STUDENTS' ATTITUDE TO PROBLEM-SOLVING, CAREER ASPIRATION AND LOCUS OF CONTROL AS DETERMINANTS OF STUDENTS' ACHIEVEMENT IN STOICHIOMETRY

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Abstract

This study determined the predictive relationship of students' attitude to problem-solving, career aspiration in chemistry and locus of control as predictors of students' achievement in stoichiometry at senior secondary school level. Using multi-stage sampling, the study sampled a total of 1.171 students from public schools in Lagos State, Nigeria. Three research questions were raised and answered in the study. Four research instruments were used to collect data for the study. The instruments were validated and the reliability was determined using Cronbach Alpha and KR-20. The data were analysed using Pearson Product Moment Correlation and Regression at 0.05 level of significance. The findings of the study showed that students' attitude to problem-solving and locus of control had a significant positive relationship with students' achievement in stoichiometry while the relationship with career aspiration was positive but not significant. The study also shows that the variables had a significant composite contribution in predicting students' achievement in stoichiometry with attitude to problem-solving and locus of control having significant relative contributions. It was therefore recommended among others, that education stakeholders should give more attention to improving the non-cognitive factors of locus of control, attitude to problem-solving and career aspiration in chemistry. Schools should also organize career day to show students career opportunities available in chemistry and science.

Introduction

Stoichiometry is regarded as one of the fundamental tools for understanding some essential concepts in chemistry. Stoichiometry focuses on establishing the quantitative relationships among constituents (elements and compounds) in a chemical reaction. According to chemistry educators, solving those stoichiometric problems necessitates having a solid understanding of chemical concepts, being able to create and balance chemical equations, and being able to use those balanced equations to determine the amount of the substances involved in the reactions. However, despite the importance of stoichiometry to chemistry, evidence in literature reveals that students have demonstrated challenges in learning some stoichiometry concepts such as balancing of chemical equations, mole concept, mass and volume relationships, identification of limiting reagents and theoretical yield as indicated by WAEC Chief Examiners' Report, 2013 -2016, 2018 -2019).

More so, Shedrack and Enunuwe (2018), found that students struggle to identify the limiting reagent, utilize inconsistent stoichiometry relationships, balance chemical equations poorly, and show poor understanding of theoretical yield determination and identification of substances in excess. Olatunde (2021), identified that students cannot balance chemical equations, properly identify products and reactants, and also cannot make sense of subscripts in a reaction. Researchers have associated many student characteristics to their achievement in stoichiometry. Among them are student attitude (Omilani and Ajayi, 2023); career aspiration (Anis, Krause and Blum, 2016); and locus of control (Arsini, Ahman, and Usmana, 2023).

Attitude serves as a key factor that motivates students towards achieving success (Mohtar, Halim and Iksan, 2016). Students' like or dislike for a subject influences their achievement in that subject. According to Jader et al. (2020), one of the essential competencies' students need to have to fit into today's fast changing world is problem-solving. Problem-solving is a mental process that entails determining how to accomplish an objective. It involves application of knowledge and computational skills to achieve set goals geared towards providing solutions to identified problems. Peloff (2016) defined students' attitude to problem-solving as the emotional and mental disposition that drives a student towards solving problems to achieve specific goals. Furthermore, the ability of a learner to apply the theoretical concepts he has learnt in solving quantitative concepts and problems in chemistry and in life is essential for building learners who will become problem solvers in the future. However, the chief examiners reports showed that one of the causes associated with students' failure in chemistry is their poor problem-solving skills which could have resulted from students' negative attitude towards

problem-solving. The attitude that students have toward solving mathematical problems and their academic performance are positively correlated, according to Cutumisu and Bulut (2017).

The term "career aspiration" refers to a person's ideal, intended professional path, and the degree to which they plan to take action to progress to a higher position. Students' stoichiometry achievement and their career aspiration in chemistry and STEM courses are strongly correlated, according to Cairns and Dickson (2021). Students who have high achievements in chemistry are motivated to advance their education in chemistry or other Science, Technology, Engineering and Mathematics (STEM) courses.

Furthermore, locus of control speaks about a person's broad assumptions about who has influence over what will happen next. Stated differently, what or who is accountable for the events that transpire. Locus of control is a psychological concept. According to Choudhury and Borooah (2017), it is the degree to which people think they exercise control over circumstances that impact them as opposed to outside factors that are out of their control. It has been discovered that, in the field of education, academic achievement strongly correlates positively with internal locus of control while external locus of control has a negative correlation (Majzub, Bataineh, Ishak and Rahman, 2016). Additionally, Arsini, Ahman, and Usmana (2023) found a positive relationship between locus of control and students' academic performance. They assert that students who believe they have power over what happens to them, are self-motivated and work harder to create their educational experiences in school which cumulatively influence their academic achievements positively.

Research Questions

1. What is the relationship between attitude, career aspiration and locus of control and students' achievement in stoichiometry?
2. What is the relative contribution of attitude, career aspiration and locus of control on students' achievement in stoichiometry?
3. What is the joint contribution of attitude, career aspiration and locus of control on students' achievement in stoichiometry?

Methodology

The study adopted the descriptive research design of the expost facto type. The study population is senior secondary school class two chemistry students and their teachers in the six education districts of Lagos State, Nigeria. A total of 1,171 students were sampled using a multi-stage sampling method. In the first stage, stratified sampling was used to select one Local Government Area from each of the six (6) educational districts to make six (6) Local Government Areas for the study. At the second stage, five (5) schools were randomly selected from each of the Local Government Areas. At the third stage, intact classes of all the chemistry students from each school were used to make up a sample of 1, 171 students. There were 486 male and 685 female participants. The instruments used were Students' Attitude Towards to Problem-solving (CSAPS), Students' Career Aspirations in Chemistry Scale (SCACS), Chemistry Students Locus of Control Scale (CSLCS) and Stoichiometry Achievement Test (SAT).

Chemistry Students Attitude to Problem-Solving Scale (CSAPS)

The Chemistry Students Attitude to Problem-Solving Scale (CSAPS) adapted from the Problem-solving skills Scale by Aiken (1979) was used for this study. It measured the students' attitude to problem-solving in chemistry. It is made up of two parts. Section A asks questions on the respondent's age, gender, and name of school. Section B is made up of 17-items which the respondent is to respond to by expressing their opinions on a 4-Likert Scale questions ranging from 1 – not like me, 2 – not much like me, 3 – somewhat like me, 4 – very much like me. Using Cronbach Alpha, the instrument's reliability coefficient was found to be 0.70.

Students' Career Aspirations in Chemistry Scale

The Career Aspirations in Chemistry Scale (CACS) adapted from the Career Aspirations rating scale developed by Osokoya (1998) was used for this study. It measured the career aspirations of the students in chemistry. It comprises a list of 30 career choices. The courses are rated based on their chemistry requirement for each profession with 30 points being the highest and 1 being the lowest. Some chemistry teachers and experts in science education were consulted for re-validation of the rating based on their relative relevance of chemistry to the different professions. The consensus of all the experts was adopted for the final rating of the instrument. The 2022/2023 JAMB brochures for The Unified Tertiary

Matriculation Examination (U.T.M.E) and Polytechnic/College of Education examinations were used as guides. The reliability of the instrument was determined using Scot's pi and the inter-rater consistency yielded 0.98.

Chemistry Students Locus of Control Scale (CSLCS)

The Chemistry Students Locus of Control Scale (CSLCS) adapted from the Locus of Control Scale developed by Yemen and Clawson (2003) was used for this study. It measured the students' locus of control. It is made up of two parts. Section A asks questions on the respondent's age, gender, and name of school. Section B comprises 20-items which the respondents are to respond to by expressing their opinions on a 4-Likert Scale questions ranging from 1 – not like me, 2 – not much like me, 3 – somewhat like me, 4 – very much like me. Using Cronbach Alpha, the instrument's reliability coefficient was found to be 0.81.

Stoichiometry Achievement Test (SAT)

The Stoichiometry Achievement Test (SAT) was used to measure students' knowledge of stoichiometry. It is made up of two parts. Section A asks questions on the respondent's age, gender, and name of school. Section B contains multiple-choice questions evaluating students' achievement in stoichiometry. The initial draft contained 40 multiple choice questions on stoichiometry selected from the West African Examination Council chemistry past question and modified to fit the purpose of this study. It had four response options A-D. Topics on which the test was based are mass and volume relationships, and chemical equations. The test was then administered to 20 SSIII chemistry students which are excluded from the sample of this study. Before they were administered, copies were given to experts in the field of science education for face and content with necessary corrections and modifications effected. Responses were collected, scored and analysed and the KR-20 reliability coefficient was found to be 0.63.

Consequently, the instrument was reviewed and items found unfit were eliminated leaving 15 questions. The 15 items had a difficulty index between 0.2 -0.75 and discrimination index of between 0.3-0.69. The reliability coefficient for the instrument was then calculated using KR-20 and was found to be 0.81. The table of specification for the 15 items is shown in table 1 below.

Table 1: Table of Specification for SAT

CONTENT	KNOWLEDGE	COMPREHENSION	APPLICATION	TOTAL
MASS & VOLUME RELATIONSHIP	$_{11}$ (1)	$_{15}$ (1)	$_{1, 3, 4, 6, 8, 10, 12, 13, 14,}$ (9)	11
CHEMICAL EQUATIONS	$_{2, 7}$ (2)	$_{5, 9}$ (2)	-	4
TOTAL	3	3	9	15

Note: The subscripts indicate the item's serial number in the SAT, while the numbers in brackets indicate the number of items in each cell.

Results

Relationship between Attitude to problem-solving , Career Aspiration and Locus of Control and Students' Achievement in Stoichiometry

Table 2: Relationship between the variables of the study

Pearson Correlation	Stoichiometry Achievement	Attitude to Prob. Solv.	Career Aspiration	Locus of Control
Stoichiometry Achievement	1.00	.16	.02	.29
Attitude to Prob. Solv.	.16	1.00	.21	.72
Career Aspiration	.02	.21	1.00	.24

Locus of Control	.29	.72	.24	1.00

N= 1, 171 Sig (2-tailed)

Table 3: Composite Contribution of Student Characteristics

Model	Sum of squares	Df	Mean square	F	Sig
Regression	997.802	3	332.601	40.519	0.00
Residual	9825.687	1168	8.209		
Total	10823.489	1171			
$R = 0.304$ Adj $R^2 = 0.090$					

Table 4: Relative Contribution of the Independent variables

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.320	.391		3.373	.001
	Std Att to Probl Solv	.026	.010	.102	2.547	.011
	Career Aspiration	.012	.007	.044	1.566	.118
	Locus of Control	.109	.012	.376	9.346	.000

Table 2 shows that the relationship between students' attitude to problem-solving ($r = 0.16$; $p < 0.05$), locus of control ($r = 0.29$; $p < 0.05$) and students' achievement in stoichiometry is positive, moderate and significant while career aspiration ($r = 0.23$; $p > 0.05$) has a positive but not significant relationship. This implies that achievement of students in stoichiometry is associated with students' attitude to problem-solving, career aspiration and locus of control.

Composite Contribution of Attitude to Problem-solving , Career Aspiration and Locus of Control to Students' Achievement in Stoichiometry

Table 3 reveals there is a significant, composite contribution of attitude to problem-solving, career aspiration and locus of control to students' achievement in stoichiometry ($F_{(3, 1200)} = 40.52$; $p < 0.05$). From table 2, the adjusted R value of 0.090 shows that the independent variables are responsible for 9% of the total variance in students' stoichiometry achievement. The remaining 91% variance is attributed to variables that are not residual in this study.

Relative Contribution of Attitude to Problem-solving, Career Aspiration and Locus of Control to Students' Achievement in Stoichiometry

Table 4 reveals that the relative contributions of students' attitude to problem-solving ($\beta = .102$; $t = 2.547$; $p < 0.05$) and locus of control ($\beta = .376$; $t = 9.346$; $p < 0.05$) to achievement in stoichiometry are significant while the contribution of career aspiration ($\beta = .044$; $t = 1.566$; $p > 0.05$) is not significant. The standardized coefficients (Beta) are used.

Discussion of Findings

This study aims to determine the influence of students' attitude to problem-solving, career aspiration and locus of control on students' achievement in stoichiometry. The findings of this study revealed that students' attitude to problem-solving is a predictor of students' achievement in stoichiometry. This implies that when students demonstrate a more positive attitude to solving problems in chemistry, their achievement in stoichiometry will improve. This result is in support of previous similar studies conducted by Cutumisu and Bulut (2017) who reported that there's a positive relationship between students' attitude to problem-solving in mathematics and their achievement. From Bandura's self-efficacy theory, students with a positive problem-solving attitude are more likely to believe they can successfully solve stoichiometric problems.This high self-efficacy increases effort, persistence, and strategic thinking, especially when the students encounter difficult mole-ratio or limiting-reagent problems.Such students are willing to attempt problems multiple times, learn from errors, and apply different strategies, leading to deeper conceptual understanding. This also agrees with the

findings of Wun and Yew (2015) who reported that students with a strong attitude to problem-solving in chemistry had higher achievement scores.

Also, the result of this study showed that students' locus of control has a predictive significant relationship with achievement in stoichiometry. This implies that the higher the locus of control of the students, the higher their achievement in stoichiometry. This result corroborates the findings of Kumar and Asha (2016) who reported that there is a significant positive relationship between students' locus of control and achievement in science. This result also agrees with the findings of Majzub, Bataineh, Ishak and Rahman (2016), who found that there's a positive relationship between locus of control and high scores of students. Students with an internal locus of control believe success in stoichiometry depends on their effort, understanding, and strategies.This belief strengthens their self-efficacy because students perceive a direct connection between what they do and how well they perform. As a result, they adopt self-regulated learning behaviors, such as checking calculations, reviewing errors, and seeking clarification which deepens their understanding and an improvement in their achievement. More so, this result also confirms the findings of Arsini, Ahman and Usmana (2023). They submitted that students with high internal locus of control had super resilience and high achievement.

Furthermore, the result of this study also shows that students' career aspirations in chemistry does not significantly predict their achievement in stoichiometry even though the results reveal a positive correlation between them. This implies that students with higher career aspirations tend to perform better in stoichiometry, however when other variables such as attitude to problem-solving, locus of control, self-efficacy, or study habits are included in a regression model, career aspiration may not explain additional variance. This suggests that career aspiration operates indirectly, influencing achievement through motivational or cognitive variables rather than directly affecting performance.Thus, while aspiration is related to achievement, it may not independently predict stoichiometry performance. This result is in consonance with the findings of Cairns and Dickson (2021) who reported that there's a positive relationship between students' career aspiration in STEM related courses and their achievement in science subjects. This result also aligns with the study conducted by Bewunetu and Tewodros (2022) that the career aspiration of students in higher education correlates with their achievement. They reported that students who showed interest in pursuing a career in higher education performed better in science subjects. Although literature shows a positive correlation between career aspiration and academic achievement, career aspiration may not be a significant predictor of senior secondary school students' achievement in stoichiometry because it is a distal, indirect, and often unstable motivational factor. Achievement in stoichiometry is more strongly driven by proximal variables such as self-efficacy, attitude to problem-solving, locus of control, and persistence, which directly influence students' engagement and learning processes.

Conclusion

The findings from this study indicated that students' attitude to problem-solving and locus of control have positive relationships and significantly predict students' achievement in stoichiometry while career aspiration in chemistry has a positive non-significant relationship and does not also significantly predict students' achievement in stoichiometry. This study is limited to only three non-cognitive variables; thus, we cannot generalize the findings for all non-cognitive variables. More so, we cannot generalize the results for cognitive variables. The study was conducted in Lagos State, therefore the findings cannot also be generalized for other states in Nigeria.

Recommendation

Based on the findings of this study, it is therefore recommended that policy makers should research on other cognitive factors that could significantly predict students' performance in stoichiometry so that teachers can consider these factors in the teaching and learning process. Schools should also organize career day to show students career opportunities available in chemistry while also encouraging students to develop their internal locus of control and attitude to problem-solving as these can cumulatively improve their performance in stoichiometry.

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