Influence of Learners' Characteristics and Enabling Inputs on Secondary School Students' Achievement in Chemistry

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***Abstract*: This paper examined the influence of learners' characteristics (prior knowledge and school readiness) and enabling inputs (instructional, infrastructural facilities and human resources) as well as school type on secondary school students' achievement in chemistry. Three research questions guided the study. Correlational and quantitative research designs were adopted which involved a sample of 469 Senior Secondary School 2 (SS2) chemistry students from Anambra State. Three instruments were used in data collection which include: Learners Characteristics Rating Scale (LCRS); Enabling Inputs Rating Scale (EIRS) and Chemistry Achievement Test (CAT). Data were analyzed using mean, standard deviation, step-wise and multiple regression analysis. Results show that school types, prior knowledge and teaching-learning materials had highest influence on students' achievement in chemistry. Also, a joint influence of teaching-learning materials, infrastructural facilities and human resources on students' achievement in chemistry was obtained. The paper concludes that adequate attention should be given to learners' characteristics and enabling inputs to foster quality education in Nigeria as stipulated in the senior secondary school chemistry curriculum. The paper suggests that schools should be adequately prepared in providing stimulating, inspiring and learner-friendly classroom environments for meaningful teaching and learning of chemistry to take place.**

***Keywords*: School Types, Prior knowledge, Achievement, Human Resource, enabling inputs**

I. INTRODUCTION

Chemistry as a science subject has contributed immensely in all fields of study. Despite its importance to national development, Nigeria government has not adequately provided enabling environment for secondary school students' to excel in science, technology, engineering and mathematics (STEM) disciplines (Okafor & Okewale, 2016). Several studies have outlined inadequate consumables, equipment, learners' unpreparedness, inadequate instructional, infrastructural and human resources as factors retrogressing achievement in chemistry (WAEC, 2015; Okafor, 2017; Okafor & Uzoechi, 2012). Okafor et al., (2016) explained that the inclusion of home and school variables could foster secondary school students' retention and completion of chemistry education. Okebukola (2005) posited that learners' characteristics which involve personal, academic and social life may influence what, how and why students' learn STEM. Okafor (2018) noted that during learning process, students construct knowledge through explanations by making connections between prior and new knowledge. Okafor (2018) further posited that prior knowledge, school facilities, students readiness, human and material resources could provide result-oriented achievement in scientific knowledge. This paper therefore, examined learners' characteristics (prior knowledge and school readiness) and enabling inputs (instructional, infrastructural facilities and human resources) as well as school type on secondary school students' achievement in chemistry.

Learners' Characteristics and Learning Environment

Learners' characteristics involve variables such as personal and academic which may influence what and how students learn. Personal characteristics focuses on age, gender, language, maturation while academic involves learning goals, prior knowledge, educational type and levels. There are different learners' characteristics according to respective groups such as pupils, students, professionals, older and disabled persons. These groups might differ in various characteristics such as motivation, prior knowledge, readiness and physical abilities and are likely to influence students' achievement in diverse ways. Ajayi, Ekundayo & Osalusi (2010) explained that prior knowledge and school readiness could predict overall development of learners' future achievement. Phala & Chamrat (2019) stated that students learning characteristics have consequences on their active learning implementation. Phala & Chamrat (2019) outlined possible outcomes of active learning in 12 traits indicating students characteristics. . Their emphases were based on how students integrate information with their prior knowledge, develop positive attitudes and self-esteem. Ayodele (2000) posited that learners' characteristics derived from gender, prior knowledge, readiness and ethnicity are recognized and require attention in students' achievement. Fakeye (2012) stated that students' prior knowledge and school readiness are very important in enhancing learners' capacities. There is a declining concern on the type of learning that takes place in most Nigeria secondary schools with less emphasis on the prior knowledge students brought to the classroom as well as schools unpreparedness in making learning environment friendly (Okafor, 2018; Okafor et al., 2016). Wolf & Fraser (2007) stated that the physical outlook of school environment forms the fulcrum on which other activities revolve. Asiabaka

(2008) explained that the transfer of knowledge thrives in an environment that provides platform for concepts to be illustrated, skills acquired and achievement ascertained by the students. A cursory look at school readiness shows that science laboratory which is an essential facility in skills acquisition is lacking, many classrooms, examination halls, libraries and office furniture are in dire need of repairs. The quality of education being provided in some Nigerian schools is shameful and embarrassing due to government years of neglect and fund embezzlement.

Enabling Inputs in Secondary Schools

Enabling inputs are the social amenities of the school environment such as teaching-learning materials, physical infrastructures, human resources and good governance. They enhance achievement when adequately provided irrespective of the school types. Lynch (2010) observed that the number of learners in a class ranges between 75 and 98 especially in many secondary school classrooms in Nigeria. Okebukola (2005) maintained that the school infrastructures and facilities play vital roles in determining students' responses to situations around them. Earthman (2004) stated that the condition of facilities in a learning environment determines teachers' and students' performance. This is because, if facilities are inadequate or dysfunctional, the learning process would be impaired and academic productivity will decrease. There is enough evidence that the inadequacy of infrastructural facilities, particularly buildings, have led to unproductive learning environment (Olatunji, 2013). Okafor & Uzoechi (2012) and Vandiver (2011) discovered that a positive relationship exists among availability of teaching-learning materials, infrastructure, human resource and student achievement in science. Okafor et al., (2012) postulated the type of facilities students need for achievement in chemistry such as; spacious laboratory, adequate instructional and recreational facilities, good housing for hospitality and general purposes. Olatunji (2013) alluded that for proper teaching and learning of science, there must be adequate provision of instructional, infrastructural and human resources in secondary schools. It is obvious that schools without adequate teachers, laboratory facilities and supportive staff would likely not achieve its objectives.

Types of Schools in Nigeria

The two types of secondary schools in Nigeria are public and private. Public secondary schools are owned and managed by government; while private schools are owned by individuals as commercial ventures. Majority of students in public schools have minimal knowledge and exposure to the required facilities that foster achievement and scientific skills acquisition in chemistry (Okafor, 2012, Okafor, 2021). Most private schools are adequately equipped with basic instructional and infrastructural facilities. Vandiver (2011) compared the science achievement of students in public and private secondary schools and found the mean scores of private school students' achievement higher than those in public schools. Umar & Samuel (2019) conducted a study on the influence of school facilities and school types on senior secondary school science students' academic performance. Their result showed a significant influence of academic performance on private and public schools. They suggested that government should provide succor to most schools in both the rural and urban areas with joint efforts of Private-Public-Partnership (PPP) for salvaging the schools from total collapse in Nigeria. It is also observed that private schools have small class size, safe, neat and welcoming environment as opposed to public schools (Umar et.al.2019). 21st Century fund (2005) stated that children who attended private schools had better achievement in sciences than their public school counterparts. The fund recommended policies for public schools to ensure that facilities are provided adequately. The perception that private schools had better achievers' than their counterparts in the public schools is also determined by adequate provision of equipment, teaching-learning facilities and human resources (Okafor et al., 2012).

Theoretical Framework

Jean Piaget (2001) in Baken (2014) described learning as interplay between two mental activities, called assimilation and accommodation. Assimilation is the interpretation of new information in terms of pre-existing concepts, information or ideas. It operates jointly with accommodation, which is the revision or modification of pre-existing knowledge to align with the new information or experience. Piagetian theory on assimilation and accommodation work together to enrich students' thinking in the creation of cognitive equilibrium, which is a balance between reliance on prior information and openness to new information. At any given time, cognitive equilibrium consists of an ever-growing repertoire of mental representations for objects and experiences. Piaget (2001) in Baken (2014) called each mental representation a schema which is an elaborated mixture of vocabulary, actions, and experiences related to the concept. However, students' achievement in the school is influenced by their prior knowledge and school readiness to support the availability of human, instructional and infrastructural facilities for efficient connection to the new experiences.

Conceptual Framework

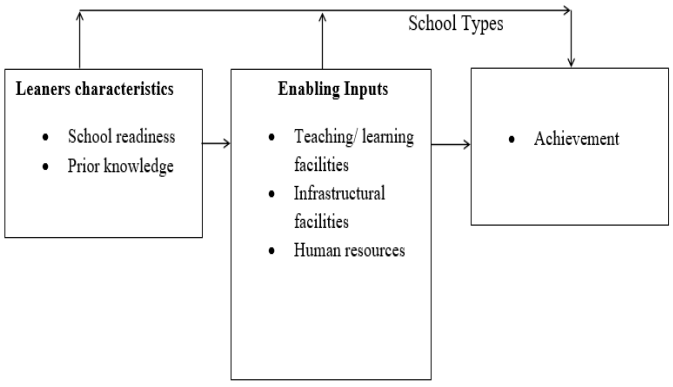

Figure 1: Adopted with modification from: Tikly, L. (2010)). Framework for understanding the quality of education

The comprehensive framework for understanding quality education was presented as a means of organizing and understanding the different variables of education quality" Two main categories of components interact to produce outcomes that should be assessed in the context of agreed objectives. Those learners' characteristics, enabling inputs and type of schools are most likely to influence achievement. This framework takes account of only cognitive outcomes. This paper therefore examined the influence of learners' characteristics (school readiness, prior knowledge) enabling inputs (teaching-learning materials, infrastructural facilities and human resources) and school types on secondary school students' achievement in chemistry.

Problem

The arbitrary neglect of public and private secondary schools in Nigeria due to poorly trained human resources, inadequate instructional and infrastructural facilities as well as non-cognizance of the knowledge students' brought to the classroom have contributed to educational sub-standard and low achievement in chemistry (Okafor, 2018). Education sector in Nigeria secondary schools has suffered inadequate laboratory facilities, poor funding, lack of incentives and poor remuneration of teaching and non-teaching staff (Okafor, 2012; Okafor et al., 2012; Ayodele, 2000). The study of Ayodele, (2000) on the relationship of the physical environment to teachers' professionalism revealed that physical environment influences students' performance. Ogbeba & Ogbeba (2007).posited that Nigeria education system is in crisis with dilapidated buildings, poorly staffed, vandalized classrooms without essential teaching and learning materials. Similarly, Ajayi, Ekundayo and Osalusi (2010) observed that numerous public secondary schools in Nigeria are languishing in crumbling walls, inadequate human and material resources. Many classrooms, laboratories, examination halls, libraries and office furniture are in need of repairs. Most public schools do not have toilet facilities and the dormitories are rat infested. During the rainy season, it is common to see classrooms and dormitories with leaking roofs, cracked walls and roofs blown off, making the students uncomfortable and these do not promote learning (Nwosu, 2015). It is obvious that the unattractive physical structure of the school buildings and compounds would likely engender poor achievement in sciences (Nwachukwu & Nwosu 2007). Hence the need to ascertain the influence of learners' characteristics (school readiness, prior knowledge), enabling inputs (teaching-learning materials, infrastructural facilities and human resources) and school types on secondary school students' achievement in chemistry.

Research Question

The following research questions guided the study:

1. What is the contribution of school type on secondary school students' achievement in chemistry?
2. What are the relative contributions of learners' characteristics (school readiness and prior knowledge) on secondary school students' achievement in chemistry?
3. What are the relative contributions of enabling inputs (teaching-learning materials, infrastructural facilities and human resources) on secondary school students' achievement in chemistry?

II. METHODS

The study adopted correlational and quantitative survey research designs which involved a sample of 469 Senior Secondary School 2 (SS2) chemistry students drawn from Ekwusigo Local Education District of Anambra State which has the highest number of schools in Anambra State. In each of the schools, only public and private schools whose principals are biased in sciences and teachers holding Masters' degree in chemistry education were considered. In all, seven public and three private schools met the criteria. All the chemistry students in each arm of the eligible schools participated in the study consisting of (396 public and 73 private) with an average age of 14 years. The SS2 chemistry students were chosen because they were not preparing for any external examination and had done chemistry at the SS1 level. In addition, only electrochemistry which students perceived to be difficult was considered. Three instruments were used in data collection such as: Learners Characteristics Rating Scale (LCRS); Enabling Inputs Rating Scale (EIRS) and Chemistry Achievement Test (CAT).

LCRS was adopted from Behavioral Characteristics of Superior Students Rating Scale with modification in some items to suit school environment in Nigeria. It has two sections A and B. Section A covers Age, Class Level and School Type while Section B has 10 statements on each of Prior Knowledge and School Readiness respectively. Respondents are to rate every statement on a four-point scale of Rarely =1, Occasionally=2, Often =3, Most of the Time =4. Each of the responses helped in ascertaining learners' characteristics.

EIRS was adopted from Instructional Materials Learning Support Rating Scale with some modifications. It has One Section which was divided into Three (3) categories of Teaching-learning Materials, Infrastructural Facilities and Human Resources. Each category contains five statements and respondents rated each using 0, 1, 2, 3 and 4 as indicators on each of the evidences such as: 0= No evidence of Facilities; 1= Facilities partially present; 2= Facilities consistently in the laboratory, 3= Facilities consistent and adjustable by teachers and 4= Facilities consistent and adjustable by students and teachers.

CAT was a 25 multiple choice items that covered the concept of electrochemistry using Test Blueprint to ensure that items covered the six levels of cognitive educational objectives. For example, (1) When a metal plate is placed in a solution containing its ion, some of the atoms from the metal plate will ionize and go into solution as negatively charged ions. This can be represented with one of the equations: (a) $M_{(s} \longrightarrow M^{2+} + e$ (b) $M_{(s)} \longrightarrow M^{+} + e$- (c) $M^{+}_{(aq)}/M_{(s)}$

(d) $M^{2+}_{(aq)}/M_{(s)}$. 2. A reaction brought about by loss of electron and gain of electron simultaneously is known as (a) Electrolytic reduction (b) Redox reaction(c) Oxidation reaction (d) reduction reaction.

The validity and reliability of the instruments were ascertained by administering each of these three instruments to three public and one private schools respectively that did not participate in the study. Their responses were determined using Cronbach Alpha and Kuder-Richardson formula 20 with reliability indices of LCRS r = 0.87, EIRS r = 0.84, CAT r = 0.76 showing evidence of internal consistency. The instruments were later administered to the target audience and their responses were analyzed using mean, standard deviation, step-wise and multiple regression analysis.

III. RESULTS

Results are discussed under the following research questions

RQ 1: What is the contribution of the school types on secondary school students' achievement in chemistry?

Table 1ai: Descriptive Statistics of School Types

School Type	Frequency	Percentage (%)	Mean
Public	396	84.4	1.16
Private	73	15.6	
Total	**469**	**100**	

Table 1ai shows 84.4% and 15.6% of public and private schools respectively with the mean of 1.16.

Table 1aii: Descriptive Statistics of School Types (public and private) Contributions on students Achievement in chemistry

Variables	Mean	SD	N	Achiev	ST
Achievement	15.35	4.319	469	1.00	
School Type(ST)	1.16	0.363	469	0.718	1.00

Table 1aii shows the descriptive statistics of school types' contribution on students' achievement with mean score of 1.16. The relationship between school types and achievement is high (r= 0.718). Hence the influence of school types on students' achievement in chemistry.

Table 1b: Relative Contribution of School Types on Students' Achievement in Chemistry

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig
	Beta (β)	Standard Error	Beta (β)		
Constant	5.665	0.637		8.900	0.000
School Type	8.536	0.384	0.717	22.231	0.000*

* = Significant at 0.05 level of significance

Table 1b reveals significant contribution of school types on students achievement (β= 0.717; t=22.231; p<0.05). Further assessment shows that private schools had more influence on students' achievement than the public schools.

RQ 2: What are the relative contributions of learners' characteristics (school readiness and prior knowledge) on secondary school students' achievement in chemistry?

Table 2a: Descriptive Statistics of Relative Contributions of Learners' Characteristics (School Readiness and Prior Knowledge) on Students' Achievement in Chemistry

Variables	Mean	SD	N	Achiev	SR	PK
Achievement	15.35	4.319	469	1.00		
School Readiness(SR)	15.28	5.108	469	0.449	1.00	
Prior Knowledge(PK)	14.79	5.275	469	0.468	0.943	1.00

Table 2a shows contributions of school readiness and prior knowledge on students' achievement. School readiness has mean score of 15.28 while prior knowledge 14.79. The influence of school readiness on achievement is r= 0.449, which is very low as compared to that of prior knowledge on achievement which is r= 0.469. This shows that students' prior knowledge has greatest influence on students' achievement in chemistry than school readiness.

Table 2b: Relative Contribution of School Readiness and Prior Knowledge on Students' Achievement in Chemistry

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig
	Beta (β)	Standard Error	Beta (β)		
Constant	9.584	0.558		17.190	0.000
School Readiness	0.056	.104	0.067	0.544	0.587
Prior Knowledge	0.332	.101	0.405	3.300	0.001*

* = Significant at 0.05 level of significance

Table 2b delineates significant contribution of prior knowledge on secondary school chemistry students' achievement in chemistry (β= 0.405; t=3.300; p<0.05), but not much significant contribution of school readiness on students' achievement in chemistry was obtained (β= 0.067; t= 0.544; p>0.05). Hence, the influence of prior knowledge over school readiness on students achievement in chemistry.

RQ 3: What are the relative contributions of enabling inputs (teaching-learning materials, infrastructural facilities and human resources) on secondary school students' achievement in chemistry?

Table 3a: Descriptive Statistics of Relative Contribution of Enabling Inputs (Teaching-Learning Materials, Infrastructural Facilities and Human Resources) on Students' Achievement in Chemistry

Variables	Mean	SD	N	Achiev	TLM	IF	HR
Achievement	15.35	4.319	469	1.000			
Teaching-Learning Materials(TLM)	9.55	5.471	469	0.610	1.000		
Infrastructural Facilities(IF)	9.52	5.472	469	0.608	0.992	1.00	
Human Resource(HR)	9.87	5.225	469	0.591	0.943	0.952	1.000

Table 3a shows the relative contributions of teaching-learning materials, infrastructural facilities and human resources on students' achievement in chemistry. Teaching-learning materials mean score is 9.55, infrastructural facilities mean score is 9.52, while the human resource has mean score of 9.87. Teaching-learning materials recorded highest contribution on achievement (r= 0.610), followed by infrastructural facilities (r= 0.608) and the least human resource (r= 0.591). This is an indication that the teaching-learning materials had most influence on students' achievement, followed by infrastructural facilities while human resources had the least influence. This means that students can efficiently learn on their own without the physical presence of teachers and other supportive staff, if teaching learning materials and infrastructural facilities are provided adequately for every student.

Table 3b: Relative Contribution of Enabling Inputs (Teaching-Learning Materials, Infrastructural Facilities and Human Resources) on Students' Achievement in Chemistry

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig
	Beta (β)	Standard Error	Beta (β)		
Constant	10.604	0.341		31.105	0.000
Teaching-Learning Materials	0.370	0.227	0.468	2.628	0.014*
Infrastructural Facilities	0.008	0.247	0.010	0.033	0.974
Human Resource	0.115	0.099	0.140	1.168	0.243

* = Significant at 0.05 level of significance

Table 3b confirms significant influence of teaching-learning materials on students' achievement (β= 0.468; t=2.628; p<0.05), but there is not much significant influence of infrastructural facilities (β= 0.010; t= 0.033; p>0.05) and human resources (β= 0.140; t= 1.168; p>0.05) on students' achievement in chemistry.

IV. DISCUSSIONS

Contribution of School Types on Students' Achievement in Chemistry

The result shows that private schools significantly contributed to students' achievement in chemistry than the public schools. This finding is in line with the assertion of Okebukola (2005) who stated that private schools are adequately equipped with basic facilities for effective learning to take place. It also corroborates with Ajayi, Ekundayo & Osalusi (2010) who confirmed that best achievement is obtained in private secondary schools than in the public schools. This could be due to the private schools small class size, neat and friendly environment as well as adequate provision of instructional and infrastructural facilities as compared to the over-populated public schools with unwelcoming atmosphere.

Learners' Characteristics (school readiness and prior knowledge) on Students' Achievement in Chemistry

The finding shows that students' prior knowledge had the highest influence on students' achievement in chemistry than the school readiness though both had joint influence on students' achievement in chemistry. This is in agreement with the assertion of Okafor (2018) who posited that prior knowledge, ideas and experiences students' bring to the classroom could influence how they learn new concepts and skills. The result also supports Okafor (2018) statement that students are not "blank slate" but could link their prior knowledge to new knowledge for concepts accommodation and assimilation. However, this finding negates the assertion of Lynch (2010) who explained that school readiness is linked to students' learning outcomes and their future achievement.

Enabling Inputs (Teaching-Learning Materials, Infrastructural Facilities and Human Resources) on Students' Achievement in Chemistry

The finding indicates that teaching-learning materials had the highest influence on students' achievement in chemistry, followed by infrastructural facilities while human resources was the least. There is also an indication that teaching-learning materials, infrastructural facilities and human resources jointly influenced students' achievement in chemistry. This corroborates with the submission of Okafor & Uzoechi (2012) who stated that no effective science education programme can exist without adequate laboratory facilities since learners achieve better when engaged in hands on activities that require consumables and non-consumables. The result also supports Okafor & Okewale (2016) who reiterated the importance of home and school opportunities in the provision of students' learning materials and infrastructural facilities for girl- child completion of chemistry education. The finding equally connects to Okafor et al., (2012) assertion that laboratory facilities when adequately provided, could enhance students achievement in chemistry The less prediction of infrastructural facilities negates the work of Earthman (2004) who explained without equivocation that the

unattractive school buildings and overcrowded classrooms contribute to poor achievement of the students in sciences but availability, relevance and adequacy of instructional and infrastructural facilities could foster students' achievement. It is well acknowledged that significant improvement in the school environment is attributed to the adequacy and availability of teaching-learning materials, infrastructural and human resources.

V. CONCLUSION

The prediction of future achievement in chemistry derived from students' prior knowledge, preparedness of the schools in the provision of adequate teaching and non-teaching staff, instructional and infrastructural facilities are recognized in this study. The observed unfriendly environments in most public and private schools in Nigeria is due to long term neglect of many dilapidated classrooms, laboratories, examination halls, libraries and office furniture. These are obvious blind-spots the hinder quality education in Nigeria. The significant contributions of school types, prior knowledge and teaching-learning facilities on secondary school students' achievement in chemistry demand the homes, school owners and Nigeria government to earmark adequate funds to its education system that would be comparable to those in other African countries. The lackadaisical attitude of most education stakeholders in Nigeria has caused several damages to education of secondary school chemistry students especially in the provision of teaching and learning materials. It is expected that adequate attention should be given to learners' characteristics and enabling inputs as variously discussed for efficient, effective and inspiring achievement of secondary school chemistry students' in Nigeria as stipulated in the senior secondary school chemistry curriculum.

VI. RECOMMENDATION

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

- The public and private schools should be adequately equipped with teaching-learning and infrastructural facilities for an enhanced achievement of secondary school chemistry students.
- Schools should be well prepared in providing stimulating, inspiring and learner-friendly classroom environment for meaningful teaching and learning to take place.
- Parents should exposed their children at home to those activities that would promote their academic, social, personal and moral development for achieving positive learning outcomes in chemistry.
- States and Federal ministries of education should ensure that learner characteristics are positively monitored and enabling inputs adequately provided for every chemistry students especially during practical activities.
- Government should provide adequate funds for provision of instructional and infrastructural facilities for improved achievement in secondary school chemistry.
- Teachers should assist the students in giving explanations on the prior knowledge they bring to the classroom for meaningful understanding of chemistry concepts.
- Public school principals should ensure that approved funds for teaching-learning materials are invested for its purpose to be at the same pace with the private schools in students' achievement.
- Principals should organize workshops and conferences for training of teachers and students on how to improvise inadequate facilities. They should also be motivated with remuneration and incentives.

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