Teaching strategies and secondary school physics students' enrolment and academic attainment in Rivers State, Nigeria: implications for teaching and learning of physics in schools

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Abstract: **This paper examines the teaching strategies commonly employed by physics teachers in the classroom. Particularly, the study utilized mixed methods involving questionnaires, tests, classroom observations and structured interviews to explore the common teaching strategies used by teachers and the effects of these strategies both on the enrollment and attainment of students in physics. Teachers and students in eight senior secondary schools were purposively selected for the study. Findings from the study show that teachers and students were at variance as to the most commonly used teaching strategy by teachers in the teaching and learning of physics and that whereas teachers reported the use of demonstration, more students reported that elements of demonstration were 'never' used by teachers than those who reported otherwise. The study also shows that the teaching strategy adopted by physics teachers directly influences the enrolment and attainment of students in the subject. The study recommends that government and relevant stakeholders should ensure the adequate provision of well-equipped laboratories and that science teacher training institutions promote trainee-teachers skill and knowledge in improvisation and resourcing of science materials for the effective teaching and learning of physics in secondary schools.**

***Keywords*: Teaching strategies, physics students, enrolment, academic attainment, teaching and learning.**

I. INTRODUCTION

It has been the interest of the science education community not only to determine what students should be learning in science lessons or the assessment as to whether or not students are actually learning but also, the 'how' in terms of what strategies or approaches teachers use that would ensure maximum understanding and effective lesson delivery. According to Tanner (2013), this is in view of drawing "attention to questioning the efficacy of traditional lecture methods and exploring new teaching techniques to support students in more effectively learning…" (p.322). The use of the traditional or conventional teaching method which is generally referred to as the 'talk-chalk' or lecture method has been much discouraged not only in science classrooms but generally in schools as a result of its gross ineffectiveness in equipping learners with life-long skills and knowledge (Selcuk & Caliskan, 2010; Adolphus, 2016). Bar-Yam, Rhoades, Sweeney, Kaput and Bar-Yam (2002) described the traditional/conventional teaching approach where educational goal is viewed as the transmission of knowledge from the teacher to student as a 'convergent' teaching approach and geared towards the teaching of specified subject matter. According to them, "the convergent approach is highly structured and teacher-centered were the students are passive recipients of knowledge transmitted to them…" They further stressed that where educational goals are geared towards "facilitating students' autonomous learning and self-expression" then approaches that enhance "open ended and self-directed learning" which they termed 'divergent' teaching" (para. 4) would be stressed.

Some researchers have investigated the common teaching methods adopted by school science teachers especially in developing countries and reported that most teachers employ the traditional, teacher-centered approaches in their classroom interactions (Buabeng, Ossei-Anto & Ampiah, 2014; Faremi, 2014; Modebelu & Nwakpadolu, 2013). For instance, Buabeng, Ossei-Anto & Ampiah (2014) examined the teaching and learning of physics in senior high schools in Ghana and concluded most physics teachers adopted teacher-centered approaches in their classroom interaction such as lecture and discussion methods. A similar finding was reported by Mehmood and Rehman (2011) who conducted their study in Pakistan on the teaching and classroom interactions used by secondary school teachers in the country. They reported a step-by-step activity of both teachers and students as follows:

1. teachers' presents a brief overview of the contents;
2. teacher's uses A.V. aids to enhance the student's comprehension of the concepts;
3. teacher speaks at a rate which allows students time to take notes;
4. teacher evaluates the success of his teaching by asking questions about the topic at the end of the session and;
5. Teacher assigns homework and checks it regularly (p.313).

This approach of teaching as illustrated above clearly presents the students as passive learners who 'take notes' while the teacher does the speaking or teaching. It does not present the teacher as a facilitator of learning where students are encouraged to engage with learning tasks both individually and in groups with relevant facilities and resources under the guidance and support of the teacher. This sort of teacher-centred approach to teaching is what Wise (1996) described as "teachers dispense knowledge to passive student audiences, with textbooks alone constituting the science curricula; students are rarely involved in direct experiences with scientific phenomena" (p.337). It is not very likely that students would gain substantial understanding of scientific knowledge when taught science in such didactic manner.

Several researchers have investigated the effect of teaching approaches on the attainment of learners in physics. (see for example, Wise, 1996; Raine & Collett, 2003; Selcuk & Caliskan, 2010; Celik, Onder & Silay, 2011; Uside, Barchok & Abura, 2013; Adolphus & Aderonmu, 2012; Adolphus, 2016). For instance, Wise (1996) conducted a secondary meta-analysis to investigate the effect of experimental teaching approach on students' attainment in middle and high schools in the United States and concluded that the experimental teaching strategies at the secondary schools' level were more effective at enhancing students' attainment than the traditional science teaching approaches. Uside, Barchok & Abura (2013) investigated the effect of discovery approach on physics students' attainment in Kenya. They compared the relative effectiveness of the Discovery Experimental Method, DEM and the Teacher Demonstration Method, TDM. Their study revealed that "there was a significant difference in the physics attainment of students in experimental and control groups among secondary school students in favour of the DEM" (p. 357). Their study further revealed that the Discovery Experimental Method "enhanced memory retention and instilled confidence in students to remember and apply knowledge accurately" (p. 357). In another study, Musasia, Abacha & Biyoyo (2012) investigated how girls' performance, attitude change and skills acquisition are affected by practical work in physics. They concluded that students "involvement in meaningful practical work contributes to improved performance in the topics from which the practical was derived" and that "a significant change occurred in the attitude (of girls) towards physics in the experimental group compared to the control group" (p. 163). In Nigeria, Akanwa and Ovute (2014) compared the effects of conventional and constructivist teaching approaches on the attainment of physics students. The students were taught lessons on sound and waves in 2 separate groups, with each group taught with either of the methods. They reported that students who were taught using the constructivist approach achieved significant high scores compared to those taught with the conventional method. Also in Nigeria, Thomas and Israel (2013) investigated the degree of effectiveness of some teaching strategies in measuring the performance of students in physics. They compared the effects of Polya's heuristic, project based and lecture methods on students' attainment and reported that "the use of Polya's heuristic method enhanced students' attainment" (p. 123). Karakuyu (2010) in Turkey compared the effects of concept mapping and conventional teaching approaches on physics students' understanding of electricity. 2 equivalent groups were taught using either method for a period of 6 weeks, with 2 classes of 1 hour each per week. At the end of his study, he reported that "the scores of the experimental group were consistently higher than those of the control group while the standard deviations were consistently lower" (p. 728). McCrory (2013) in his article, "in defence of the classroom science demonstration" maintained that demonstrations in science classroom emotionally engage students and make them focus and curious on what is the content of demonstration. According to him, "demonstrations are perfectly suited to exploiting curiosity (which is) the powerful engine driving most of our learning" (p. 83).

The primary goal of every teacher is to ensure that his students gain proper understanding of the materials and or concepts they are engaged with, in the classroom or school setting so as to produce a reasonable change in behaviour. This is what is referred in literature as 'teachers' educational goals' (Rich, 1993), or 'learner goals' as one of the categories of goals teachers may set (McGreal, 1980). According to Tebabal and Kahssay (2011), such desired changes in behaviour expected of students 'may be in the form of acquiring intellectual skills, solving problems and inculcation of desirable attitudes and values' (p. 374). Teachers employ different strategies and create enabling environment so as to support students acquire the desired skills and knowledge with various classroom and or laboratory experiences. This study therefore investigates how the teaching strategies employed by physics teachers affect secondary school students' enrollment and attainment in physics.

Purpose of the Study

Specifically, the study sought to find out:

i. teaching strategies that are commonly used by physics teachers in their lesson delivery, and
ii. The effects of teaching strategies adopted by physics teachers on students' enrolment and attainment in physics.

Research Questions

Two research questions were formulated to guide the study.

i. What teaching strategies are commonly used by physics teachers in their lesson delivery
ii. What are the effects of the teaching strategies adopted by physics teachers on students' enrolment and attainments in physics?

II. METHODOLOGY

The population of the study is all physics students in public secondary schools in Rivers State. Purposive sampling was adopted to select teachers and students from eight senior secondary schools with records of high or low physics performance in past Senior Schools Certificate Examinations in Rivers State. The study utilized mixed methods involving questionnaires, tests, classroom observations and structured interviews to explore the common teaching strategies used by teachers and the effects of these strategies both on the enrollment and attainment of students in physics. According to Creswell (2012), mixed research methods involves the collection and analyzing of data by both quantitative and qualitative methods in a single study or series of studies to understand a research problem. Particularly, the study adopted the descriptive survey together with the case study design. As a survey, questionnaires and tests were used to obtain information on teachers' choice of teaching strategies and opinion from both teachers and students on the effects of teachers' choice of strategy on students' enrolment and attainment. For the purpose of anonymity, schools used in this study have been coded with letters.

III. RESULTS

Teachers' self-reporting in response to the questionnaire item on the teaching strategies they usually adopt in teaching physics to the students is presented below. All 14 teachers responded to this section of the questionnaire although, one teacher did not make any response for 'demonstration'. In Table 1 the numbers in bracket represent the percentage response while the numbers preceding the brackets are the actual count of teachers that responded to the questionnaire item.

Table 1: Teachers' self-reporting of teaching strategies adopted for physics lessons

Responses	Every or	About half the	Some lessons	Nev er	Tota l
	almost every	Lesson			resp onse
Strategies	Lesson				
Demonstratio n	8 (61.5)	1 (7.7)	3 (23.1)	1 (7.7)	13
Lecture	1 (7.1)	3 (21.4)	3 (21.4)	7 (50)	14
Guided discovery	3 (21.4)	4 (28.6)	5 (35.7)	2 (14. 3)	14
Laboratory	0 (0)	1 (7.1)	10 (71.4)	3 (21. 4)	14
Field trip	0 (0)	0 (0)	3 (21.4)	11(7 8.6)	14
Excursion	0 (0)	0 (0)	3 (21.4)	11(7 8.6)	14
Collaborative					
learning	1 (7.1)	2 (14.3)	7 (50)	4 (28. 6)	14
Problem solving	3 (21.4)	7 (50)	4 (28.6)	0 (0)	14
Project method	0 (0)	1 (7.1)	8 (57.1)	5 (35. 7)	14

The teachers' self-reporting of strategies they commonly used for teaching physics shows that the most commonly used teaching strategy among physics teachers is 'Demonstration'. Most of the teachers (61.5%) indicated that they usually use the method in 'every or almost every lesson'. Also, 50% of physics teachers use 'Problem solving' method in 'about half the lesson' – that is, about 1 in every 2 lessons. Most teachers also indicated that they rarely use Laboratory, Collaborative learning and Project methods in 'some lessons' with 71.4%, 50% and 57.1 % respectively. The response of the teachers shows that 'Field trip' and 'Excursions' are not usually used as a teaching strategy with most teachers (78.6%) indicating that they 'Never' use them. Interestingly, 50% of teachers also indicated that they 'Never' use 'Lecture' as a teaching strategy in their physics classes. Teachers have also reported that they seldom use students' collaborative learning approach in their physics lesson with just 14.3% indicating that they use the strategy in about half the lessons.

On the strategies adopted by teachers in teaching physics, qualitative data from the teachers' interview suggests that teachers commonly use lecture and demonstration methods in their teaching. This can be seen in the excerpts from the interview with some of the teachers in response to the question on the teaching strategy they commonly use in class.

"…most times I use lecturing method, most times I use demonstration, I demonstrate, then most times I use question and answer, just for interaction sake, and most times too I do research, I give them work to go and research, a kind of project they should go and research on something and come back" (Physics Teacher 1).

Teaching strategies used by this teacher, according to him are lecture, demonstration, Socratic (questioning) and project depending on the content of instruction. Another teacher responded very explicitly as presented below:

"Ok, most a times I adopt the demonstration method of teaching. What do I mean by demonstration? I go with… most times the apparatus that are available, to demonstrate to students on the use of these apparatus while teaching, like when I was teaching SS I just this morning. I went with the conductor, I went with the ammeter, the volt meter, the cell, I went with the key and the… all necessary materials to demonstrate to them the need to understand what we mean by a circuit or what we mean by close circuit, open circuit and short circuit. So most times I do use the demonstration method to teach for easy understanding of the students" (Physics Teacher 2).

The inference from this teachers' expression is that the most common teaching strategy he uses is 'Teacher Demonstration' method. Incidentally, of the 7 physics classes observed, this was the only teacher that used a teaching resource in his lesson. He was teaching 'Heat Energy: Temperature and its measurement' in an SS2 class (about 15-year olds) and passed on a thermometer for them to 'see' and 'observe' although students' 'passing on thermometer' without actual materials for them to take real measurements and carry on some hands-on activities is obviously inadequate for the teaching of that topic. Probing further on how students get involved in demonstration, the teacher explained that:

"The only students that… are… mostly allowed to come into the… say, made-shift laboratory is the SS III because of space, so most of the JSS students are not allowed until they are able to get to SS III before they can have a feel of this apparatus" (Physics Teacher 2).

The expression above reveals that students do not have the opportunity to get involved with hands-on activities until they are in the final year of secondary education. It is also clear from the above expression of this teacher that what he understands 'demonstration method' to be is 'teacher demonstration' while the students simply watch. It is unlikely that students would learn science effectively in that way.

Table 2: Teachers' opinion on main school-related factors affecting students' choice of Physics in secondary schools

Factors/Responses	Strongly Agree	Agree	Disagree	Strongly disagree	Can't say	Total
Lack of adequate number qualified physics teachers	7 (50.0)	1(7.1)	2(14.3)	3(21.4)	1(7.1)	14
Teaching physics by theory without practical	4(28.6)	5(35.7)	3(21.4)	1(7.1)	1(7.1)	14
Lack of lab equipment for demo/experiments	7(50.0)	2(14.3)	1(7.1)	4(28.6)	0(0)	14
Lack of career guidance/counselling services	8(61.5)	5(38.5)	0(0)	0(0)	0(0)	13
Unsocial lifestyle of some physics teachers	2(14.3)	3(21.4)	3(21.4)	4(28.6)	2(14.3)	14

On the teachers' response of their common use of 'demonstration', it is important to note that most teachers (64.3%), (see Table 2) indicated that 'lack of lab equipment for demonstration and experiments' was a major school-based factor that affects students' choice of physics in their school.

Table 3: Teachers' opinion on factors limiting the effective teaching of physics in schools

Factors/Response	Not at all	A little or some	A lot	Total respondents
Shortage of computer hardware	1(8.3)	7(58.3)	4(33.3)	12
Shortage of computer software	2(16.7)	6(50.0)	4(33.3)	12
Shortage of textbooks for students' use	1(8.3)	3(25.0)	8(66.7)	12
Shortage of instructional equipment for students' use	0(0)	2(16.7)	10(83.3)	12
shortage of equipment for teacher's use in demo	3(25.0)	2(16.7)	7(58.3)	12
Inadequate physical facilities	0(0)	5(45.5)	6(54.5)	11
High student/teacher ratio	3(25.0)	5(41.7)	4(33.3)	12
Unavailability of computers with internet access	0(0)	4(33.3)	8(66.7)	12

Also, 58.3% of teachers (see Table 3) revealed that 'shortage of equipment for teachers' use in demo' was a limiting factor to the effective teaching and learning of physics. It is therefore surprising to observe that 61.5% of physics teachers usually use demonstration method in 'every or almost every' of their physics lessons. Teachers' clear understanding of some of these teaching strategies that was not probed in this study may also account for some of the inconsistencies in their responses. For instance, the response of some teachers on 'students' participatory learning' in physics classes during the interview may suggest that some teachers may have understood and interpreted the various teaching strategies in various ways. Presented below are excerpts of two responses of physics teachers to the question: 'to what extent are students involved in participatory learning during your physics classes?'

"The participation to physics students in physics classes is satisfactory. Sometimes I might be too busy, with administrative work forgetting that I have time with them in physics, they will be the ones to come and call me and tell me that, sir we need you, we want to learn physics, then sometimes too they might be so free not doing anything like free period most of them will just come, sir, come and occupy us with physics so if I am free I will still go even without my period, that is it" (Physics Teacher 3).

"Well, I think, e...h... I would say they are trying, they are coping. The only problem I have is this SS III, they had problem in their SS I and SS II because then they had no teacher, if not for the newly employed teachers that now filled up those gaps. So I am just trying to battle with them - you understand? Picking up things from SS I, SS II, just to make up but they are still trying" (Physics Teacher 2).

The responses of these teachers to the question that was posed to them may suggest that they do not understand what 'participatory learning' was all about.

Some of the items in the students' questionnaire sought to get the opinion of students on how often they do certain activities in their physics lessons – 'listen to the teacher present new material', 'watch the teacher demonstrate an experiment or investigation', 'conduct an experiment or investigation', and some others. The students' response is presented below and would be compared with that of their teachers. 248 physics students from the 8 schools involved in the study responded to the questions, although between 5 and 11 students did not respond to some of the questions. Their responses are presented in Table 4. The figures in bracket are the percentages while the actual numbers of student respondents precede the brackets.

Table 4: Students' response on how they learn in physics lessons

Responses Activities	Every or almost every Lesson	About half the lesson	Some Lessons	Never	Total response
We listen to the teacher present new material	51 (21.8)	29 (12.4)	93 (39.7)	61(26.1)	234
We work problems on our Own	82 (31.7)	50 (20.8)	101(42.1)	7 (2.9)	240
We work on problems together with other students	96 (40.3)	35 (14.7)	74 (31.1)	33(13.9)	238
We watch the teacher demonstrate physics on a Computer	4(1.7)	4 (1.7)	5 (2.1)	229(94.6)	242
We watch the teacher demonstrate an experiment or investigation	56 (23.3)	16 (6.7)	97 (40.4)	71 (29.6)	240

Student responses as shown in Table 4 reveal that 40.3% of physics students indicated that they 'work on problems together with other students. Although that percentage is low, with no clear consensus of students' opinion, working on problems together with other students appears to be the commonest activity or how they learn physics. In terms of demonstrations in physics lessons, students were near unanimous in their responses with 94.6% indicating that they 'Never' watch their teachers demonstrate physics on a computer. As to whether they 'watch the teacher demonstrate an experiment or investigation', only 23.3% indicated its occurrence in 'every or almost every lesson', 6.7% in 'about half the lesson', 40.4% in 'some lessons' while 29.6% responded 'Never'.

It is evident from the foregoing that whereas teachers posited that 'demonstration' strategy was most commonly used for physics lessons, the response from the students has not suggested that that is what they experience in physics classrooms. More students indicated that the demonstration elements – 'We watch the teacher demonstrate physics on a computer' and 'We watch the teacher demonstrate an experiment or investigation' 'Never' occur often in physics lessons with 94.6% and 29.6% respectively, than those who posited that they occur in 'every or almost every' lesson with 1.7% and 23.3% respectively for the two demonstration elements. The understanding of some teachers on demonstration method as 'teacher demonstration' to the exclusion 'student demonstration' as discussed earlier may explain the difference between teachers and students' responses on the use of demonstration method in physics lessons.

Result as presented in Table 4 suggests that students' working together with other students is the commonest way students learn physics with 40.3% of the students indicating that they often work on problems together with other students in "every or almost every physics lesson". This does not agree with what physics teachers have claimed as can be observed from Table 1, where only 7.1% of the teachers have said they use "collaborative learning" which implies students' working together, for physics lessons and 14.3% using the strategy in "about half the lessons". From the contradiction between the students and teachers' response on the use of 'collaborative learning' or students working on problems together with other students, it is possible that students understood the question to mean how they learn physics and not necessarily what happens during the physics lessons in school. For instance, in one of the students' interviews, a participant described how they assist one another to better understand what they could not understand in the classroom with their teacher:

"there are some students that understand what the teacher is doing, just because they read their text books. They understand what the teacher is doing… so immediately the teacher leaves, he can call the other of his colleague just like what my friend always does to me…he showed me the details and how the thing is being done. Some of the students are afraid to ask the teacher in the class they do meet one-on-one with their fellow students and when they explain it will be better than when the teacher taught them" (Physics student 1).

The students in their interviews also gave some light on what happens in their physics lessons. In one school, a student in describing how they learn physics stated that:

"when the physics master gets into the class to teach, the first thing he does, he will write down the topic on the board and then explain what that topic simply means, then after that, he goes over to the calculation…" (Physics student 2).

A student in another school described what happens in their physics class this way:

"The teacher normally… when he comes to the class, he writes the note and he will have to teach. In the aspect of teaching, he explains the topic he is teaching and he breaks it down for our understanding, he breaks it down to the knowledge, to the understanding of what he is teaching and also in order for us to learn" (Physics student 3).

The description of how students learn physics in schools as illustrated by these students and few others as captured in the interviews tell more of the use of 'lecture' method and not 'demonstration' as claimed by most of the teachers.

Some students explained how the classroom interactions and teaching strategy adopted by their teachers affect their understanding of physics.

"I study physics and I'm a physics student. Physics… I find it very interesting and the way my teacher teaches physics and he analyses it…if it is a topic, he brings out the things to show us and we understand it…the class flows when he teaches, so I just like it" (Physics student 1).

"…and also our teacher, he makes us enjoy the subject very much, like she said, analysing it, showing us things, asking us questions, if we understood it or not and also contributing to what he has taught…" (Physics student 4).

"In the aspect of teaching he explains the topic he is teaching and he breaks it down for our understanding, he breaks it down to the knowledge, to the understanding of what he is teaching and also in order for us to learn… when he is teaching, he also asks questions to know if we are truly following… and if we do not respond he tries to make us understand that it's good to ask questions in whatever we don't understand. So when we ask questions he clarifies us and we gain that knowledge… He encourages the students…" (Physics student 2).

The above quotes of students from the interviews illustrate positive effects of the teaching strategies and classroom interactions on students understanding of the subject.

There were also some students who expressed how they have been discouraged from continuing with the study of physics and how the teacher's style of teaching, by their claims, did not effectively support their learning.

"…this is what we are saying, this is the problem we physics students are facing today, em.., when we look into the learning environment, we find out that there are no good things to back up em… the study of physics that is why most students run away; in fact there is no laboratory in which we conduct most practical, all thing are theoretical which are not helping matters and this is one of the things that make students run away because they don't understand this, because practical makes you understand more, that is just the thing" (Physics student 2).

"…when we started learning physics, the first teacher that taught physics, he was doing very well, but when they changed the teacher to a female, I find it difficult to flow and the female teacher that was teaching us physics was not really good at physics. She was making it difficult for me that was why I don't choose physics" (Non-physics student 1).

"…in SS I, the teacher, the male teacher that taught physics was a very good teacher but and I also believe that female teachers are not good in teaching science subjects like physics. The female teacher that took us physics was not that sound, she was not teaching very well to our understanding" (Non-physics student 2).

"When I was in JSS our physics teacher is the basic science teacher, he always talk about... also the basic technology teacher… they talk of light, he talk of plus and minus, maximizing things and they don't do practical, they just do it, they just say it, they just say it theory and we don't even understand what they are saying and they don't even care, they just say it…" (Non-physics student 3).

The excerpts above represent claims of mainly non-physics students and those who could not continue with the subject having lost interest in the subject as a result of the teaching strategies adopted by their teachers. All these suggest that whether positively or negatively, the classroom interactions and teaching strategies affect students' physics enrolment and attainment.

In the next section, the classroom observation report of the researcher will be presented for all schools observed. This is done to corroborate or otherwise, the claims of both the students and the teachers on how physics lessons are conducted in the schools. The lesson topic being observed together with the teachers' and students' activities of the observed lessons would be reported.

Classroom observation of physics lessons

Classroom observation of physics lessons was made in 7 out of the 8 schools used in the study. As explained earlier, the teacher in the 8th school was reluctant to have his lesson observed. The Science Classroom Observation Worksheet (SCOW), Classroom Observation Schedule (COS) together with field notes made in observation sessions were used to obtain data. In this section, the information and data regarding the topic taught, average age of the students, teaching resources that were used, both teacher and students' activities during the observed lessons and the duration of the classes observed are presented. Table 5 summarizes the observations of the 7 lessons in 7 schools.

Table 5: Classroom observation summary of physics lessons

School	Topic taught	*Resources	Observed Activities	
			Teacher	Students
A1	Types of waves	-	Review of previous lesson, introduce new lesson, explaining, telling, questioning, note giving	Answer questions, passive, listening, note copying
B1	Heat energy: Temperature and its measurement	Thermometer	Questioning, review of previous lesson, introducing new lesson, explaining, illustrating (showed students a thermometer and passed on from one student to another), telling, writing key points, note giving	Answering questions, listening passively, observing thermometer, note copying
C1	Capacitor and Capacitance	-	Recall previous lesson, introduce new topic, lecture (informing), Occasionally	Listening, passive, answer questions, note

			questioning, explaining, note giving	copying
D1	Electromagnetic field	-	Review of previous lesson/Questioning, introducing new lesson, lecture (telling), explanation, Note giving	Answer questions, passive, listening, jotting, Note copying
B2	Simple AC circuit	-	Introducing new lesson, teaching (telling), Explaining, note giving	Passive, listening, note Copying
C2	Resistors: Factors affecting resistance of a wire	-	Started with a math problem from previous lesson, introduced new topic, lecture- listing factors, explanations, dictating notes	Listening, answer questions, passive, asked question, listening, copying notes
E	Waves: Characteristics, types and properties	-	Review of previous lesson/Questioning, explanation, problem solving	Passive, Answer questions, listen, take notes

(*As teachers use available materials in the classroom to facilitate learning, basic materials like chalk and chalk board which are expected to be used by all teachers are excluded as teaching resources and are not listed)

The national physics curriculum as used in Nigeria at the time of the study would form the basis of the evaluation or assessment of the teaching and learning as observed for the lessons, especially in terms of the curriculum proposed teacher and student activities, together with the resources and facilities the curriculum suggests to be utilized for effective teaching and learning of the topics that were taught. Some of the lessons would be evaluated and at the end, what teaching strategy that has been used would be highlighted and compared with the claim of both teachers and students as presented above.

School A1 is a coeducational school. The topic taught was ‘Types of waves’. The curriculum document suggests the use of rope or slinky as ‘teaching and learning materials’. Under the teacher activities, the curriculum suggests the teacher ‘provide rope and slinky to demonstrate transverse and longitudinal waves’ while students were expected to ‘use the rope and the slinky to demonstrate transverse and longitudinal waves’ (FME, 2009:18). A look at Table 5 shows that the teacher neither used any of the suggested teaching and learning materials nor any other teaching resource to facilitate learning and students’ understanding of the concepts. A resourceful teacher who strives to make a student learning-friendly classroom environment, would at least provide a rope (if the slinky is not available and could not be obtained) or possibly ask students to come with one with adequate permission and communication with parents and school authorities. Clearly as shown in the table, neither the teacher nor the students’ activities reflect the suggested activities by the curriculum. The teacher was simply teaching by lecture method, while the students passively listened and took notes. Clearly, the teaching strategy used here is more of the lecture method and nothing of demonstration.

School B1 is one of the coeducational schools that were used for the study. The teacher was observed teaching the Senior Secondary 2 (SS2) class on the topic: ‘Heat Energy: Temperature and its measurement. The teaching and learning materials recommended by the curriculum for this topic are thermometers – different types of liquid-in-glass thermometers, container with moveable position e.g. Bicycle pump or round or flat bottomed flask with delivery tube connected to a water manometer, glass capillary tube, biro tube, coloured water, hot water, cold water, beaker and Bunsen burner. As part of the teacher activities, the teacher was expected among others to “demonstrate (1) how to calibrate a thermometer in Celsius scale (2) how to construct a resistance thermometer and a thermocouple”, while students were expected to “Calibrate a thermometer in Celsius scale and to construct a resistance thermometer and a thermocouple and use them to measure the temperature of water and immediate environment” (FME, 2009:11). It is worth noting that part of the performance objectives for this lesson states that:

“students should be able to: construct a device for measuring the temperature of a body, use the variation of: pressure of a gas with temperature, the expansion of solid, liquid or gas with temperature, electrical resistance of a material to measure the temperature of a body” (FME, 2009:11).

The teacher skipped the students’ hands-on activities that would have exposed them to skills and knowledge necessary to meet that performance objective. The teacher simply came to class with a mercury-in-glass thermometer and passed it on to students at a point, who took turns as it was moved round to ‘touch’ and ‘observe’ the lower and upper fixed points. Teacher and student activities as prescribed by the curriculum document were not carried out in the lesson. The teacher theoretically explained and informed the students, for instance, of the effect of variation of pressure and electrical resistance on temperature. It is however important to observe that of the 7 lessons observed, it was only in this school that the teacher employed a resource – the thermometer, although not adequate, but somehow, to possibly facilitate learning. That notwithstanding, it is evident that in view of the expected teacher and student activities in class, no demonstration activity took place in the class either by the teacher or the students. The lecture method could be used to best describe the teachers’ approach.

School C1 one was one of the two girls' schools that were used for the study. The Senior Secondary 3 (SS3) class was observed with the teacher teaching the topic: Capacitor and capacitance. The topic is a sub-topic under the topic 'Electric fields' that is grouped under the theme: Fields at rest and in motion in the SS3 physics curriculum. As teaching and learning materials, the school physics curriculum suggests the use of copper plates, connecting wires, centre-zero galvanometer, cells/accumulators and capacitors. On the teacher activity, the physics curriculum did not state any activity for the section covering 'capacitance and capacitor'. There were however two stated activities for the students: "Determine the equivalent capacitance for: series, parallel arrangements of capacitors" and to "Calculate the energy stored in a charged capacitor for given values of V, Q and C" (FME, 2009:8). Although there were no stated teacher activities, it may therefore be implied that if students were to 'determine the equivalent capacitance…' then the teacher should demonstrate that determination. It was observed during the lesson that no teaching and learning material (as prescribed by the curriculum) was used for the lesson. Also, there were no activities that involved the students. If resources were available, one would imagine that the lesson would have been more interesting with better learning taking place if the teacher had exposed students to some hands-on activities of connecting capacitors in parallel and serial connections to determine, for instance, the capacitance. The teacher was observed writing down relevant formulas and solving problems while the students occasionally answered questions from the teacher and 'watched' on with some, copying from the blackboard into their note books. There were no student-student interactions neither were students on individual basis given some tasks or problems to solve with the teacher facilitating the classroom experience of the students.

School F is a specialist science college. The school had well-equipped science laboratories for Biology, Chemistry and Physics respectively. During the time of visit, it was noticed that all physics lessons were taught in classrooms, not in the laboratory. For the class observation, one of the three physics teachers in the school was observed teaching the SS 2 class in their classroom.

The topic the teacher was observed teaching was: Waves – characteristics, types and properties. For the effective teaching of this topic, the curriculum has suggested the use of teaching and learning materials to enhance students' learning experiences. Materials required for this lesson are rope or slinky, ripple tank or wide transparent plastic bowl, thin horizontal bar ruler, water, ray box, plane mirror or concave mirror, screen, source of sound, reflector, hard surface, source of heat, optical pin, glass block and triangular prism. The physics curriculum document also has some activities specified for the teacher and students which are thought would enhance learning. The teacher was expected to "provide rope and slinky to demonstrate transverse and longitudinal waves" under the types of waves, while the students were expected to "use the rope and the slinky to demonstrate transverse and longitudinal waves" (FME, 2009:18). The curriculum also provided for teacher and student activities to investigate the aspect of the properties of waves. The teacher was expected to "set up the ripple tank to produce various waves, demonstrate reflection of sound from wrist watch by a reflector, reflection of heat energy by a polished surface *and to* lead the class to discuss properties of waves" (FME, 2009:19). Unfortunately, during the class as observed, none of the demonstrative activities of the teacher was carried out during the lesson. The teacher was also not seen leading the class to "discuss" as was prescribed by the curriculum developers. The teacher was observed more of "lecturing" as he listed wave types and their properties and gave explanations with occasional recall questions which some students responded to.

Also, the student activities were not carried out. The teacher did not provide any of the required teaching and learning materials for the topic. Students were also not encouraged to express their understanding or contribute in a way of discussion of the content other than responding to some recall questions from the teacher. The situation in this school is one in which the resources for teaching are available but not utilized. This is so as the researcher saw the equipped physics laboratory in the school. The senior physics teacher in the school during the interview also held that his school had enough resources for teaching and demonstration at that level.

"As far as this school is concerned, we have enough material resources - in terms of text books, we have the textbooks, we have an available library stocked with books where the students… even if you… if there is any particular text you don't have, it's there in the library. In addition to that, we also have an e-library with all the facilities that the students can access for whatever materials they need. Also, we have our laboratories, though built over the years and all that, but the fact still remains that we have the apparatus, enough apparatus to demonstrate at this level whatever they are supposed to know" (School F teacher).

One therefore wonders why available resources are not utilized. Although only one teacher was formally observed in class, the researcher during visits to the school observed all three physics teachers teaching physics in class at different times without materials. Bothered by the observations and students' comments on non-usage of laboratory facilities, a follow-up interview was held with the senior physics teacher who attributed the perceived lack of usage of resources by students to the increasing number of students that do not match with the available resources which are not expanded to meet up the demands of the growing school population.

"The only thing the students can say about the lab is that as we speak to you now, the lab is not as big as it should; because as the number of students is increasing, there is supposed to be a commensurate expansion. But in terms of setting up… having the materials to set up the practical, we have all that it takes. And when we are having especially an external exam like this, WAEC usually have their requirement, the apparatus they need in the school and if we do not have those, we go and buy and put in the lab so as to make sure that those apparatus are there" (School F teacher).

When asked whether the students' response was possibly as a result of late exposure to laboratory and practical work, the teachers responded:

"Probably yes… probably that could be what they may be thinking. But there is no way we could expose the students to laboratory work from SS1… you don't expect… because most of the topics in SS1 would not take them to the lab. It is in 2nd term in SS2 that we actually begin the laboratory work for SS2 and then SS3" (SCT, 209-212).

That was the explanation of the physics teacher. This explanation may not be valid as the class that was observed was an SS2 class in their 2nd term, yet, no teaching material was employed to facilitate learning. At other times during the visits to the school, the SS 3 class was observed being taught without resources. There are possibilities that teacher non-use of available resources may also be a problem of lack of teacher knowledge in usage of the facilities or inadequate teacher quality training in use of resources during training, which has not been investigated in the present study.

The evidence of the classroom observation as reported above does not seem to support the claim of most of the teachers (65%) that they use demonstration method in "every or almost every lesson". The observation report shows that 6 out of the 7 teachers observed, which represents 85.7% did not utilize any teaching and learning material in their physics lessons even when the curriculum that guides their class activities had suggested the use of those resources to facilitate the understanding of the students. Students did not also have the opportunity to articulate their understanding of the concepts as they were generally not intellectually engaged.

What was observed in the classrooms does not conform to the ideals of the physics curriculum as specified in the document which states in part:

"In order to stimulate creativity and develop process skills and correct attitudes in students, the course is student-activity oriented with emphasis on experimentation, questioning, discussion and problem solving" (FME, 2009: iii).

Unfortunately, in all the 7 lessons observed, this lofty objective of the curriculum developers to make physics teaching in schools to be "student-activity oriented" with key elements of experimentation, questioning, discussion, and problem solving were completely absent. It may only be assumed that the poor state of resource availability for physics teaching and learning in most of the schools may explain the mix-match between the curriculum provision and its actual implementation.

To ascertain the academic attainment of students, a research constructed Physics Achievement Test was with established validity and reliability was administered to students. Secondary data – Senior Secondary Certificate Examination results on past performance was also obtained from the schools. The scores of students in all eight schools used for the study is presented in

Table 6: SSCE and PAT Performance by school

Schools	Mean SSCE %	Mean PAT %	Difference (%)
A1	54.2	15.5	38.7
B1	31.6	20.3	11.3
C1	45.2	13.5	31.7
D1	47.9	11.6	36.3
A2	52.9	25.3	27.6
B2	56.2	18.7	37.5
C2	58.4	27.6	30.8
F	58.1	47.3	10.8
Mean	50.6	22.5	

IV. DISCUSSION OF FINDINGS

Findings on the influence of teachers' teaching strategy on students' enrolment for physics, suggest that teacher-centered teaching strategies commonly used by teachers have not encouraged students to enrol for the subject at the senior secondary school level and may also have contributed to the poor attainment of students in physics as evidenced in the physics attainment test. The findings are discussed below.

On the influence of teachers' teaching strategy on students' enrolment for physics, findings from the present study suggest that teachers commonly use teacher-centered teaching strategies such as lecture and discussion and that the adoption of such approaches has not encouraged students to enrol for the subject in the post compulsory classes of secondary education. The finding of the present study agrees with those of Ebenezer and Zoller (1993), Osborne, Simon and Collins (2003) and Aina and Akanbi (2013) who reported that the quality of teaching was a major factor in students' determination to choose physics after the compulsory years of secondary education. For instance, Ebenezer and Zoller (1993) investigated the perception of Grade 10 pupils and their attitudes towards science teaching in British Colombia using mixed methods research and concluded that the way in which science was taught contributed significantly to students' choice of continuing to study science post-16. Similarly, Aina and Akanbi (2013) studied the students' views on the causes of low science enrolment in Nigerian secondary schools and reported that the inability of science teachers to teach properly either as a result of lack of commitment on their part or bad teaching approaches was among major factors that influenced the low enrolment of students in science.

On the effect of teachers' teaching approach on students' enrolment, students have in the present study desired an appropriate use of laboratory and other teaching facilities that could inspire their motivation and facilitate effective learning. These aspirations of the students to have a better experience of physics teaching and learning is consistent with the finding of Sundberg, Dini & Li (1994) that teachers use of 'content-intensive' approach was not effective and that the rate of withdrawals from science classes could be controlled as students' evaluation showed that laboratory experience strengthens the understanding of core concepts from the lectures with the provision of positive learning experiences to students than in class discussions and lectures. Woolnough (1994) in same vein reported that "those schools which encouraged extra-curricular activities and student science projects, through clubs, competitions, projects and school-industry links, were the ones which sent a large proportion of their students on to higher education to continue with their sciences or engineering" (p. 29). The essential part of Woolnough's finding is that the physics teacher's versatility in identifying relevant activities and resources both within and outside the classroom to enrich the learning experiences of students is key to sustaining their interest in the subject.

Unfortunately, findings from the present study show that most physics teachers do not employ out-of-classroom experiences in their teaching with close to 80% of teachers saying that they have 'never' utilized 'field-trips' and 'excursions' in their teaching. It is important that science teachers employ appropriate pedagogy that would make science classes appealing to majority of the students. According to Osborne, Simon & Collins (2003), science teachers may have a good content knowledge of their subject but may fail to support the effective learning of their students and make them less interested in the subject when they not effectively communicate their lessons by drawing from a rich variety of learning opportunities as a result of their teaching styles. All these show that the teaching strategy adopted by teachers and the ability of teachers to explore all possible resources, personnel and avenues both within and outside the school and classroom goes a long way in presenting physics interestingly to students and could encourage students' enrolment and continuity in the subject.

On the effect of teachers' teaching strategy on physics students' attainment, the result of students in the Physics Attainment Test that was used in the present study shows that students' attainment in physics was low (see Table 6). Also, the classroom observation report of the present study indicates that most teachers adopted teacher-centered approaches in their physics classrooms that are known not to facilitate effective students' learning (see Table 5). Interview data from most students suggest that the teacher-centered approaches adopted by most teachers do not support students' understanding of physics. It is therefore possible that among other factors (some of which have not been investigated in the present study, for instance, parents' socio-economic status), the poor attainment of students in physics may be associated with the teaching strategy adopted by physics teachers. This assumption is supported by the findings of Wise (1996), Uside, Barchok & Abura (2013), Musasia, Abacha & Biyoyo (2012) and Akanwa & Ovute (2014) who concluded that alternative science teaching strategies that are student centered in which students get more active and involved in the learning process were more effective than the traditional science teaching strategies. For instance, Wise (1996) reported that at the secondary school level, the alternative science teaching strategies which included questioning, enhanced materials, instructional media strategies amongst others were found to be more effective than the traditional strategies at improving the attainment of students in the sciences. Similarly, Akanwa & Ovute (2014) compared the effects of conventional and constructivist teaching approaches on the attainment of secondary school physics students in Nigeria and found that those taught with the constructivist approach achieved significantly higher scores than those who were taught with the conventional didactic approach.

The findings of the present study and those of previous studies on the role of teachers' teaching strategies on students' enrolment and academic attainment have clearly underscored the importance of teacher training and retraining on the knowledge and utility of relevant pedagogical strategies that could present physics and generally science as interesting and enjoyable by school pupils and that could improve students' attainment. This is considered relevant for policy planning, teachers' continuing professional development programmes and curriculum developers in institutions that are involved in the training and certification of teachers in Nigeria.

V. IMPLICATION OF FINDINGS

The implication of these findings is that schools need well trained teachers who are conversant with the use of relevant and diverse methods or approaches together with the knowledge of use of necessary scientific appliances and equipment in physics classrooms. Also, that these necessary resources are made available by government and other stake holders, not only for the teachers' use in class demonstration, but also for the use of the individual students in their discovery learning tasks. For most developing countries, the provision of these learning resources and the utilization of appropriate teaching and learning techniques will no doubt better the performance of students in physics and science in general.

VI. CONCLUSION

Physics is a key subject taught at both the secondary and tertiary levels and is central to the study of engineering, medicine, technology and other related fields that drive the global economy in the 21st century. It is therefore important that physics teachers are aware of this pivotal position of the subject, and of the need to effectively engage students with appropriate teaching and learning experiences that would encourage more young people to study the subject, and to get properly motivated as potentially drivers and actors in the knowledge driven fields of science, technology, engineering and mathematics.

VII. RECOMMENDATIONS

Based on the findings and implications of the study, it is recommended that

1. Government and relevant stakeholders should ensure the adequate provision of well-equipped laboratories to enable physics acquire requisite knowledge and skills through engagement with hands-on learning activities
2. Science teacher training institutions promote trainee-teachers skill and knowledge in improvisation and resourcing of science materials for the effective teaching and learning of physics in secondary schools.
3. Relevant monitoring bodies are adequately funded to carryout routine checks on the implementation of prescribed curriculum provisions by teachers in schools.

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