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Analysis of Interaction Pattern in the Senior Secondary School Mathematics Classroom in Ogun State

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Abstract

Mathematics is crucial for skill development and societal progress, warranting its inclusion as a mandatory subject in secondary education. Despite this, Nigerian Senior Secondary School (SSS) students' performance in Mathematics has only been slightly above average in National Examination while previous studies have explored the impact of parental, teacher, and student factors on Mathematics achievement, limited attention has been given to Classroom Interaction Patterns (CIP). This study analysed interaction patterns in Mathematics classrooms, using a descriptive research design, sampling 40 teachers and 1,185 senior secondary school II students across four local government areas in Ogun East Senatorial District. Data were collected using the Mathematics Interaction Sheet (r = 0.998) and analysed through descriptive statistics and chi-square tests at 0.05 level of

significant. Findings indicated that teachers' activities focused largely on explanations (20.2%) and solving mathematics problem on the chalkboard (13.1%), with no recorded use of instructional materials. For students, chorus responses (10.9%) and note-taking (10.7%) were common, while disruptive behaviour like fighting were absent. A significant difference was found in teacher-initiated (cal. 317.69 > tab. 23.685) and student-initiated activities (cal. 965.11 > tab. 19.675) between public and private schools. The study recommended that mathematics teachers need to diversify their instructional methods beyond explanations and chalkboard problem-solving.

Keywords: Interaction Pattern, Mathematics, Teachers-initiated Activities, Students-initiated activities, School Type

Introduction

Mathematics is an intrinsic part of human existence, it is essential for studying sciences, humanities, and technology. It originated from historical problem-solving by scientists and mathematicians (Kolawole & Oluwatayo, 2015). Scholars like Oyedeji (2000) and Ifamuyiwa (2019) have defined Mathematics in various ways, highlighting its role in logical analysis, pattern recognition, and problem-solving. Mathematics equips students with essential skills and livelihood opportunities, supporting fields such as engineering, business, tailoring, and carpentry. Its logical foundation and practical applications across various fields, including agriculture, ecology, medical technology, and genetics, make it a universal language of science, fostering intellectual growth and rational thought (Rosen, 2017). Mathematics is a bridge to all knowledge and is crucial for societal growth. Its inclusion as a compulsory subject in primary and secondary school curricula underscores its importance.

Despite its relevance, student performance in Mathematics at Nigeria's senior secondary school level has been of concern (Bature, 2020). The unsatisfactory performance in the senior secondary school certificate examination in Mathematics has influenced the courses and

careers the students seek in the world of work and this highlights the need for continued focus on improving mathematics education outcomes. The students' performance in the senior secondary school certificate examination in mathematics between 2013 and 2022 conducted by the West African Examination Council in Table 1 can attest to this unsatisfactory achievement in Mathematics.

Table 1: Summary of Students' Performance in the Senior Secondary School Certificate

Examination in Mathematics between 2013 and 2022

Years	Total Entry	Total Obtained Credits & Above (A1-C6)	% Obtained Credits & Above (A1-C6)	Total Obtained (D7-F9)	% Obtained (D7-F9)
2013	1,543,683	555,726	36	987,957	64
2014	1,692,435	529,732	31.3	1,162,703	68.7
2015	1,593,442	544,638	34.18	1,048,804	65.82
2016	1,544,234	597,310	38.68	946,924	61.32
2017	1,559,162	666,074	42.72	893088	57.28
2018	1,572,196	785,883	49.98	786,513	50.02
2019	1590173	1020519	64.18	669,654	35.82
2020	1,538,445	1,003,668	65.24	569,654	34.76
2021	1,560,261	1,274,733	81.7	285,528	18.3
2022	1,601,047	1,222,505	76.36	378,542	23.64
2023	1,613,733	1,287,952	79.81	325,781	20.19
2024	1,805,216	1,301,949	72.90	503267	27.10

Source: WAEC. (2022)

Table 1 shows that students' performances with grades A1-C6 in the first six years (2013, 2014, 2015, 2016, 2017, and 2018) were below

50%. It revealed that within 12 years, there were only six consecutive years that students' percentage pass in mathematics rose above 50% (i.e., 2019: 64.18%, 2020: 65.24%, 2021: 81.70%, 2022: 76.36%, 2023; 79.81%, and 2024; 72.9%). These six years show a significant increase in students obtaining credits and above in both categories. The increase in the percentage of students obtaining credits and above in mathematics during the period is a positive trend indicating potential improvements in mathematics academic performance. However, despite this improvement, the outcomes still do not meet the target objectives or desired learning outcomes. This is worrisome, for it has powerful implications for studying science subjects and other related courses at institutions of higher learning. It is an excellent challenge to Mathematics students, teachers, and even all education stakeholders to address this phenomenon before it aggravates further quickly.

Researcher like Oyedeji (2000), has attributed unimpressive students' performance to various factors, including government-related factors, school-related factors, examination body-related factors, curriculum-related factors, test-related factors, textbook-related factors, home-related factors, and student-related factors. Specifically, one significant factor that has been identified that affects students' learning outcomes in mathematics is the interaction patterns within the classroom environment (Patel & Smith, 2021). Ifamuyiwa and Lawani (2008), described classroom interaction as a series of interconnected occurrences that occur one after the other, and each takes up a little time.

To further strengthen the study on classroom interaction in Nigeria, it may be necessary to go beyond what previous studies have done by introducing the dimension of school type. Most past studies rely heavily on the Flanders interaction analysis categories and the five-minute interaction grades. However, using a Mathematics Interaction Sheet (MIS), this study took a different pattern. MIS provides a moving picture of the interaction in the mathematics classroom during the

observation period (i.e., the process of teaching and learning), and it also provides the frequency of occurrence and time during teaching. Extending it to interactions in Mathematics classrooms would be equally appropriate, especially in Ogun State and, by extension, Nigeria.

It is essential to understand the influence of school type on the interaction pattern of teachers teaching Mathematics. School ownership determines school type; public schools are funded and operated by the government, typically at the federal, state, or local level, while private schools are independently owned and operated. Various findings are reported about the influence of school type on students` achievement. In Nigeria, it is a common belief that private schools outperform public ones in terms of the availability of facilities, support personnel, and student achievement. This situation has led many parents to enroll their children in private secondary schools (Hernando & Sammy, 2020). However, results in this regard have also been mixed. Hernando and Sammy (2020) found no statistically significant impact on the student's academic performance based on the school attended.

Therefore, the study investigated the classroom interaction patterns in terms of teacher-initiated activities and students-initiated activities with moderating variables such as school type in the mathematics classroom in Ogun State, Nigeria.

Objectives of the Study

The study's main objective is to analyse interaction patterns in terms of teacher-initiated activities and student-initiated activities in senior secondary schools' mathematics classrooms in Ogun State, Nigeria.

Specifically, the study investigated:

i. The general interaction pattern in terms of teacher-initiated activities and students'- initiated activities in the senior secondary school mathematics classes.

ii. If there is any significant difference between teacher-initiated activities and students-initiated activities based on school types.

Research Questions

1. What is the general interaction pattern in terms of teacher-initiated activities and students'- initiated activities in the observed Mathematics classroom?
2. Is there any significant difference in the classroom interaction pattern in the observed mathematics classroom based on school types in terms of teacher-initiated activities?
3. Is there any significant difference in the classroom interaction pattern in the observed mathematics classroom based on school types in terms of student-initiated activities?

Methodology

The study adopted the descriptive survey research design. The target population comprised all the senior secondary school teachers teaching mathematics at the senior secondary school II and students in the public and private schools in Ogun State. The study sample consisted of 40 teachers teaching mathematics at senior secondary school II and 1,185 senior secondary school II studentsin their classes. In the sample selection, a multi-stage sampling procedure was adopted; In the first stage, a simple random sampling technique was used to select the Ogun East senatorial district out of the three existing senatorial districts in the State. In the second stage, a simple random sampling technique was used to select four local government areas out of the nine existing local governments from the selected senatorial district. In the third stage, a purposive sampling technique was used to select twenty public senior secondary schools and twenty approved private secondary schools in the selected local governments with one teacher chosen from each school. This was done based on the teachers' acceptability to participate in the study.

The Mathematics Interaction Sheet (MIS), a systematic observation guide, was adapted from Adetayo (2011). The adaptation was made to accommodate mathematical terms like "solving". This instrument was used to observe teachers-initiated and students-initiated activities during the teaching and learning of mathematics at senior secondary schools. The adaptation was made to accommodate mathematical terms like "solving". The instrument has six major categories and thirty-two sub-categories arranged so that recorded behaviours reflect the sequence of occurrences and their frequency. The six major categories of the instrument are teacher-students-materials activity, students-students-materials activity, individual students` activity, the teacher not facilitating learning, confusion, and others. For this study's purpose, the instrument was validated by experts in evaluation at the Institute of Education, University of Ibadan. Their advice and suggestions were used to modify the items for adequacy, simplicity of language, and content relevance. For reliability purposes, four teachers teaching mathematics at the senior secondary school level who were not part of the study but had similar characteristics were observed, and the inter-rater reliability using Scots-pi yielded values of 0.812–0.998.

The researchers were physically present in the classroom throughout the observation period (i.e., the teaching and learning periods of the selected mathematics teachers) without interfering in the classroom activities and coding up every 10 seconds of verbal exchange between the teacher and the students by using the mathematics interaction sheet, which is the primary instrument used in data collection. The data collected for this study was analysed using descriptive statistics such as frequency count, and percentage. A chi-square test was used to answer research questions 2 and 3. Thus, the chi-square formula can be given as:

$\chi^2 = \varepsilon\left(\frac{(O-E)^2}{E}\right)$ O = Observe frequency E = Expected frequency

Thus, $E = \frac{TR\ xTC}{GT}$ Where TR = Total Row, TC = Total Column, GT = Grand Total

Result

Research Question One: What is the general interaction pattern regarding teachers-initiated activities, and students-initiated activities in the observed Mathematics classroom?

Table 2: Summary of the general interaction pattern regarding teachers-initiated activities, students-initiated activities and confusion in the observed mathematics classroom.

Teacher-Students-Materials Activities	**Frequency**	**Per centage**
Writing on the chalkboard	957	5.9
Solving on the chalkboard	2130	13.1
Demonstrating using Instructional Materials	0	0
Explaining	3289	20.2
Questioning	982	6
Giving Directives	295	1.8
Reinforcing Correct Responses	158	1
Monitoring	654	4
Answering Question	226	1.4
Working with Group	0	0
Working with individual students	342	2.1
Students-Students-Materials-Activities		
Listening	1788	11
Solving	534	3.3

Chorus response	1785	10.9
Writing	1741	10.7
Interacting with Instructional Materials	0	0
Brainstorming	82	0.5
Individual Students Activities		
Questioning	158	1
Reading	25	0.2
Solving on the chalkboard	309	1.9
Drawing on the chalkboard	0	0
Answering Question	348	2.1
Interacting with Instructional Materials	0	0
Teachers Not Facilitating Learning		
Punishment	0	0
Using negative reinforcement	38	0.2
Discussing with the other teacher or visitor	70	0.4
Announcement	0	0
Confusion		
Noise	143	0.9
Silent	39	0.2
Students wandering aimlessly	13	0.1
Students fighting	0	0
Students talking to one another	206	1.3

Table 2 presents the general observations of the study conducted during the observed period. When considering teachers-initiated activities, the following frequencies values were observed: 957 (5.9%) for teacher writing on the chalkboard, 2130 (13.1%) for teacher solving on the chalkboard, 0 (0.0%) for teacher demonstrating, using instructional materials, 3289 (20.2%) 82.23 for teacher explaining, 982 (6.0%) for teacher questioning, 295 (1.8%) for teachers giving directives, 158 (1.0%) for teachers reinforcing correct responses, 654

(4.0%) for teacher monitoring, 226 (1.4%) for teachers answering questions, 0 (0.0%) for teachers working with a group, and 342 (2.1%) for teachers working with an individual student.

Regarding teachers not facilitating learning, the frequency values were as follows: 0 (0.0%) for teachers punishing students, 38 (0.2%) for teachers using negative reinforcement during the teaching engagement, 0 (0.0%) for teachers demonstrating without the use of instructional materials, 70 (0.4%) for teachers talking with the other teacher or visitor during the teaching and learning process, and 0 (0.0%) for teachers making an announcement.

In the context of students-initiated activities, the observed frequency values were as follows: 1788 (11.0%) for students listening during classroom interaction, 534 (3.3%) for students solving class activities on their notes, 1785 (10.9%) for students responding chorus, 1741 (10.7%) for students copying notes from the chalkboard, 0 (0.0%) for students interacting with instructional materials as a group, and 82 (0.5%) for students brainstorming. Concerning individual student activities, the frequencies are as follows: 158 (1.0%) for individual students questioning, 25 (0.2) for reading, 309 (1.9%) for individual students solving on the chalkboard, 0 (0.0%) for individual students drawing on the chalkboard, and 348 (2.1%) for individual students answering questions during the teaching and learning process. Additionally, 0 (0.0%) was recorded for individual students interacting with instructional materials.

Finally, in instances of confusion during the teaching and learning process in the Mathematics classroom, the observed frequencies were as follows: 143 (0.9%) for a noisy classroom during the observation period, 39 (0.2%) for a silent period during the observation period, 13 (0.1%) for students wandering during the teaching and learning process, 0 (0.0%) for students fighting, and 206 (1.3%) for students talking to one another.

Research Question Two: Is there any significant difference in the classroom interaction pattern in the observed Mathematics classroom based on school types in terms of teacher-initiated activities?

Table 3: Result of Chi-Square (χ^2) Statistics of the teacher-initiated activities based on the school types.

Teacher-initiated activities	Public Schools		Private Schools		
	O	E	O	E	Total
Teacher-Student-Materials Activities					
Writing on the chalkboard	354	433.74	603	523.26	957
Solving on the chalkboard	1136	965.39	994	1164.61	2130
Demonstrating Using Instructional Materials	0	0.00	0	0.00	0
Explaining	1651	1490.68	1638	1798.32	3289
Questioning	359	445.07	623	536.93	982
Giving directives	143	133.70	152	161.30	295
Reinforcing correct responses	78	71.61	80	86.39	158
Monitoring	249	296.41	405	357.59	654
Answering Question	27	102.43	199	123.57	226
Working with group	0	0.00	0	0.00	0
Working with individual students	88	155.01	254	186.99	342
Teacher Not Facilitating Learning					
Punishment	0	0.00	0	0.00	0
Using negative reinforcement	20	17.22	18	20.78	38

Discussing with the other teacher or visitor	38	31.73	32	38.27	70
Announcement	0	0.00	0	0.00	0
Total	**4143**		**4998**		**9141**

Table 3 revealed the total observed frequency values and their equivalent expected frequency values recorded throughout the observation period for public and private school teacher-initiated activities. The chi-square statistics summary is presented in Table 4.

Table 4: Summary of Chi-Square (χ^2) statistics of the teacher-initiated activities based on the schools' types

School Types	N	df	Chi-Square Values		Decision
			χ^2cal.	χ^2tab.	
Public Private	20 20	14	317.69	23.685	Significant

Significant at .05

As shown in Table 4, the chi-square calculated value (χ^2cal.) greater than the critical value from the chi-square table (χ^2tab.), which is 317.69 > 23.685, at a 0.05 level of significance. Therefore, it was concluded that there is a significant difference in the public and private school teacher-initiated activities in the observed mathematics classroom.

Research Question Three: Is there any significant difference in the classroom interaction pattern in the observed Mathematics classroom based on school types in terms of Student-initiated activities.

Table 5: Result of Chi-Square (χ^2) Statistics of the students`-initiated activities based on the school types.

Students-Initiated Activities	Public Schools		Private Schools		
	O	**E**	**O**	**E**	**Total**
Listening	1186	724.97	602	1063.03	1788
Solving	89	216.52	445	317.48	534
Chorus response	790	723.76	995	1061.24	1785
Writing	400	705.92	1341	1035.08	1741
Interacting with Instructional Materials	0	0.00	0	0.00	0
Brainstorming	0	33.25	82	48.75	82
Individual Student Activities					
Questioning	43	64.06	115	93.94	158
Reading	13	10.14	12	14.86	25
Solving on the chalkboard	141	125.29	168	183.71	309
Drawing on the chalkboard	0	0.00	0	0.00	0
Answering Question	83	141.10	265	206.90	348
Interacting with Instructional Materials	0	0.00	0	0.00	0
Total	**2745**		**4025**		**6770**

The results of the observed frequencies and the calculated expected frequencies for students'-initiated activities in public and private schools are recorded in Table 5. The chi-square statistics summary is presented in the Table 6.

Table 6: Summary of Chi-Square (χ^2) statistics of the students`-initiated activities based on the schools' types

School Types	N	df	Chi-Square Values		Decision
			χ^2cal	χ^2tab.	
Public Private	20 20	11	965.11	19.675	Significant

Significant at .05

As shown in Table 6, the chi-square calculated value (χ^2cal.) greater than the critical value from the chi-square table (χ^2tab.) which is 965.11 > 19.675, at 0.05 level of significance. Therefore, we concluded that there is a significant difference in the public and private school student-initiated activities in the observed mathematics classroom.

Discussion

The findings in this study reveal the general interaction pattern (teacher-students-material and students-students-material) in the observed mathematics classroom. It showed the distribution and involvement of the teachers and students in activities that co-occurred, such as how teachers explain, use instructional materials, teach, monitor, raise questions, obtain feedback, and motivate students, as well as how students learn; participate in class activities, responds to questions, uses instructional materials; brainstorm; and provide input for further instructions The interaction happened in teacher-to-the-whole-class, teacher-to-the-individual student, individual student-to-teacher, and individual student-to-individual student interactions.

The teachers' activities were divided into teacher-students-materials activities and teacher-non-facilitating learning. The study found that the most common teacher-initiated activities were teachers delivering the contents through explanations and chalkboard problem-solving to the whole class. It was observed that none of the teachers used instructional materials throughout the observation period. The high

frequency of writing, solving, and explaining suggests a traditional teaching approach that may not fully engage all students or cater to diverse learning styles. The non-use of instructional materials during observation confirms abstract mathematics teaching, which points to missed opportunities for more interactive and engaging lessons. While monitoring is present, individual attention is limited, which might affect students needing additional help. The study's results aligned with Ifamuyiwa and Lawani's (2008) research, which discovered that mathematics classes in Ogun State Secondary Schools dominated lecturing and a lack of instructional materials. This finding supported the outcome of Oktaviani's (2019), indicating that teacher talk was the most dominant aspect of verbal classroom interaction.

The students' activities were separated into two categories: student-student-material activities and individual activities. The primary interaction pattern was between students and teachers during the teaching activities. Students listened to the teacher's explanation, responded in chorus, and copied notes from the chalkboard were observed. Activities like listening, chorus responses, and writing indicate active student participation, though problem-solving and questioning are less frequent. Minimal brainstorming and no interaction with instructional materials suggest a need for more varied and interactive learning opportunities. The study showed that some students responded without understanding the lesson, which could not provide adequate evidence to the teacher that all students grasped the material. Occasionally, the classroom became noisy, and students began to talk with one another. This usually happens towards the end of the class activities when the students feel the teaching is almost over.

An investigation was conducted to determine whether there were significant differences in teacher-initiated activities and student-initiated activities between public and private schools in a mathematics classroom. The results showed that private school teachers were observed to initiate activities more frequently than public school

teachers. They were more involved in monitoring individual students' activities due to the smaller class sizes in private schools. On the other hand, public school teachers had larger class sizes, making it more challenging to interact with individual students. As a result, public school students had less participation than private school students, who were seen questioning and solving on the chalkboard more frequently and engaging with one another when given classwork. These findings may be surprising given the expectation that public schools, where taxpayer money is spent, would perform better than profit-oriented private schools.

The results could have been associated with private school students being more likely to have socio-economic characteristics positively associated with academic success and to have school peers with university-educated parents. The outcome of the result is in line with the study of Frenette andChan (2015), who found that private high school students score significantly higher than public high school students on reading, mathematics, and science assessments at age 15 and have higher levels of educational attainment by age 23.

Conclusion

The interaction pattern and its influence on students` learning outcomes in mathematics in Ogun state have been examined. The research study has provided a comprehensive understanding of the teachers-initiated activities and student-initiated activities in mathematics classrooms. The results revealed that teacher-centred instructional strategies are primarily used in the observed classrooms, focusing significantly on chalkboard problem-solving and explanations. However, the non-use of instructional materials and a prevalence of memory-based questions indicate a need for varied teaching methodologies. The study also highlighted a clear distinction between group and individual activities, with students generally responding to teachers rather than initiating

interactions. Towards the end of class activities, noise and student conversations indicate the need for improved class management.

Recommendations

The study provided valuable insights into classroom dynamics, revealing areas where improvement can enhance teaching and learning. Based on the findings, here are some possible suggestions for improving classroom interaction in mathematics:

1. Mathematics teachers must diversify their teaching methods beyond explaining and solving on the chalkboard by incorporating interactive techniques, such as hands-on activities and real-world examples, to make mathematics more engaging.
2. The government needs to set up a team that will regularly monitor the teaching and learning of mathematics in the public and private sectors
3. The students must participate actively in classroom activities, taking advantage of opportunities to engage with the teacher, fellow students, and instructional materials.

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