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Effects of hands-on instructional strategy on senior school students' performance in waves

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ABSTRACT

The research examined the effects of hands-on teaching strategy on senior school learners' performance waves in Ilorin, Nigeria. Senior secondary school (SSS2) science students were sampled at intact classes using a purposive sampling technique. Researcher-designed instructional packages on waves and Physics achievement test on waves (PATW) were the instruments employed. The gathered data were analysed with the use of descriptive and inferential statistics. Percentage, mean and standard deviation were employed in answering the research question. Meanwhile, Analysis of Variance (ANOVA) was utilised in testing the hypotheses formulated at a 0.05 alpha level. The study showed that students' performance exposed to hands-on instructional strategy was very impressive, while students' performance exposed to traditional strategy was low, there was a significant effect of hands-on instructional technique on the performance of students in waves and no statistically significant collaborative effect of hands-on instructional technique and students' gender on performance in waves. It was suggested that hands-on instructional strategies should be integrated and used to make teaching and learning more concrete and active based for both teachers and students.

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1. INTRODUCTION

The knowledge of Physics is very vital in comprehending of contemporary technology and the multitudes of scientific advancements. Physics leans its applications to almost all areas of human endeavors. For instance, the applications of physics knowledge in medicine have helped to develop equipment and machines for the treatment of all kinds of diseases which in turn help humans to live longer and healthier. It explained that some of the extreme innovations in new medicine by Physicists were developed through discoverable knowledge such as nuclear magnetic resonance, X-rays, particle accelerators, ultrasound, and radioisotope detection and insertion procedures in the medical field [1].

Physics creates important awareness that is required for prospective technological advancements that will carry on in moving the global economic drives [2]. The application of the knowledge of physics in the agriculture domain has contributed to the shift from a mere subsistent farming system to a highly mechanized farming system which in turn enhanced sufficiency in the food supply in most countries of the world. According to Gliński *et al*. [3], physics plays very part in the restriction of threats to agricultural resources (agricultural products, soils, foods and plants) and, the environment.

In addition, Physics is so important that it has become one of the major prerequisite criteria for the engineering study, medicine, information and communication technology (ICT), astronomy, and the like. Johnson [4] asserted that as a field of study, physics covers all other courses and other disciplines are dependent on the techniques and concepts established via physics. Applications of physics knowledge are also evident in an improved communication system in the world through the invention of various electronic devices, such as the radio, television set, cell phones, computer systems, a global positioning system (GPS), satellites, and so on. According to Agrell *et al*. [5], progressive system of communication supports the industrial operations, vehicles and transportation systems; businesses, and banks; domestic entertainment gadgets, and the universal movement of news and awareness.

Despite the importance of physics as an instrument for technological and scientific advancements of a country, the performance of learners in physics at the senior secondary school stage has not over the years been satisfactory. Unstable physics learning achievement of students can be caused by several basic things such as lack of quantity and quality of physics teachers, inadequate equipment and laboratory facilities, lack of appropriate physics textbooks, and inappropriate teaching methods used in teaching, among others [6], [7]. The teaching method that a teacher embraces and the resources and materials available the teacher uses in teaching are issues that may affect the achievemen of students [8], [9].

Kuti [10] pointed out that many secondary schools in Nigeria are deprived of an essential laboratory for physics. Furthermore, the period allotted to physics on the school timetable (40 minutes of three periods each per week) is not sufficient to contain laboratory periods [11]. According to Adesina [12], some physics teachers are quite perefferd to complete the scheme of work, rather than the quality of teaching. Hence, full opportunity required by learners to improve skills and proper methods to systematic exercises and consideration is not possibly made.

In the same vein, Onah and Ugwu [13] found out that teachers' gender, qualifications, school location, laboratory resources and facilities, and students' interest were some of the factors that could predict students' performance in physics. Xavier *et al*. [14] observed that teaching approaches, unqualified and inexperienced physics teachers, poor students' attitude, poor learning environment, and gender effects were responsible for students' poor performance in physics. According to Guido [15], opine that student do not mereunderstanding to practical learning in applying the learning principles. Guido further posited that Physics is mostly considered as difficult within the domain of science and it conventionally fascinates less students than other sciences like biology and chemistry. Most students see physics as a tough subject while in senior school which becomes more difficult when they are in college and even more thought-provoking in higher institution [15].

Physics curriculum has numerous conceptions that learners find problematic to comprehend. Some of these difficult physics concepts contain light waves, sound waves, waves, magnetism, electricity, nuclear physics, vectors, pressure, simple harmonics and measurements of thermal energy [16]. Obafemi and Onwioduokit [16] reported that students' difficulty in the understanding of physics concepts focus on curriculum and teaching contents. Moreover, it is observed that the difficulties stem from the way the concepts of physics are presented. From this time, there is a drastic, observable and constant decrease in the level of achievement in science (Physics inclusive) at many levels of education in Nigeria [17]. Having identified some of the reasons for poor achievement of physics students, the area of interest in this study was instructional teaching strategies that are capable of enhancing students' motivation and interest to learn physics concepts as well as improving their academic performance.

Awandia [18] observed that the methods of teaching adopted by teachers of physics should be investigated because they can influence students' attitudes and performance in physics. Teaching methods are processes, arranged and monitored through teaching and learning to improve the distribution of contents of the subject matter [19]. For physics learning to be effective, physics teachers must not only be conversant with innovative instructional strategies that are capable of promoting learning but also ensure proper implementation of such strategies in physics classrooms. Kola [20] revealed that, if more students are to be encouraged to learn physics, there is a need to identify instructional aids as an influential factor that causes students to be interested in the study of physics. The use of experiments as a high school physics learning procedure is very important for effective concepts in the delivery of lessons by Physics teachers and mastery of concepts by students [21]. Adesina [12] suggested the use of multimedia instruction in enhancing students' performance in physics practicals. Hence, an innovative classroom setting requires the students to make an active part in the learning process by actually handling physics experiments and watching audio-visual tapes of classroom instructions.

Hands-on is an instructional strategy that encourages learners' active participation in the teaching-learning processes [22]. Practice helps students to learn some science process skills such as measurement [23]. Practical tests help students to develop their discoveries in promoting student independence, problem solving, and improving their attitudes towards physics [24]–[26].

According to Akani [27], a hands-on instructional strategy inspires learners to cultivate a spirit of investigation and let them to gain shows a vital part in teaching and learning of physics, in that it engenders permanence of knowledge. With hands-on, learners become active while learning and acquiring scientific knowledge and skills in a significant context [12]. While some teachers agree that hands-on instruction is the cardinal part of learning physics [28].

The main aim of this study is to investigate the effects of hands-on instructional strategy on senior school students' achievement in waves in Ilorin, Nigeria. Precisely, this study determined the: i) Senior secondary school students' performance in waves in Ilorin, Nigeria; ii) Effects of hands-on instruction on students' performance in waves; and iii) Effects of hands-on instruction on students' performance in waves based on gender. The questions were raised to guide this study, they are: i) What is the performance of senior secondary school students in waves in Ilorin, Nigeria?; ii) Is there any effect of hands-on instruction on students' performance in waves?; and iii) Is there any interaction effect of hands-on instruction and gender on students' performance in waves?. While the null hypotheses were formulated for this study, they are: i) Ho_1: There is no significant effect of hands-on instruction on students' performance in waves; and ii) Ho_2: There is no significant interaction effect of hands-on instruction and gender on students' performance in waves.

2. RESEARCH METHOD

The study was a quasi-experimental pre-test, post-test control group design where the selection of students into groups followed a non-randomized procedure since secondary school lessons existed as intact class and the school management did not generally permit the classes to be reconstituted and rearranged for the purpose of research. Two group pre-test post-test design. The instructional strategies were at two levels, namely the hands-on strategy and the conventional method. The number two stands for students' gender were at two levels (male and female). The experimental groups were taught using a hands-on instructional strategy (demonstration using apparatus) while the control group was taught using a traditional strategy. All the groups were pretested and after receiving treatments they were given post-tests as shown in Table 1.

Table 1. Research design

Groups	Pre-test	Treatment	Post-test
Experimental group	O_1	X_1	O_2
Control group	O_1	-	O_2

O_1 denotes the pre-test for the experimental group and the control group;
X_1 denotes treatment for the experimental group- denotes no treatment for the control group.

The population of this study comprised all senior secondary school science students in Ilorin, Nigeria. The target population consisted of all public senior secondary school students in Ilorin. There were two public schools selected for this study, out of which one school constituted the experimental group while the second school constituted the control group. Under this, schools that were co-educational that operate the same admission policy and are not situated in the same location were considered for this study. Senior secondary school (SSS2) science students were sampled at intact class using a purposive sampling technique. These classes of students were selected because they were at the stage/period (SS2 class) when they began to be introduced to the topics that were more complex in physics and thus, the need for the integration of highly effective instructional strategies was necessary.

The instruments used for data collection were retreatment group using a hands-on instructional strategy in waves, while the second package was a lesson plan for the control group using the conventional method of teaching waves. However, the Physics achievement test on waves (PATW) was adapted by the researcher using some of the items from West African Senior School Certificate Examination (WASSCE) 2010-2019 that were relevant to the study. The PATW contains two sections (A and B). Section 'A' comprises the demographic information of the school and students while section 'B' consisted of 20 items with four options multiple choice objective tests on waves and were used to determine the level of achievement of students in each group for both pretest and post-test. To safeguard both content and face validity of the research instruments, the physics PATW together with the drafted lesson plans on waves was given to two physics education lecturers in the Department of Science Education and one educational technology lecturer all from the University of Ilorin, Ilorin, Nigeria and two practicing senior secondary schools' teachers in physics. Their suggestions and corrections were affected on the instruments before administering them to the experimental and control groups.

Another psychometric property considered in this study was the estimation of reliability. To carry out this, two steps were taken. The first step was the computation of item analysis which primarily focused on the item-level information. This was used to determine a test of desired quality that could yield very high reliability in the physics PATW. The item analysis was carried out in two folds, item difficulty and item discrimination using Item response theory (IRT) WinGen3 Window software. Thus, those items found too difficult or too easy and those items with negative discrimination were reconstructed and ensured they were moderate for the sampled population.

The second step was the computation of the reliability estimate. This study used a test of split-half to measure the reliability of the physics PATW. This was used to determine how many errors in a test score are due to poor test construction. This test was distributed to students outside the study sampled. Thereafter, the split-half reliability was applied to measure the internal consistency of the test items PATW. Thereafter, the Kuder Richardson KR 20 formula was used to determine the reliability coefficient of 0.72 for the instrument.

Permission was sought from the Principal and Head of the Department of the selected schools to seek their approval to involve their physics teachers and students in the study. The researcher gave each of the students a form to seek their consent and participation in the study. No student was covered to participate in the study while the researcher explained the aim and benefits of the study as well as their level of involvement in the study.

The researcher assured that all the participating students' personal information and scores were obtained during the exercise for a singular purpose of the study and therefore were treated with the utmost confidentiality. The voluntary participation of students from the sample schools was upheld by the ethical practices of research. The consent form was presented to school authorities, physics teachers, and students offering physics for their willingness to participate in the study. A pretest was administered to both experimental and control groups. Thereafter, the experimental group was exposed to the treatments, while the control group was not exposed to any form of treatment.

The study was conducted within the space of four weeks. In the first week, the administration of the pre-test was conducted on both groups to determine students' level of understanding of waves before exposing them to the treatments. The second and third weeks were used to administer the treatment to experimental and control groups. During these weeks, the experimental group was exposed to wave using hands-on experiments for two lessons while the control group was taught the same topic at the same time using the conventional teaching method. Hence, the groups were taught only two lessons respectively. These lessons lasted for 45 minutes each.

While in the fourth week, a post-test was examined to all the schools selected for the study to determine the effects of the treatment and non-treatment on students' performance. Thereafter, the pretest and post-test were marked for each group, and the scores obtained for each of the groups were used for data analysis. Scores of students from all the groups in the pre-test and post-test were assessed and recorded for data analysis, upholding the confidentiality of students' scores in the study.

The data gathered from the reseach were analyzed using both descriptive and inferential statistical tools. The percentage was used to describe the background information of the students. Mean and standard deviation was employed to answer the raised research question with no corresponding hypothesis, while all the formulated hypotheses were tested using Analysis of Variance (ANOVA) at a 0.05 alpha level.

3. RESULTS AND DISCUSSION

Table 2 reveals the demographic data of the students (experimental and control groups). Out of 69 (100.0%) respondets involved in the study, 29 (42.0%) of the students formed the experimental group (Hands-on instruction) from which 13 (18.8%) were males and 16 (23.2%) were females. Also, 40 (58.0%) of the students involved in the control group (Traditional strategy) from which 15 (21.7%) of the students were males and 25 (36.2%) were females.

Table 2. Distribution of the groups by gender

Groups	Gender	Frequency (%)	Sub-total (%)
Experimental group	Male	13 (18.8%)	29 (42.0%)
(Hands-on instruction)	Female	16 (23.2%)	
Control group	Male	15 (21.7%)	40 (58.0%)
(Conventional method)	Female	25 (36.2%)	
Total			69 (100.0%)

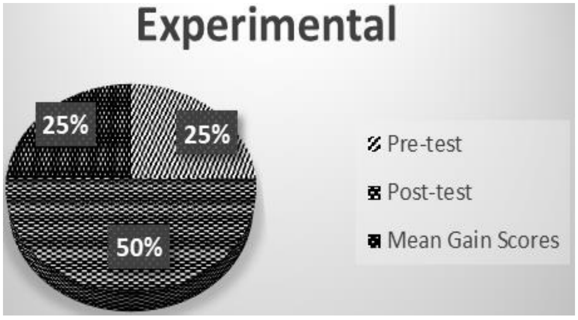
As revealed in Table 3, the students' performance (both the experimental and control groups) in the pretest was low. In the post-test, the performance mean score (17.27) of the group taught with a hands-on instructional strategy was very high, whereas, students' performance taught with a traditional strategy was moderate (mean score of 10.03). As shown in Table 4, learners that were exposed to hands-on instructional strategy had the highest mean gain (8.62) while students that were exposed to traditional startegy had low mean gain (1.32) as duplicated in Figure 1.

Table 3. Descriptive statistics on the performance of students in waves (before and after the treatment)

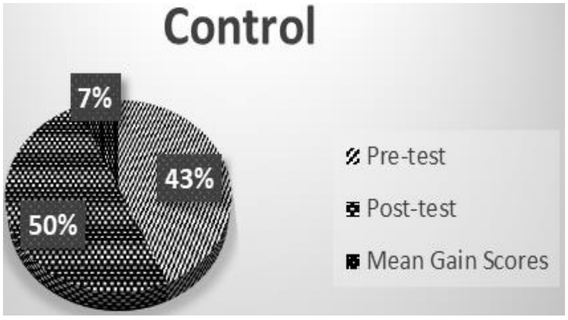
Groups		Min	Max	Mean	S.D.
Experimental I	Pre-test	6.00	13.00	8.65	3.22
(Hands-on instruction)	Post-test	12.00	19.00	17.27	4.09
Control	Pre-test	6.00	12.00	8.71	3.75
(Conventional method)	Post-test	8.00	13.00	10.03	5.31

Table 4. Mean gain scores of the students in waves after the treatment

Groups	Pre-test	Post-test	Mean gain scores
Experimental (Hands-on instruction)	8.65	17.27	8.62
Control (Conventional method)	8.71	10.03	1.32



(a)



(b)

Figure 1. Mean gain scores of the students in waves after the treatment

All research hypotheses formulated for this reasearch were tested using Analysis of Covariance (ANCOVA) at a 0.05 alpha level. Hypothesis one: There is no significant effect of hands-on instruction on leaners' performance in waves. The outcome in Table 5 shows that the *F*-value of 11.562 is got with a p-value of 0.000 when calculated at a 0.05 alpha level. Since the p-value (0.000) is less than the significance level (0.05), the null hypothesis one is not retained, and thus, there was a statistically significant effect of hands-on instructional strategy on the performance of learners in waves ($F_{(1, 66)}$=11.562, p<0.05).

Table 5. Analysis of covariance showing the effect of hands-on instructional strategy on the performance of students in waves

Source	Type III sum of squares	df	Mean square	*F*	Sig.
Corrected model	1937.126[a]	2	968.563	15.722	.000
Intercept	2247.800	1	2247.800	36.487	.000
Pretest	6.513	1	6.513	.106	.746
Treatment	830.963	1	830.963	11.562	.000
Error	4743.562	66	71.872		
Total	60501.000	69			
Corrected total	6680.688	68			

a. R Squared=.290 (Adjusted r squared=.272)

The pairwise comparison analysis is depicted in Table 6 to reveal the effect of the hands-on instructional strategy on learners' performance). As revealed in Table 6, learners taught with hands-on instructional strategy (Experimental group) had a fair mean score of 17.27 than those taught waves using conventional teaching strategy (Control group) with a mean score of 10.03. Thus, the actual effect of hands-on instructional strategy on students' performance in waves is shown by the mean difference of 7.24.

Table 6. Pairwise comparisons analysis showing the effect of the hands-on instructional strategy on students' performance in waves

Treatment	Mean	Mean diff. (I-J)	Std. error	Sig.[b]	95% Confidence interval for difference	
					Lower bound	Upper bound
Hands-on (I)	17.27	7.24*	2.516	0.000	4.23	14.25
Control (J)	10.03	-7.24*	2.516	0.000	-14.25	-4.23
Grand mean=13.65						

*The mean difference is significant at 0.05 level; b. Adjustment for pairwise comparisons: Bonferroni

As shown in Table 7, the *F*-value of 1.068 is obtained with a p-value of 0.311 when calculated at a 0.05 level of significance. Since the p-value (0.311) is greater than the level of significance (0.05), the null hypothesis two is accepted. Hence, there was no statistically significant interaction effect of hands-on instructional strategy and gender on students' performance in waves ($F_{(1, 26)}$=1.068, p>0.05).

Table 7. Analysis of covariance showing the interaction effect of hands-on instructional strategy and gender on students' performance in waves

Source	Type III Sum of squares	df	Mean square	*F*	Sig.
Corrected model	40.488[a]	2	20.244	1.231	.309
Intercept	1283.682	1	1283.682	78.045	.000
Pretest	19.595	1	19.595	1.191	.285
Gender	17.558	1	17.558	1.068	.311
Error	427.650	26	16.448		
Total	21880.000	29			
Corrected total	468.138	28			

a. R squared=.086 (Adjusted r squared=.016)

The non-significant interaction effect of hands-on instructional strategy and gender on students' performance in waves is therefore depicted in Table 8. It could be observed that the difference in the performance of males (16.93) and females (17.63) was not significantly taught with hands-on instructional strategy. This implies that the hands-on instructional strategy did not segregate between male and female students.

Table 8. Descriptive statistics of male and female students' performance in waves when taught using videotaped instructional strategy

Gender	N	Mean	Std. deviation
Male	13	16. 938	3.683
Female	16	17. 631	4.139
Total	29	17.272	

Findings from this study revealed that the performance of students (mean score 17.27) exposed to a hands-on instructional strategy was very high. Meanwhile, students' performance exposed to the traditional strategy was low (mean score 10.03). This shows that hands-on instructional strategies have exposed students beyond the conventional method of teaching as students taught with these modern teaching strategies achieved more than those exposed to traditional strategy. This finding substantiates Wambugu *et al.* [29] whose study showed that the incorporation of teaching strategies in lesson delivery bring about improved the performance of students in the subjects and academic achievement when equated with the use of the conventional instructional method only. Similarly, this could be ascribed to the fact that the videotaped instructional method enabled students to work cooperatively and developed interpersonal and small group interaction skills, waves.

This study also found that there was a statistically significant effect of hands-on instructional strategy on learners' performance in waves. Students taught with hands-on instructional strategy (Experimental group I) had a better mean score of 17.27 than those taught waves using conventional teaching strategy (Control group) with a mean score of 10.03. Hence, the actual effect of hands-on instructional strategy on students' performance in waves is shown by the mean difference of 7.24. This indicated that hands-on instructional strategy must have given the learners time to conduct experiments and mastered the topics of discussion in waves through sub-sections of equal instructional strategy (creating a generating questioning, forecast, clarifying and summarising) in the learners whereby learners aggressively relate to one aother by distributing knowlegde thereby students learn to improve their knowledge of waves as a concept in physics. This finding is in tandem with the outcome of Okono [21] who revealed that the usage of experiments as instructional strategies for teaching physics in secondary school is essential for effective concept in teaching by the teachers as well as concepts comprehend by the students; Salami and Egiethua [22] in their study found out that hands-on as an instructional strategy encourages learners' active participation in the teaching-learning processes; Azar and Şengüleç [30] found out that hands-on plays a key part in instructional delivery in physics, in that it engenders permanence of knowledge and Sadi and Cakiroglu [31] found out that hands-on startegy enhanced instruction improvement on students' performance. From the foregoing, it can be deduced that the use of hands-on instructional strategy motivated students to learn waves as a concept with a better understanding of their preconception and enhanced their academic performance when tested on waves.

In the same vein, it was found that there was no statistically significant interaction effect of hands-on instructional strategy and gender on students' performance in waves. This signifies that hands-on instructional strategy does not segregate students regardless of their gender status as both male and female learners were correspondingly treated by the use of hands-on instructional strategy. By way of inference, the hands-on instructional strategy used in this study was bias-free and effective irrespective of male and female students varying learning abilities and allowed students to gain cooperatively from one another.

4. CONCLUSION

The study revealed that hands-on instructional strategies were effective teaching techniques, as strategies made teaching and learning more concrete when compared with the conventional teaching procedure. Moreover, it was concluded that there was no difference in the performance of male and female students taught using a hands-on instructional strategy. Hands-on instructional strategies should be integrated and used to make teaching and learning more concrete and active based for both teachers and students of physics. Curriculum planners should introduce hands-on instructional strategies for enhancing utmost academic achievement in all school subjects. Hence, textbook writers should consider it a priority to include in their texts, the effective use, and application of hands-on instructional strategies in teaching and learning of school subjects.

REFERENCES

[1] R. Powers, "Advances in Nuclear Magnetic Resonance for Drug Discovery," *Expert Opinion on Drug Discovery*, vol. 4, no. 10, pp. 1077-1098, 2009, doi: 10.1517/17460440903232623.

[2] J. K. Amunga, M. M. Amadalo, and G. Musera, "Disparities in the physics academic achievement and enrolment in schools in western province: Implications for strategy renewal," in *Problems of Education in the 21st Century*, 2011, p. 31.

[3] J. Gliński, J. Horabik, and J. Lipiec, "Agrophysics - physics in agriculture and environment," *Soil Science Annual*, vol. 64, no. 2, pp. 67–80, 2013, doi: 10.2478/ssa-2013-0012.

[4] S. Johnson, "Application of physics in everyday life," *SCIENCING*. 2018, [Online]. Available: https://sciencing.com/applications-physics-everyday-life-8637595.html.

[5] E. Agrell *et al.*, "Roadmap of optical communications," *Journal of Optics (United Kingdom)*, vol. 18, no. 6, 2016, doi: 10.1088/2040-8978/18/6/063002.

[6] A. Jacob Kola, "Perceived causes of students' low enrolment in science in secondary schools, Nigeria," *International Journal of Secondary Education*, vol. 1, no. 5, p. 18, 2013, doi: 10.11648/j.ijsedu.20130105.11.

[7] S. O. Daramola and Esther. O. Omosewo, "An appraisal of the new Nigerian senior secondary school physics curriculum ," *Journal of Education and Practice*, vol. 3, no. 8, pp. 191–195, 2012. doi: 10.7176/JEP.

[8] H. R. Mills, *Teaching and Training: A handbook for Instructors*. UK: Palgrave, 1977.

[9] T. O. Bello, "Effect of group instructional strategy on students' performance in selected physics concepts," *The African Symposium*, vol. 11, no. 1, pp. 71–79, 2011. [Online]. Available: www.tas.theafricanresearch.org.

[10] J. Kuti, "Effect of split attention multimedia principle and cognitive load on senior secondary school students' retention in quantum physics in Ogun State, Nigeria," Unpublished Ph.D. thesis, University of Ibadan, Nigeria, 2012.

[11] J. N. Chukwunenye, "Effect of mathematical modelling on senior secondary school students' achievement and interest in geometry," University of Ibadan, 2015.

[12] B. Adesina, "Improving students' learning outcomes in practical physics, which is better? Computer simulated experiment or hands-on experiment?," *IOSR Journal of Research & Method in Education (IOSRJRME)*, vol. 2, no. 6, pp. 18–26, 2013, doi: 10.9790/7388-0261826.

[13] D. U. Onah and E. I. Ugwu, "Factors which predict performance in secondary school physics in Ebonyi north educational zone of Ebonyi State, Nigeria," *Pelagia Research Library Advances in Applied Science Research*, vol. 1, no. 3, pp. 255–258, 2010, [Online]. Available: www.pelagiaresearchlibrary.com.

[14] M. Xavier, S. Jean, and D. Croix, "Attitude of physics students towards physics at college of science and technology – University of Rwanda," *Rwandan Journal of Education*, vol. 3, no. 2, pp. 1–10, 2016.

[15] R. M. D. Guido, "Attitude and motivation towards learning physics." 2018, [Online]. Available: http://arxiv.org/abs/1805.02293.

[16] D. T. A. Obafemi and F. A. Onwioduokit, "Identification of difficult concepts in senior secondary school two (ss2) physics curriculum in Rivers State , Nigeria," *Asian Journal of Education and e-Learning*, vol. 01, no. 05, pp. 317–322, 2013.

[17] E. S. Oche, "Assessing the relative effectiveness of three teaching methods in the measurement of student' achievement in mathematics," *Journal of Emerging Trends in Educational Research and Policy Studies*, vol. 3, no. 4, pp. 479–486, 2012.

[18] J. T. Awandia, "Impact of teaching methods on students negative attitudes towards physics," *Greener Journal of Educational*

Research, *vol. 11*, no. 1, pp. 11-23, 2021.
[19] M. U. Cyril, “Effect of individualized, demonstration and discovery methods of teaching mechanical craft practice in technical colleges in Adamawa State,” *Nigerian Vocational Association Journal (NVAJ)*, vol. 18, no. 2, May 2013.
[20] A. J. Kola, “Effective teaching and learning in science education through information and communication technology [ict],” *IOSR Journal of Research & Method in Education (IOSRJRME)*, vol. 2, no. 5, pp. 43–47, 2013, doi: 10.9790/7388-0254347.
[21] E. O. Okono, “Experimental approach as a methodology in teaching physics in secondary schools,” *International Journal of Academic Research in Business and Social Sciences*, vol. 5, no. 6, 2015, doi: 10.6007/ijarbss/v5-i6/1688.
[22] I. A. Salami and O. L. Egiethua, “Hands-on/mind-on activities and intellectual development of preschool children,” *Journal of Educational Development and Practice*, vol. 3, no. 1, pp. 52–64, 2012.
[23] N. Hırça, “The influence of hands on physics experiments on scientific process skills according to prospective teachers’ experiences,” *European Journal of Physics Education*, vol. 4, no. 1, pp. 1–9, 2012, [Online]. Available: http://ejpe.erciyes.edu.tr/index.php/EJPE/article/view/82.
[24] T. J. Turpin, *A study of the effects of an integrated, activity-based science curriculum on student achievement, science process skills, and science attitudes*. University of Louisiana at Monroe, 2000.
[25] G. Uzal, A. Erdem, F. Önen, and A. Gürdal, “Basit araç gereçlerle yapılan fen deneyleri konusunda öğretmen görüşleri ve gerçekleştirilen hizmet içi eğitimin değerlendirilmesi,” *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, vol. 4, no. 1, pp. 64–84, 2010. [Online]. Available: https://dergipark.org.tr/en/pub/balikesirnef/issue/3370/46519.
[26] A. Özlem and E. Ali, “Effectiveness of hands-on and minds-on activities on students’ achievement and attitudes towards physics,” *Asia-Pacific Forum on Science Learning and Teaching*, vol. 12, no. 1, pp. 1–22, 2011.
[27] O. Akani, “Laboratory teaching: Implication on students’ achievement in chemistry in secondary schools In Ebonyi State of Nigeria,” *Journal of Education and Practice*, vol. 6, no. 30, pp. 206–213, 2015.
[28] Patience Chinyere Agommuoh, “Physics teachers’ perception of effective teaching/learning of physics in senior secondary school for global competitiveness,” *IOSR Journal of Research & Method in Education (IOSRJRME)*, vol. 4, no. 1, pp. 20–24, 2014, doi: 10.9790/7388-04152024.
[29] P. Wambugu, J. M. Changeiywo, and F. G. Ndiritu, “Effects of Experiential Cooperative Concept Mapping Instructional Approach on Secondary School Students’ Motivation in Physics in Nyeri County, Kenya,” *Journal of Education and Practice*, vol. 5, no. 15, pp. 74–83, 2014.
[30] A. Azar and Ö. A. Şengüleç, “Computer-assisted and laboratory-assisted teaching methods in physics teaching : The effect on student physics achievement and attitude,” *Eurasian Journal of Physics and Chemistry Education*, vol. 1, no. 1, pp. 43–50, 2011, [Online]. Available: www.eurasianjournals.com/index.php/ejpce/article/download/613/284.
[31] Ö. Sadi and J. Cakiroglu, “Effects of hands-on activity enriched instruction on students’ achievement and attitudes towards science,” *Journal of Baltic Science Education*, vol. 10, no. 2, pp. 87–97, 2011.

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