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Effects of Station Rotation Model on Students' Academic Performance in Algebraic Expressions among Senior Secondary Schools in Kebbi State, Nigeria

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Abstract

This study investigated the effect of Station Rotation Model on senior secondary school students' academic performance in algebraic expressions in Kebbi State, Nigeria. A quasi-experimental pre-test and post-test non-randomized research group design was adopted. The sample of 134 students selected from two public secondary schools through purposive sampling using intact classes assigned to experimental (66 students) and control (68 students) groups. The experimental group was taught using the Station Rotation Model, while the control group received instruction through the demonstration teaching method. Data were collected using the Student Algebraic Expression Performance Test (SAEPT), a 25-item multiple-choice instrument validated by experts, with a reliability coefficient of 0.80. Descriptive statistics (mean and standard deviation) and inferential statistics (independent and paired sample t-tests) were used for data analysis at a 0.05 level of significance. The findings revealed that students taught using the Station Rotation Model performed significantly better than those taught using the demonstration method. Furthermore, a significant difference was observed in the performance of male and female students in the experimental group, with male students outperforming their female counterparts. The study concluded that the Station Rotation Model enhances students' understanding, engagement, and academic performance in algebraic expressions. It was therefore recommended that mathematics teachers adopt the Station Rotation Model in classroom instruction and that educational stakeholders provide adequate training and resources to support its effective implementation.

Keywords*:* Academic Performance, Algebraic Expressions, Station Rotation Model

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Introduction

Algebraic expressions is a fundamental part of mathematics that involve the use of letters, numbers, and mathematical operations (such as addition, subtraction, multiplication, and division) to represent relationships and solve problems. They are used to describe patterns, model, real-life situations, and make generalizations using symbols. As a key component of algebra, algebraic expressions play an essential role in helping students to develop mathematical reasoning and problem-solving skills. Algebra as a whole is a cornerstone of modern mathematics and global development of its applications in science, technology, engineering, and mathematical disciplines (Kathuria, 2024). Algebraic forms the basis for logical reasoning and critical thinking, which are crucial for innovation and advancement in today's world (Babu, Nagaraju & Johnson, 2023) Beyond the classroom, algebra is applied in various fields such as computer programming, financial modeling, data analysis, and engineering design. Therefore, mastery of algebra, particularly algebraic expressions, is vital for students' academic performance Kebbi State, as it prepares them for more advanced mathematical topics like calculus, statistics, and linear algebra, by improving their ability to represent and solve complex problems symbolically.

Furthermore, algebraic expressions play a vital role in mathematics education by helping students develop the ability to generalize patterns, manipulate symbols, and solve real-world problems (Root, 2016). These expressions act as a bridge between basic arithmetic and more advanced mathematical concepts, supporting the development of abstract reasoning and logical thinking skills that are important not only in academic settings but also in daily decision-making (Alam & Mohanty, 2024). Building a strong foundation in algebraic expressions is especially important for success in secondary school mathematics and serves as a stepping stone to advanced studies and careers in Science, Technology, Engineering, and Mathematics (STEM) fields (Musi, 2022).

Regardless of its importance, teaching and learning algebraic expressions continue to present significant challenges. One major difficulty is the abstract nature of algebra, which often makes it hard for students to move from concrete arithmetic operations to symbolic representations (Alzubaidi & Abdah, 2025). Many students struggle to understand how variables function,

how to structure expressions, and how to apply algebraic rules to solve equations (Ferretti et.al., 2020). This shift in thinking requires a high level of cognitive flexibility, which some students find it difficult to achieve. Moreover, teachers also face difficulties in effectively teaching these abstract concepts, particularly in environments where instructional resources and training in student-centered strategies are lacking (Ray, 2024). These difficulties contribute to persistent underachievement performance in algebra among students, affecting their overall academic performance in both secondary and higher education, where algebra remains a foundational subject.

Additionally, in Kebbi State**,** this challenge is particularly pronounced. Students in these areas often show limited understanding of basic algebraic concepts (Jega & Bashir, 2018). The concept involves the use of variables, the formation of algebraic expressions, and the application of algebraic operations to solve mathematical problems effectively (Juraev & Bozorov, 2024).To further respond to persistent difficulties in learning algebra, education stakeholders are increasingly exploring more effective and innovative instructional approaches tailored to meet students' diverse learning needs (Hott et.al., 2019).

Moreover, the integration of basic digital tools within a station rotation setup in Nigerian classrooms such as a dedicated technology station with preloaded educational videos or mobile apps could create a more dynamic and interactive learning environment compared to static, whole-class textbook instruction (Jayaraman & Aane, 2024). However, as noted by Oshowole (2024), the adoption of models like station rotation remains limited due to systemic challenges such as inadequate infrastructure, insufficient teacher training in managing rotational pedagogies, unsteady electricity supply, and poor internet connectivity, especially in rural communities like parts of Kebbi State. These constraints significantly hinder the full-scale implementation of technology integrated rotational models in Nigerian classrooms (Algarni, 2021).

The Station Rotation Model (SRM) is an instruction strategy in which students move through different learning stations on fixed schedule or at the teacher’s discretion (Ogude & Chukweggu, 2019). Each station is designed to provide unique learning experience such as individual work, collaborative activities, and digital learning tasks allowing students to engage with content in multiple ways. (Belize & Ganapathy, 2021). Typically, these stations include teacher-

led instruction, collaborative or group work, and independent or online learning, allowing for a combination of direct teaching, peer interaction, and self-paced digital practice (Belazi & Ganapathy, 2021). The SRM supports differentiated instruction by enabling teachers to tailor activities and materials to meet diverse learner needs while maximizing classroom time efficiency (Puri & Puri, 2025). It also promotes student engagement and autonomy, as learners take responsibility for their progress through various learning modalities. This model is particularly effective in classrooms integrating technology, as it blends traditional face-to-face instruction with digital tools to enhance personalized learning experiences. According to Yılmaz and Açıkgul (2024), Station Rotation Model provides a structured yet flexible framework that encourages active learning and helps bridge the gap between traditional and online education.

The station rotation model offers significant advantages by structuring learning into targeted stations, which can include teacher-led instruction, collaborative problem-solving, and independent digital practice (Ojaleye, 2016). This model leverages multimedia content, simulations, and video tutorials at dedicated stations to clarify abstract algebraic concepts, such as variables, expressions, and equations. It systematically sustains essential teacher-led discourse while simultaneously allowing learners to engage with algebraic content at their own pace, revisit challenging concepts at practice stations, and access differentiated resources based on their proficiency levels. By designing stations that support multiple learning styles (visual, auditory, and kinesthetic). The station rotation model promotes deeper conceptual understanding and fosters learner autonomy. Ultimately, its structured yet adaptable framework makes it an effective strategy for addressing common obstacles in algebra instruction, potentially improving students' comprehension, retention, and academic achievement (Egara & Mosimege, 2024).

Theoretical Foundations

The theoretical foundation encompasses the theories underpinning this study which includes: Vygotsky's Social Constructivist Theory and Cognitive Theory of Multimedia Learning. Figure 1: illustrates the theoretical framework of the study.

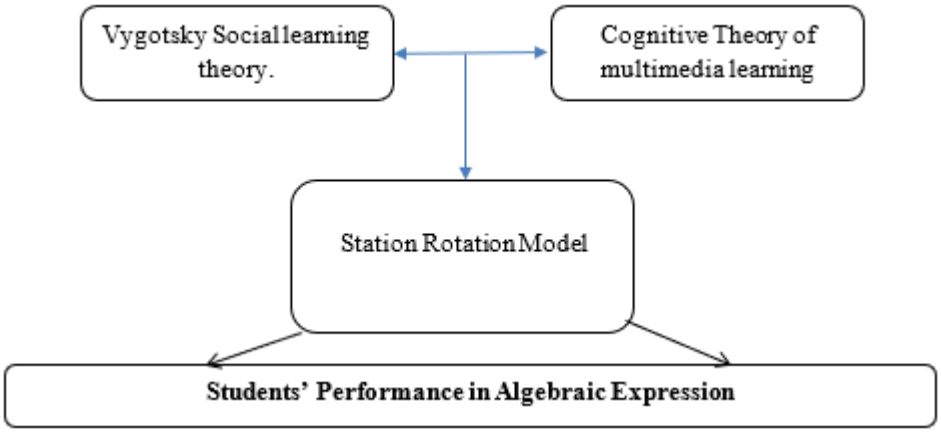

Figure 1: Theoretical Framework

The figure presents the theoretical framework of the study, showing that the Station Rotation Model is grounded in two major theories: Vygotsky's Social Learning Theory and the Cognitive Theory of Multimedia Learning. The framework implies that students learn more effectively when they interact with one another, receives guidance, and engage with learning materials in different formats. These theories support the use of the Station Rotation Model because the model allows students to move through different learning stations, interact with peers, and learn various instructional activities and improves students' performance in algebraic expression.

The station rotation model, as a key of blended learning approach, can be particularly effective for teaching algebraic expressions. In this model, students rotate through multiple learning stations designed to address specific performance indicators. For example, at the teacher-led station, students receive targeted instruction and guided practice on simplifying expressions; at the online learning station, they engage with adaptive digital tools that provide instant feedback and differentiated tasks; and at the collaborative station, they work in small groups to apply algebraic reasoning to real-world or project-based problems (Horn & Staker, 2014). This structure allows for continuous assessment of performance, catering to diverse learning needs while promoting autonomy and engagement.

Despite the growing recognition of the station rotation model and the many educational benefits associated with it, there are still limited empirical studies that specifically examine its effect on students' mastery of algebraic content.

This gap in the literature highlights the need for further inquiry into how this structured rotational approach influences learners' understanding and performance in algebra. Performance in learning algebraic expressions is best evaluated through students' performance to demonstrate mastery in understanding, applying, and manipulating symbols and variables to represent and solve mathematical problems (Musi, 2022). Within a performance-based framework, learners are assessed not only by their ability to recall procedures but also by how effectively they can apply algebraic concepts in novel contexts. In senior secondary education, this competence forms the foundation for advanced mathematical reasoning in topics such as equations, functions, and calculus (Braimah, 2020). To enhance performance outcomes, integrating blended learning, which combines face-to-face instruction with digital and interactive components, provides a flexible, student-centered environment that supports conceptual understanding and skill application (Graham et.al., 2019).

To address these persistent challenges and close the widening gaps in academic performance in algebraic expressions, there is an urgent need to explore alternative instructional strategies such as Station Rotation Model, which combines traditional face-to-face instruction with computer-based learning. In light of this, the present study aims to investigate the Effect of the Station Rotation Model on Students' Performance in Algebraic Expressions among Senior Secondary schools in Kebbi State, Nigeria.

Statement of the Problem

Algebraic expressions form a foundational pillar of secondary school mathematics, essential for advanced STEM learning and problem-solving in daily life. However, a widespread challenge in Nigerian education is students' underperformance in algebraic expressions. Students often perceive algebra as an abstract, and difficult topic leading to low achievement scores and negative attitudes that hinder their academic progression. Research attributes this hinderance to prevalent, traditional teacher-centered pedagogies dominated by rote memorization, which fail to make algebraic concepts concrete or engaging for learners. Consequently, students in Kebbi State classrooms are often passive recipients of information, lacking the active, meaningful learning experiences necessary to master abstract topics in mathematics (Abdurrahman & Sani, 2020).

While blended learning models like the Station Rotation Model (SRM) have been shown internationally and in some Nigerian contexts to improve

engagement by promoting active, differentiated, and student-centered learning, there is a critical gap in localized research. Specifically, there is a lack of empirical studies investigating the effect of the Station Rotation Model on the academic performance of senior secondary school students in algebraic expressions within the unique educational landscape of Kebbi State. Therefore, this study seeks to address this gap by investigating the effect of the Station Rotation Model on the performance of senior secondary school students in algebraic expressions in Kebbi State, Nigeria. Without such targeted intervention-based research, the cycle of low achievement in algebra is likely to persist, limiting the academic and future opportunities for students in the state.

Objectives of the Study

The objective of the study is to investigate the effect of Station Rotation Model on Students academic Performance in algebraic expression among Senior Secondary School Students in Kebbi State, Nigeria, and the specific objectives are to:

I. Determine the difference between academic performance scores of senior secondary school students taught algebraic expression using the Station Rotation Model and those taught using a conventional method in Kebbi State, Nigeria.

II. Compare the difference between the academic performance scores of male and female senior secondary school students taught algebraic expressions using the Station Rotation Model in Kebbi State, Nigeria.

Research Questions

The research questions were stated as follows:

I. What is the difference between the academic performance scores of senior secondary school students taught algebraic expression using the Station Rotation Model and those taught using a conventional method in Kebbi State, Nigeria?

II. What is the difference between the performance scores of male and female senior secondary school students taught algebraic expressions using the Station Rotation Model in Kebbi State, Nigeria?

Null Hypotheses

In line with the research questions raised, the following null hypotheses were tested at 0.05 level of significance

H_{01}: There is no significant difference between the academic performance scores of senior secondary school students taught algebraic expression using the Station Rotation Model and those taught using a conventional method in Kebbi State, Nigeria.

H_{02}: There is no significant difference between the academic Performance scores of male and female senior secondary school students taught Algebraic Expressions using the Station Rotation Model in Kebbi State, Nigeria.

Methodology

The study used a quasi-experimental pre-test and post-test control group design. Two groups were involved: an experimental group taught algebraic expressions using the Station Rotation Model, and a control group taught with the conventional method. The study involved Senior Secondary School II (SS II) students in Kebbi State, Nigeria, with a population of 26,625 students from 215 public senior secondary schools.

A sample of 134 students was purposively selected from two public secondary schools that possessed adequate ICT facilities. The participants were divided into an experimental group (66 students), taught using the Station Rotation Model, and a control group (68 students), taught using the conventional teaching method. Two instruments were employed for data collection: the Senior Secondary School Students' Algebraic Expressions Performance Test (SSSAEPT), consisting of 25 multiple-choice items, and the Senior Secondary School Students' Algebraic Expressions Interest Questionnaire (SSSAEIQ), comprising 20 items on a four-point Likert scale. The instruments were validated by experts in Mathematics Education and Measurement and Evaluation, while reliability coefficients obtained through Cronbach's alpha were 0.80 and 0.85, respectively. A pilot study involving 40 students outside the sample was conducted to refine the instruments. Both groups were given a pretest before the intervention. The experimental group received instruction through the Station Rotation Model, whereas the control group received conventional instruction for six weeks, with two lessons per week. At the end

of the treatment period, a posttest was administered to determine the effect of the intervention. Data collected were analyzed using SPSS version 20. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to answer the research questions, while the hypotheses were tested at 0.05 level of significance using the independent samples t-test.

Results

This section presents the results obtained from the study.

Research Question One: What is the difference between the academic performance scores of senior secondary school students taught Algebraic expression using the Station Rotation Model and those taught using a conventional method in Kebbi State, Nigeria?

In answering this research question, the scores obtained from the two groups were analyzed using mean, standard deviation and mean difference. The scores were categorized based on: Experimental Group (Station Rotation Model) and the Control Group (Conventional Method) using conventional method as presented in Table 1

Table1: Summary of Descriptive Statistics of the Academic Performance Scores of Experimental and Control Groups.

Groups	N	Mean	Standard Deviation	Mean Difference
Experimental Group (SRM)	66	35.79	5.89	
				4.71
Control Group (Conventional)	68	31.07	4.46	

Table 1 Presented the summary of descriptive statistics on the performance of 66 participants in the experimental group with mean score of 35.79 (SD = 5.89) and 68 participants in control group with a mean score of 31.01(SD = 4.46) with the mean different of 4.71. The results revealed that the participants in the experimental group performed better than those in the control group which implies that station rotation model is effective in improving students' Academic performance in algebraic expressions.

Research Question Two: What is the difference between the Performance scores of male and female senior secondary school students taught Algebraic Expressions using the Station Rotation Model in Kebbi State, Nigeria?

In answering this research question, the scores obtained from the two groups in which 34 were male and 32 were female was analyzed using mean, standard deviation and mean difference. The scores of the gender were grouped according to male and female in the experimental group, which employed the Station Rotation Model (See Table 2).

Table 2: Summary of Descriptive Statistics on the Performance Scores of Male and Female Students in the Experimental Group

Group	Gender	N	Mean	Standard Deviation	Mean difference
Experimental Group	Male	34	40.41	3.73	9.53
	Female	32	30.88	3.09	

Table 2 presented the descriptive statistics of performance scores for male and female students in the experimental group. The results showed that male students were 34 with mean scores of 40.41 (SD = 3.73), while female students were 32 with mean scores of 30.88 (SD = 3.09). The mean difference of 9.53 indicates that male students performed better than their female counterparts in algebraic expression after being exposed to the Station Rotation Model. This suggested that the station rotation model had a greater positive effect on the performance of male students compared to female students in the study.

Testing the null Hypotheses

This section presented inferential statistical analysis of all the null hypotheses formulated to guide the study. The null hypotheses were tested at 0.05 level of significance in the performance of student thought Algebraic Expression using Station Rotation Model.

Hypothesis One

There is no significant difference between the Performance scores of senior secondary school students taught Algebraic Expression using the Station Rotation Model and those taught using a conventional method in Kebbi State, Nigeria.

The null hypothesis was tested using independent sample t- test at 0.05 level of significance on SPSS Statistics and the result is presented in Table 3 below

Table 3: Summary of Independent sample T-test for Experimental and Control Group

Group	N	Mean	SD	Df	t-value	p- value	Decision
Experimental	66	35.76	5.89	132	5.236	0.000	Rejected
Control	68	31.07	4.46				

α- value= 0.05

Table 3 showed the result of an independent t-test analysis on performance of students in Algebraic Expression between the experimental group of students exposed to Station Rotation Model and the control group of students exposed to conventional method using conventional method. The experimental group had a mean score of 35.76 with standard deviation of 5.89. While the control group had a mean of score of 31.07 with standard deviation of 4.46. This result indicated that the value of t = 5,236 with degree of freedom (df) = 132 and the value of P=0.000, whoever student Exposed to conventional method.

The results of the analysis revealed that However, since the p-value of 0.000 was less than α- value of 0.05 ($P < \alpha$) level of significance, the null hypothesis 1 is rejected. This implies that Station Rotation Model was significantly more effective on improving academic performance of students in Algebraic Expressions than the conventional method in Kebbi State, Nigeria.

Hypothesis Two

There is no significant difference between the Performance scores of male and female senior secondary school students taught Algebraic Expressions using the station rotation model in Kebbi State, Nigeria. Null hypothesis was tested using independent sample t-test at 0.05 level of significance on SPSS Statistics and the result is presented in Table 4

Table 4: Summary of Independent sample T-Test of Academic Performance Scores of Male and Female Students in the Experimental group.

Group	Gender	N	Mean	SD	Df	t-value	p- value	Decision
Experimental Group	Male	34	40.41	3.73	64	11.283	0.000	Rejected
	Female	32	30.88	3.09				

α- value= 0.05

Table 4 showed the result of an independent sampled t-test analysis conducted to test the significance of the Mean Performance scores of male and female senior secondary school students taught algebraic expressions using the station rotation model**.** The results showed that 34 male students obtained a Mean a

mean score of with 40.41 (SD = 3.73) while 32 female students recorded mean score of 30.88 (SD = 3.09). The results of the analysis revealed that there was statically significance difference between the performances of male and female students in Station Rotation Model in favor of the male students. The result indicated that the value of t=11.283 with degree of freedom (df) = 64 and the value of P=0.00, t(64) = 11.283, P = 0.000. However, since the p-value of 0.000 was less than α- value of 0.05, the null hypothesis 3 is rejected. This implies that this means that there is a statistically significant difference between the performance of male and female senior secondary school students taught algebraic expressions in the experimental group in Kebbi State, Nigeria**.**

Summary of the Major Findings

The following are major findings of this study:

I. The findings revealed that students taught using the Station Rotation Model performed significantly better than those taught using the conventional teaching method.

II. The study found that male students performed better than the female students taught Algebraic Expression using station rotation model.

Discussion

The first finding of the study revealed that students taught Algebraic Expressions using the Station Rotation Model (SRM) performed significantly better than those taught using the conventional method in Kebbi State, Nigeria. This finding is supported by Mondragon and Acelajado (2018), who reported that students taught using the Station Rotation Model achieved higher academic performance and developed more positive attitudes toward mathematics compared to those taught using traditional methods. Similarly, Osuji and Abraham (2024) found that the Station Rotation Model significantly improved students' academic performance in science subjects. In addition, Ayob, Abd Halim, and Zulkifli (2020) reported significant improvement in students' achievement in Chemistry after exposure to the Station Rotation Model, further confirming the effectiveness of the approach.

The superior performance observed in the present study can be explained by Vygotsky's Zone of Proximal Development (ZPD), which emphasizes that learners achieve higher levels of understanding when provided with

appropriate guidance and social interaction. Through the Station Rotation Model, students engaged in collaborative learning, teacher-guided instruction, and technology-supported activities that provided scaffolding within their zone of proximal development. These interactions enabled students to construct mathematical knowledge more effectively and solve Algebraic Expression problems beyond what they could achieve independently.

The effectiveness of the Station Rotation Model can also be interpreted through Mayer's Multimedia Learning Theory. The model activated several multimedia learning principles, including the multimedia principle, whereby students learned better from the combination of words, symbols, visual representations, and digital resources than from verbal explanations alone. The modality principle was also evident as information was presented through both visual and auditory channels, thereby reducing cognitive overload. In addition, the segmenting principle allowed students to learn Algebraic Expressions in smaller and manageable stages through different learning stations, while the interactivity and feedback embedded in technology-enhanced activities promoted active learning and improved understanding.

However, some studies present contrasting findings. Mondragon (2018) reported no clear evidence that the Station Rotation Model significantly improves student engagement and achievement in mathematics. Likewise, a meta-analysis by Ramadan et al. (2025) indicated that while many studies showed positive effects, others reported negative or non-significant differences when compared with conventional teaching methods. These inconsistencies suggest that the effectiveness of the Station Rotation Model may depend on factors such as subject content, implementation strategy, availability of technological resources, and the learning environment.

The second finding of the study revealed that male students performed better than their female counterparts when taught Algebraic Expressions using the Station Rotation Model in Kebbi State, Nigeria. This finding agrees with Ojaleye and Awofala (2018), who reported that gender significantly influenced students' achievement in algebra when exposed to innovative instructional strategies such as the Station Rotation Model and Problem-Based Learning. The observed difference may be attributed to differences in students' confidence levels, engagement patterns, and familiarity with technology-based learning environments, which may influence the extent to

which learners benefit from the scaffolding opportunities provided through the Station Rotation Model.

However, the result contradicts Ogude and Chukweggu (2019), who found no significant difference in the performance of male and female students taught using the Station Rotation Model, although females had slightly higher mean scores. Overall, these inconsistencies suggest that the influence of gender on students' performance under the Station Rotation Model is not definite and may depend on factors such as instructional strategy, classroom environment, and learner characteristics. Further research is therefore needed to better understand how gender interacts with innovative teaching methods to promote equitable learning outcomes.

Conclusion

The study concluded that the Station Rotation Model is more effective than the conventional teaching method in improving students' performance in teaching algebraic expressions. It promotes active participation, engagement, collaboration, and problem-solving among students. Although both male and female students benefited from the model, some differences in their performance levels were observed. Overall, the Station Rotation Model is an effective instructional strategy for teaching algebraic expressions in senior secondary schools in Kebbi State, Nigeria.

Recommendations

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

I. Mathematics teachers in senior secondary schools should adopt the Station Rotation Model in teaching Algebraic Expressions and other mathematics topics

II. Teachers should ensure equal participation opportunities for both male and female students during teaching using the Station Rotation Model. Special attention should be given to female students through encouragement, guided practice, and active engagement strategies to reduce performance gaps in mathematics.

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