EFFECT OF MULTIPLE INTELLIGENCE- BASED INSTRUCTIONAL APPROACH ON STUDENTS' ACADEMIC ACHIEVEMENT IN THE LEARNING OF DIFFICULT CONCEPT IN PHYSICS IN ANAMBRA STATE

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Abstract
This study investigated the effect of Multiple Intelligence Based Instructional Approach (MIBIA) on students' academic achievement in the learning of the difficult physics concepts in Anambra State. Two research questions guided the study and two hypotheses were formulated and tested at 0.05 level of significance. The research design was quasi-experimental study (non-equivalent control group). Specifically, the study was non-randomized pre-test, post-test, control group design. The sample was made up of 100 SS1 students from two randomly selected co-educational secondary schools in Nnewi Educ8ation zone. The Physics Achievement Test (PAT) instrument was used for data collection. Test-retest was used to determine the reliability of PAT. The application yielded coefficient of 0.92. Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the null hypotheses at $P < 0.05$. The finding indicates that there was no significant difference in the mean achievement scores of students taught difficult physics concepts using MIBIA and Conventional Lecture Method (CLM). More so, there were no significant gender difference in the mean achievement scores and interest rating scores since both male and female achieved great scores and demonstrated a similar level of interest in the subject matter. It was recommended among others that educators should consider diversified instructional methods like the Multiple Intelligence Based Instructional Approach (MIBIA) and traditional methods like the Convectional Lecture Method (CLM) to cater for student's diverse needs and preferences, fostering engagement and improving learning outcome.

Keyword: Multiple intelligence- based instructional approach, Academic Achievement, Physics

Introduction

The need to produce functional individual and society is the concern of educational bodies. Today, educators, researchers and curriculum planners lay emphasis on functional and implementable education due to the effect of globalization and increasing complexity of science and technology (Okekeokosisi, Anaekwe & Okeke, 2016). Physics, Chemistry and Biology are core science subjects. Physics as a subject is highly needed for the nation's technological breakthrough and advancement because Physics is a science that studies the most fundamental rules in the universe. It deals with matter, energy, their behaviors and structures. The study of physics enhances an understanding of the interplay of forces in nature and therefore forms veritable armour against superstition which helps technological advancement everywhere.

Despite the importance of Physics in national development and its popularity among students, performance of this subject has not been encouraging (Bassey and Sari 2020). According to Omeje, & Ogwo (2021) the failure rate of students in science generally and Physics in particular at Senior Ce2r8tificate Examinations has been persistently high. Olatoye and Aanuoluwa (2015) attributed the high failure rate in Physics to a number of factors such as lack of qualified teachers, inadequate learning facilities, overpopulated classes, overloaded curriculum, poor mastery of the concepts and inappropriate use of teaching methods. Thompson (2021) blamed under achievement in science on conceptual difficulty. Samba and Eriba (2012) informed that the decline in physics and indeed other science subjects were as a result of students perceiving some of the concepts difficult to learn.

Difficult Physics concepts are those concepts in physics which the students are not finding easy to learn. This implies that the students lack the framework to deepen their understanding of these concepts. It is an observed fact that some concepts in physics curricula are very difficult for students to comprehend. Some of the concepts include matter, energy, simple harmonic motion, electromagnetism, gravitational field, among others (Akpan, 2012; Sari, 2020). Among the reasons advanced for this situation is difficulty in mastery of the concepts which is attributed to poor handling of the concepts by the teachers and the unsatisfactory methods of teaching these concepts. (Okpe, 2018). According to Jada (2019) poor academic achievements in the schools suggest poor methodology of instruction and therefore called for an in-depth investigation of instructional strategies that will improve students' achievement more appropriately. This search for methods and strategies for effective teaching and learning have engendered the birth of many procedures and methods that include multiple intelligence strategies and activities for teaching of science. It is on this premise that the researcher has pinpointed Multiple Intelligence Based Instructional Approach.

A multiple intelligence – based instructional approach is one in which a teacher employs various intelligences as identified in Howard Gardner's theory of multiple intelligences to achieve the objectives of the lesson. The theory of multiple intelligence was proposed by Howard Gardner in 1983 as a model of intelligence that differentiates intelligence into various specific (primarily sensory) modalities. It pre-supposes that all human possesses a number of distinct intelligences which manifest themselves in different skills and competencies and they represent different ways to learn and demonstrate understanding (Toli & Kallery, 2021). This new outlook on intelligence differs greatly from the traditional view which usually recognizes only two intelligences – verbal and computational. Multiple-intelligence pluralizes the traditional concept of intelligence from logical and linguistic problem solving to a set of abilities, talents of mental skills called intelligence. Armstrong (2000) reported that Gardner official words describe different ways individuals are "smart", that is, how their natural talents are manifested and how they learn best. These intelligences are verbal – linguistic intelligence (word smart), visual - spatial intelligence (picture smart), logical – mathematical intelligence (number and reasoning smart) and bodily kinesthetic intelligence (body smart). Others are musical – rhythmic intelligence (music smart), inter-personal intelligence (people smart), intra – personal intelligence (self smart) and naturalist intelligence (nature smart). Verbal-linguistic intelligence: It deals with the ability to think in words and to use spoken and written words or languages to express ideas, appreciate meaning and accomplish other goal2s (Djudin, 2018). Logical - mathematical intelligence: This area has to do with logic, abstractions, inductive and deductive reasoning and use of numbers. Visual spatial intelligence: Hazari (2013) described the visual spatial intelligence as the ability to think in pictures, to create mental image and to transform visual or spatial ideas into imaginative and expressing creations. Bodily-kinesthetic intelligence: Driel (2018) described the bodily kinesthetic as the ability to use one's body in part or whole to solve problems or fashion out products. It can equally be said to be the ability to use the body effectively, like a dancer or surgeon in part or whole to solve problems or fashion out products. Musical - rhythmic intelligence: According to the Firelight User Network (FUN) (2000), it enables individuals to be sensitive to non-verbal sounds and to discern rhythmic, pitch, timbre and tone. Inter-personal intelligence: This has to do with interaction with others. Intra-personal intelligence: being able to understand one's own interest and goals. Intra-personal intelligence refers to the ability to understand oneself, recognize one's feeling' strengths and weaknesses and to use the information and direct one's life. Naturalistic intelligence: This area has to do with nature, nurturing and relating information to one's natural surroundings. The capacity to recognize and classify natural species (Flora and Fauna) in one's environment is what Gardner describes as naturalist intelligence (FUN, 2000).

Gardner claimed that the eight intelligences very rarely operate independently. Armstrong (1994, 2000) advocated that teachers applying the multiple intelligence approach in their classroom should

present their lesson using a wide variety of instructional techniques involving the use of words, numbers and logic, music, group activities, physical activities, pictures, self-reflection and the physical surrounding in order to adequately cater for the diverse learning preferences of the students. It is therefore important that teachers should assess their students' learning in ways that will give them the opportunity to use their well-developed intelligence and do well. Students could write reports, give oral presentations using visual materials prepared by them, present graphic designs, concept maps, models, independent projects and creative tasks.

The following instructional techniques adopted by Wang and Wu (2014) which address the intelligence(s) indicated were adopted in the present study. These are project-based learning, collaborative learning, active learning, authentic instruction and self-assessment. Project - based learning (bodily-kinesthetic intelligence). Patak (2018) considered project approach as an example of activity technique. To him, it is a student – centered approach where the student has some control over the teaching process and directs more or less the instructional activities with the teacher providing adequate guidance. Collaborative learning (inter-personal intelligence) – is also called cooperative learning and occurs whenever students interact in pairs or groups. Active learning (verbal-linguistic and logical – mathematical intelligence) -According to Bonwell and Elson (2003), active learning is an instructional technique by which students are actively engaged in the learning process. Authentic instruction (visual-spatial intelligence) - is an approach to learning that intends to make learning more meaningful by increasing connections between the classroom and the real World (Calaveras, 2000). Self-assessment (intra-personal) – is a technique by which a learner assesses his or her own achievement and progress.

Multiple intelligence theory believes that all students can learn and that no one is of low intelli2gence because everyone is gifted in at least one intelligence category. The studies of some researchers like Patak, Sari and Djudin (2018), Thomson (2021) and Akpan (2012) revealed that the multiple intelligence approach improves achievement and interest of learning in a wide range of subjects in both children and adults. It is logical to say that if there is poor academic achievement in any subject area, especially in sciences, physics in particular, then insufficient learning has taken place in that subject area since it is only what is learnt that is expressed as academic achievement. Learning therefore plays complementary roles in determining academic achievements in any subject area.

Academic achievement according to Ali in Obialor (2016) is anything that somebody has done successfully especially using his own effort and skills. Academic achievement is the overall performance outcome of education that indicates the extent to which a learner has achieved set-out goals. It is an index of measurement that shows a student‘s cognitive, affective and psychomotor domains in an educational setting (Joe, Kpolovie, Osonwa and Iderima, 2014). More so, Verma (2016) defined academic

achievement as a measure of knowledge, understanding or skills in a specific subject or a group of subjects.

Apart from teaching method/strategy used by teachers in teaching the students; gender issue may be another factor affecting students' academic achievement in physics. Close (2019) found out that females achieved better than males in the science subjects. Osuafor and Obialor (2016) reported that there is no significant difference in the academic achievement of male and female students exposed to biology using project work. The present study therefore is challenged with the dearth of research studies on the applicability of multiple Intelligence Based Instructional Approach on students' achievement and interest in the teaching and learning of difficult physics concepts due to gender in Anambra State.

Research Questions

The following research questions were asked to guide the study.

1. What are the mean achievement scores of students taught difficult concepts in physics using MIBIA and that of those taught using Conventional Lecture Method (CLM)?
2. What are the mean achievement scores of male and female students taught difficult concepts in physics using MIBIA and that of those taught using CLM?

Hypotheses

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

1. There is no significant difference between the mean achievement scores of students taught difficult concepts in physics using MIBIA and that of those taught using the CLM.
2. There is no significant difference between the mean achievement scores of male and female students taught difficult concepts in physics using MIBIA and that of those taught using CLM.

Method

The design was quasi-experimental study (the Non-Equivalent Control, Group). Specifically, the study was non-randomized pre-test-post-test, control group design to observe the academic achievement of student2s before and after manipulations of the independent variables (MIBIA and CLM). The study was carried out in Nnewi Education Zone of Anambra State. The population of the study consisted of 1,534 SS1 students who offer physics in the 39 co-educational public secondary schools in Nnewi Education Zone of Anambra State The study adopted the use of intact classes. A simple random sampling technique

was used to sample the two schools out of 39 secondary schools. Using a flip of a coin, one of the schools was chosen as experimental group and the other control group. In each of the two schools one intact class was randomly sampled. The experimental group has intact size of 50 (34 males and 16 females while control group has intact size of 50 (32 males and 18 females). All the students in each of the two intact classes were used for the study. The total sample size was one hundred (100). The instrument used for data collection for the study was Physics Achievements Test (PAT). The PAT consists of 50 items, 5 options multiple choice tests with items drawn from the concepts of matter, energy, simple harmonic motion and heat and temperature which were identified as difficult concepts in physics by the students. The Physics Achievement Test (PAT) was validated by an experienced physics teacher in secondary school. Also two specialists in Educational Foundations and one in Science Education all in Nnamdi Azikiwe University Awka, validated the instruments. The degree of consistency of the instrument was estimate using test-retest. It was used to determine the reliability of the PAT. The PAT was administered on 30 SS1 students in one of the secondary schools in Enugu State outside the research area which has homogenous culture as the research area. Two weeks later the same test was re-administered to the same students which were correlated using Pearson Product Moment Correlation Technique which yielded a correlation index of 0.92. The treatment group was taught using MIBIA while the control was taught using CLM. At the end of the treatment, the scores of the experimental group in both pre-test and post-test were recorded and compared with the scores obtained by the control group in both tests. Data collected were analysed using mean, standard deviation and analysis of covariance (ANCOVA) at 0.05 level of significance.

RESULTS

Research Question 1: What are mean achievement scores of students taught difficult concepts in physics using MIBIA and that of those taught using Conventional Lecture Method (CLM)?

Table 1: Pretest and Posttest Mean Achievement Scores of Students Taught Difficult Concepts in Physics Using MIBIA and Conventional Lecture Method

Groups		Pretest		Post test		
	No	Mean	Stand dev	Mean	Stand dev	Mean Gain
M2BIA Technique	50	44.96	8.14	76.10	8. 58	31.14
Conventional Lecture Method	50	46.80	8.46	71.70	15. 8	24.90

Table 1 show that the mean achievement gain scores for experimental group was 31.14 while the mean achievement gain score for the control group is 24.90. This indicates that students taught difficult physics concepts using the MIBIA Technique showed a higher mean gain in achievement scores compared to those ta2ught using the Conventional Lecture Method. Therefore, it can be concluded that the MIBIA Technique is more effective in facilitating student learning and understanding of difficult physics concepts than the Conventional Lecture Method.

Research Question 2: What are the pretest and posttest mean achievement scores of male and female students taught difficult concepts in physics using MIBIA and that of those taught using CLM?

Table 2: Pretest and Posttest Mean Achievement Scores of Male and Female Students Taught Difficult Concepts in Physics Using MIBIA and that of those taught using CLM

Gender		Pretest		Post test		
	No	Mean	Stand dev	Mean	Stand dev	Mean Gain
MALE	34	43.23	8.42	75.02	8.74	31.79
FEMALE	16	48.62	6.27	78.37	8.03	29.75

Table 2 show that both the male and female students' experienced substantial improvements in their achievement scores after being taught difficult physics concepts using either the MIBIA Technique or the Conventional Lecture Method. The male students showed a pretest mean score of 43.23, which increased to 75.02 in the posttest, resulting in a mean gain of 31.79. Similarly, the female students had a pretest mean score of 48.62, which increased to 78.37 in the posttest, resulting in a mean gain of 29.75.

The results indicate that both male and female students benefited from the instructional methods used, as reflected by their significant mean gains in achievement scores. There were no notable differences between the genders in terms of overall improvement. This implies that both MIBIA and CLM can be effective teaching approaches for enhancing the understanding and performance of both male and female students in challenging physics concepts.

Hypothesis One: There is no significant difference between the mean achievement scores of students taught difficult physics concepts using MIBIA and those taught using the CLM.

Table 3: ***Comparison of Mean Achievement Scores of Students Taught Physics Concepts using MIBIA and CLM***

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	694.057[a]	2	347.028	2.147	.122
Intercept	20920.664	1	20920.664	129.462	.000
AchieveControl	210.057	1	210.057	1.300	.257
Group	410.149	1	410.149	2.538	.114
Error	15674.943	97	161.597		
Total	562490.000	100			
Corrected Total	16369.000	99			

a. R Squared = .042 (Adjusted R Squared = .023)

Table 3 showed that at the 0.05 level of significance, with 2 degrees of freedom (df) in the numerator and 97 degrees of freedom in the denominator, the calculated F-value of 2.147 with a p-value of 0.122. Since the p-value (0.122) is greater than the chosen significance level (0.05), this indicates that there is no significant main effect of the teaching methods (MIBIA and CLM) on the mean achievement scores of students. The $F(2, 97) = 2.147$, $p > 0.05$.

The results suggest that there was no statistically significant difference in the mean achievement scores between students taught difficult physics concepts using MIBIA and those taught using the CLM. Thus, the hypothesis stating that there is no significant difference between the mean achievement scores of students taught difficult physics concepts using MIBIA and those taught using the CLM is not rejected based on these findings.

Hypothesis Two: There is no significant difference between the mean achievement scores of male and female students taught difficult physics concepts using MIBIA and those taught using CLM.

Table 4: ***Comparison of Mean Achievement Scores of Male and Female Students Taught Physics Concepts using MIBIA and CLM***

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1074.951[a]	3	358.317	2.249	.088
Intercept	21453.939	1	21453.939	134.665	.000
Gender	739.654	1	739.654	4.643	.034
gender * AchieveControl	1004.391	2	502.195	3.152	.047
Error	15294.049	96	159.313		

Total	562490.000	100
Corrected Total	16369.000	99

a. R Squared = .066 (Adjusted R Squared = .036)

Table 4 show that at the 0.05 level of significance, with 3 degrees of freedom (df) in the numerator and 96 degrees of freedom in the denominator, the calculated F-value was 2.249 with a p-value of 0.088. This indicates that there is no significant main effect of the factors included in the analysis (gender and the interaction between gender and Achieve Control) on the mean achievement scores of students. The F (3, 96) = 2.249, $p > 0.05$.

The results suggest that while there was no significant difference in the mean achievement scores between male and female students (gender main effect), the interaction between gender and Achieve Control had a significant influence on the achievement scores.

The overall model accounted for a relatively small proportion of the variance in the dependent variable, with an R-squared of 0.066 (adjusted R-squared = 0.036). This indicates that the factors included in the analysis explain only a limited amount of the variation in the achievement scores.

Based on these findings, the null hypothesis, which states that there is no significant difference between the mean achievement scores of male and female students taught difficult physics concepts using MIBIA and those taught using CLM, is not rejected. The main effect of gender was not significant, but the interaction between gender and Achieve Control was significant, suggesting that the relationship between gender and the Achieve Control variable influenced the achievement scores.

Discussion

The study compared the achievement scores of students taught difficult physics concepts using MIBIA and those taught using the Conventional Lecture Method (CLM). Both groups showed improvements in their post-test achievement scores, but the difference between the two instructional methods was not statistically significant. This implies that MIBIA and CLM were equally effective in teaching difficult physics concepts to students.

The finding that MIBIA and CLM are equally effective in teaching difficult physics concepts is supported by previous research. Other alternative teaching methods have also enhanced learning outcomes in various subject areas. For example, interactive engagement teaching techniques are significantly more likely to produce high student learning gains than traditional lecture-based instruction (Hake, 2016). Additionally, a study by Gómez-Zaldívar and López-Santos (2019) proposed a

methodology for teaching physics that explored multiple intelligences, including linguistic, logical-mathematical, and visuospatial, and found that with pedagogical interventions, students showed promising results, expressed more interest, and liked the classes. Another study by Al-Abbasi and Al-Abbasi (2020) discussed Engaged pedagogy. This novel interactive teaching method can support students in studying Physics more efficiently and develop critical and quantitative thinking skills. These studies suggest that alternative teaching methods can effectively enhance learning outcomes in various subject areas. On the other hand, some studies contradict the finding of equal effectiveness between MIBIA and CLM. Park and Kim (2013) examined the effects of multiple intelligences-based instructions, which shares similarities with MIBIA, on science achievement in elementary school students. They found that this instructional approach led to significantly higher science achievement scores than traditional instruction. Additionally, Wang and Wu (2014) explored the effects of multiple intelligences-based instructions on students' learning outcomes in science courses and found that it positively influenced their achievement. These studies suggest that MIBIA or similar approaches may be advantageous over CLM in specific contexts.

The discrepancy in findings could be attributed to various factors, such as the specific instructional methods employed, the characteristics of the student population, and the assessment measures used in each study. Different instructional techniques and variations in implementation may yield varying results. Moreover, students' diverse cognitive profiles and learning preferences may influence the effectiveness of different instructional methods. In conclusion, the study's findings indicate that MIBIA and CLM are equally effective in teaching difficult physics concepts. However, it is essential to acknowledge that other studies have reported different outcomes, suggesting that the effectiveness of instructional methods may vary depending on specific factors. Further research is necessary to understand the conditions under which each instructional method can benefit most.

The study's third finding revealed no significant gender differences in the mean achievement scores of students taught difficult physics concepts using Multiple Intelligence Based Instructional Approach (MIBIA) and the Conventional Lecture Method (CLM). Both male and female students demonstrated improvements in their post-test achievement scores and the disparity between the two groups was not statistically significant. Several other studies have also discovered no significant gender differences in the effectiveness of MIBIA. In a study conducted by Adiguzel and Kaya (2019), the researchers investigated the effectiveness of MIBIA on the academic achievement and academic self-efficacy of middle school students. Their findings revealed no significant gender differences in academic achievement and self-efficacy between male and female students taught using MIBIA. In another study conducted by Vahedi and Khatib (2016), the researchers examined the effectiveness of MIBIA on the

academic achievement and motivation of high school students. Their study's results indicated no significant gender differences in academic achievement and motivation between male and female students taught using MIBIA. Similarly, in a study conducted by Ismail et al. (2018), the researchers investigated the effectiveness of MIBIA on the academic achievement of secondary school students in Malaysia. Their findings demonstrated no significant gender differences in academic achievement between male and female students taught using MIBIA.

Contrary to the current study, Leslie et al. (2018) investigated the existence and persistence of a performance gender gap in conceptual understanding Newtonian mechanics in three UK universities. Using the Force Concept Inventory, they found that students' at all three universities exhibited a statistically significant gender gap, with males outperforming females. This gap was narrowed but not eliminated after instruction, using a variety of instructional approaches. Furthermore, they found that the quartile with the lowest performance on the diagnostic instrument comprises a disproportionately high fraction (around 50%) of the total female cohort before instruction. The majority of these students remain in the lowest-performing quartile post-instruction.

Another study by Maries et al. (2018) investigated the prevalence of the belief that men generally perform better in physics than women (a gender stereotype) among introductory physics students and the extent to which agreeing with this gender stereotype is correlated with the performance of female and male students in algebra-based and calculus-based introductory physics I and II on the commonly used conceptual standardized physics tests. They found that female students who agreed with the gender stereotype performed worse than those who disagreed at the end of the year-long calculus-based physics course. A study by Tsai (2016) examined the relationship between multiple factors, including gender, and the development of multiple intelligences among students. The study found that gender was among the many factors significantly influencing the development of multiple intelligences among students. However, the study did not directly investigate gender differences in achievement scores in physics courses. Thus, It is important to acknowledge that conflicting findings can arise due to various factors, such as differences in sample characteristics, instructional variations, and assessment methods used in the studies. Further research is needed to gain deeper insights into the complexities of gender differences in achievement scores across different instructional approaches.

Conclusion

In conclusion, the current study demonstrated that MIBIA and CLM effectively taught difficult physics concepts, as evidenced by improvements in achievement scores. MIBIA, however, stood out by generating higher interest ratings, suggesting a more engaging and captivating learning experience for

students. Importantly, no significant gender differences were observed in achievement scores or interest ratings, indicating that both instructional methods were equally beneficial for male and female students.

Recommendations

Based on the findings of this study, several recommendations can be made to enhance educational practices and promote effective teaching and learning. These recommendations are as follows:

1. Diversify Instructional Methods: Educators should consider incorporating various instructional methods, including innovative approaches like the Multiple Intelligence Based Instructional Approach (MIBIA) and traditional methods like the Conventional Lecture Method (CLM). By diversifying their instructional strategies, educators can cater to student's diverse needs and preferences, fostering engagement and improving learning outcomes.
2. Provide Professional Development: Educators may benefit from professional development programs and training sessions to effectively implement different instructional methods. These programs can equip teachers with the necessary skills and knowledge to leverage innovative instructional approaches like MIBIA while effectively utilizing traditional methods. Ongoing support and collaboration among educators can further enhance their instructional practices.
3. Enhance Curriculum Design: Curriculum developers should consider integrating interactive elements, technology-based resources, and real-life applications of concepts into the curriculum. This can enhance student achievement and engagement, making the learning experience more meaningful and relevant. Curriculum designers should also strive to create materials that cater to diverse learning styles and abilities, ensuring accessibility and inclusivity.
4. Encourage Research and Evaluation: The study emphasizes the need for further research on instructional methods and their impact on student outcomes. Educational institutions should encourage and support research initiatives to continually evaluate the effectiveness of different instructional approaches in specific subject areas and contexts. Longitudinal studies can provide valuable insights into the long-term effects of these methods on student learning and achievement.
5. Foster Gender Equality in Education: The finding of no significant gender differences in 2achievement scores indicates the need to continue promoting gender equality in education. Educators and policymakers should create inclusive learning environments that empower male and female students to excel in academic domains, including traditionally male-dominated

subjects like physics. Equal opportunities and support for all students can help break gender barriers and foster a more inclusive and equitable educational system.

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