

ASSESSMENT OF INNOVATIVE TEACHING STRATEGIES IN ENHANCING PHYSICS AND MATHEMATICS ACHIEVEMENT

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Abstract: This study focused on the assessment of innovative teaching strategies in enhancing physics and mathematics achievement of students in senior secondary school. Two research questions and one hypothesis tested at 0.05 level of significance guided the study. The study employed descriptive survey design. Two co-educational senior secondary schools having a total population of 386 SS1 Physics and Mathematics students in Afikpo north LGA in Afikpo Education zone of Ebonyi State were used. The sample comprise of 190 students sampled out of 386 students using purposive sampling. A four-point Likert type questionnaire developed by the researcher was used for the collection of data on the assessment of innovative teaching strategies in enhancing physics and mathematics achievement of students. The instrument is made up of 10 items. The reliability of the instrument after validation yielded an of index of 0.82. The research questions were answered using mean analysis while the entire hypothesis were tested using chi-square statistics. The result revealed that inquiry method, discovery learning, discussion, role play, simulation, games, team teaching, brainstorming and other similar strategies were agreed to be innovative teaching strategies that can enhance achievement in physics and mathematics. Based on this, it was recommended that physics and mathematics teachers should be encouraged to employ these innovative teaching strategies in the teaching of physics and mathematics.

Keywords: Innovation, Teaching Strategies, Science, Mathematics.

Introduction

Every aspect of our day to day lives is hugely influenced by scientific changes happening around us. The most causative catalysts for these changes are revolutionary advancement in information technology and communication along with globalization. Socio-economic changes intermingling with the scientific advancement in real life caters to open up enormous scope of learning before the new generation. This also creates some challenges to the new generation teachers. Knowledge of some new skills side by side with the traditional skills become inevitable such as, logical thinking and problem-solving, creativity and innovation, communication and co-operation. Presently, all the Teacher Education programs aim to incorporate all these essential skills in the

methodology of teaching process. The future teacher can cater their services purposefully to help overall development of their learners. The tasks of science teacher also include them to inculcate science education amongst the learners of various levels. The school level science classrooms are the hatching field for learners who will take science in their higher studies. Science is a dynamic human activity which is concerned with the working of the world. It is the bedrock on which modern day technological breakthrough is built. This is why developing countries like Nigeria are working hard to develop scientifically and technologically since the world is a scientific and technological global village where all proper functioning of lives largely depends on science. Science according to Ting-Kueh (2017) plays major roles in creating new knowledge,

economic development and wealth creation. This assures social wellbeing by eradicating poverty and providing better health care which improves the quality of human living in several ways. Science finds its application in all facets of life such as agriculture, medicine, energy and power supply, biotechnology, space research and nuclear technology. This means that the understanding of science helps man to know more about the universe and things around us. Nigeria as a nation appreciates the importance of science in its quest to transform its economy successfully. This can be seen in the mission statement of the new National Policy on Science, Technology and Innovation (FRN, 2016), which seeks to evolve a nation that develops and utilizes science, technology and innovation to build a large, strong, diversified sustainable and competitive economy that will guarantee a high standard of living and quality of life for all its citizens. Without the application of science, it will be very difficult for man to live and adjust in a fast scientifically developing world.

Science comprises the basic discipline such as Physics, Chemistry, Mathematics and Biology. Physics which is one of the core sciences is crucial to understand the world around us, the world inside and the world beyond us. It is the most basic and fundamental science. Physics challenges our imagination with concepts like relativity and strong theory which leads to great discoveries and technologies that change our lives. Its importance cannot but over emphasized hence the need for all citizens to study the subject with utmost understanding. Mathematics which is a science that draws necessary conclusions also provides special skills required by an individual to solve his day to day problems, communicate effectively, reasons appropriately and makes necessary connections (Harbour – Peter 2015; Obodo, 2015; Kolawole and; Borasi, 2018). The British National curriculum (2014) asserted that mathematics equips pupils with

uniquely powerful tools to understand and change the world. The importance of mathematics can be seen in its applications to science and technology, medicine, the economy, the environment and in public decision making.

Instructional strategies such as inquiry method, discussion, role play, simulation, games and other similar strategies have been shown to enhance the active participation of students in the teaching and learning of physics and mathematics. According to Screeden and Sudler (2013) some other approaches for effective physics and mathematics teaching includes;

1. Orientation: at this stage, the teacher introduce the topic.
2. Elicitation of ideas in which students are given opportunities to explore and explain their ideas.
3. Classification and Exchange: where students are given a chance to realize scientific and mathematical ideas in examining their own ideas.
4. Exposures to conflict situation: this, enable the students to test the level of their ideas.
5. Constructions of new ideas- students are provided with opportunities to restructure (extend, modify or replay their ideas.
6. Evaluation: involves students being provided with opportunities to test the validity of their newly construct ideas.
7. Applications of ideas involving students applying their ideas in new situations to reinforce the ideas.
8. Review change in ideas: which involves students being given opportunity to refer upon how and why their ideas have changed.

Effective teaching according to Obi (2018) is a process related to the teacher's consciousness of the individuality of each child, including his needs, strengths, weakness, growth patterns and background of experiences. This means an effective teacher has to create an atmosphere for a wholesome teaching and learning. Stressing further on this, Anyachebelu (2015) explained that effective teaching is a situation

whereby the teacher is vast in attainment, knowledge and skills as well as possession of certain pre-requisites and acceptable practices within the codes of ethics of teaching profession. Obi (2018) identified five components of effective teaching to include:

1. Possession of knowledge of subject matter
2. Ability to help students with their works
3. Ability to present subject matter appropriately
4. Able to motivate students to excel
5. Honest in preparing marking guides and grades of student's examination

For effective and successful physics and mathematics teaching, teachers must understand how students think and construct scientific and mathematical knowledge. The implication is that physics and mathematics teachers need to teach these subjects effectively for a successful preparation of today's individuals for tomorrow (Zakaria & Iksan, 2020). The teacher must know how students learn these subjects and how best to teach them. Physics and mathematics teaching is not for knowledge depositing and information thrusting but should inculcate scientific temper and values. For effective teaching, the learner is provided with opportunities to have an optimal learning experience through constructing his own knowledge. The teacher must provide a democratic climate in the classroom for effective teaching and learning of physics and mathematics. The democratic climate creates conducive environment for the students to enable the freely state their point of view. This encourages active participation of students in the classroom. The focus is for the teacher to use learner centered innovative pedagogical strategies in the teaching and learning of the subjects. Such innovative strategies include peer tutoring, In spite of the importance and usefulness of physics and mathematics, secondary school students' achievement in the subjects is very discouraging. Researchers have shown that secondary school students are gradually showing no

interest in the subjects (Esiobu, 2015). Studies have also shown that the performance of physics and mathematics was generally and consistently poor in the years (Agwagah, 2014). Poor academic achievement in physics and mathematics could be attributed to many factors among which are the teachers' teaching strategies. This means that physics and mathematics concepts cannot be well understood if students are not taught with effective teaching strategies. Many researchers have blamed this poor achievement in physics and mathematics on the use of inappropriate teaching strategies which might lead to lack of interest and retention of physics and mathematical concepts (Agommuoh, 2014; Agwagah, 2014; Ifeanacho, 2017; Iji and Harbour – Peters, 2015; Kurumeh, 2015; and Ogbonna 2019). Current studies on how students learn science and mathematics revealed new and innovative instructional approaches in the teaching of science and mathematics (Agommuoh, 2015; Ifeanacho, 2015; and Ogbonna, 2019). Science and especially physics and mathematics teaching have undergone a paradigm shift from a passive process to an active construction and interpretation of experiences. Screeden and Sudler (2013) explained that learning is a treasure within, and scientific knowledge is being actively built up and constructed by the learners. This is the constructivist view of learning science and mathematics. The constructivists see learning as an interaction between the learner and his environment. During this interaction between the learner and his environment his prior knowledge becomes the basis for him to interpret and construct new knowledge. The implication is that learning is a process in which the learners invent and develops new ideas. This means that learning physics and mathematics is a process of conceptual change and knowledge navigation. Learning in this case involves the restructuring of student conceptions. Teachers must learn to appreciate the ideas students bring into the learning situation, understand the processes by

which the conceptual change occurs in order to design the learning programs. Learning is learner centered which makes the learner an active participant in the learning environment. New learning in this case depends on the learners' previous knowledge that may at times interfere with the understanding of the new information.

The minds of the young need to be exposed to critical thinking, analysis and problem solving strategies in a fast-changing world like ours. The teaching and learning of science especially mathematics and physics requires a unified and comprehensive approach relying on teachers that are professionally trained and equipped with requisite knowledge and skills. The adoption of student-centered simulation, team teaching, brainstorming, cognitive apprenticeship, discovery learning, inquiry and role play strategies. The secondary school physics and mathematics curriculum is designed to provide students with knowledge and skills that will enable them solve problems and make decision in everyday life (Ministry of Education Malaysia, 2015). Students need knowledge, problem-solving skills, creative and critical thinking for proper adjustment into a fast scientifically and technologically developing society like ours. Students must therefore be taught to meet up with the challenges ahead and demand by daily living. This is very imperative since lecture based instruction which is teacher centered has been identified as a major shortcoming in the teaching and learning of physics and mathematics (Madu, 2015). This is because according to Kurumah (2015), lecture method emphasizes passive acquisition of knowledge by students who do not have conceptual understanding but memorize the learning content. Bearing in mind the nature of physics and mathematics, there is therefore, the need for the teacher to use innovative teaching strategies in the teaching of the subjects so as to enable the students learn and acquire positive attitudes and values,

process skills and problem-solving skills. Hence the need for the study. The teaching and learning of physics and mathematics must aim at achieving the aims and approaches of physics and mathematics education which includes;

1. Development of process skills such as observation, classification, communication, measurement, estimation and prediction.
2. Acquisition and development n of knowledge and skills for problem solving
3. Ability to apply generalization reached to real problem solving
4. Ability to understand inter-relationship between science and mathematics
5. Ability to think logically and draw conclusion on the bases of experiment
6. Promoting creativity for innovation in science and mathematics

Purpose of the Study

The purpose of this study is to investigate the assessment of innovative teaching strategies towards enhancing senior secondary school students' achievement in physics and mathematics.

Research Questions

The following research questions guided the study.

1. What are senior secondary school students' assessment of innovative teaching strategies in enhancing achievement in physics and mathematics?
2. What are male and female senior secondary school students' assessment of innovative teaching strategies in enhancing achievement in physics and mathematics?

Hypothesis

The hypothesis below tested at $P < 0.05$ significant level guided the study

1. There is no significant difference in the scores of male and female senior secondary school students' assessment of innovative teaching strategies in enhancing physics and mathematics achievement.

Methodology

The study adopted a descriptive survey. A total of one hundred and ninety (190) students made up of 98 males and 92 females were drawn out of a population of three hundred and eighty six (386) senior secondary school one (SS1) physics and mathematics students from two co-educational senior secondary schools in Afikpo north LGA of Afikpo education of Ebonyi State was sampled using purposive sampling. The instrument used for data collection which was developed by the researcher is a four point-scale structured questionnaire of the Likert type on assessment of innovative teaching strategies in enhancing student’s physics and mathematics achievement. The responses were Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) weighted 4, 3, 2 and 1 respectively. It is a ten item questionnaire made up of innovative teaching strategies that can be used in

teaching physics and mathematics. The instrument was face and content validated by three experts in Science Education, Ebonyi State University Abakaliki, Ebonyi State, Nigeria. Cronback alpha was used to determine the reliability index which yielded an index of 0.88. The questionnaire was distributed by the researcher and collected back at the spot to ensure 100% return. Two research questions and one hypothesis tested at 0.05 level of significance guided the study. The research questions were answered using mean analysis, while the hypothesis was tested using Chi-square statistics.

Results

The result in respect of mean scores of students assessment of innovative teaching strategies in enhancing achievement in physics and mathematics used in answering research questions 1 and 2 are shown in tables 1 and 2 respectively.

Table 1: Mean scores of senior secondary school students’ assessment of innovative teaching strategies in enhancing achievement in physics and mathematics.

S/N	ITEM	SA	A	D	SD	X	REMARKS
1.	Peer Tutoring	80	60	35	15	3.08	Agree
2.	Simulation	85	66	25	14	3.17	Agree
3.	Team Teaching	88	68	23	11	3.23	Agree
4.	Brainstorming	90	70	20	10	3.26	Agree
5.	Experiential Learning	85	65	25	15	3.16	Agree
6.	Cooperative Learning	84	64	30	12	3.16	Agree
7.	Cognitive apprenticeship	85	72	20	13	3.21	Agree
8.	Discovery Learning	86	67	23	14	3.18	Agree
9.	Inquiring Learning	88	70	21	11	3.24	Agree
10.	Role Play	68	90	20	12	3.13	Agree

Table 1 above clearly showed that all the items have mean values greater than 2.5 which is the mean value of the four point scale used in the study

meaning that all the students agreed that these items are innovative teaching strategies that can enhance achievement in physics and mathematics.

Table 2: Mean scores of male and female senior secondary school students’ assessment of innovative teaching strategies in enhancing achievement in physics and mathematics.

S/N	ITEM	MALE(X)	REMARKS	FEMALE(X)	REMARKS
1.	Peer Tutoring	3.30	Agree	2.85	Agree
2.	Simulation	3.21	Agree	3.12	Agree
3.	Team Teaching	3.35	Agree	3.10	Agree
4.	Brainstorming	3.30	Agree	3.28	Agree
5.	Experiential Learning	3.42	Agree	2.88	Agree
6.	Cooperative Learning	3.06	Agree	3.26	Agree
7.	Cognitive apprenticeship	3.17	Agree	3.24	Agree
8.	Discovery Learning	3.42	Agree	2.94	Agree
9.	Inquiring Learning	3.26	Agree	3.22	Agree
10.	Role Play	3.36	Agree	2.88	Agree

Results in table 2 shows that all the items have mean values greater than 2.5 meaning that the ten item innovative teaching strategies favoured all the students (both male and female) towards enhancing their physics and mathematics achievement.

Table 3: χ^2 values of male and female secondary school students’ assessment of innovative teaching strategies that can enhance physics and mathematics achievement.

Gender	SA	A	D	SD	Fcal	Fcrit	Df
Male	432.7	356.9	124.8	65.5	50.6	7.3	3
Female	406.3	355.1	117.2	61.5			
Total	839	712	242	127			

Table 3 indicate that χ^2 calculated value of 50.6 is greater than the χ^2 critical value of 7.82. The null hypothesis of no significant difference was rejected and upheld the alternative hypothesis that there is significant difference in the mean scores of male and female student’s assessment of innovative teaching strategies in enhancing Physics and Mathematics achievement.

Discussion

Tables 1 and 2 showed that all the items have mean values greater than 2.5 which means that all the students both males and females agreed that peer tutoring, simulation, team teaching, brainstorming, experiential learning, cooperative learning, cognitive apprenticeship, discovery learning, inquiring learning and role play are innovative teaching strategies that will enhance their achievement in physics and mathematics. This result is in agreement

with Akinbobola (2018) who opined that new approach of communicating science and mathematics is by involving students and making sure that they participate fully rather than listening to talks and taking notes. Science teaching has been shifted from the teacher centered approaches to student centered approaches of learning such as inquiring and problem – solving methods (Akinbobola, 2018). This result also agrees with Akinbobola and Ado (2017) who explained that these innovative strategies which include brainstorming, peer tutoring and role play help the learner to acquire appropriate skills, abilities and competences as equipment for the individual to solve life problems and contribute to the development and growth of the society. According to Bransford, Brown and Cocking (2018) the major goal of teaching is to prepare students to be able to adopt

knowledge to various problems and setting and using multiple context. This can only be achieved by using innovative teaching strategies that will involve students full participation in the teaching and learning environment. Effective teaching of physics and mathematics puts a great emphasis on students' participation in the learning process which implies that students have to be active rather than simply passive recipients of information from the teacher, textbook or any other source of information involved in the learning contexts. Active participation and involvement of the students in the learning situation can only be through the use of a wide range of innovative teaching and learning strategies such as peer tutoring, simulation, team teaching, brainstorming, experiential learning, cooperative learning, cognitive apprenticeship, discovery learning, inquiring learning and role play.

Conclusion

In this entire discussion the emphasis is mostly given on innovative teaching strategies in enhancing physics and mathematics achievement. The above results and discussion are very relevant in the teaching and learning of physics and mathematics subjects. The job of the teacher requires that he assists the learner to learn. The teacher can do this effectively by making the teaching environment stimulating, challenging and dynamic. The aim of teaching is not only to transfer information but also to transform passive students into active receptors of knowledge and constructor of their own knowledge.

Recommendations

1. Physics and mathematics teachers should utilize innovative practices in their lesson delivery so as to enhance students' active participation in the lesson for enhanced academic achievement.
2. Intensive in-serve programs should be organized to get physics and mathematics teachers acquainted with and trained on how to effectively utilize innovative teaching strategies in their lesson delivery.

3. Physics and mathematics teachers should be allowed to visit schools that are utilizing innovative practices to observe new strategies and materials in action.

4. Science teachers and principals should be encouraged to become more versatile in approaching teaching strategies.

5. Schools or academic institutions should create and maintain the culture of innovative teaching strategies in physics and mathematics.

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