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EDITORIAL

STEM Journal of Anambra STAN (STEMJAS) is a publication of **Science Teachers Association of Nigeria, Anambra State Chapter.** STEMJAS is developed to disseminate information on Science, Technology, Engineering and Mathematics (STEM) to teachers, teacher-trainers, researchers and other interested persons. Articles that are of relevance to STEM education are published in this journal.

We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Ebele C. Okigbo

Editor-in-Chief

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EFFECTS OF META-CONCEPTUAL AND SCAFFOLDING LEARNING STRATEGIES ON STUDENTS' ACHIEVEMENT IN WAVES

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Abstract

The purpose of this study was to determine the Effects of Meta- conceptual and Scaffolding Learning Strategies on Senior Secondary School two (SS2) Students' Achievement in wave concept in Physics in Enugu Education Zone of Enugu state. The study adopted quasi-experimental research design, specifically, a non-equivalent control group design was used. The population for the study was 4,090 SS2 students in the 33 secondary schools. The sample size was 259 SS2 students, which was determined using multi-stage sampling procedure. Waves Achievement Test (WAT) is the instrument that was used for data collection. WAT was used to elicit the students' achievement in Waves. WAT underwent both face and content validation. The instrument was validated by three experts, from the Faculty of Education, Enugu State University of Science and Technology (ESUT), Enugu. The reliability estimate for WAT was determined using Kuder-Richardson formula method (K-R 20), which gave an estimated reliability coefficient of 0.89. Mean and standard deviation were used in answering the research questions while Analysis of Covariance was used in testing the research hypotheses at 0.05 alpha levels. The study discovered that Scaffolding Learning Strategy was the more superior to Meta-Conceptual Learning Strategy and thus significantly enhanced students' achievement scores more than Meta-Conceptual Learning Strategy while Meta-Conceptual Learning Strategy significantly enhanced students' achievement scores more than Lecture Method. Thus, the researcher recommended that Physics teachers should use Scaffolding Learning Strategy more often than the Meta-Conceptual Learning Strategy since that Scaffolding Learning Strategy is more efficacious than the Meta-Conceptual Learning Strategy in teaching Waves.

Keywords: Meta-Conceptual, Scaffolding Learning Strategies, Students' Achievement

Introduction

Physics is the study of laws that determine the structure of the universe with reference to the matter and energy in the universe. Someone who studied Physics is called Physicist. Physics is a cross-cutting discipline that has applications in many sectors of economic development, including health, agriculture, energy, and information technology. Physics is the study of natural phenomenon at its most fundamental levels and manner. Anyakoha (2016) defined Physics as a natural science that involves the study of matter and energy and their interactions. In studying Physics, students acquire the knowledge and the skills to understand how and why natural things happen the way they do; to make predictions and venture into unknown areas of knowledge and more importantly using the knowledge and skills to design and make new things. The study of Physics enables students and practitioners in the field to understand the changing and existing world. In Nigeria, Physics is considered an important component of science subject and is taught during the last three years in the secondary school as a single subject and tertiary levels of education (Isiadinso, 2018). The knowledge of physics according to Gabriel (2012) offers the students the opportunity to think critically, reason analytically and acquire the spirit of enquiry. The knowledge of Physics develops in students, the scientific and technological knowledge, skills and attitudes which will assist them to make decisions based on the observation and experimentation. Physics has so many branches like waves, electricity, heat mechanism, nuclear Physics, atomic physics, electro-dynamics.

Wave is defined as the transport of energy and momentum without the transfer of matter. Wave is a disturbance which travels through a medium transferring energy and momentum from one point to another without causing permanent displacement to the medium itself. The study of wave is extremely tremendous to the development of science and telecommunication industry together with medical sciences (Onah, 2022). The concepts of mobile phones, radio and television broadcasting is built upon the principle of wave motion. This had helped in the development of modern science. Again, the knowledge of sound and acoustic waves resulted in the determination of gestation period, pre-natal examination, and other mammographic examination. The WAEC Chief Examiner's Report (2019) showed that Waves is one of the concepts where students have great misconception. They suggested that this misconception demonstrates the abstract nature of the mathematical concepts eluded. The Theoretical background method of instructional delivery used by teachers are usually teacher-centered like the Lecture method. They suggested that Physics teachers should teach students rules guiding Physics diagrams like Sinusoidal waves and provide teaching aids and diagrams with model to help students understand Physics concepts.

The Lecture Method is an instructional delivery method where the Physics teacher talks and solves the Physics concepts while the students listen. Lecture Teaching Method is the most employed teaching methodology by most Physics teachers because it enables the Physics teacher to cover more Physics content in shortest possible time (Ahmed, 2015). Gbamanja (2021) observed that in using the method, the teacher talks about science while the students read about science. However, one major disadvantage that this method has is that the students, who are the cardinal point of the lesson has little or no contribution in the lesson. During lectures, students' questions are not normally encouraged and in cases where questions arise, they are usually for clarification of important facts. According to Dike and Adebayo (2021) observed that teachers used this Lecture method to make

students memorize the Physics concepts without questioning how and why, thereby making it difficult for the students to learn.

Once, the students forget the Physics concepts they memorized, the students become stranded in furthering his/her learning of Physics concepts. This is because according to Eze (2021), the method is mainly teacher-centered, with the students being consistently passive and contents taught as absolute knowledge. This method does not facilitate the development of reasoning skills and processes in the students. Lecture method had failed in the recognition of the uniqueness of the inquiry-based nature of science and the learner's individuality. Hence, Ahuja and Jahangiri (2003) suggested that student-centered teaching strategy would be more effective in learning Physics than the teacher-centered strategy. The use of appropriate teaching methods is important to the successful teaching and learning of Physics (Bello, 2022). Udeji (2017) showed that effective teaching method enhances students' achievement. There is therefore need to adopt and use student-centered strategies in teaching Physics. The student-centered learning strategy that any teacher must use to teach students Physics should in all situations develop the three learning domains of the students: cognitive, affective and the psychomotor domains (Andaya, 2014). Any strategy that has developed the students' three learning domains must have complied with Lev Vygotsky's theory (Andaya, 2014; Shayer, 2012). According to Vygotsky (1978), a student learns better in a social interaction environment where there are collaborative activities among the students. Vygotsky (1978) revealed that the teacher should be able to use strategy that can provide the students intervention/assistance, and the intervention/assistance used by the students must ensure that it allows social interaction among the students. According to Shayer (2012), Gredler & Shields (2008) and Donato (2014), an educational theorist, Lev Vygotsky (1896 – 1934) in his theory outlined five (5) principles Physics teachers must consider before choosing an instructional strategy/method, which are:

1. The good instruction strategy/method should proceed ahead of development and should awaken and rouse to life an entire set of functions, which are in the stage of maturation and lie in the Zone of Proximal Development (ZPD).
2. The instruction strategy/method should be subjective, which means that the instructional strategy should be able to allow two individuals with different understanding to begin a Physics task and eventually arrive at a shared understanding of Physics.
3. The instruction strategy/method should allow mediation, which means that the instructional strategy should allow other significant people/things in the students' lives to play a part in the learning process of the students, and by so doing, the learning of Physics will be enhanced by selecting and shaping the learning experiences presented to them.
4. The instructional strategy/method should allow scaffolding, whereby the teacher models the desired learning strategy or task then gradually shifts responsibility to the students.
5. The instructional strategy/method should be from the culture that exists in the students' environment.

From these five (5) principles which were outlined from Lev Vygotsky (1896 – 1934)'s theory by these scholars like Shayer (2012), Gredler & Shields (2008) and Donato (2014) showed the efficacy of innovative teaching strategies and what makes teaching strategies innovative. In this regard,

Jonassen, Peck and Wilson (2019) stated that the use of innovative teaching strategies may help students to develop better understanding of Physics which may lead to improved performance in students' achievement. The high students' achievement in Physics may be attained using innovative teaching strategies such as Constructivism Approach, Meta-conceptual Strategy Gaming Method, Problem-solving Method, Scaffolding Learning Strategy, among others. From all these methods mentioned, only Meta-Conceptual Teaching and Scaffolding Learning Strategies that were greatly pronounced by Lev. Lev Vygostsky in his theory as seen in third and fourth principles of Lev Vygostsky. They are also the two teaching strategies that fulfilled the five (5) principles of Lev Vygostsky. Meta-conceptual Learning Strategy (MLS) refers to one's knowledge concerning one's own conceptual processes (Kuhn & Dean, 2014).

MLS is a teaching strategy that comprises of Meta- conceptual and Learning Strategy. Meta-conceptual is derived from a Greek word meaning "beyond comprehension". Meta- conceptual is the monitoring and control of students' understanding of a concept (Martinez, 2016). Onovughe, Adedipe and Temidayo (2021) defined meta-conceptual as a level of thinking that involves active control over the process of understanding that is used in learning situations. Kuhn and Dean (2014) regarded meta- conceptual as awareness and management of one's own thought. Based on Kuhn and Dean's work, meta- conceptual is what enables a student who has been taught a particular strategy in a particular problem context to retrieve and use that same strategy in a similar context while Learning strategy is what a teacher or student arranged in order to establish interaction between the teacher, the students, and the subject matter, of any combination of these three dimensions (Vijaya & Jinto, 2024). However, many scholars like Sangowawa (2019) have regarded Meta-conceptual Learning Strategy as being theoretically applicable to a wider range of educational materials and popular among students and this has prompted researchers to be in constant search for more emerging trends in teaching and learning in schools. One of the emerging pedagogies is Scaffolding Learning Strategy. The idea of scaffolding emerged from socio-constructivist views of learning, especially Vygotsky's (1978) socio-cultural notion of the ("Zone of Proximal Development" ZPD) (Sangowawa, 2019).

This zone reflects the distance between the actual development level of the learner as determined by activities that can be performed without assistance and the potential development level of the learner as determined by performance of tasks under guidance of a more capable person (Sangowawa, 2019). This person guides the student through the ZPD towards a new actual development level in a gradual process of scaffolding. The notion of scaffolding is increasingly being used to describe the support provided for students to learn successfully in classroom (Janneke, Volman, Oort and Beishuizen, 2015). Janneke, Volman, Oort and Beishuizen (2015) emphasized that learning occurs in rich social context marked by interaction, negotiation, articulation and collaboration. Hartman (2022) identified several important scaffolds like giving approval, probing student's ideas, structuring task activities and providing general hints or specific suggestions that will help the learner throughout the task. Asking learner's questions and using appropriate written materials are other important scaffolding tools. Sawyer (2016) stated that scaffolding is the provision of support to promote learning when concepts and skills are being first introduced to the students. He further expatiated that these supports may include resources, a compelling task, templates and guidance on the development of cognitive and social skills. He added that these supports are gradually removed as the students develop autonomous learning strategies, thus promoting their own cognitive, affective and psychomotive

learning skills and knowledge. The teacher, therefore, helps with only those skills that are beyond the students' capability. To carry out scaffolding strategy the teacher must first identify and determine:

i) What students can accomplish independently.
ii) What students can accomplish with guidance (in other words, teacher determines the students' zone of proximal development; and
iii) Teacher then provides the instructions that are just enough to support the learner in task beyond reach without teacher's support.

Scaffolding students' participation results in a community of scientific discourse. In this interactive setting, students can articulate their own understanding, and other students may benefit from this. The social environment of the classroom becomes the setting for the scaffolding of values while it supports and fosters the development of students' competency. The dialogue for individual students does not only give new insights to subject matter, but also provides ways of thinking strategically and reflectively. Sharpe (2016) provided conditions for Scaffolding for research skills to be effective if met include strong team-based planning and implementation activities, students' engagement, and a collaborative learning environment. McKenzie (2020) provided a guide to instructional designers that includes eight characteristics of scaffolding to incorporate in a project-based instructional plan that is appropriate both in an electronic context and classroom environment.

i) Scaffolding provides clear directions to students.
ii) Scaffolding clarifies purpose.
iii) Scaffolding offers assessment to clarify expectations.
iv) Scaffolding points students to worthy resources and thus reduces wasted time.
v) Scaffolding reduces uncertainty, surprise and disappointment.
vi) Scaffolding delivers efficiency by eliminating boredom and non-relevant materials.
vii) Scaffolding creates momentum by channeling energy

Scholars assert that Meta-Conceptual and Scaffolding Learning Strategies enhance students' achievement in Physics. But the strategy that would improve the students' achievement more than the other in Physics is not determined yet. This is as Sangowawa (2019) reported that a significant difference existed in the performance scores of the participants in favour of the experimental group (Scaffolding Learning Strategy) in Ecology while for Meta-Conceptual Learning Strategy, Okoza, Aluede & Owens-Sogolo (2023) reported that students' achievement in Biology was enhanced and effective correlates of success in college anatomy and physiology when Meta-conceptual approach was used. Xiying and Gang (2020) found out that students achieved higher in English when taught using Meta-conceptual strategies. Nwankwo, Achufusi and Offiah (2019) reported that Meta-conceptual Learning Strategy (MLS) boosts students' achievement in Waves. This warranted the researchers to determine the effectiveness of meta-conceptual and scaffolding learning strategies on senior secondary school students' achievement in Waves in Enugu Education Zone of Enugu State. Students' Achievement in Waves is the act of obtaining a result in Waves through efforts in the quality and quantity of students' work in Physics. Bitrus (2014) stated that students' achievement is a measure of knowledge gained through education process usually indicated by test scores, grade point average and degree.

Purpose of the Study

The purpose of this study was to determine the Effects of Meta- conceptual and Scaffolding Learning Strategies on Senior Secondary School Students' Achievement in Physics in Enugu Education Zone. Specifically, the study determined;

1. Difference in the mean achievement scores of students taught Waves using Meta- conceptual and Scaffolding Learning Strategies.
2. Difference in the mean achievement scores of students taught Waves using Meta- conceptual Strategy and those taught using Lecture method.
3. Difference in the mean achievement scores of students taught Waves using Scaffolding Learning Strategy and those taught using Lecture method.

Research Questions

The following research questions guided this study;

1. What is difference in the mean achievement scores and standard deviations of students taught Waves using Meta- conceptual and Scaffolding Learning Strategies in the pretest and posttest?
2. What is difference in the mean achievement scores and standard deviations of students taught Waves using Meta- conceptual Strategy and those taught using Lecture method in the pretest and posttest?
3. What is difference in the mean achievement scores and standard deviations of students taught Waves using Scaffolding Learning Strategy and those taught using Lecture method in the pretest and posttest?

Hypotheses

The following null hypotheses which were tested at 0.05 levels of significance guided this study;

HO_1: There is no significant difference between the mean achievement scores of students taught Waves using Meta- conceptual and Scaffolding Learning Strategies in the posttest.

HO_2: There is no significant difference between the mean achievement scores of students taught Waves using Meta- conceptual Strategy and those taught using Lecture method in the posttest.

HO_3: There is no significant difference between the mean achievement scores of students taught Waves using Scaffolding Learning Strategy and those taught using Lecture method in the posttest.

Method

The design of this study was quasi-experimental research design. The design was specifically a non-equivalent control group design. This study was conducted in public coeducational secondary schools in Enugu Education zone of Enugu State. The population for the study was 4090 SSS II students in the 33 secondary schools. The sample size of the study was 259 SSS II students. The sample size was determined using the actual number of students in each of the selected intact classes in the three (3) selected coeducational secondary schools that were used for the study. The three (3) coeducational

secondary schools are selected based on multi-stage sampling procedure. Waves Achievement Test (WAT) is the instrument that was used for data collection. WAT was used to elicit the students' achievement in Waves. WAT underwent both face and content validation. The instrument was validated by three experts, two in the Department of Science Education and one in the Measurement and Evaluation option in the Department of Mathematics and Computer Education, all from the Faculty of Education, ESUT, Enugu. The reliability estimate for WAT was determined using Kuder-Richardson formula method (K-R 20), which gave an estimated reliability coefficient of 0.89. Mean ($\bar{x}$) and standard deviations (s) were used in answering the research questions while Analysis of Covariance (ANCOVA) was used in testing the research hypotheses at 0.05 alpha levels.

Results

Research Question 1: What is difference in the mean achievement scores and standard deviations of students taught Waves using Meta- conceptual and Scaffolding Learning Strategies in the pretest and posttest?

Table 1: Mean Achievement Scores and Standard Deviations of students taught Waves using Meta-Conceptual and Scaffolding Learning Strategies

Groups	n	Pretest		Post-test		Gained mean score
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)	
Experimental 1	90	32.87	7.97	52.53	8.23	19.66
Experimental 2	89	34.36	8.25	59.27	9.49	24.91

WHERE MAXIMUM VALUE = 100.00; MID-VALUE = 50.00; MINIMUM VALUE = 00.00

Table 1 shows that the students taught using Scaffolding Learning Strategy gained higher (with the gained mean score of 24.91) than their counterparts taught using Meta-Conceptual Learning Strategy (with the gained mean score of 19.66). With these gained mean scores, the results also, show that the learning took place within the two groups but the extent that learning took place depended on the learning strategy. However, the mean achievement scores of the students taught Waves using Meta-Conceptual and Scaffolding Learning Strategies are homogeneous because the differences in their standard deviations in both pretest and posttest which are 0.28 and 1.24 respectively are relatively small.

Research Question 2: What is difference in the mean achievement scores and standard deviations of students taught Waves using Meta- conceptual Strategy and those taught using Lecture method in the pretest and posttest?

Table 2: Mean Achievement Scores and Standard Deviations of students taught Waves using Meta-Conceptual Strategy and Lecture Method

Groups	n	Pretest		Post-test		Gained mean score
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)	
Experimental 1	90	32.87	7.97	52.53	8.26	20.13
Control	80	34.90	9.08	43.76	10.32	8.86

WHERE MAXIMUM VALUE = 100.00; MID-VALUE = 50.00; MINIMUM VALUE = 00.00

Table 2 shows that the students taught using Meta-Conceptual Learning Strategy gained higher (with the gained mean score of 20.13) than their counterparts taught using Lecture Teaching Method (with the gained mean score of 8.86). With these gained mean scores, the results also, show that the learning took place within the Control group as well but the extent that learning is small unlike their counterparts in the Experimental Group 1 (Meta-Conceptual Learning Strategy). However, the mean achievement scores of the students taught Waves using Meta-Conceptual Learning Strategy and Lecture Teaching Method are homogeneous because the differences in their standard deviations in both pretest and posttest are 1.11 and 2.06 respectively which are comparatively trivial and can be ignored.

Research Question 3: What is difference in the mean achievement scores and standard deviations of students taught Waves using Scaffolding Learning Strategy and those taught using Lecture method in the pretest and posttest?

Table 3: Mean Achievement Scores and Standard Deviations of students taught Waves using Scaffolding Learning Strategy and Lecture Method

Groups	n	Pretest		Post-test		Gained mean score
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)	
Experimental 2	89	34.36	8.25	59.27	9.49	24.91
Control	80	34.90	9.08	43.76	10.32	8.86

WHERE MAXIMUM VALUE = 100.00; MID-VALUE = 50.00; MINIMUM VALUE = 00.00

Table 3 shows that the students taught using Scaffolding Learning Strategy gained higher (with the gained mean score of 24.91) than their counterparts taught using Lecture Teaching Method (with the gained mean score of 8.86). Also, the result in the Table 3 shows that the mean achievement scores of the students taught Waves using Scaffolding Learning Strategy and Lecture Teaching Method are homogeneous because the differences in their standard deviations in both pretest and posttest which are 0.83 and are small.

HO₁: There is no significant difference between the mean achievement scores of students taught Waves using Meta- conceptual and Scaffolding Learning Strategies in the posttest.

Table 4: Analysis of Covariance (ANCOVA) of the Mean Achievement Scores of the Students in the Experimental 1 and 2 Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	9329.049[a]	2	4664.525	122.358	.000	
Intercept	8363.843	1	8363.843	219.396	.000	
PreWAT	7298.441	1	7298.441	191.449	.000	
GROUP	1368.909	1	1368.909	35.909	.000	S
Error	6709.487	176	38.122			
Total	575033.000	179				
Corrected Total	16038.536	178				

a. R Squared = .582 (Adjusted R Squared = .577)
b. WHERE S = Significant at P< .05; NS = Not Significant at P> .05

The GROUP (Meta- conceptual and Scaffolding Learning Strategies) in Table 4 gives an F-value of 35.909 and is significant at .000. Since .000 is less than 0.05, the null hypothesis is rejected as stated. Hence, the study concludes that there is significant difference between the mean achievement scores of students taught Waves using Meta- conceptual and Scaffolding Learning Strategies in the posttest.

HO₂: There is no significant difference between the mean achievement scores of students taught Waves using Meta- conceptual Strategy and those taught using Lecture method in the posttest.

Table 5: Analysis of Covariance (ANCOVA) of the Mean Achievement Scores of the Students in the Experimental 1 and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	11169.373[a]	2	5584.686	141.833	.000	
Intercept	4332.576	1	4332.576	110.034	.000	
PreWAT	7911.266	1	7911.266	200.921	.000	
GROUP	4524.515	1	4524.515	114.908	.000	S
Error	6575.622	176	39.375			
Total	416077.000	179				
Corrected Total	17744.994	178				

a. a. R Squared = .629 (Adjusted R Squared = .625)
b. WHERE S = Significant at P< .05; NS = Not Significant at P> .05

From Table 5, the GROUP (Meta- Conceptual and Learning Strategy and Lecture Teaching Method) in Table 5 gives an F-value of 114.908 and is significant at .000. Since .000 is less than 0.05, the null hypothesis is rejected as stated. Hence, there is significant difference between the mean achievement scores of students taught Waves using Meta- conceptual Learning Strategy and those taught using Lecture method in the posttest.

HO_3: There is no significant difference between the mean achievement scores of students taught Waves using Scaffolding Learning Strategy and those taught using Lecture method in the posttest.

Table 6: Analysis of Covariance (ANCOVA) of the Mean Achievement Scores of the Students in Experimental 2 and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	18268.615[a]	2	9134.307	184.812	.000	
Intercept	5464.798	1	5464.798	110.568	.000	
PreWAT	8137.483	1	8137.483	164.643	.000	
GROUP	10698.164	1	10698.164	216.453	.000	S
Error	8204.533	166	49.425			
Total	482202.000	169				
Corrected Total	26473.148	168				

a. R Squared = .690 (Adjusted R Squared = .686)
b. WHERE S = Significant at P< .05; NS = Not Significant at P> .05

From Table 6, GROUP (Scaffolding Learning Strategy and Lecture Method) gives an F-value of 216.453 and is significant at 0.000. Since 0.000 is less than 0.05, the null hypothesis is rejected as stated. Thus, the study concludes that there is significant difference between the mean achievement scores of students taught Waves using Scaffolding Learning Strategy and those taught using Lecture method in the posttest.

Discussion

It was discovered from the study that students who were taught Waves using Scaffolding Learning Strategy significantly had higher mean achievement scores than their counterparts taught using Meta-Conceptual Learning Strategy and the students who were taught Waves using Meta-conceptual and Scaffolding Learning strategies respectively significantly achieved better than their counterparts taught using Lecture method. These findings have shown that both the Meta-conceptual and Scaffolding Learning strategies have proven to be effective in boosting students' achievement in Waves because the strategies enable the students to be actively involved in the learning of Waves and the both strategies offer supports to the students in their various stages of learning Waves (Alake, 2017). These findings tally with the findings of these scholars like Okoza, Aluede & Owens-Sogolo (2023), Xiying and Gang (2020), Sangowawa (2019), Ogunseemi (2013).

For Scaffolding Learning Strategy, Sangowawa (2019) reported that a significant difference existed in the performance scores of the participants in favour of the experimental group (Scaffolding Learning Strategy) in Ecology. Ogunseemi (2023) reported that students exposed to scaffolding strategy performed significantly better than their counterparts who were exposed to traditional method while for Meta-Conceptual Learning Strategy, Okoza, Aluede & Owens-Sogolo (2023) reported that students' achievement in Biology was enhanced and effective correlates of success in college anatomy and physiology when Meta-conceptual approach was used. Xiying and Gang (2020) found out that students achieved higher in English when taught using Meta-conceptual strategies. Nwankwo, Achufusi and Offiah (2019) reported that Meta-conceptual Learning Strategy (MLS) boosts students' achievement in Waves because it plans the teaching in a way of strategizing a learning task, monitor the students' comprehension and evaluate the progress towards the completion of the Physics task. Asiyai (2015) advised that when Physics is taught using Meta-conceptual Learning Strategy, the students can easily view immediately all the concepts in the topics taught. He went further to say that Physics teachers should make efforts to enable students to acquire meaningful learning in Physics by making the teaching of the subject exciting, purposeful and participatory.

The Scaffolding Learning Strategy has also become the most efficacious in boosting students' achievement in Waves than Meta-conceptual Learning Strategy and Lecture Teaching Method and the Meta-Conceptual Learning Strategy is more effective than the Lecture method. This is because according to Sawyer (2016), Scaffolding Learning Strategy offers provision of support to the students to promote learning when concepts and skills are being first introduced to the students. These supports are resources, a compelling task, templates and guidance on the development of cognitive and social skills and these supports are gradually removed as the students develop autonomous learning strategies, thus promoting their own cognitive, affective and psychomotive learning skills and knowledge. Thus, when a Physics teacher wants to maximally boost students' achievement in Waves, they should offer to use strategies that offer support to students in their act of learning Waves.

Conclusion

This study investigated the Effects of Meta- conceptual and Scaffolding Learning Strategies on Senior Secondary School Students' Achievement in Waves in Enugu Education Zone. The study was guided by three (3) research questions and three (3) research hypotheses. From the findings of the study, it was deduced that the Scaffolding Learning Strategy made the students to understand question faster and respond sharply. Thus, the Scaffolding Learning Strategy is more effective in boosting students' achievement in Waves.

Recommendations

Based on the implications and findings of the study, the following recommendations are made;

1. The serving Senior Secondary School Physics teachers should ensure that they use Meta-conceptual and Scaffolding Learning Strategies particularly on the use of Scaffolding Learning Strategy in teaching Waves since that the use of Scaffolding Learning Strategy has proven to be most effective in teaching Waves.
2. Federal/State governments and other relevant professional bodies should sponsor seminars, conferences, workshops or refresher courses on the use of Meta- conceptual and Scaffolding Learning Strategies particularly on the use of Scaffolding Learning Strategy in teaching

Waves since that the use of Scaffolding Learning Strategy has proven to be most effective in teaching Waves.

3. Physics educators involved in curriculum development should restructure the Senior Secondary School Physics Syllabus and textual materials that can create opportunities for the use of Meta- conceptual and Scaffolding Learning Strategies in teaching Physics.

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