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Extent of availability and usage of various laboratory equipment among physics students' in Port-Harcourt, Nigeria

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Abstract

This study investigated the availability and usage of laboratory equipment among physics students' in Port Harcourt, Nigeria. A descriptive survey design was used for this study. To guide this work, four research questions were stated. The population of the study covers all SS2 students offering physics in Port Harcourt. A sample size of 390 physics students selected through simple random sampling technique were used for the study. A questionnaire titled " Extent of Availability and Utilization of Laboratory Equipment for physics Instruction Questionnaire (EAULEPIQ)" was used for the study for compliance of respondents .The data were analyzed using mean and standard deviation to answer all the 4 research questions. Findings from this study showed that availability and utilization of laboratory equipment for learning physics are at low extent and this is unethical for Physics instructional practices. As a result the following recommendations among others were made: the state Government and all educational stakeholders should ensure that adequate laboratory equipment are supplied to all physics laboratories in all secondary schools; also the state educational board should always organize physics practical inter school competitions where winners will go with enviable prizes, this will motivate teachers and students to always use laboratory equipment for instruction thereby producing physics students that are competent in their use of it for easy understanding of concepts and simplifying abstract concepts in physics. When this is achieved, incompetence in the use of laboratory equipment will be overcome by physics students thereby improving performance.

Keywords: Laboratory equipment**;** Physics students; Quantitative skills; Practical activity; Scientific knowledge

1. Introduction

Physics is a discipline of science that studies matter and energy, as well as their interactions and measurements (Omeodu, 2018). In a different perspective, Henry (2009) defined physics as "the rational development of tests, observations, and theories to explain the fundamental structure of what we observe." This definition is critical for effective living in this age of research and technology. Physics provides the foundational knowledge required for future technological advancements that will continue to power the world's economic engines.

(Oraifo, 2005; Nashon, 1989).To still buttress on the importance of Physics, Amadalo and Ocholla (2012) stated that it imbues learners with systematic thinking, provides the theories necessary for understanding the mechanics of how the things mankind relies on work and also provides students with analytical problem solving and quantitative skills, which are important for many sciences. They went on to say that physics teaches students how to collect and evaluate data as well as how to present their findings in a clear and intelligible manner.

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Ugwuanyi, Nwankwo and Ugwoke (2016) listed the following objectives of teaching Physics at the secondary school level in their study: to enable the students acquire scientific knowledge; to present physics to the students as a stimulating subject; intellectually satisfying and significantly related to their experiences of life; to develop in the students an awareness of the structure of physics and an understanding of the fact that physics is an expanding field; to familiarize the students with fundamental principles, theories and concepts of physics in modern terms and with the scope of physics among others. In other words, it contributes to the technical infrastructure and offers the skills employees required to benefit from scientific advancements and discoveries (Kuhn & Brekl, 2012; Okoye,2014).

Despite these numerous benefits of physics education, performance of students over the years has consistently been poor (Nja & Obi 2019; Ntibi & Neji 2018; Edoho, Ntibi, & Esuong 2017 all cited in Ibok & Uko, 2020). Ali, (1998) attributed this poor performance of students to teaching strategies used by teachers for physics instruction. In agreement with this, Daniel (2014) observed inadequate and under-utilization of laboratory equipment meaning over usage of lecture method in teaching instead of ample time for practical method. Still corroborating these findings, research has shown that laboratory equipment and tools seen in schools are nothing to write home about and teachers most of the time avoid conducting practical work (Yahya & Shamsudeen, 2019) thereby using more of lecture and other methods in teaching. If this ugly trend continues, one of the objectives of the physics curriculum which is to provide basic literacy in physics for functional living in the society and the technological development expected from the knowledge that will be acquired if physics education is properly learned can never be achieved by the society.

Daniel (2014) found a substantial difference in Physics achievement between low-performing students subjected to laboratory-based instructional intervention (LBII) and those exposed to traditional teaching methods in his research (CTM). He recommended in his study that using a laboratory-based instructional intervention technique of teaching as a benefit to Physics students and teachers in senior secondary schools should be encouraged. Similar to his finding, Dahar and Faize (2011), as referenced by Agu and Iyamu (2018), reported in their work that there is a link between scientific laboratory availability and academic accomplishment. However, experience has shown that the majority of secondary school pupils are inept at using laboratory equipment to understand physics. Imeh (2008) conducted a study in Nigeria that clearly demonstrated that underachievers can learn more if the teaching methods are tailored to their learning styles and study habits. Such teaching approaches, according to him, would include the utilization of familiar activities and illustrations, as well as unique materials, equipment, evaluation systems, and sympathetic guiding. He concluded that science teachers will gain a better understanding of students' issues and goals by doing so.

According to Saif (2019), practical activity is at the center of a strong scientific curriculum and offers students with experiences that are aligned with science learning objectives. Tamir (2004) said that practical activity fosters scientific attitudes, increases problem-solving abilities, and enhances conceptual knowledge. Practicals are carried out in a laboratory setting. A laboratory, according to Omiko (2015), is a room or facility dedicated to scientific experiments and research, or a space in a school or institution where the practical part of science is taught. Umoren (2016) remarked that successful teaching and learning requires proper provision of apparatus and equipment for practical physics. The number of times available science laboratory equipment is used during classes or laboratory practical lessons is referred to as utilization of science laboratory equipment (Malach, 2016). Laboratory equipment availability, according to Yahya and Shamsudeen (2019), has a critical role in determining the level of learners' acquisition of science process skills and competency in science ideas. They went on to say that using a laboratory entails making efficient use of its equipment for observation, experimenting, and understanding scientific facts.

In their study of a group of Physics teachers' ideas about practical work in Vietnam, Ng and Nguyen (2006) discovered that while Physics teachers give demonstrations in their classes, the frequency of these demonstrations is quite low. Physics practical is useful in developing students' concepts, according to 75% of these Physics teachers. Their study also showed that Physics teachers preferred to carry out demonstrations rather than leaving pupils to do the practical on their own. The reasons attributed for this were the lack of proper arrangements, unavailability of science equipment and the shortage of time for performing practical, as the teachers have to complete the curriculum in the scheduled time. This is in agreement with the findings of Hassan and Ma'oyi's (2011) as cited in Umoren (2016). They discovered that physics students typically do not graduate from the National Certificate Examination (NCE) program with enough practical skills due to a lack of adequate equipment and apparatus as well as a lack of knowledge about workshop practical. These undergraduate physics students will eventually become tomorrow's teachers, it's no surprise that laboratory equipment is used sparingly in the secondary schools or not at all. This is unethical for physics instruction practices.

However, the teachers training colleges are under severe criticism for its short duration and poor quality of training. The science teachers are trained in theoretical aspect of pedagogy with little emphasis on teaching practice (Memon,

2007) and training in conducting science (especially physics) practical skills for effectively conducting laboratory work. Because science is about learning about the real world and understanding how things work, students' knowledge should be applied to real-world problems (Lunetta, Hofstein, & Clough 2007, as cited in Amadalo, 2016). As a result, it's not surprising that policymakers criticize science professors for students' lack of inventiveness and practical applications (Amadalo, 2016).

However, many researchers had diverse opinions on what could be the challenges facing the teaching and learning of science education, especially physics. Ajayi (2007) outlined inadequate teaching, a lack of learning resources, learners' attitudes, government policy, parental background, a lack of learners' preparation, poor management style, and a lack of adequate competent teachers as factors that influenced physics teaching-learning outcomes over time. According to Obioha (2006), there are insufficient resources for teaching science topics in Nigerian secondary schools. He went on to say that if there are few resources, they are frequently in poor condition, and the few that are in good condition are insufficient to cover everyone who needs them. Adebola (2007) listed poor teacher preparation, shortage of quality teachers, poor methods of teaching and non-usage of instructional materials which also include laboratory equipment as challenges to science instruction. In his study, Omosewo (2008) considered the human factors as the teacher's professional commitment, creativity, mechanical skills, initiative and resourcefulness. He found that many of Nigerian science teachers were aware of possibility of improvisation in tackling the problem of inadequate or unavailability of laboratory equipment but many exhibited poor attitudes towards improvisation. Alamina (2008) reiterated that despite the fact that the world is in the age of technological advancement, the fact still remain that developing countries of the world are still lagging behind with regard to obtaining adequate standard science resource materials for the teaching and learning of science in school especially in Physics. Improvization according to her therefore becomes imperative if the students are to have the practical experience involved in the various science topics.

Oluwasegun and Olabode (2020) stated in their study that practical activities in the laboratory should be close to the students, not at a distance, for proper manipulation of the apparatus, acquisition of necessary skills, and knowledge of principles, ideas, and concepts. Supporting them, Ahmed, Auta, Mohd, David, Buba, and Usman (2019) opined in their work that students will only understand the concepts expected of them if practical activities are used in all science (physics in particular) classes; otherwise, learning short of this could be considered abstract content teaching. No wonder, Nwagbo and Uzoamaka in Ahmed et al (2019) reported in their study that this condition causes pupils to become less engaged and more prone to memorization of facts, which in turn fosters rote learning, a problem that has plagued physics education. Dikmenli (2009), cited in Omeodu (2018), stated that the primary goal of laboratory work in science education is to provide students with the conceptual and theoretical knowledge needed to help them learn specific concepts and scientific methods in order to comprehend the nature of science. This could be the reason why Solomon (1980) also cited in Omeodu (2018) asserted that "Science simply belongs to the laboratory as naturally as cooking belongs to the kitchen and gardening belongs to the garden,".

In physics courses it is crucial that abstract concepts are related to real life events, boring mathematical problems are eliminated and the weight of lab practice is increased (Çelik & Karamustafaolu, 2016; Papanastasiou, Drigas, & Skianis, 2017 all cited in Gülsüm, 2017).

The abstract nature of Physics could be the reason why Esiobu (2005) noted in his study that students in secondary schools are not very much interested in science, physics inclusive (Esiobu, 2005). Manpower demands in technological development are such that science teaching should stimulate students' interest and eventually direct as many students as possible to choose a career in science (Okoye, Okongwu & Nweke, 2015). However, this is not the case since throughout the teaching-learning process, teachers have relied heavily on the use of words to communicate and impart concepts and facts. This practice is termed the "chalk-talk" method where the teacher do the talking while the student listen and take down notes. How can this arouse physics students' interest for the subject? Besides developing critical thinking skills, laboratory work creates motivation and interest for learning (Tamir, 2004). It is therefore imperative that teachers give more time for laboratory work with their students.

Nwagbo (2008) outlined various reasons why science (Physics) education in primary and secondary schools, particularly at the secondary level, is critical. To begin with, he believes that the quality of any educational program in any country is determined by people who teach it. As a result of the scarcity of appropriately prepared science teachers, standards in science classrooms may suffer he added. Explaining further, Nwagbo (2008) reiterated that deficiencies in practical skills and conceptual understanding are passed down from one generation to the next, from teacher to learner, who then becomes a teacher. This loop promotes ineptitude and, over time, can lead to a decline in standards. Secondly, secondary school students serve as a source of recruiting (admission) for future research scientists (applied and fundamental), science teachers, and other scientific and technology-related training programs. He went further to state that in each of these fields, it is possible to argue that the quality of science education in primary and secondary schools, and especially in secondary schools, determines the number and quantity of students who pursue science and technology careers in higher educational institutions. From the foregoing, it is clear that physics must be well-taught, and that this cannot be accomplished without science teachers and students getting more involved in laboratory work. As concluded by Millar (2004) that Practical work is an essential component of science teaching and learning both for the purpose of developing students' scientific knowledge and for the purpose of developing students' knowledge about science.

Hence, this study deemed it necessary to investigate on availability and usage of laboratory equipment among physics students' in Port–Harcourt, Nigeria.

1.1. Purpose of the Study

The purpose of this study was to investigate the Availability and usage of various laboratory equipment among physics students' in Port Harcourt, Rivers State. Specifically, the study seeks to:

- Ascertain the extent of availability of laboratory equipment for physics instruction in senior secondary schools in Port-Harcourt.
- Ascertain the extent of accessibility of laboratory equipment for physics instruction in senior secondary schools in Port Harcourt.
- Ascertain the extent of utilization of laboratory equipment for physics instruction in senior secondary schools in Port Harcourt.
- Ascertain how students rate their physics teachers' knowledge of use of laboratory equipment usage during physics practical.

1.2. Research Questions

The study was guided by the following research questions:

- To what extent is the availability of laboratory equipment for physics instruction in senior secondary schools in Port Harcourt city?
- To what extent are laboratory equipment made accessible to students for physics instruction in senior secondary schools in Port Harcourt City?
- To what extent are physics laboratory equipment utilized for physics instruction in senior secondary schools in Port Harcourt Local Government Area?
- To what extent would you rate your teachers' knowledge of physics laboratory equipment usage during practical?

2. Methodology

A descriptive survey research design was used for the study. The population for this study covered all SS2 students offering physics in Port-Harcourt Local Government Area. Random sampling technique was used to select 400 students. The questionnaire was face and content validated by an expert in science education. An instrument titled "Extent of Availability and Utilization of Laboratory Equipment for physics Instruction Questionnaire (EAULEPIQ)"was administered and questionnaires collected the same day and spot. The questionnaire was structured in such a way that it contained 40 items. The response to the questionnaire was based on 3 points Likert scale. This means that the rating range from: High Extent (HE), Moderate Extent (ME), Low Extent (LE). High extent has 3 marks, moderate extent has 2 marks while low extent has 1 mark on the three point likert scale.

Out of the 400 students sampled, 390 were able to submit their questionnaires. Mean and standard deviation were used to answer the research questions.

3. Results

3.1. Research Question One

To what extent is the availability of laboratory equipment for physics instruction in senior secondary schools in Port Harcourt city?

Table 1 Response of students to the availability of laboratory equipment

S/N	Item Statement	HE (3 Points)	ME (2 Points)	LE (1 Points)	Total	X	SD	Remark
1	Meter rule	-	351	39	741	1.9	0.3	Moderate extent
2	Ammeter	-	85	305	475	1.22	0.413	Low extent
3	Stop watch	8	258	124	664	1.7	0.501	Moderate extent
4	Knife edge	-	186	204	576	1.48	0.5	Low extent
5	Thermometer	8	172	210	578	1.48	0.54	Low extent
6	Vanier caliper	15	186	189	606	1.55	0.57	Low extent
7	Mass	8	172	210	578	1.48	0.54	Low extent
8	Voltmeter	8	227	155	633	1.62	0.526	Low extent
9	Key	8	209	173	615	1.52	0.536	Low extent
10	Batteries	8	171	211	577	1.48	0.54	Low extent
Pool Mean						1.543		

From the analysis of data in table 1, the respondents agreed that items 1 and 3 are available at moderate extent while item 2,4 – 10 are available at low extent. The pool mean of 1.543 showed that availability of physics laboratory equipment for instruction are at low extent.

3.2. Research Question Two

To what extent are laboratory equipment made accessible to physics students for physics instruction in senior secondary schools in Port Harcourt City?

Table 2 Response of students to the accessibility of laboratory equipment

S/N	Item Statement	HE (3 Points)	ME (2 Points)	LE (1 Point)	Total	X	SD	Remark
1	Meter rule	39	288	71	748	1.92	0.525	Moderate extent
2	Ammeter	-	76	314	466	1.19	0.397	Low extent
3	Stop watch	8	158	224	564	1.45	0.537	Low extent
4	Knife edge	-	62	328	452	1.16	0.366	Low extent
5	Thermometer	-	62	328	452	1.16	0.366	Low extent
6	Venier calliper	-	52	338	442	1.13	0.34	Low extent
7	Mass	-	54	336	444	1.14	0.346	Low extent
8	Voltmeter	-	54	336	444	1.14	0.346	Low extent
9	Key	-	53	337	443	1.14	0.343	Low extent
10	Batteries		55	335	445	1.14	0.348	Low extent
Pool Mean						1.257		

From analysis of data in table 2, the respondents, showed that item 1 is accessible at moderate extent to physics students while items 2 – 10 are accessible at low extent. The pool mean of 1.257 shows that physics laboratory equipment are accessible at low extent by the students.

3.3. Research Question Three

Are physics laboratory equipment utilized for physics instruction in senior secondary schools in Port Harcourt Local Government Area?

Table 3 Response of students to the utilization of physics laboratory equipment

S/N	Item Statement	HE (3 Points)	ME (2 Points)	LE (1 Point)	Total	X	SD	Remark
1	Meter rule	159	101	130	809	2.07	0.859	Moderate extent
2	Ammeter	7	135	248	539	1.38	0.522	Low extent
3	Stop watch	32	135	223	589	1.51	0.644	Low extent
4	Knife edge	16	87	287	509	1.31	0.543	Low extent
5	Thermometer	8	72	310	478	1.23	0.465	Low extent
6	Vanier calliper	8	80	302	486	1.25	0.465	Low extent
7	Mass	8	84	318	470	1.21	0.452	Low extent
8	Voltmeter	-	71	319	461	1.18	0.386	Low extent
9	Key	-	64	326	454	1.16	0.371	Low extent
10	Batteries	8	40	342	446	1.14	0.405	Low extent
Pool Mean						1.344		

From analysis of data in table 4, the respondents agreed that item 1 is utilized at moderate extent while items 2 - 10 are utilized at low extent. The pool mean of 1.344 revealed that physics students utilization of laboratory equipment is at a low extent.

3.4. Research Question Four

To what extent would you rate your teacher's knowledge of physics laboratory equipment usage during practical?

Table 4 Response of students to the rating of their teacher's knowledge on physics laboratory equipment usage

S/N	Item Statement	HE (3 Points)	ME (2 Points)	LE (1 Point)	Total	X	SD	Remark
1	Meter rule	211	108	47	896	2.54	0.783	Moderate extent
2	Ammeter	47	212	131	696	1.78	0.641	High extent
3	Stop watch	79	195	116	743	1.91	0.702	High extent
4	Knife edge	31	226	133	678	1.74	0.594	High extent
5	Thermometer	32	247	111	701	1.8	0.571	High extent
6	Vanier calliper	16	280	94	702	1.3	0.493	High extent
7	Mass	16	241	133	663	1.7	0.541	High extent
8	Voltmeter	24	255	111	693	1.78	0.545	High extent
9	Key	-	231	159	621	1.59	0.492	Low extent
10	Batteries	32	209	149	663	1.7	0.612	High extent
Pool Mean						1.834		

From analysis of data in table 3, respondents revealed that their teacher's knowledge on the use of meter rule was at low extent, item 9 showed low extent while items 2 - 8 and 10 showed high extent. Pool mean of 1.834 revealed generally that physics teachers' knowledge of laboratory equipment usage is at high extent.

4. Discussion

The analysis of data on research question 1, seeks to find out the extent to which laboratory equipment's are available for physics instruction. It was observed in the analysis of data in table 1 that laboratory equipment's are available at low extent for physics instruction. This is in consonance with the findings of Ajayi (2008) and Umoren (2016). In his work titled "Evaluation of the Implementation of Senior Secondary School Physics Practical Activities in Nigeria", Ajayi (2008) asserted that physics laboratory equipment are grossly inadequate despite the emphasis of the Federal Ministry of Education.

Also research question 2 which was designed to find out the extent to which students gain access to the use of laboratory equipment's, table 2 showed that students access to the use of laboratory equipment is at a low extent. This is in agreement with the findings of Enoh, (2007). In his work titled "the effect of availability and use of laboratory equipment in effective teaching and learning of Biology" in Ethiope-West Delta, he found out that students are not giving access to the use of laboratory equipment facilities and this has led to the poor performance of physics students in their exams.

Also research question 3 which was designed to find out the extent to which laboratory equipment are utilized, table 3 showed that laboratory equipment are utilized at low extent.. This result is in agreement with the findings of Malach (2019) whose study established that although a majority of the public day secondary schools have the basic laboratory equipment, their utilization by students is somewhat low in physics. This work is also in consonance with Lawal (2013). In his work titled "Resource utilization for teaching Biology towards achieving millennium goals in selected secondary schools in Zaria metropolis", he found out that laboratory equipment are not utilized due to inadequate or ill laboratory and poor knowledge of teachers on their use of laboratory equipment.

The analysis of data on research question 4 seeks to investigate the extent to which physics students rate their teachers knowledge on the use of laboratory equipment. This present study showed that physics students rated their teachers at an high extent but contradicts the findings of Olofunke (2012) and Lawal (2013). According to them, science teachers knowledge on the use of laboratory equipment is at a low extent.

5. Conclusion

The study concluded that laboratory equipment are not adequately available, accessible and utilized very well for physics instruction. This is unethical for proper physics instruction since understanding of concepts will be difficult and this will lead to poor performance of students.

Recommendations

The following recommendations were made:

- Government and other stakeholders in education should ensure that adequate equipment and apparatus are supplied to physics laboratories.
- The state educational board should organize physics practical inter school competitions where winners will go with enviable prizes. This will make teachers and students to sit up.
- Physics teachers should be encouraged to make use of the laboratory equipment provided for teaching of physics practical in secondary schools in Port-Harcourt.
- Steady power supply should be made available in the physics laboratory which otherwise can stand as a barrier to some practical works.
- School heads and laboratory technicians should see it as a need to maintain and adequate storage of laboratory equipment should be encouraged.
- Educational bodies should frequently make rooms for Workshops where physics teachers can be trained regularly.
- Adequate physics technicians and laboratory technologists should be employed in our secondary schools.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest exists among the authors.

References

[1] Adebola A. The relative effectiveness of activity based approach and lecture method on the cognitive achievement in integrated science of students. Nigeria Journal of science Teachers Association. 2007; 32(1&2): 36 – 40.

[2] Agu AP, Iyamu OC. Relationship between Laboratory Facilities' Utilization and Senior Secondary School Physics Students' Achievement in Federal Capital Territory, Abuja, Nigeria. International Journal of Innovative Social & Science Education Research. 2018; 6(3): 1-5.

[3] Ahmed U, Auta A, Mohd A, David L, Buba MD, Usman BU. Effect of practical activities method on junior secondary students'achievement in basic science in Gombe metropolis,Gombe state. Science Teachers Association of Nigeria,60th Annual conference Proceedings. 2019; 174 – 181.

[4] Ajayi PO. Evaluation of the implementation of senior secondary school physics curriculum in South West Nigeria. Ph.D Thesis, University of Ado-Ekit, Nigeria. Radiation hazards. 2007.

[5] Ajayi OP. Turning point:Preparing schools for vision 20: 2020 & beyond.Proceedings of the 3rd bi-annual conference of school of science,Delta state college. 2012; 106–108.

[6] Alamina JI. Fundamental principles of science teaching and learning. Port Harcourt: Votex publishers. 2008.

[7] Ali A. Strategic Issues and Trends in Science Education in Africa. Onitsha: Cape publishers international limited. 1998.

[8] Amadalo MM, Ocholla AA. Effect of Practical Work in Physics on Girls' Performance, Attitude change and Skills acquisition in the form two-form three Secondary Schools' transition in Kenya. International Journal of Humanities and Social Science. 2012; 2(23): 151-166.

[9] Amadalo MM. Physics Practical Work and Its Influence on Students' Academic Achievement. Journal of Education and Practice. 2016; 7(28): 129 – 134.

[10] Amunga JK, Musasia MA, Musera G. Disparities in the Physics Achievement and Enrolment in Secondary Schools in Western Province: Implications for Strategy and Renewal. Problems of Education in the 21st Century. 2011; 31(31): 18-32.

[11] Çelik H, Karamustafaolu O. Science Prospective Teachers' Self-efficacy and Views on the Use of Information Technologies in the Teaching of Physics Concepts. Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education. 2016; 10(1): 182-208.

[12] Daniel O. Impact of Laboratory-Based Instructional Intervention on the Learning Outcomes of Low Performing Senior Secondary Students in Physics. Creative Education. 2014; 5(4): 197-206.

[13] Dahar MA, Faize FA. Effect of the availability and use of science laboratories on academic achievement of students in Punjab (Pakistan). European Journal of Scientific Research. 2011; 52(2): 193-202.

[14] Dikmenli M. Biology students teachers ideas about purpose of laboratory work. Asia Pacific Forum of Science Learning and Teaching. 2009; 10.

[15] Edoho EA, Ntibi JEE, Esuong U.U. Mathematical concept of area: A tool for mathematical quantification and estimation. British Journal of Education. 2017; 5(8): 59-62.

[16] Enoh OG. The Effect of availability and 7 use of laboratory equipment in the effective teaching of physics. Proceedings of the 3rd bi-annual conference of the school of Delta state college of physical education. 2007.

[17] Esiobu GO. Gender issues in science and technology education development. In Ivowi, U.M.O. (Ed.) Science and Technology Education for Development. NERDC Press, Lagos. 2005; 137-156.

[18] Freeman T. The Lancet highlights role of physics in medicine, medicalphysicsweb. 2012.

[19] Gülsüm A. The Impact of the V irtual Laboratory on Students' Attitudes in a General Physics Laboratory. International Journal of Education (iJOE). 2017; 13(4): 23.

[20] Hassan AM, Ma'oyi SA. Measures for improving Acquisition of psycho productive skill in woodwork Technology by NCE (Technical) students in North central state of Nigeria Sokoto .Education Review. 2011; 12: 17 .

[21] Henry S. Science meets faith: An interdisciplinary conversation. Mumbai.St Pauls. 2009.

[22] Ibok EE, Uko JD. Students' background variables and academic performance of senior secondary Background variables and academic performance of senior secondary school Physics student in Ikot Ekpene Local Government Area of Akwa Ibom State. A published first degree project work. 2020.

[23] Igwe IO. Principles of Science and Science Teaching in Nigeria (An Introduction). Enugu: Jones communication publishers. 2003.

[24] Imeh B. Teaching Methods for the Underachievers in Nigeria Secondary Schools. Science Education Newsletters. 2008; 27(5).

[25] Kuhn L, Brekl R. Ability of Experimental Skills Application in the Teaching and Learning Science , National Academy of Sciences. Washington DC. 2012.

[26] Lawal FK. Resource utilization for teaching biology towards achieving millennium development goals objectives in selected secondary schools in Zaria metropolis.54th Annual Conference Proceedings of Science Teachers Association of Nigeria. 2013; 197 – 202.

[27] Lunetta VN, Hofstein A, Clough MP. Teaching and learning in the school science laboratory. An analysis of research, theory, and practice. In, S. K. Abell and N. G. Lederman (Eds), Handbook of Research on Science Education. Mahwah, NJ: Lawrence Erlbaum Associates. 2007; 393–431.

[28] Malach MM. Availability and Utilization of Physics Laboratory Equipment on Academic Achievement of Students in Public Day Secondary Schools. International Journal of Research and Innovation in Social Science (IJRISS). 2019; 3(8): 438–445.

[29] Memon GR. Education in Pakistan: The key issues, problems and the New Challenges. Journal of Management and Social Sciences. 2007; 3(1): 47-55.

[30] Millar R. The role of practical work in the teaching and learning of science. Paper prepared for the committee: High School Science Laboratories: Role and Vision. National Academy of Sciences. Washington, DC. 2004.

[31] Nashon SM. Practical work in science: A critical look at practical work in Kenyan secondary schools. Unpublished M. Ed Dissertation, School of Education, The University of Leeds. 1989.

[32] Ng W, Nguyen VT. Investigating the integration of everyday phenomena and practical work in physics teaching in Vietnamese high schools. International Educational Journal. 2006; 7(1): 36-50.

[33] Nja CO, Obi JJ. Effect of Improvised Instructional Materials on Academic Achievement of SS1 Chemistry Students in Cross River State Nigeria. International Journal of Applied Research. 2019; 5(7): 444 - 448.

[34] Ntibi JEE, Neji HA. Effect of problem solving method of teaching on performance in physics and chemistry in Calabar municipality, Cross river state, Nigeria. Global Scientific Journal. 2018; 6(2): 121-140.

[35] Nwagbo C. Science, technology and mathematics curriculum development: Focus on problems and prospects of biology curriculum. In Nzewi (Ed). Proceedings of the 49th Annual Conference of Science Teachers Association of Nigeria: Heinemanne Educational Books. 2008.

[36] Obioha NE. STAN Physics for Senior Secondary Schools. Nigeria: Heinemann Education Book Publishers. 2006.

[37] Okoye P. E- learning utilization:An approach to dimensions of creativity for effective STEM curriculum delivery in colleges of education.55th STAN annual conference proceedings. 2014; 3 – 14.

[38] Okoye CM, Okongwu CJ, Nweke SO. Student's interest as a correlate of achievement in Chemistry. 56th Annual Science Teachers of Nigeria(STAN) Proceedings. 2015; 222 – 229.

[39] Olofunke BT. Effect of Availability and utilization of Physics Laboratory Equipment on Students Academic Achievement in Senior Secondary Schools Physics. World Journal Education. 2012; 2(5): 1- 7.

[40] Oluwasegun MO, Owolabi TOO. Effects of Virtual Laboratory Instructional Strategy on Secondary School Students' Learning Outcomes in Physics Practical. International Journal of Scientific and Research Publications. 2020; 10(4): 406 - 413.

[41] Omiko A. Quality research infrastructure: Bedrock for effective science education in Nigeria. 56th Annual Preceedings of Stan. 2015; 1: 30 – 39.

[42] Omosewo EO. Physics Teachers Education and National Education Reforms. In Lawal A.R. (Eds): Education Reforms in Nigeria-Past, Present and Future. Lagos: Stirling-Horden Publishers Ltd. 2008; 247-250.

[43] Omeodu MD. Impact of Practical Work in the Teaching of Physics in Secondary Schools in Rivers State. International Journal of Education and Evaluation. 2018; 4(5): 12-22.

[44] Oraifo SO. Teaching methodology in science and technology education.In .U.M.O.Ironi(ed).Science and technology education for development. 2005; 1 – 24.

[45] Papanastasiou GP, Drigas AS, Skianis C. Serious Games in Preschool and Primary Education: Benefits And Impacts on Curriculum Course Syllabus. International Journal of Emerging Technologies in Learning. 2017; 12(1).

[46] Ugwuanyi SC, Nwankwo C, Ugwoke E. Assessment of the efficacies of Power Point Presentation and Demonstration Methods on the Interest and Achievement of students in Physics. 57th Annual conference of STAN Proceedings. 2016; 487- 493.

[47] Umoren FA. Assessment of Apparatus and Equipment Available for the Teaching of Practical Physics at NCE Level for Contemporary Teacher Education: A Study of Federal College of Education , Bichi Kano. Multidisciplinary Journal of Research Development. 2016; 25(1): 1 - 6.

[48] Saif SA. Virtual Lab Implementation in Science Literacy: Emirati Science Teachers' Perspectives Al-Ain, United Arab Emirates. 2019.

[49] Tamir P. Practical work in school science: An analysis of current practice. In B.E. Woolnough (Ed.), Practical Science: The Role and Reality of Practical Work in School Science. Milton Keynes: Open University Press. 2004.

[50] Yahya MK, Shamsudeen B. Senior Secondary Biology Curriculum and Society: The need for Adequate Laboratory Equipment and supporting Staff. 60th Annual Conference of STAN Proceedings. 2019; 197-202.