MODESTUM EURASIA Journal of Mathematics, Science and Technology Education, 2025, 21(9), em2704
ISSN:1305-8223 (online)
OPEN ACCESS Research Paper https://doi.org/10.29333/ejmste/16884

The 5E instructional model of constructivism in mathematics education: Teachers' beliefs and classroom practices

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Received 31 March 2025 ▪ Accepted 29 June 2025

Abstract

The study explores the beliefs and practices of mathematics teachers regarding the use of the 5E instructional model of constructivism in teaching mathematics. In addition, the study also examines the impact of variables such as gender, educational attainment, school type, age group, and experience level on the implementation of the 5E instructional model. Data collected from a sample of 94 mathematics with responses analyzed using descriptive statistics and nonparametric tests the study shows that the 5E instructional model of constructivism improves the teaching and learning processes in mathematics. The study also found that the educational attainment of teachers, age group, gender, and experience level of mathematics teachers was found to influence the utilization of the 5E instructional model in teaching and learning mathematics. However, different school types of teachers (private vs. government) did not influence the use of the 5E instructional model.

Keywords: constructivism, 5E instructional model, mathematics, teaching, mathematics education

INTRODUCTION

Mathematics is a fundamental discipline with profound applications across various aspects of human life. Studies have shown that mathematics influences nearly every domain of human activity, underscoring its universal relevance (Istiqomah & Pramudya, 2019; Maliki et al., 2009). As such, mathematics education is essential for equipping individuals with the skills necessary to navigate various life scenarios (Istiqomah & Pramudya, 2019; Pujawan & Suryawan, 2021). Mathematics goes beyond rote memorization of formulas, instead, it serves as a foundational science that cultivates analytical reasoning, problem-solving capabilities, and critical thinking skills (Vergara & Balquedra, 2024). Toumasis (1993) further asserts that mathematical knowledge is essential not only for effective societal participation but also for contributing meaningfully to environmental and societal development. Similarly, Davies and Hersh (2012) highlight mathematics as a critical subject for academic success and future preparedness, regardless of students' chosen career paths. Umameh (2011) reinforces this view, stating that mathematics is deeply intertwined with everyday life, making it indispensable for human functionality. Given its significance, schools must prioritize effective teaching and learning of mathematics (Adesoji & Yara, 2008).

In Nigeria, mathematics is a core subject in the national curriculum, mandated at both primary and secondary education levels (Federal Republic of Nigeria, 2004). As a compulsory subject, it requires students to develop a deep understanding of mathematical concepts, necessitating effective instructional strategies. However, studies have consistently identified poor student performance in mathematics as a persistent issue in Nigeria. Sa'ad et al. (2014) attribute this underperformance to factors stemming from schools, students, teachers, and governmental policies. Among these, teaching methods employed by mathematics teachers have been identified as a critical barrier to student achievement (Wanbugu et al., 2013).

Many Nigerian mathematics teachers rely heavily on traditional, didactic teaching methods, which involve the teacher delivering content verbally while students passively listen and take notes (Benard et al., 2013). Emaiku (2012) notes that such methods often fail to foster student interest, achievement, or retention, raising concerns about their efficacy. Effective teaching, as

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Contribution to the literature

- This study is the first systematic investigation of 5E model implementation in Nigerian mathematics classrooms.
- It identifies key demographic factors influencing constructivist pedagogy adoption and provides evidence-based recommendations for teacher professional development.
- It contributes to global conversations about culturally-responsive mathematics instruction.

argued by Ost (2014), requires the use of diverse instructional strategies that cater to varied learning needs and promote high levels of student achievement. Modern teaching methods must actively engage students, encourage interaction, and stimulate interest to enhance learning outcomes (Nguyen et al., 2012). Omotayo and Adeleke (2017) further emphasize that incorporating student interests into lessons can significantly improve teaching effectiveness.

Constructivism, a learning theory that emphasizes active knowledge construction through experience and interaction, has emerged as a promising alternative to traditional methods. Anyanwu and Iwuamadi (2015) define constructivism as a process where learners build knowledge based on prior experiences, fostering active engagement, problem-solving, and collaboration. In constructivist classrooms, teachers act as facilitators, guiding students and encouraging participatory discussions. This approach aligns with instructional models like the 5E instructional model, which integrates constructivist principles to create student-centered learning environments (Toraman & Demir, 2016; Walia, 2012).

The 5E instructional model–comprising engagement, exploration, explanation, elaboration, and evaluation–provides a structured framework for designing effective, constructivist-based lessons (Hu et al., 2017). The engagement phase serves as a crucial initial step, allowing educators to tap into students' pre-existing knowledge and pique their curiosity, setting the stage for deeper exploration (Gu, 2023). This initial engagement is critical from a cognitive standpoint, as it stimulates the recall of relevant information, thereby facilitating the assimilation of new concepts (Martín & Bybee, 2022). The exploration stage further enables students to actively investigate the topic at hand, fostering a deeper understanding through hands-on experiences. The explanation stage allows for the formal introduction of concepts and terminology, providing a structured framework for students' understanding. The subsequent elaboration phase offers opportunities to expand and apply their newly acquired knowledge in different contexts. The evaluation stage provides a mechanism for assessing students' understanding and skills, ensuring that learning objectives have been met (Gu, 2023). The 5E model mirrors the constructivist learning theory, emphasizing that students construct their own understanding through active participation in the learning process (Santi & Atun, 2021). Researchers have found that the 5E instructional model helps teachers create student-centered (constructivist learning environment) lessons that are effective for teaching and learning (Toraman & Demir, 2016; Walia, 2012). Similarly, the 5E model enhances mathematical understanding and improves learning outcomes by encouraging students to discover knowledge through practical, hands-on activities (Yonwilad et al., 2022). Furthermore, the 5E instructional model serves as a guide for teaching because it enables the teacher to structure their lesson in an organized way from start to finish. Since it was first proposed, the 5E instructional model has been extensively used in classroom instruction by teachers.

Research Gap

While constructivism has been widely recognized as a pivotal approach in modern education, and the 5E instructional model has emerged as an effective framework for implementing constructivist principles (Gu, 2023), there remains a significant gap in the literature regarding its application in Nigerian mathematics education. Although studies such as Omotayo and Adeleke (2017) have explored the impact of the 5E model on student performance and learning outcomes, their focus was limited to secondary school students, leaving a critical gap in understanding the beliefs and practices of mathematics teachers in utilizing this 5E constructivist instructional model in teaching and learning mathematics. Furthermore, existing research has not sufficiently examined how demographic and professional variables–such as gender, educational attainment, school type, age, and teaching experience–influence teachers' adoption and implementation of the 5E model. This study addresses this gap by investigating Nigerian mathematics teachers' beliefs and practices of the 5E instructional model and the factors that shape its utilization in their classrooms.

Purpose of the Study

The primary purpose of this study is to explore how Nigerian mathematics teachers implement the 5E instructional model of constructivism in their teaching practices. Specifically, the study aims to examine the influence of key variables–including gender, educational attainment, school type (private vs. government), age group, and teaching experience–on teachers' adoption and application of the 5E model. By identifying patterns and challenges in the implementation of this model, the study seeks to provide a deeper understanding of how constructivist approaches can be effectively integrated into mathematics education in Nigeria.

Significance of the Study

This study holds significant implications for improving mathematics education in Nigeria. By identifying gaps and challenges in the implementation of the 5E instructional model, the findings will offer actionable insights for enhancing teaching practices and fostering student engagement, achievement, and retention in mathematics. Additionally, the study contributes to the broader discourse on constructivist pedagogy by highlighting the role of teacher-specific variables in the successful adoption of innovative instructional models. The outcomes of this research will inform policymakers, teacher educators, and curriculum developers, providing evidence-based recommendations for professional development programs and policy reforms aimed at improving mathematics education in Nigeria. Ultimately, this study seeks to bridge the gap between theory and practice, ensuring that constructivist approaches like the 5E model are effectively utilized to address the persistent challenges in Nigerian mathematics education.

Research Questions

1. Is there any significant difference between the gender of mathematics teachers regarding their perception of the use of the 5E instructional model in teaching mathematics?
2. Is there any significant difference between the school type (private or government schools) in the perception of mathematics teachers regarding the use of the 5E instructional model in teaching mathematics?
3. Is there any significant difference between the educational attainment in the perception of mathematics teachers regarding the use of the 5E instructional model in teaching mathematics?
4. Is there any significant difference between the age groups in the perception of mathematics teachers regarding the use of the 5E instructional model in teaching mathematics?
5. Is there any significant difference between the experience level of mathematics teachers on the perception regarding the use of the 5E instructional model in teaching mathematics?

Hypothesis

1. There is no significant difference between the gender of mathematics teachers regarding their perception of using the 5E instructional model of constructivism.
2. There is no significant difference between the school types of mathematics teachers regarding their perception of using the 5E instructional model of constructivism.
3. There is no significant difference between the educational attainment of mathematics teachers regarding their perception of using the 5E instructional model of constructivism.
4. There is no significant difference between the age groups of mathematics teachers regarding their perception of using the 5E instructional model of constructivism.
5. There is no significant difference between the experience level of mathematics teachers regarding their perception of using the 5E instructional model of constructivism.

LITERATURE REVIEW

Constructivism is a learning theory that posits individuals construct knowledge and meaning through their experiences and interactions with the world (Bimbola & Daniel, 2010). According to Anyanwu and Iwuamadi (2015), constructivism involves the active process of integrating prior knowledge with new information to create new understandings. Semerci and Batdi (2015) further define constructivism as a process where learners acquire knowledge based on their perceptions, emphasizing the active role of students in constructing their own understanding. In a constructivist classroom, learners are not passive recipients of information but active participants who engage with concepts through social and individual experiences, with teachers acting as facilitators (Do et al., 2023; Mvududu & Thiel-Burgess, 2012). This approach aligns with the view that learning is most effective when students are actively involved in constructing their own knowledge rather than passively receiving information (Efgivia et al., 2021).

Constructivism has been widely recognized as a transformative approach in education, particularly in science and mathematics, given its emphasis on active knowledge construction by learners rather than passive reception of information (Alt, 2012; Do et al., 2023). This learner-centered paradigm, which posits that individuals generate knowledge through unique experiences and social interactions (Efgivia et al., 2021), fundamentally shifts education toward fostering critical thinking and problem-solving abilities. The 5E instructional model serves as a powerful framework for operationalizing this transformative potential through its five phases: engage, explore, explain, elaborate, and evaluate. In the engage phase, cognitive dissonance is created by challenging prior assumptions, mirroring Mezirow's (2000) concept of "disorienting dilemmas" in transformative learning. The explore and explain phases encourage perspective-taking through collaborative discourse, aligning with Vygotsky's social constructivism (Jůvová et al., 2015), while the elaborate and evaluate phases promote metacognition and self-assessment (Kyle & King, 2002), enabling learners to reconstruct their understanding iteratively. Empirical studies demonstrate this transformative impact, with Yonwilad et al. (2022) showing how the 5E model enhances problem-solving abilities through active exploration, and Omotayo and Adeleke (2017) linking it to increased student agency. Particularly in contexts like Nigeria, where traditional didactic methods dominate (Sa'ad et al., 2014), the 5E model's transformative value lies in its ability to center student inquiry and challenge passive learning approaches, thereby promoting more equitable and meaningful mathematics education (Adesoji & Yara, 2008).

In mathematics education, constructivism provides a robust framework for understanding how students learn mathematical concepts and for designing instructional strategies that promote active learning and conceptual understanding (Simon, 1995). Constructivist approaches in mathematics emphasize the importance of students exploring mathematical ideas, making connections between concepts, and constructing their own understanding of mathematical principles (Efgivia et al., 2021). This contrasts with traditional methods, where students often passively receive information without engaging deeply with the material.

Research has demonstrated the effectiveness of constructivist approaches in improving student outcomes in mathematics. For example, Bimbola and Daniel (2010) found that students taught using constructivist methods outperformed those taught through conventional lectures, with significantly higher retention rates of concepts. Similarly, Peter et al. (2010) demonstrated that constructivist instructional approaches enhanced students' ability to handle complex tasks in technical education, highlighting the practical benefits of active learning. These findings underscore the potential of constructivism to transform mathematics education by fostering deeper engagement and understanding.

However, the implementation of constructivist approaches in mathematics education faces challenges, particularly in contexts where traditional teaching methods are deeply entrenched. Teachers often struggle to transition from teacher-centered to student-centered practices, highlighting the need for professional development and supportive instructional models like the 5E framework.

The 5E instructional model comprising engagement, exploration, explanation, elaboration, and evaluation–is a widely recognized framework for implementing constructivist principles in the classroom (Hu et al., 2017). Each phase of the model is designed to promote active learning and deeper understanding. The engagement phase activates prior knowledge and stimulates curiosity, setting the stage for learning (Gu, 2023). The exploration phase allows students to investigate concepts through hands-on activities, fostering inquiry and discovery. During the explanation phase, teachers introduce formal concepts and terminology, helping students articulate their understanding. The elaboration phase encourages students to apply their knowledge in new contexts, promoting transfer of learning. Finally, the evaluation phase assesses students' understanding and skills, ensuring that learning objectives are met (Martín & Bybee, 2022).

The 5E model aligns closely with constructivist learning theory, emphasizing the active role of students in constructing knowledge. Research has shown that the 5E model enhances teaching practices and student outcomes. For instance, Hu et al. (2017) found that novice teachers who adopted the 5E model demonstrated significant improvements in their instructional design and classroom practices. Similarly, Bahtaji (2021) highlighted the model's effectiveness in promoting conceptual understanding in physics, particularly when compared to traditional teaching methods.

The application of the 5E instructional model in mathematics education has shown promising results in enhancing student engagement, understanding, and achievement. Omotayo and Adeleke (2017) conducted a quasi-experimental study to compare the effectiveness of the 5E model with traditional instruction in mathematics. Their findings revealed that students taught using the 5E model demonstrated significantly higher performance, improved mathematical abilities, and greater interest in the subject. The study attributed these outcomes to the active participation and inquiry-based learning fostered by the 5E model.

Similarly, Bahtaji (2021) investigated the impact of the 5E model on students' conceptual understanding of physics, noting its effectiveness in promoting deeper learning. While the study focused on science education, its findings are highly relevant to mathematics, as both disciplines require conceptual understanding and problem-solving skills. The 5E model's emphasis on exploration and elaboration aligns with the constructivist approach to mathematics education, where students are encouraged to explore mathematical ideas and apply them in diverse contexts.

Despite its potential, the adoption of the 5E model in mathematics education faces challenges, particularly in contexts where traditional teaching methods dominate. Teachers often require training and support to effectively implement the model, highlighting the need for professional development programs. Additionally, the model's success depends on the availability of resources and a supportive learning environment, which may not always be present in under-resourced settings.

RESEARCH METHODOLOGY

This chapter outlines the research design, methods, and procedures employed in this study. It begins by describing the research design and approach, followed by details on the population and sample, data collection methods, validation and reliability of instruments, data analysis procedures, and ethical considerations. The study aimed to investigate Nigerian mathematics teachers' beliefs and practices regarding the use of the 5E instructional model of constructivism in teaching mathematics, as well as the influence of variables such as gender, school type, educational attainment, age, and teaching experience level.

Research Design and Approach

The research design refers to the strategic plan and methodology used to address the research questions (Creswell, 2003). As Omari (2011) emphasizes, it provides a structured framework for investigating research problems. This study adopted a cross-sectional quantitative survey design to explore the beliefs and practices of Nigerian mathematics teachers regarding the 5E instructional model. A cross-sectional design was chosen because it allows for the simultaneous examination of multiple categories of participants, making it suitable for capturing diverse perspectives within a specific timeframe (Cohen et al., 2005). Additionally, cross-sectional studies are particularly effective for online data collection, as they facilitate participation from geographically dispersed respondents (Cohen et al., 2011).

An online survey was conducted using Google Forms to collect quantitative data. The survey instrument was designed using a 5-point Likert scale, with responses ranging from "strongly agree" (5) to "strongly disagree" (1). Online surveys were selected for their efficiency in reaching a large sample size within a short period and their accessibility across multiple devices and locations. This approach aligns with the study's objective of gathering data from a geographically diverse population of mathematics teachers in Nigeria.

Population and Sample

The target population for this study consisted of mathematics teachers in primary and secondary schools across both private and government schools in Nigeria. The study aimed to explore teachers' perceptions of the 5E instructional model and examine the influence of variables such as gender, school type, educational attainment, age, and experience level on its implementation. A total of 94 mathematics teachers participated in the study, representing a diverse sample from both private and government educational institutions. This sample size was deemed adequate for a quantitative survey, ensuring sufficient data for statistical analysis while maintaining feasibility.

Validation and Reliability of the Study Instruments

To ensure the validity and reliability of the survey instrument, a pilot study was conducted prior to full-scale data collection. The questionnaire was reviewed by subject matter experts and professors from the college of education at UAE University, who provided feedback to refine the instrument. Additionally, the reliability of the data was assessed using IBM SPSS statistics (version 23). The Cronbach's (1951) alpha test was employed to measure the internal consistency of the scale, yielding a coefficient of 0.75. This value indicates good internal consistency, confirming that the items on the scale reliably measured the same construct.

Data Analysis Procedure

Data analysis involves systematic organization, coding, categorization, and interpretation of collected data (Kothari, 2004). In this study, quantitative data from closed-ended questions were analyzed using descriptive statistics and nonparametric tests. Descriptive statistics were used to summarize the data, while nonparametric tests were employed to identify patterns, trends, and correlations among variables. This approach allowed for the drawing of inferences and generalizations regarding teachers' perceptions and the factors influencing their use of the 5E instructional model.

Ethical Considerations

Ethical considerations were prioritized throughout the research process. Informed consent was obtained from all participants before they began the survey. Participants were provided with a clear explanation of the study's purpose, the nature of the survey questions, and their right to withdraw at any time without consequences (Omari, 2011). No personal identifying information was collected, and all responses were kept confidential, accessible only to the researcher. These measures were implemented to uphold the integrity of the research and protect participants' rights.

RESULTS

Demographic Profile of Respondents

Table 1 provides an overview of the demographic characteristics of the study participants. The sample consisted of 94 mathematics teachers from both private and government schools in Nigeria. The majority of respondents were male (68.1%), while 31.9% were female. In terms of school type, 71.3% of the participants taught in private schools, and 28.7% taught in government schools. Regarding educational attainment,

Table 1. Distribution of respondents

Demographic		F (N)	P (%)
Gender	Male	64	68.1
	Female	30	31.9
	Sub-total	94	100
School type	Private	67	71.3
	Government	27	28.7
	Sub-total	94	100
Educational attainment	Master's	28	29.8
	Bachelors	56	59.6
	Diploma	10	10.6
	Sub-total	94	100
Experience level	Below 2 years	14	14.9
	2-5 years	28	29.8
	5-7 years	16	17.0
	8-10 years	16	17.0
	10 years above	20	21.3
	Sub-total	94	100
Age group	21-30 years	29	30.9
	31-35 years	30	31.9
	36-40 years	26	27.7
	40-50 years	9	9.6
	Sub-total	94	100

Note. F: Frequency & P: Percentage

29.8% held a master's degree, 59.6% held a bachelor's degree, and 10.6% held a diploma. The age distribution of participants was as follows: 29.8% were aged 21-30 years, 32.3% were aged 31-35 years, 28.1% were aged 36-40 years, and 9.4% were aged 40-50 years. In terms of teaching experience, 14.6% had less than 2 years of experience, 29.2% had 2-5 years, 17.7% had 5-7 years, 16.7% had 8-10 years, and 21.9% had over 10 years of experience. Overall, 56.3% of the respondents had more than 5 years of teaching experience, indicating that the sample comprised predominantly experienced teachers. An overview of the demographic profile of the study sample is presented in **Table 1**. 94 valid responses were recorded and qualified for data analysis.

Table 2 presents the results of the Kolmogorov-Smirnov and Shapiro-Wilk normality tests for the variables related to the 5E instructional model (engage, explore, explain, elaborate, and evaluate). The results indicated that the variables were not normally distributed ($p < 0.05$). Consequently, non-parametric tests (Mann-Whitney U and Kruskal-Wallis tests) were employed for further analysis.

The Kolmogorov-Smirnov and Shapiro-Wilk normality tests for the variables in **Table 2** showed that the 5 variables that were related to the 5E instructional model of constructivism were not normally distributed ($p < 0.05$). Therefore, the remaining tests were carried out using non-parametric tests (the Mann-Whitney U-test and the Kruskal-Walli's test).

Gender of Mathematics Teachers Regarding Their Beliefs and Practices of the Use of the 5E Instructional Model in Teaching Mathematics

Ho1. There is no significant difference between the genders of mathematics teachers regarding the use of the 5E instructional model of constructivism.

Table 3 shows the results of an independent sample Mann-Whitney U-test. The results revealed that the gender of mathematics teachers is highly significant in the use of the 5E model of constructivism in teaching mathematics. Engage, was statistically significant ($p = 0.005 < 0.05$), explore, was statistically significant (female: mean rank = 52.20, n = 30; male: mean rank = 37.47, n = 64; $p = 0.012 < 0.05$), explain, was statistically

Table 2. Test for normality of normality for the variables related to the 5 E instructional model engage, explore, explain, and elaborate

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Significance	Statistic	df	Significance
Engage	.248	94	.000	.858	94	.000
Explore	.238	94	.000	.871	94	.000
Explain	.325	94	.000	.824	94	.000
Elaborate	.172	94	.000	.924	94	.000
Evaluate	.386	94	.000	.746	94	.000

Note. [a]Lilliefors significance correction

Table 3. Independent samples Mann-Whitney U test summary (gender)

Statistics	Engage	Explore	Explain	Elaborate	Evaluate
Total N	94	94	94	94	94
Mann-Whitney U	623.500	659.000	669.500	766.000	639.000
Wilcoxon W	1,088.500	1,124.000	1,134.500	1,231.000	1,104.000
Mean rank (female, N = 30)	52.76	52.20	52.04	50.53	52.52
Mean rank (male, N = 64)	36.28	37.47	37.82	41.03	36.80
Text statistic	623.500	659.000	669.500	766.000	639.000
Standard error	119.850	120.036	115.125	121.426	108.467
Standard test statistics	-2.808	-2.508	-2.523	-1.598	-2.959
Asymptotic significance (2-sided test)	.005	.012	.012	.110	.003

Table 4. Independent samples Mann-Whitney U test summary (school type)

Statistics	Engage	Explore	Explain	Elaborate	Evaluate
Total N	94	94	94	94	94
Mann-Whitney U	730.000	455.000	1,057.500	446.500	1,063.500
Wilcoxon W	1,108.000	833.000	1,435.500	824.500	1,441.500
Mean rank (female, N = 30)	50.10	54.21	45.22	54.34	45.13
Mean rank (male, N = 64)	41.04	30.85	53.17	30.54	53.39
Text statistic	730.000	455.000	1057.500	446.500	1,063.500
Standard error	116.334	116.514	111.747	117.864	105.285
Standard test statistics	-1.500	-3.858	1.369	-3.886	1.510
Asymptotic significance (2-sided test)	.134	.000	.171	.000	.131

Table 5. Independent samples Kruskal-Wallis test summary (educational attainment)

Statistics	Engage	Explore	Explain	Elaborate	Evaluate
Total N	94	94	94	94	94
Text statistic	21.031	12.539	9.933	3.930	12.198
df	2	2	2	2	2
Asymptotic significance (2-tail)	.000	0.002	0.007	.140	.002
Multiple comparisons	(1) D-B	1) D-B	1) D-B	NA	1) D-B
	(2) D-M	(2) D-M	(2) D-M	NA	(2) D-M

Note. D: Diploma; M: Master's & B: Bachelor's

significant (female: mean rank = 52.04, n = 30; male: mean rank = 37.82, n = 64; p = 0.012 < 0.05), elaborate, was found to have no statistically significant (female: mean rank = 50.53, n = 30; male: mean rank = 41.03, n = 64; p = 0.110 > 0.05), evaluate (female: mean rank = 52.52, n = 30; male: mean rank = 36.80, n = 64; p = 0.03 < 0.05). There was a significant difference based on the gender of mathematics teachers regarding the use of engagement, explore, explain, and evaluate. Hence, the null hypothesis was rejected.

School Type of Mathematics Teachers' Beliefs and Practices Regarding the Use of the 5E Instructional Model of Constructivism

Ho2. There is no significant difference between the school types the mathematics teachers teach regarding the use of the 5E instructional model of constructivism.

Table 4 shows no statistical significance between private school and government schoolteachers on the views on using the 5E model of constructivism, engage (p = 0.134 > 0.05), explore (private school: mean rank = 54.21, n = 67; government school: mean rank = 30.85, n = 27; p = 0.000 < 0.05), explain (private school: mean rank = 45.22, n = 67; government school: mean rank = 53.17, n = 27; p = 0.171 > 0.05), elaborate (private school: mean rank = 54.34, n = 67; government school: mean rank = 30.54, n = 27; p = 0.000 < 0.05), evaluate (private school: mean rank = 45.13, n = 67; government school: mean rank = 53.39, n = 27; p = 0.131 > 0.05).

There was no significant difference based on the school type of mathematics teacher regarding their use of engagement, explain, and evaluate. Hence, the null hypothesis was upheld.

Educational Attainment of Mathematics Teachers' Beliefs and Practices Regarding the Use of the 5E Instructional Model of Constructivism

Ho3. There is no significant difference between the educational attainment of mathematics teachers regarding the use of the 5E instructional model of constructivism.

The independent-samples Kruskal-Wallis test in Table 5 showed statistical significance in the educational attainment of Nigerian mathematics teachers on the use of the 5E model of constructivism, engage (p = 0.000 < 0.05), explore (p = 0.002 < 0.05), explain (p = 0.007 < 0.05), elaborate (p = 0.140 > 0.05), evaluate (p = 0.002 < 0.05). There was a significant difference based on the educational attainment of mathematics teachers regarding their use of engagement, explore, explain, and evaluate. Hence, the null hypothesis was not upheld.

Age Groups of Mathematics Teachers Regarding Their Beliefs and Practices Regarding the Use of the 5E Instructional Model of Constructivism

Ho4. There is no significant difference between the age groups of mathematics teachers regarding the use of the 5E instructional model of constructivism.

The independent-samples Kruskal-Wallis test in Table 6 shows statistical significance between the age groups of mathematics teachers on their view of using the 5E model of constructivism, engage (p = 0.031 < 0.05), explore (p = 0.346 > 0.05). explain (p = 0.024 < 0.05), elaborate (p = 0.026 < 0.05), and evaluate (p = 0.006 < 0.05). There was a significant difference based on the age groups of mathematics teachers regarding their use of engagement, explain, elaborate, and evaluate. Hence, the null hypothesis was rejected.

Table 6. Independent samples Kruskal-Wallis test summary (age group)

Statistics	Engage	Explore	Explain	Elaborate	Evaluate
Total N	94	94	94	94	94
Text statistic	8.895	3.309	9.480	9.295	12.373
df	3	3	3	3	3
Asymptotic significance (2-tail)	.031	.346	0.024	.026	.006
Multiple comparisons	(1) 21-30 years-36-40 years	NA	(1) 21-30 years-36-40 years	(1) 31-35 years-40-50 years	(1) 21-30 years-36-40 years

Table 7. Independent samples Kruskal-Wallis test summary (experience level)

Statistics	Engage	Explore	Explain	Elaborate	Evaluate
Total N	94	94	94	94	94
Text statistic	13.145	10.398	12.970	12.894	18.944
df	4	4	4	4	4
Asymptotic significance (2-tail)	.011	.034	0.11	.012	.001
Multiple comparisons	(1) Below 2 years-8 to10 years	(1) Below 2 years-2 to 5 years	(1) Below 2 years-5 to 7 years	(1) Below 2 years-2 to 5 years	(1) Below 2 years-5 to 7 years
	(2) Below 2 years-Above 10 years		(2) Below 2 years-8 to 10 years		(2) Below 2 years-8 to 10 years
			(3) Below 2 years-Above 10 years		(3) Below 2 years-Above 10 years

Experience Level of Mathematics Teachers Regarding Their Beliefs and Practices of the Use of the 5E Instructional Model in Teaching Mathematics

Ho5. There is no significant difference between the level of experience of mathematics teachers regarding the use of the 5E instructional model of constructivism.

A significant difference is noted in the independent-sample Kruskal-Wallis test in Table 7 for the experience level of Nigerian mathematics teachers' views on using the 5E model of constructivism, engage ($p = 0.011 < 0.05$, explore ($p = 0.034 < 0.05$), explain ($p = 0.11 > 0.05$), elaborate ($p = 0.012 < 0.05$), evaluate ($p = 0.001 < 0.05$). There was a significant difference based on the experience level of mathematics teachers regarding their use of engagement, explore, elaborate, and evaluate. Hence, the null hypothesis was rejected.

DISCUSSION

This study examined Nigerian mathematics teachers' beliefs and practices regarding the 5E instructional model. The results reveal significant insights about gender differences, school type variations, and the impact of educational qualifications, age, and teaching experience on constructivist teaching practices.

Gender is one of the important components that affect teachers' views of teaching mathematics (Abdullah et al., 2017; Maulana et al., 2015). The results showed that male and female mathematics teachers had mixed perceptions of the use of the 5E instructional model of the constructivist approach. Our findings indicate that while both male and female teachers effectively implemented the engagement ($p = 0.005$), exploration ($p = 0.012$), explanation ($p = 0.012$), and evaluation ($p = 0.003$) phases of the 5E model, However, the results showed that there was no significant predictor in the way male and female teachers elaborated while teaching mathematics in class. This partial alignment with Smail's (2017) findings suggests that while genders may share similar philosophical approaches to mathematics instruction, implementation nuances may exist in specific pedagogical components. On the other hand, the results contrast with Alghazo's (2005) and Driessen's (2007) assertions about gender-based evaluation differences, suggesting that contemporary mathematics teaching practices may be evolving toward greater gender parity in assessment approaches. The evolution may be connected to teacher education programs emphasizing standardized assessment literacy (Martín & Bybee, 2022).

Contrary to expectations, the analysis revealed no statistically significant differences between the school type (private and government) of schoolteachers' implementation of the 5E model (engage: $p = 0.134$; explain: $p = 0.171$; evaluate: $p = 0.131$). This finding suggests that the institutional sector may be less influential than individual teacher characteristics in adopting constructivist approaches. The result aligns with recent work by Santi and Atun (2021), who found that teacher beliefs and training outweigh school-type factors in pedagogical innovation adoption.

Furthermore, the result found that the educational attainment level of mathematics teachers has significant differences in their views regarding the use of the 5E instructional model of constructivism. The study identified significant differences based on educational qualifications (engage: p = 0.000; explore: p = 0.002; explain: p = 0.007; evaluate: p = 0.002), reinforcing Adeniji's (1999) and Abe's (2014) findings about qualification-based teaching effectiveness. Particularly noteworthy was the marked performance gap between diploma-holding teachers and those with bachelor's or master's degrees. This disparity may reflect the deeper pedagogical content knowledge acquired in advanced degree programs (Efgivia et al., 2021), highlighting the need for ongoing teacher education initiatives.

The results showed that the age groups of mathematics teachers had significant differences in their use of the 5E instructional model of the constructivist approach. The findings showed that teachers across different age groups engaged the students while teaching mathematics. The findings also showed that mathematics teachers across different age groups allow their students to explain, elaborate, and evaluate when teaching them. The analysis revealed significant age-related differences in 5E implementation, particularly between early-career (21-30 years) and mid-career (36-40 years) teachers. These findings complement Suliman et al.'s (2019) work on experience-mediated teaching practices, suggesting that both age and professional level of experience influence constructivist adoption.

Teaching experience levels emerged as particularly impactful, with highly experienced teachers (> 10 years) demonstrating significantly more effective implementation across all 5E phases (engage: p = 0.011; Elaborate: p = 0.012; evaluate: p = 0.001). The findings align with the broader consensus that teacher experience positively contributes to student learning (Ost, 2014), particularly when distinguishing novice from experienced practitioners. Here, experienced teachers were defined as those with at least 4 years of classroom experience (Hatton, 2004). The results showed that teachers across different experience levels engaged the students while teaching mathematics. The findings also showed that mathematics teachers across different experience levels allow their students to explore, elaborate, and evaluate when teaching them. A significant difference was also noted in how mathematics teachers with an experience level < 2 years and teachers with an experience level of 8 to 10 years and above 10 years on how they engage the students. Differences were also noted in the perception of mathematics teachers with an experience level below 2 years and teachers with experience levels of 2 to 5 years, 5 to 7 years, 8 to 10 years, and above 10 years in the way they explore, explain, elaborate, and evaluate their students. These patterns resonate with Abbas and Nilofar's (2012) and Suliman et al.'s (2019) findings that experienced teachers leverage pedagogical expertise to create more dynamic learning environments. The progression mirrors the constructivist trajectory described by Szabó and Csépes (2022), wherein efficacy grows through reflective, student-centered adaptation–a process arguably requiring the sustained classroom immersion that Hatton (2004) advocates for in teacher professional development.

Recommendations

Based on the study's findings, three key recommendations emerge for improving the implementation of the 5E instructional model in Nigerian mathematics education. First, comprehensive professional development programs should be established to enhance teachers' understanding and application of constructivist pedagogy, with particular attention to addressing implementation challenges identified in the elaboration phase. These programs should be differentiated to meet the needs of teachers at various career stages and qualification levels. Second, educational policymakers should develop guidelines and support mechanisms to institutionalize the 5E model within the national mathematics curriculum, including the provision of appropriate instructional materials and classroom resources. Third, school administrators should implement mentoring systems that pair experienced teachers skilled in constructivist methods with their less experienced colleagues to facilitate practical knowledge transfer. These interventions should be accompanied by ongoing monitoring and evaluation to ensure fidelity of implementation and to identify emerging best practices.

Limitations

The study only focuses on a small number of mathematics teachers in Nigeria, so the findings may not be generalizable to all mathematics teachers in Nigeria, and the context of the study is only limited to Nigeria. In addition, the study relies on the self-reported data of mathematics teachers. Furthermore, the study examined only five demographic variables (gender, school type, educational attainment, age, and experience) there may be other overlooking influential factors such as class size, resource availability, or school leadership support that were not considered. Lastly, the study does not examine the impact of the use of the 5E instructional model on student learning outcomes, which could provide valuable insights into its effectiveness.

CONCLUSION

This study provides valuable insights into Nigerian mathematics teachers' beliefs and practices regarding the use of the 5E instructional model, revealing both opportunities and challenges for implementing constructivist approaches. The findings demonstrate that while teachers generally embrace the engagement, exploration, explanation, and evaluation phases of the model, implementation varies significantly based on teacher characteristics such as gender, qualifications, age, and experience. The absence of differences between private and government schoolteachers suggests the model's potential applicability across institutional contexts. These results contribute to ongoing discussions about pedagogical reform in mathematics education, particularly in developing nation contexts where traditional teaching methods remain predominant. The study highlights the need for systemic support structures to facilitate the effective adoption of constructivist approaches while identifying specific areas requiring targeted intervention. Future research should build on these findings by examining actual classroom implementation and investigating the relationship between 5E model use and student achievement outcomes, thereby providing a more comprehensive understanding of constructivist pedagogy's effectiveness in Nigerian mathematics education.

Funding: No funding source is reported for this study.

Acknowledgments: The author would like to thank postgraduate students and Dr. Shashidhar Belbase for their valuable contributions to this research. The author would also like to thank the participating mathematics teachers in Nigeria who generously shared their time and insights.

Ethical statement: The author stated that the study was conducted in accordance with UAE University's research ethics guidelines. The authors further stated that the research aligns with standard ethical protocols for educational studies in Nigeria, where formal ethics approval is not mandated for non-invasive, survey-based research involving educators. Written informed consents were obtained from the participants.

AI statement: The authors acknowledge the use of an AI-based tool (Grammarly) to enhance a manuscript's clarity, language, and readability. Grammarly was employed for proofreading, grammar checks, and refining sentence structures. However, all conceptual development, critical analysis, interpretation of results, and scholarly arguments remain the original contributions of the authors. The authors take full responsibility for the content, accuracy, and integrity of this work.

Declaration of interest: No conflict of interest is declared by the author.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the author.

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