PRIOR KNOWLEDGE AND REASONING ABILITY AS PREDICTORS OF ACADEMIC ACHIEVEMENT AMONG SECONDARY SCHOOL CHEMISTRY STUDENTS IN KADUNA SOUTH LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

BY

GOJE L.
Department of Science Education,
Faculty of Education, Kaduna State University, Nigeria
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Abstract
The study investigated prior knowledge and reasoning ability as predictors of academic achievement among secondary school chemistry students in Kaduna South Local Government Area, Nigeria. The sample comprised of four hundred (400) SS11 students, selected using simple random sampling technique from a population of two thousand eight hundred and eighty nine (2889) students. Correlational study was adopted for the study. Two instruments were validated and used for data collection; these are Group Assessment of Logical Thinking (GALT) with a reliability coefficient of 0.84 and Chemistry prior knowledge test (CPKT) with a reliability coefficient of 0.86.The students' MOCK Examination scores were used as the achievement score and was used to measure the academic achievement of the students. Three research questions were stated to guide the study, these research questions were analyzed using descriptive statistics. Three null hypotheses were also stated and Regression analysis was employed to analyze the data at $P \leq 0.05$. Major findings of the study indicated that prior knowledge and reasoning ability are good predictors of academic achievement in chemistry and could account for achievement by 90% and 49% respectively for reasoning ability and prior knowledge. Based on this, it was concluded that reasoning ability and prior knowledge are positive predictors of academic achievement in chemistry and that reasoning ability is the best predictor of academic achievement of students in chemistry. It is therefore recommended that students at all levels should be exposed to reasoning ability skills and adequate prior knowledge in teaching and learning environment.

Keywords: *Prior knowledge, Reasoning ability, Academic achievement.*

Introduction
Education is vital to national development because it equips citizens with knowledge, skills and values needed to drive economic growth, foster innovation and promote social progress in every component of the society. The purpose of education in Nigeria was first unveiled at the national curriculum conference of 1969 where, the focus of education in the country was designed. The need for the accessible, qualitative and

relevance of education in Nigeria was stressed because, the basic philosophy of the national policy on education is that, if the right kind of education is given, the nation's ills will be solved (Akanbi and Abiolu, 2018). Despite the focus and plans on Nigeria's educational system, sciences and scientific principle have been faced with multiple challenges that need to be given attention to. Science is increasingly a central aspect of people's everyday lives hence, educators, policy makers and researchers are focusing on ensuring that science education helps in preparing future citizens to attain scientific literacy because scientific principles are important tools required by all nations for technological innovations (Tytler, 2014).

Students are different in thoughts, reasoning, confidence, and behavior which depend largely on their nature and the way they view and interpret the world. This could affect the students in achieving success academically and other facets of life and that is why researchers like Nafrin & Hudaida (2021) stated that education includes the process of making changes to one's attitude and behavior in order to reach maturity through teaching and training activities. In this era of scientific innovation and development, most developed and developing nations have designed their educational policies to fit into the new trend, and Nigeria is part of. Hence, the National Policy on Education (FRN, 2013) stressed the need for a functional education for the building of: a free and democratic society, a just and egalitarian society, a united, strong and self-reliant nation, a great and dynamic economy, and a land full of bright opportunities for all citizens. The policy also stated that, education shall continue to be highly rated in the national development plan because education is the most important instrument of change in the intellectual and social outlook of the society. These national development goals can be achieved with education as a tool.

Reasoning ability refers to the power and effectiveness of the processes and strategies used in drawing inferences, reaching conclusions, arriving at solutions and making decisions based on available evidence (Patrick, 2020). Paul (2016), stated that, the higher the ability of an individual to reason abstractly, the better the chances of the individual to function effectively in the society. Hence, reasoning ability has great influence in the overall life pattern of an individual and academic achievement in particular. Empirical study in support of this was provided by Lawson-Mari (2012) who reported that reasoning ability highly correlated with performance on concepts acquisition tasks for Biology and Chemistry students. Study by Mehraj (2016) also revealed that reasoning ability assist students in gaining true knowledge because knowledge is based on logic and rationality. There are six components of reasoning ability which include, conservation, proportionality, control of variables, probability, combinatorial and correlational reasoning.

Studies of Santosa (2015) and Egolutm & Mbaegbu (2023) have shown that, there is a direct link between prior knowledge and academic achievement. Their studies indicated how prior knowledge can influence learning outcomes. According to Karunia

and Yutdhanegara (2015), learning can work well if one can adapt new knowledge to the previously existing one in the cognitive domain. Therefore, considering students prior knowledge to manage learning process is very important. Studies on prior knowledge, reasoning ability and academic achievement indicated a direct link between these variables. The reports indicated that students with adequate prior knowledge and high reasoning ability performed better in science (Bhat2016 and Dangana 2021). Researches shows that some science topics are more abstract than others, thus, it seems reasonable to correlate achievement of students in different topics in chemistry to determine which of them relate more with reasoning ability. Researches into the factors that could affect students' academic achievement were attributed to factors like prior knowledge (Egolutm & Mbaegbu, 2023) and reasoning ability (Dangana, 2021)among others, hence this study.

Statement of the Problem

Available evidence from West African Examination Council (WAEC) and WAEC Chief Examiners Reports (2007-2021), revealed that students' achievement in chemistry at the senior secondary school level has been fluctuating and unsatisfactory. This persistent poor performance of students in science and chemistry in particular has called for divergent investigations into the factors responsible for the problems. Some of the problems encountered by students in chemistry include the abstract and highly conceptual nature of the subject which seems to be difficult for the students due to its specialized language, mathematical expressions, and the amount of content to be learned among others. Academic achievement in science is affected by a variety of factors which include reasoning ability and prior knowledge. These factors require students' attainment of formal operational stage and adequate prior knowledge. There are other factors which influence pupil's academic achievement, these ranges from school climate, parental involvement, intelligence, parental occupation, their educational level, problem solving interest, aptitudes, learning styles and socio-economic status of the parents and many other factors (Can, 2009).

Researches like those of Egolum & Mbaegbut (2023), Yenilmez (2016), Dangana (2021) among others have shown that positive relationship exist between reasoning ability and prior knowledge in the academic achievement of students and reasoning ability is a primary factor influencing achievement. Research in science education has focused largely on cognition and instructional methods like inquiry, demonstration, problem solving among others, with little consideration of affective constructs and its relationship with academic achievement (Fortus & Vedder-Weiss, 2014). Hence, there is the need to turn our attention to affective construct such as reasoning ability with a view to addressing a dearth of research investigating these factors related to science education (Fortus and Daphna, 2017). This is because no matter how good an instructional strategy is, student variable could affect learning. The influence of these variables could be

determined in this study since there are conflicting results that established each of these variables under study.

Objectives of the Study

The objectives of the study are to:

1. Determine the relationship between reasoning ability as a predictor of academic achievement of chemistry students in Kaduna South Local Government Area.
2. Determine the relationship between prior knowledge as a predictor of academic achievement of chemistry students in Kaduna South LGA.
3. Determine the relationship between reasoning ability, prior knowledge and academic achievement as predictors of academic achievement in chemistry.

Research Questions

The following research questions were stated to guide the study:

1. Does reasoning ability predict the academic achievement of chemistry students in Kaduna South LGA?
2. Does prior knowledge predict the academic achievement of chemistry students in Kaduna South LGA?
3. Does reasoning ability and prior knowledge predict the academic achievement of chemistry students in Kaduna South LGA?

Null Hypotheses

The following Null hypotheses were formulated and tested at $p \leq 0.05$ level of significance.

Ho_1: Reasoning ability is not a predictor of academic achievement among chemistry students in Kaduna South Local Government Area.

Ho_2: Prior knowledge is not a predictor of academic achievement among chemistry students in Kaduna South Local Government Area.

Ho_3: Reasoning ability and prior knowledge are not predictors of academic achievement among chemistry students in Kaduna South LGA.

Methodology

The study employed descriptive design involving correlational study. Correlational research involves the collection of data in order to determine whether a relationship exist between two or more quantifiable variables. The population of the study comprised all SS11 chemistry students in 2022/2023 academic session in Kaduna South Local Government Area of Kaduna State. 400 students were randomly sampled from a total population of 2889 students. Two instruments namely, the group assessment of logical thinking (GALT) consisting of multiple choice test and chemistry prior knowledge test (CPKT) consisting of forty multiple test items that covers SS1 and SS11

curriculum were used to generate data for the study. These instruments were administered to the respondents and retrieved immediately after completion. The researcher administered the instrument with the help of the chemistry teachers in the schools. The study employed the split half method to determine the reliability coefficient of 0.84 and 0.86 for GALT and CPKT respectively. For academic achievement, previous marks obtained by the students in their state MOCK examination were used. This examination is jointly written by all SS11 students in the entire state. It is organized by the ministry of Education in Kaduna state. Descriptive statistics involving mean and standard deviation were used to analyse the research questions while regression analysis was used to test the hypotheses at 0.05 alpha level of significance.

Results

The research questions and hypotheses were treated based on the data collected from the respondents.

Table 1: Descriptive statistics on relationship between Reasoning Ability and academic achievement among Chemistry Students

Variables	N	Mean	Std. D	M.d r
Reasoning Ability	400	39.69	8.870	
				2.11 0.95
Academic Achievement	400	41.82	7.174	

Table 1 shows the mean value of 41.82 for academic achievement and 39,69 for reasoning ability. The r value of 0.95 indicates the existence of prediction between reasoning ability and academic achievement.

Table 2: Linear Regression Analysis on reasoning ability as Predictor to Students' Academic Achievement in Chemistry

Unstandardized Coefficients values			M		R-value			P			
B	S.E	Df		R-cal	R^2		Adj. R^2		Remark	Decision	
Reasoning Ability(Constant)	34.78		2.618			39.69					
					398		0.95	0.90	0.70	0.00	Sig	Reject
Students' Academic Achievement	0.117		0.062			41.82					

P value < 0.05, R> 0.440

Table 2 shows the linear regression analysis on reasoning ability as a predictor of students' academic achievement in chemistry. The calculated regression value R = 0.95 is higher than the standard regression value of 0.44 and the p value of 0.00 is less than the adopted alpha value of 0.05. The result indicated that reasoning ability is a significant predictor of students' academic achievement in chemistry.

Table 3: Descriptive statistics on relationship between Prior knowledge and academic achievement among Chemistry Students

Variables	**N**	**Mean**	**Std. D**	**M.d**	**r**
Prior Knowledge	400	38.10	24.04		
				3.72	0.70
Academic Achievement	400	41.82	7.174		

Table 3 shows the mean value of 38.10 for prior knowledge and 41.82 for academic achievement. The r value of 0.70 indicates the existence of prediction between prior knowledge and academic achievement.

Table 4: Linear Regression Analysis on Prior knowledge as a Predictor to Students' Academic Achievement in Chemistry

Unstandardized Coefficients values			**M**		**R-value**		**P**			
B	**S.E**	**Df**		**R-cal**	**R^2**	**Adj. R^2**		**Remark**	**Decision**	
Prior knowledge (Constant)	37.09	7.127		38.10						
			398		0.70	0.49	0.24	0.00	Sig.	Reject
Students' Academic Achievement	0.024	0.168		41.82						

The result revealed that the calculated regression value of R=0.70 is higher than the standard regression value of 0.44, and the p value of 0.00 is less than the adopted alpha value of 0.05. The result indicated that prior knowledge is a significant predictor of students' academic achievement in chemistry.

Table 5: Descriptive Statistics on the relationship between Reasoning Ability, prior knowledge and Academic Achievement among Chemistry Students

Variables	N	Mean	Std. D	R
Reasoning Ability	400	39.69	8.870	
Prior knowledge	400	38.10	24.03	0.95
Academic Achievement	400	41.82	7.174	

The table revealed that the r value of 0.95 between reasoning ability, prior knowledgeand academic achievement indicate the existence of positive prediction between reasoning ability, prior knowledge and academic achievement in chemistry.

Table 6: Multiple Regression Analysis on Reasoning Ability and Prior knowledge as Predictors of Academic Achievement in Chemistry

Unstandardized Coefficients values			**M**			**R-value**		**P**	
B	S.E	D.f			R-cal	R^2	P		Remark
Reasoning Ability (Constants)		0.070	0.041		39.69				
Prior Knowledge		0.002	0.015	398	38.10	0.95	0.89	0.00	0.00 Sig.
Academic Achievement		38.81	1.681		41.82				

P value < 0.05, R> 0.440

The result revealed that the calculated regression value of R=0.95 is higher than the standard regression value of 0.44, and the p value of 0.00 is less than the adopted alpha value of 0.05. The result indicated that prior knowledge and reasoning ability are significant predictors of students' academic achievement in chemistry.

Discussion

The findings of the study revealed that students reasoning ability positively predicted students' academic achievement in Chemistry. It indicated that reasoning ability accounted for a 90% increase in academic achievement. This is due to the fact that reasoning ability allows students to analyze information objectively, evaluate arguments, and identify logical inconsistencies among others. This finding is in agreement with the findings of Rani (2017) and Bojan (2017), who asserts that students' formal reasoning ability can be enhanced through effective instruction and is also a predictor of science achievement in general. The finding is also in line with the findings of Paul (2016), Vilia*et al* (2017), Anwar and Zein (2019), Dangana (2021) who revealed a positive correlation between reasoning ability and academic achievement. The finding of this study is in disagreement with that of Kunchon (2018) who reported that reasoning ability is not a good predictor of academic achievement. This could be as a result of differences in level of the students and environmental factors.

The findings revealed that prior knowledge positively predicted students' academic achievement in Chemistry. It indicated that prior knowledge accounted for a 49% increase in academic achievement. This is due to the fact that prior knowledge serve as a foundational building block for new knowledge. This finding is in agreement with the findings of Smith et al (2019), and Zambrano (2019) who concluded that for students to have better academic achievement in chemistry there is a need for them to have adequate prior knowledge. Other researchers like Siswa et al (2018), Binder et al (2019) and Han et al (2023) revealed prior knowledge to be a significant predictor of academic achievement.

Conclusion

Based on the findings of the study, the researcher concluded that reasoning ability and prior knowledge positively and significantly predicted the academic achievement of SSII students in chemistry. The study also concluded that reasoning ability was a good predictor of academic achievement in Kaduna South Local Government Area based on the percentage rating of the variables.

Recommendation

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

i. Chemistry teachers and other science-based teachers should tailor their strategies to adopt students varying patterns on reasoning ability for improving students' academic achievement.
ii. Students should be exposed to adequate prior knowledge and reasoning ability skills, for improving and re-addressing problems in academic achievement.

iii. Government agencies and stakeholders should organize in-house training and retraining of teachers on regular workshops and seminars for chemistry teachers on reasoning ability and prior knowledge for maximum academic achievement.

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