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CLASSROOM VARIABLES AND ITS INFLUENCE ON VERBAL REASONING OUTCOMES IN BASIC TECHNOLOGY AMONG SECONDARY SCHOOL STUDENTS: APPLICATION OF DISCRIMINANT ANALYSIS

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ABSTRACT

This study investigates the influence of classroom variables on verbal reasoning outcomes in basic technology among secondary school students in Cross River State, Nigeria. The research adopts a survey research design, utilizing both quantitative and qualitative data collection methods to evaluate the relationship between interactive teaching practices and student performance. A sample size of 1176 students from various secondary schools in the state was selected through stratified random sampling to ensure a diverse representation of the student population. One research question and one research hypothesis guided the quantitative part of this study. Structured questionnaires were administered to gather quantitative data on students' perceptions of classroom variables and their corresponding verbal reasoning outcomes in basic technology. Meanwhile, in-depth interviews and focus group discussions with teachers and students provided data on the dynamics of classroom interactions and their effects on learning. The study's findings indicate a significant positive correlation between the frequency and quality of classroom variables and improved verbal reasoning outcomes in basic technology. Furthermore, the research highlights the importance of interactive teaching methods, timely feedback, and supportive communication in enhancing students' understanding and retention of basic technology concepts. Based on the study findings, it was recommended that the policy makers and educators should invest in training programs that enhance interactive teaching skills and promote effective classroom communication.

KEYWORDS: Classroom variables; Verbal reasoning Outcomes; Basic Technology, Secondary School Students; Cross River State

lj **Background to the study**

Technology is recognized as a major factor in the development of any nation. Its importance in education stems from the need to enhance the developmental stage of the economy and to advance the objectives of teaching and learning. Experts in Nigeria have maintained that technology can be used for wealth creation, poverty eradication, job creation, global competitiveness, and improved learning (Zakari, Ibeme, & Lugurd, 2023).

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Education, encompassing the totality of life experiences people acquire, enables them to cope with and derive satisfaction from living in the world. It facilitates social competence and individual development, making the quality of a nation's education proportional to its prosperity (Elem, 2023). From the beginning of time, man has strived to improve his quality of life through the use and application of knowledge, skills, tools, and materials, which we today describe as technology. Basic technology is a phase of general education designed to introduce learners to the basic processes, materials, and products of various industries (Olabiyi, 2024). The first National Policy on Education in 1977 divided the secondary school system into six years, comprising three years of junior secondary school (JSS) and three years of senior secondary school. In JSS, technical subjects are integrated and called Basic Technology, aimed at developing positive attitudes towards technical subjects. Basic Technology, the only core subject among pre-vocational subjects at the JSS level, involves the practical study of materials and energy sources with the intention of applying this knowledge to create a comfortable environment for humans (Obeng, 2024). The objectives of Basic Technology, include providing pre-vocational orientation for further training in technology, offering basic technological literacy for everyday living, and stimulating creativity (Iyoha, 2023).

The quality of education extends beyond curriculum content to include the learning environment and school factors. Nunes, Oliveira, Castelli, & Cruz-Jesus, (2023), notes that classroom learning environments and school factors exert dominant influences on learner achievement. School proprietors strive to provide an enabling environment for effective teaching and learning, aiming for high-quality assurance in schools, which entails providing factors that enhance effective teaching and learning, ultimately affecting students' academic achievement. These factors include teacher variables, environment/family variables, and school variables, with teacher variables being the most influential on learning outcomes. For a nation to develop properly, its populace must have basic technological knowledge and skills to enhance individual employability. As technology becomes more prevalent, educational institutions expect students to use technology both at school and at home (Keane, Linden, Hernandez-Martinez, Molnar, & Blicblau, 2023). Despite its importance, students' performance in Basic Technology in Nigeria remains relatively poor (Uchegbue and Amalu, 2020, Oladejo, Nwaboku, Okebukola, & Ademola, 2023). necessitating further research to improve knowledge and retention in this crucial subject.

The challenges associated with classroom variables significantly influence verbal reasoning outcomes in Basic Technology among secondary school students in Cross River State, Nigeria (Johnson, 2024). These challenges include inadequate teacher training, resulting in a lack of proficiency in delivering technical content effectively and engaging students (Abedi, 2023). Additionally, large class sizes hinder meaningful interactions, making it difficult for teachers to address individual student needs and provide personalized feedback. Insufficient classroom resources and outdated teaching methods further exacerbate the problem, limiting students' opportunities to actively participate and develop their verbal communication skills. Furthermore, cultural and socio-economic factors may contribute to students' reluctance to engage in verbal interactions, impacting their overall learning experience. This study is apt as it seeks to identify and address these challenges, aiming to enhance classroom variables and improve verbal reasoning outcomes in Basic Technology. By doing so, it contributes to the broader goal of advancing the quality of education and equipping students with essential skills for future technological and vocational pursuits. This study aimed at determining the extent to which the following classroom variables (class size, classroom settings, classroom management skills, classroom lightings, proper thermal condition, student-student interaction, teacher-students' interaction) predict students' low and high verbal reasoning group to learning.

LITERATURE REVIEW

Classroom variables is a critical component of the educational experience, significantly influencing students' learning outcomes. According to Hanaysha, Shriedeh, & In'airat, (2023), Uchegbue, Edet, Otu, Amalu and Oyo-Ita, 2021). The quality of classroom interaction has been demonstrated to have a substantial influence on students' academic achievements. Positive perceptions of classroom environments are linked to better learning outcomes, as students who feel

supported and engaged by their teachers are more likely to succeed academically. This is particularly relevant in subjects like Basic Technology, where the integration of verbal instructions and practical skills is essential for comprehensive learning.

Class size and the nature of classroom variables play a pivotal role in shaping learning outcomes. Elliot (2000) and Attah (2002) emphasize that smaller class sizes facilitate more effective participation and individualized attention, enhancing the teaching and learning process (Alshuraiaan, 2023). In the context of Basic Technology, where verbal reasoning and practical application are intertwined, the ability to interact closely with students allows teachers to address individual learning needs and clarify complex concepts more effectively. This interaction not only aids in the development of verbal skills but also fosters a deeper understanding of technological principles.

Research has shown that various classroom variables, including teacher-student interaction, significantly influence learning outcomes. Studies by Edet (2010) and Igiri (2013) highlight that effective classroom management, conducive learning environments, and positive classroom variables are crucial for student success (Hunter, Jasper, Barnes, Davis, Davis, Singleton, & Scott, 2023). In Basic Technology, where students must grasp both theoretical knowledge and practical skills, the quality of classroom variables can determine the extent to which students engage with and retain the material (Kaahwa, Nansamba, & Muweesi, 2023). Teachers who create supportive and interactive classroom environments can significantly enhance students' verbal reasoning and technological proficiency.

Moreover, the social and emotional aspects of classroom variables cannot be overlooked. Dai, Xiong, Zhao, & He, (2024), found that healthy interpersonal relationships between teachers and students promote higher academic achievement and better verbal reasoning skills. This is particularly important in Basic Technology, where students often work on collaborative projects and rely on clear communication for successful outcomes. Positive interactions with teachers can boost students' confidence, encouraging them to participate more actively and take intellectual risks necessary for mastering complex technological concepts.

Graham, Ridder, Thiemann, & Zamarro, (2023), defines class size as the number of students in one classroom under the control of a teacher at a time. Effective student participation in the classroom is vital for effective learning. Smaller class sizes allow more students to contribute to the teaching/learning process and enable teachers to distribute questions and interact with students on a one-on-one basis Graham, (2023). This dynamic is crucial for understanding the interrelationships between verbal-reasoning attainment and vocational interest, especially in technology among secondary school students in Calabar, Nigeria. The National Policy on Education (Jacob, & Ndubuisi, 2023), stipulates a teacher-student ratio of 1:40 in secondary schools. Effective classroom management involves techniques for making the classroom conducive to learning.

To achieve specific educational objectives as stated in the National Policy on Education, a conducive classroom learning environment should be nurtured and utilized by knowledgeable teachers. Such an environment invigorates the cognitive, affective, and psychomotor domains. Teachers with extensive subject knowledge and a good learning environment are expected to enhance students' intellectual achievements. Variables like class size, teaching-learning settings, classroom management skills, lighting, thermal conditions, and classroom variables significantly influence learning outcomes (Farhat, 2021).

The secondary school classroom has a powerful influence on shaping students both cognitively and socially. Individuals develop a consciousness of self through interaction with their environment, making the classroom an important milieu for total growth. The classroom environment is crucial for educators, teachers, and students to effectively achieve educational goals. According to Ferreira, Martinsone, & Talić, (2020), the total achievement surrounding an individual is composed of a complex network of forces related to human characteristics (Munna, & Kalam, 2021).

A conducive school environment enhances learning. Cooperation among various groups in the school setting can positively affect student performance, while tension and friction can have negative effects (Vidić, 2021). Kuhlenengel, Konstantzos, & Waters, (2021), found that aspects of the indoor environment, such as daylight, significantly impact students' learning, as

measured by improvements in standardized Math and reading tests. Classroom interaction patterns also influence learning outcomes, promoting student achievement, verbal reasoning, and healthy interpersonal relationships (Banks, & Smyth, 2021). Given the positive relationship between verbal reasoning ability and vocational learning outcomes in Basic Technology among secondary school students, this research is necessary and timely (Bochkareva, Akhmetshin, Zekiy, Moiseev, Belomestnova, Savelyeva, & Aleynikova, 2020).

The importance of understanding the specific context of Nigerian secondary schools, particularly in regions like Cross River State, adds another layer of complexity to the study of classroom variables in Basic Technology. Previous studies, such as those by Oladejo, Okebukola, Olateju, Akinola, Ebisin, & Dansu, (2022), indicate that culturally and regionally specific factors can influence the effectiveness of educational strategies. Investigating how classroom variables affect verbal reasoning outcomes in Basic Technology within this context is crucial for developing tailored educational approaches that address local needs and challenges. Given the increasing emphasis on technological education for economic and social development, this research is both timely and relevant.

MATERIALS AND METHODS

Cross River State, located in the south-south geo-political zone of Nigeria is known for its rich tourism and educational institutions such as the famous Hope Waddel Training Institute (HOWAD), West African People's Institute (WAPI) among others. With Calabar as its capital, the state comprises eighteen local government areas and experiences a tropical climate with heavy rainfall due to its proximity to the Atlantic Ocean. Cross River boasts several tourist attractions like Agbokim waterfalls, the Obudu Ranch Resort, and Tinapa business resort. The state has a strong educational presence with institutions such as the University of Calabar and University of Cross River State. The primary ethnic groups include the Efiks, Yakurr, Bekwarras, and Ejahgams, with most residents engaged in farming, fishing, and petty trading. The study adopted the ex-post facto research design. The study's population includes all Junior Secondary School 3 (JSS3) students taking Basic Technology in Cross River State's three educational zones: Calabar Zone (Akamkpa, Akpabuyo, Biase, Calabar Municipality, Calabar South, Odukpani), Ikom Zone (Abi, Boki, Ikom, Obubra, Yakurr), and Ogoja Zone (Bekwarra, Obanliku, Obudu, Ogoja, Yala). The total population is 58,816 students. JSS3 is chosen for its suitability in measuring learning outcomes due to students' accumulated knowledge and skills in Basic Technology by this stage.

This study employed multiple stages of sampling techniques to ensure a representative sample. Initially, stratified sampling divides Cross River State into its three educational zones: Calabar, Ikom, and Ogoja. Stratified random sampling then selects sixteen out of eighteen Local Government Areas. Proportionate stratified sampling follows, choosing 2% of the student population from these sixteen areas to generalize findings. Purposive sampling selects schools offering Basic Technology, and simple random sampling selects Junior Secondary School 3 students from these schools based on the targeted sample percentage. The study sampled 1176 Junior Secondary School students, representing 2% of those enrolled in schools offering Basic Technology across 45 institutions in Cross River State. This percentage was chosen to manage the study's scope effectively, ensuring a feasible number for comprehensive analysis without overwhelming the research capacity. This sample size proportionately reflects the total student population of 58,816 across the selected schools as seen in Table 1. Structured questionnaire was the instrument for data collection.

To determine the validity of the instrument to be used for this study, the researchers subjected the instrument to face validity by two experts in Test, measurement and evaluation who checked and ensured that the items were appropriate to measure what it meant to measure items those that lacked face validity were expunged and replaced with the correct ones. To determine the reliability of the instrument to be used for this study, 50 copies of the questionnaire were administrated on 50 students drawn from the study area who were not subjects for the study. This was done using Cronbach Alpha reliability method. The reliability estimates ranged from .73 to .85. The respondents were informed of the exercise and essence of giving objective responses to the items. The questionnaires were administered personally by the researchers with the help of two research assistants.

TABLE 1: Distribution of sample by Education Zone

Zone	LGA	No. of JSS Students	School Offering Basic Technology	Sample 2%
Calabar	Akamkpa	2649	8	53
	Akpabuyo	1218	2	24
	Biase	2288	2	46
	Calabar Mun.	9761	7	195
	Calabar South	5807	6	116
	Odukpani	2222	1	45
Ikom	Abi	1833	2	37
	Boki	3999	2	80
	Ikom	5750	1	115
	Obubra	3615	1	72
	Yakurr	3846	3	77
Ogoja	Bekwarra	2360	2	47
	Obaniku	1820	3	36
	Obudu	3806	2	76
	Ogoja	3415	1	68
	Yala	4427	2	89
Total		58816	45	1176

RESULTS AND DISCUSSIONS

The study utilized Fisher's linear stepwise discriminant analysis to examine whether classroom variables (class size, classroom setting, classroom management skills, classroom lighting, proper thermal conditions, student-student interaction, teacher-student interaction) predict students' verbal reasoning outcomes in Basic Technology among junior secondary school students in Cross River State. Results from Tables 2 to 12 indicated that while classroom setting, teacher-student interaction, and thermal conditions significantly predicted verbal reasoning outcomes ($P < 0.05$), student-student interaction, classroom lighting, and classroom management did not show statistical significance ($P > 0.05$). The discriminant function analysis yielded one discriminant function with an Eigen value of 0.21, explaining 100% of the variance in classroom variables and achieving a classification accuracy of 80.1% in predicting students' learning outcomes, demonstrating the function's robust predictive capability despite assumptions about covariance equality being violated due to the large sample size.

The analysis of classroom variables and their influence on students' verbal reasoning outcomes reveals significant insights. As shown in Table 2, the mean scores for various classroom factors such as classroom setting, student-student interaction, teacher-student interaction, classroom lighting, classroom management, and thermal conditions are consistently higher in the low verbal reasoning group compared to the high verbal reasoning group. Specifically, classroom setting and teacher-student interaction mean scores were slightly higher in the low verbal reasoning group, indicating a potential inverse relationship between these factors and verbal reasoning skills. The discriminant analysis (Table 3) highlights that classroom setting ($F=6.592$, $p=.010$), teacher-student interaction ($F=7.779$, $p=.005$), and thermal condition ($F=18.101$, $p=.000$) significantly predict students' verbal reasoning outcomes, suggesting that these variables play a crucial role in shaping students' verbal reasoning abilities.

Furthermore, the Eigenvalues and Wilk's Lambda (Tables 6 and 7) confirm that the discriminant function derived from the classroom variables accounts for 100% of the variance in the dataset, with a significant Chi-square value ($\chi^2=22.413$, $p=.001$). This indicates that the function effectively discriminates between low and high verbal reasoning groups.

The standardized canonical discriminant function coefficients (Table 8) show that thermal condition (.795) and classroom setting (.333) are the strongest predictors, while the structure matrix (Table 9) further emphasizes the significant roles of teacher-student interaction (.585) and thermal conditions (.893). The classification results (Table 12) demonstrate a high accuracy rate, with 95.5% of the low reasoning group and 89.7% of the high reasoning group correctly classified, reflecting the robustness of the discriminant function in predicting verbal reasoning outcomes based on classroom variables.

TABLE 2: Group statistics for verbal reasoning

	Low		High		Total	
	Mean	Std.	Mean	Std.	Mean	Std.
Classroom setting	12.23	2.681	11.78	2.941	12.05	2.791
Student-student interaction	12.59	2.813	12.28	3.135	12.47	2.943
Teacher student interaction	12.39	2.684	11.89	3.047	12.20	2.838
Classroom lightings	13.12	2.849	12.96	3.151	13.06	2.968
Classroom management	12.87	2.665	12.60	2.948	12.76	2.779
Thermal condition	12.39	3.005	11.56	3.287	12.07	3.141

TABLE 3: Tests of equality of group means of classroom variables

	Wilk's Lambda	F	p-level
Classroom setting	.994	6.592	.010
Student-student interaction	.997	2.999	.84
Teacher-student interaction	.993	7.779	.005
Classroom lightings	.999	.732	.393
Classroom management	.998	2.514	.113
Thermal condition	.984	18.101	.000

df = 1,1086

TABLE 4: Log determinants-verbal reasoning

Verbal reasoning	Rank	Log determinants
Low reasoning group	6	11.424
High reasoning group	6	11.979
Pooled within-group	6	11.690

TABLE 5: Box's M test result of the variance in the different classes of classroom variables

Box's M	57.709
Approx.	2.731
df1	21
df2	2904733.031
Sig.	.000

TABLE 6: Eigenvalues of the discriminant functions derived from the discriminant variables of students' classroom variables

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	.021	100.0	100.0	.143

TABLE 7: Wilk's Lambda of the discriminating power of the classes from the discriminant variables of students' classroom variables

Test of Function	Wilk's Lambda	Chi-square	Df	p-level
1	.980	22.413	6	.001

TABLE 8: Standardized canonical discriminant function coefficients in the prediction of class of students' classroom variables

Classroom variables	Function
Classroom setting	.333
Student-student interaction	-.065
Classroom variables	.298
Classroom lightings	-.163
Classroom management	-.030
Thermal condition	.795

TABLE 9: Structure matrix of the predicted discriminating functions

Classroom variables	Function
Classroom setting	.539
Student-student interaction	.363
Teacher-student interaction	.585
Classroom lightings	.180
Classroom management	.333
Thermal condition	.893

TABLE 10: Functions at group centroids

	Functions
Verbal reasoning groups	1
1. Low reasoning group	.114
2. High reasoning group	- .183

TABLE 11: Classification function coefficients

Classroom variables	Verbal reasoning group	
	Low reasoning group	High reasoning group
Classroom setting	.751	.717
Student-student interaction	.376	.383
Classroom lightings	.413	.382
Classroom management	.677	.694
Thermal condition	.662	.665
(Constant)	.575	.499
	-22.278	-21.372

Fisher's linear discriminant functions

TABLE 12: Classification of results

Verbal reasoning groups			Predicted group membership		Total
			Low reasoning group	High reasoning group	
Original	Count	Low reasoning group	640	30	670
		High reasoning group	375	43	418
	%	Low reasoning group	95.5	4.5	100.0
		High reasoning group	89.7	10.3	100.0

62.8% of original cases correctly classified

CONCLUSION AND RECOMMENDATIONS

The study on classroom variables and its effect on verbal reasoning outcomes in Basic Technology among secondary school students in Cross River State reveals significant findings. The discriminant analysis demonstrates that classroom variables, particularly teacher-student interaction, classroom setting, and thermal conditions, significantly impact students' verbal reasoning abilities. The data show that these variables are strong predictors of whether students fall into low or high verbal reasoning groups. Notably, classroom variables and classroom setting have a substantial influence, underscoring the importance of a conducive learning environment and effective teacher engagement in enhancing verbal reasoning outcomes.

These results suggest that improving classroom conditions and fostering better teacher-student interaction can lead to improved verbal reasoning skills among students. The high accuracy in classification further validates the effectiveness of these classroom variables in predicting students' verbal reasoning outcomes. Consequently, strategic interventions focusing on these areas could substantially benefit students' academic performance in Basic Technology and potentially other subjects, highlighting the critical role of the learning environment and teacher engagement in educational outcomes.

RECOMMENDATIONS

Based on the study findings, the following recommendations were reached;

i. Enhance classroom variables through regular training and professional development for teachers on effective communication and engagement strategies.

ii. Improve classroom settings by ensuring adequate space, proper seating arrangements, and minimal distractions to create a conducive learning environment.

iii. Increase focus on student-student interactions by encouraging collaborative learning activities and group work to foster peer learning and support.

iv. Conduct periodic evaluations of classroom environments to identify and address any issues that may negatively impact students' learning experiences.

v. Involve students in decision-making processes regarding classroom improvements to ensure their needs and preferences are considered, enhancing their engagement and satisfaction.

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