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Impact of Hybrid Activity-Based Approach on Secondary School Students' Misconceptions and Achievement in Physics in Zonkwa Education Zone, Kaduna State, Nigeria

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ABSTRACT
This study investigated the impact of the Hybrid Activity Based Approach (HABA) on secondary school students' misconceptions and achievement in Physics in the Zonkwa education zone, Kaduna State Nigeria. Two research questions were raised and two research hypotheses were formulated to guide the study. The study adopted a pre-test, post-test quasi-experimental control group design. The sample consisted of 98 students from senior secondary school two (SS 2) who were selected from two schools within the Zonkwa Education Zone. The two schools were classified into two groups, the experimental group and the control group. The experimental group was taught Physics concepts using a Hybrid Activity Based Approach (HABA) while the control group was exposed to a conventional lecture method for six weeks. The instrument for data collection was the Physics Diagnostic Test (PDT). This instrument was validated by three experts from the University of Jos. Reliability Coefficients of 0.922, and 0.801 were obtained for PDAT when measuring students' misconception and achievement scores respectively. Data collected were analysed using descriptive statistics of mean and standard deviation for the research question while Analysis of Covariance (ANCOVA) was used to test the hypotheses of the study. The findings of this study revealed that the experimental group had a significant loss in misconceptions mean scores than their counterparts in the control group, and the experimental group had a significant gain in achievement mean scores than their counterparts in the control group. Based on the outcome of this study, it was recommended that HABA should be used as a remediating tool to reduce students' misconceptions and improve students' achievement in senior secondary schools in Kaduna state, Nigeria.

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INTRODUCTION

The future of any country and its citizens' contribution to the economy depend on its ability to develop its human capital in education, science and technology. Nations in the world are classified as developed and developing, mainly based on their economic, scientific, and technological strength (Almas, Jungsuk & Donghyun, 2018). Nigeria is classified as a developing nation because of the country's technological limitations, poor road conditions, an underdeveloped transportation system, low life expectancy, and many more. For a nation like Nigeria to attain the status of a developed nation and be able to solve its numerous problems, such as poverty, food security, unemployment, and insecurity, the country needs to equip her citizens with the needed scientific and technological knowledge to tackle such challenges in which the knowledge of Physics is paramount for such

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changes required. Physics knowledge facilitates the understanding of disciplines such as agricultural science, medical science, and environmental science.

Physics is a branch of Physical science that explains the properties of matter and energy and the relationship between them. It focuses on the general nature of the natural world and has played a crucial role in serving mankind. Its principles are applied daily in man's home and life. Discoveries made from these principles have been of great importance to human existence. Disciplines such as Agriculture, Environmental, Biological Sciences, and Engineering utilize the principles, laws, and theories of Physics to enhance their understanding. Furthermore, the fundamental discoveries in Physics are used by medical communities to innovate new techniques for diagnosing and treating illnesses such as cancer, nervous system and cardiovascular disorders.

In recognition of the importance of Physics and other science subjects to technological development, the Federal Government of Nigeria encourages its citizens to undertake programmes in science and technology by enacting policy such as the Nigerian National Policy on Science and Technology. This policy gave science and technology teachers opportunities for retooling, re-training, and professional support; every science teacher in Nigeria is entitled to not less than forty hours of staff development training Programme locally or internationally per year (FME, 2018).

Furthermore, the admission policy in the University of 60:40 Sciences to Humanities favours 60% of admissions to be granted to candidates who apply to study Science and Technology courses, with only 40% favour ing candidates who apply for humanities. More commitment by the Nigerian government is in the establishment of Universities of Science and Technology, Federal Colleges of Education (Technical), and Science and Technology Research Institutes across the country. Others are the training and re-training of Nigerians through various scholarship schemes such as the Petroleum Technology Development Fund (PTDF), and the launching of Nigerian Satellites (NigeriaSat-1, NigComSat-1R, and Nigeria Sat-X in 2003, 2007, and 2009, respectively). Moreover, the subject is faced with many challenges, which include inadequate and inexperienced Physics teachers, inadequate teaching facilities, and poor teaching strategies (Peter & Abot, 2021).

Students' achievement in Physics has been a cause of concern to Physics Education Researchers since students' achievement is a measure of the extent to which students have attained learning goals (Ikechuku, 2020). It is the yardstick that is used to measure the performance of teachers, schools, educational areas, and states. Most of the research in Physics Education (for example, the works of Atadoga (2017), Babatunde (2018), Isreal (2021), and Etukudo 2022) was geared towards improving the achievement of Physics students. Despite the efforts of Physics Education Researchers, students' achievement in secondary school Physics is still below expectations as indicated by the WAEC Chief Examiners' reports of 2018, 2019, 2020, 2021, and 2022.

When one examines the senior secondary school Physics results, in WAEC in Nigeria, and particularly in Zonkwa Educational Zone of Kaduna State, in the previous years (2013-2024), the results show that students' achievement in Physics was generally below average. Students who scored credit and above are regarded as those who achieved well and are being considered for admission to study courses like medicine, environmental science and engineering. The majority of the students scored less than a credit in the WASSCE examinations. Students' poor achievement in Physics could be a result of students' misconceptions, poor teaching approaches by teachers, or inadequate teaching materials.

Students' achievement in Physics is very important, because it gives the students a sense of accomplishment, increases their self-confidence in the subject, and provides an opportunity to choose a better career. Physics is a hub for many environmental science, medicine, and engineering courses in the university, no student would be admitted to study these courses

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without a credit pass in Physics. When most students' grades in Physics at the secondary level are poor it is an indication that in the future there will be a dearth of manpower such as scientists, engineers, and medical doctors in the society. Therefore, necessary steps are needed to correct these abnormalities.

Misconceptions in students can significantly hinder their achievement. These misconceptions are often deeply rooted in prior experiences, everyday language or incomplete understanding. Students may bring informal Physics knowledge to the classroom. Students who offer Physics as a subject may come to class with different types of scientific interpretations and terminologies based on everyday experiences and language (Haryono & Aini, 2021). The researchers in 2022 observed that some students have misconceptions about thunder and lightning in the study area. Some students believe that thunder and lightning are not atmospheric electric charges but a sharp axe of middle finger size prepared by the gods to cause havoc to the wicked. Haryono and Aini (2021) opined that, as the learning process is considered to be sequential, so also is a misconception. If a student holds a misconception, it will be difficult for them to build a true and deep understanding of the subject. Effective teaching in physics, therefore, needs to focus on identifying misconceptions and promoting conceptual mastery.

Many teaching methods, strategies, and approaches have been in use in Physics classrooms to enhance students' understanding of concepts. Such approaches include Activity-. Activity-Based Approaches include approaches such as dramatization, playing cards, group discussion, solving puzzles, games, brain activity, storytelling, discussion, laboratory method, concept mapping, problem-based, and sense-making. A combination of two or more of the approaches constitutes the hybrid Activity-Based Approach. Hybrid Activity-Based Approach (HABA) in the context of this study is the combination of Sense-Making and Problem-Based Approaches, which would be the independent variable to be manipulated as a treatment for the experimental group. The big question is would HABA be a remedial solution to students' misconceptions and improve their achievement in Physics in Zonkwa education zone of Kaduna State, Nigeria?

STATEMENT OF THE PROBLEM

Physics is one of the principal science subjects, and a prerequisite for most science and engineering courses in colleges and universities today. Despite its importance, in Kaduna state, there has been consistently poor academic achievement in senior secondary school Physics. For example, Statistics from Quality Assurance Office Zonkwa on West Africa Senior School Certificate Examination (WASSCE) from 2018 to 2024 indicated a decline in achievement with percentage failure rates of 55%, 56%, 53%, 49%, 57%, 55% and 52%, respectively while result of SSCE conducted by NECO from 2018 to 2021 shows inconsistencies in students' achievement with percentage failure rate of 59%, 50% 54% 43%, 52%, 54% and 58% respectively. This means that the above percentages of students who registered and sat for the examinations failed without a credit pass in Physics and, hence, may have missed out on admission to study science-based courses that required Physics in tertiary institutions. Moreover, if the above percentage of students lose out in the admission to study science-based courses related to Physics, such as medical sciences, environmental sciences, engineering and agricultural sciences. The study area would experience a shortage of manpower.

Kaduna state government, in connection with the Teachers Service Board Kaduna, has employed the services of additional science teachers, organized workshops for the re-training of science teachers across the state in order to enhance students' achievement in Physics and other science subjects. Physics education researchers such as Atadoga (2017), Israel (2021) and others conducted research and made recommendations on how to improve students' achievement in senior secondary school Physics in Kaduna State, yet the problem persists. It is on this note that the researcher is proposing the use of the Hybrid Activity-Based Approach to remediate students' misconceptions and improve

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their achievement of Physics concepts in the Zonkwa education zone of Kaduna State.

The Activities-Based Approach (ABA) has been used to reduce students' misconceptions and improve students' achievement in subjects such as mathematics, Biology and Chemistry with a positive outcome. Such studies include Omilani and Amfowose (2022), Senyigit (2021), Ramazan (2020) and Oyedokun (2018). Nevertheless, HABA has not been used as a remediating treatment for students' misconceptions in Physics in the study area to the best knowledge of the researcher. Therefore, the problem of the study is to investigate the impact of the Hybrid Activity-Based Approach on secondary school students' misconceptions and achievement in Physics, Zonkwa Education Zone, Kaduna state, Nigeria.

Aim and Objectives of the Study

The study aimed to determine the impact of the Hybrid Activity-Based Approach on secondary school students' misconceptions and achievement in Physics in Zonkwa Education Zone, Kaduna State, Nigeria. The specific objectives of the study are to:

1. determine the impact of HABA on senior secondary school (SSS) II students' misconceptions of Physics concepts
2. establish the impact of HABA on senior secondary school (SSS) II students' achievement in Physics.

Research Questions

The following research questions were used as a guide to the study:

1. What are the pre-test and post-test mean scores of SSS II students on misconceptions in Physics in the experimental (HABA) and control group?
2. What are the pre-test and post-test mean scores of SSS II students on achievement in Physics in the experimental (HABA) and control groups?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference in pre-test and post-test misconception mean scores between the experimental and control groups.
2. There is no significant difference in pre-test and post-test achievement mean scores between experimental and control groups.

METHODOLOGY

The study employed a quasi-experimental research design. Specifically, pre-test, post-test non-equivalent control group design was used for the study. This implies that intact classes (non-randomized groups) participated in the study. The population of the study comprises of all SS 2 students offering Physics in the Zonkwa Zone of Kaduna State Ministry of Education. According to the 2023/2024 school census report of Kaduna State Ministry of Education, there were 30 public coeducational Senior Secondary Schools in Zonkwa Education Zone that offer Physics as a subject. The report shows that there are 1,687 SS II students, consisting of 1054 male and 633 female students in Zonkwa Education Zone offering Physics. The sample for the study consisted of 98 SSS II students offering Physics. The experimental group is made up of 51 students (29 male and 22 female) while control group is made up of 47 students (26 male and 21 female).

Physics Diagnostic Test (PDT): This is a three-tier test instrument constructed by the researcher. It consists of 26 Items from, WAEC and NECO pass examination test items of 2012 – 2023. PDT is designed to measure Physics students' achievement, and misconceptions of Physics concepts. The items cover heat energy and motion under gravity. PDT comprises three sections A, B, and C; Section A focuses on demographic data namely student's school, gender and class. Section B of the instrument is in three tiers. The first tier contains a traditional multiple-choice question that assesses the student's understanding of concepts of heat energy and motion under gravity. It presents a

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scenario or problem and asks the student to select the correct answer from a set of options. This tier is also used to assess students' achievement.

The Second-Tier content Justification for selecting an option in the first tier. After answering the content question, the student is asked to provide a reason for their answer. This is crucial for uncovering the student's thought process and identifying the underlying reasoning behind their choice. The justification options include a mix of correct and incorrect explanations. The students are expected to choose the best option that matches their reasons for their selection in the first tier. Third Tier assesses students' confidence Level. This helps to gauge the strength of the student's belief in their understanding and can reveal areas where they may be guessing or have shaky knowledge.

The instrument identifies misconceptions by analyzing patterns in student responses across all three tiers. A student with a misconception may choose the incorrect answer in the first tier and provide a justification that reflects a flawed understanding of the concept and indicate a high confidence level in the third tier. Choosing the correct answer in the first tier, but providing an incorrect justification in the second tier with high confidence in the third tier, indicates that they have the correct answer for the wrong reason (that is, they have a misconception). But choosing the correct answer and providing a correct justification and then expressing low confidence suggests a lack of conceptual mastery of the concept. For more details, check Table 1. Section C of this instrument is an essay-type question that consists of six items with instructions for students to answer all the questions.

Content validity of the instrument was carried out by three experts: they include Physics teacher from secondary school, Department of Science and Technology Education (Physics unit), and (Research Measurement and Evaluation unit), University of Jos. These experts reviewed the instrument in terms of clarity, adequacy, appropriateness, and content coverage.

Split-half reliability technique was employed in determining the reliability of the instrument. Using Pearson Product-Moment Correlation Coefficients to estimate the coefficient of reliability of the instrument. Reliability Coefficients of 0.922, and 0.801 were obtained for PDT when measuring students' misconceptions, and achievement scores, respectively. These values were considered adequate for the study as suggested by Nwanko and Anulika (2021).

The misconception scores were obtained from the analysis of the first, second and third tiers of PDT as indicated in Table 1. If a student did not answer either the first, second or both tiers of questions correctly and the student is sure of the answer given in the first and second tiers, it would be recorded as a misconception and awarded 5 marks; otherwise, 0. The total misconception score expected from the PDT section B is 5 marks X 20 questions, which is equal to 100 marks.

Table 1: Three-tier Test Table of Analysis

Answer Pattern			Categories	Code
1st Tier	**2nd Tier**	**3rd Tier**		
Correct	Wrong	Sure	misconceived	MC
Wrong	Wrong	Sure		
wrong	Correct	Sure		
Correct	Correct	Sure	Conceptual Mastery	MA
Correct	Wrong	not sure	Misunderstanding	MU
Wrong	Wrong	not sure		
Wrong	Correct	not sure		
Correct	Correct	not sure		

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From the Table 1, the researcher analysed and identify students' misconception, level of Conceptual mastery and misunderstanding using the three-tier section of each item and score it as 5 marks for misconception, or conceptual mastery or misunderstanding otherwise 0. The descriptive statistics of mean, standard deviation was used to answer all research questions. The justification for the use of mean and standard deviation is that it takes into consideration the distribution of the scores from the centre and the variability of the scores. Analysis of covariance (ANCOVA) was used in testing the hypotheses at the 0.05 level of significance. ANCOVA was used in order to take care of initial differences between the groups.

RESULTS

Research Question one.

What are the pre-test and post-test mean scores of SSS II students on misconceptions in Physics in the experimental (HABA) and control group in Zonkwa educational zone of Kaduna State?

Table 2: Misconception Mean Scores and Standard Deviation for Experimental and Control Groups

		Pre-test		Post-test		Mean
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Loss**
Experimental	51	41.47	16.38	8.72	7.41	32.75
Control	47	33.83	22.19	27.97	8.05	5.86
Mean Difference		7.64		19.25		

The data in Table 2 shows that the experimental group's pre-test misconception mean scores and post-test misconception mean scores are 41.47 and 8.72, with standard deviation scores of 16.38 and 7.41, respectively. However, the control group has a pre-test and post-test misconception mean scores of 33.83 and 27.97 and standard deviations of 22.19 and 8.05, respectively. Furthermore, the result in Table 3 reveals that misconception means lost scores for the experimental and control groups are 32.75 and 5.86, respectively. Therefore, the answer to research question one is positive, students exposed to HABA have a lower misconception mean lost score compared to the control group.

Hypothesis One

There is no significant difference in pre-test and post-test misconception mean scores between the experimental and control groups.

Table 3: Summary of ANCOVA Results of Students' Misconceptions in Experimental and Control groups

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	9230.979[a]	2	4615.490	78.850	.000
Intercept	5049.004	1	5049.004	86.256	.000
Pre-test Misconception score	164.278	1	164.278	2.806	.097
Group	9194.866	1	9194.866	157.082	.000
Error	5560.857	95	58.535		
Total	46400.000	98			
Corrected Total	14791.837	97			

Table 3 shows that F(157,082) is significant at .000 for the groups at 1 and 97 degrees of freedom (df). This is because .000 is less than the 0.05 significance level earlier set for the hypothesis. Hence, the hypothesis is not accepted. Thus, there is a significant difference between the misconception mean scores of students taught with HABA and those taught with the conventional method.

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Research Question two

What are the pre-test and post-test mean scores of SSS II students on achievement in Physics in the experimental (HABA) and control groups?

Table 4: Achievement Mean Scores and Standard Deviation for Experimental and Control Group

		Pre-test		Post-test		
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Experimental	51	27.25	10.72	78.67	9.29	51.42
Control	47	25.95	6.6	54.79	9.73	28.84
Mean Difference		1.3		23.88		

The data in Table 4 revealed that the experimental group's pre-test and post-test achievement mean scores are 27.25 and 78.67, with standard deviation scores of 10.72 and 9.29, respectively. While their counterpart in the control group has pre-test and post-test achievement mean scores of 25.95 and 54.79, with a standard deviation of 6.60 and 9.73. In addition, the table indicated achievement mean gain scores for the experimental and control groups as 51.42 and 28.84, respectively. With this result, the answer to the research question seven is positive. Students exposed to HABA have a better achievement mean gain compared to the control group.

Hypothesis two

There is no significant difference in pre-test and post-test achievement mean scores between experimental and control groups.

Table 5: Summary of ANCOVA Results of Students' Achievement Scores in Experimental (HABA) and Conventional method.

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	16160.218[a]	2	8080.109	118.783	.000
Intercept	27204.515	1	27204.515	399.925	.000
Pre-Test Achievement	2212.924	1	2212.924	32.532	.000
Group	13080.488	1	13080.488	192.292	.000
Error	6462.282	95	68.024		
Total	465363.000	98			
Corrected Total	22622.500	97			

Table 5 shows that F(192.292) is significant at .000 for groups at 1 and 97 degrees of freedom (df). This is because 0.000 is less than the .05 significance level earlier set for the hypothesis. Therefore, the hypothesis is not accepted. Thus, there is a significant difference between the achievement mean scores of students taught with HABA and those taught with the conventional method.

DISCUSSION OF FINDINGS

The purpose of this study was to determine the impact of the Hybrid Activity-Based Approach on secondary school students' misconceptions and achievement in Physics in Zonkwa Education Zone, Kaduna State, Nigeria. The findings from research question one revealed that students in the experimental group had a lower misconception mean loss score compared to their counterparts in the control group. In the same vein, Hypothesis One revealed that there is a significant difference between the

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misconception mean scores of students taught with HABA and those taught with the conventional lecture method. These findings are in agreement with the findings of Ramazan (2020) and Karabulut and Bayraktar (2018). Similarly, the findings are also in agreement with the findings of Omilani and Amfowose (2022), who reported that the activity-based approach has a significant effect in reducing students' misconceptions compared to the conventional lecture method. These findings imply that HABA is more effective in remedying students' misconceptions in senior secondary school Physics than the conventional lecture method.

The findings from Research Question two revealed that the experimental group post-test achievement mean score is higher compared to their counterpart in the control group. Meanwhile, findings from Hypothesis Five show that there is a significant difference between the achievement mean scores of students taught with HABA and those taught with the conventional lecture method. These findings are in agreement with the findings of Ahmed and Solomon (2019), who found a significant difference in achievement mean scores between students exposed to the Activity-Based Approach (ABA) and those exposed to the conventional lecture method. This finding implies that the use of HABA would significantly enhance students' achievement in Physics than the conventional lecture method.

CONCLUSION

The study examined the impact of Hybrid Activity Based Approach on Secondary School students' misconceptions and achievement in Physics in Zonkwa Educational Zone of Kaduna State Nigeria. The study revealed that the experimental group had a significant mean loss score compared to their counterparts in the control group. Furthermore, the study shows that students exposed to HABA, obtained a higher achievement mean score compared with their counterpart in the control group.

RECOMMENDATIONS

Based on the findings and conclusion of the study, the following recommendations were made: Teachers should be encouraged in the use of HABA as a remediating approach to reduce students' misconceptions and improve their achievement in physics concepts and HABA should be incarnated into the teacher education curriculum and be taught as a teaching method as it encourages teachers creating room for students to be actively involved in the teaching and learning of Physics.

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