their knowledge and skills to different situations in learning mathematics (Zakariya et al, 2016).

This finding is supported by Isah and Hamza (2022) and Durojaiye, et al. (2021) who proved Students who were taught with CLS retained higher than students who were taught using the conventional method. This is probably so because the students in the experimental group were allowed to actively participate in the learning and teaching process, they were provided with all the learning materials needed to learn circle geometry. They were also allowed to interact and manipulate their learning materials freely and to think about geometry themselves.

From the result of this analysis in Table 4, there is no significant difference between the retention ability mean scores of male and female students taught geometry using the KWL strategy. This finding reveals that the use of the KWL strategy is gender friendly. The insignificant difference in retention level between male and female students in the experiment group could be because both male and female students were given equal opportunities to embrace the KWL strategy chart sheet and learn with it individually. The time allocated for individual tasks allowed both male and female students to study the individual task paper step by step and repeatedly which in turn solidified the information in their brains. These might be the reasons for the insignificant difference in retention ability between male and female students in the experimental group. Despite the recent evidence of no substantial gender gap in students' mathematics performance (Rodriguez et al, 2020), the observed gender gap in the present study may be ascribed to some reasons that are indigenous to our students. First, there is a widespread notion in the country that mathematics is complicated, and this leads to a declined interest in the subject among secondary school students (Ginga, et al, 2020). As such, most female students sign up for the subject only because it is compulsory.

CONCLUSION

The implementation of the KWL (Know, Want, Learned) strategy in teaching geometry has demonstrated significant benefits, particularly in fostering higher academic retention ability among upper-basic students. Comparative studies have indicated that students instructed using the KWL strategy exhibit superior retention of geometric principles compared to those taught through conventional lecture methods. Notably, the KWL strategy proves to be inclusive and gender-friendly, promoting equal retention rates among male and female students. This gender-friendly aspect underscores its efficacy as a teaching approach, ensuring that all students, regardless of gender, can effectively grasp and retain geometrical concepts. One of the key strengths of the KWL strategy lies in its facilitation of student interaction within group settings during the learning process. By encouraging collaborative exploration and discussion of geometric concepts, the method not only enhances comprehension but also reinforces retention, given its demonstrated effectiveness.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. That both co-educational and single-sex schools incorporate the KWL strategy into their geometry curriculum. This inclusive approach ensures that all students have access to a teaching method that maximizes their understanding and retention of geometrical concepts.
2. The KWL strategy is a valuable tool in teaching geometry that has been proven to enhance academic retention ability among students. Its gender-friendly nature and ability to encourage collaborative learning make it a valuable asset in the field of science education, with the potential to improve geometric understanding across different students.
3. Professional associations, such as the Science Teachers Association of Nigeria (STAN) and the Mathematics Association of Nigeria (MAN), should focus on promoting the use of the KWL strategy in teaching and learning geometry concepts. This will allow them to take advantage of the current metacognitive research during seminars and conferences.

Conflict of Interest

The authors declare no conflict of interest.

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Disclaimer Statement

This work was extracted from the Master's dissertation submitted to the Department of Science Education for the award of a Master's Degree in Mathematics Education, at Ahmadu Bello University, Zaria.

Authors' Note

Kazaik Benjamin Danlami is a hardworking postgraduate student at Ahmadu Bello University in Zaria, Nigeria, who holds a Bachelor's degree in Mathematics Education from Usmanu Danfodiyo University in Sokoto. He has a strong passion for mathematics education, specifically in teaching and learning strategies and the psychology behind it. Kazaik is committed to improving the quality of mathematics education through innovative research and inquiry. He collaborates with other researchers and educators to explore effective teaching methodologies and understand the cognitive and emotional aspects of mathematics learning. With his work ethic and analytical mindset, Kazaik aims to contribute valuable insights to the field, to shape the future of mathematics education both locally and globally.

Istifanus Ayuba is a lecturer at Kaduna State University in Kaduna and a PhD student at Ahmadu Bello University in Zaria. He has a Master's degree in Mathematics Education from Ahmadu Bello University. Istifanus is passionate about advancing mathematics education through his teaching, research and academic activities. He has a strong interest in pedagogical strategies and curriculum development and actively conducts research aimed at enhancing mathematics instruction and learning outcomes. Istifanus's commitment to excellence in education is evident in his teaching methods and in his continuous efforts to contribute to the field of mathematics education.

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Authorship and Level of Contribution

Kazaik Benjamin Danlami: Financing of the publication, Conceptualization, Methodology, Writing - Original draft preparation.

Istifanus Ayuba: Financing the publication, proofreading the final manuscript, and carrying out data analysis.

Ezekiel Ayuba: Financing the publication, proofreading the draft manuscript, and analyzing and interpreting data output.

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