

EFFECT OF HANDS-ON MINDS-ON INSTRUCTIONAL APPROACH ON STUDENTS' ACHIEVEMENT IN SECONDARY SCHOOL BIOLOGY: IMPLICATION FOR CREATIVITY AND INNOVATION

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Abstract

Hands-on minds-on instructional approach is a kind of active learning that promotes learning by doing. The study examined the effect of hands-on–minds-on instructional approach on students' achievement in Biology and the implication in promoting creativity and innovation among secondary school students. Design of the study was quasi-experimental, specifically non-equivalent control group. Three research questions and three null hypotheses guided the study. Population for the study comprised 324 senior secondary school one (SSI) students in Nkanu – West Local Government Area of Enugu State. Sample for the study consisted of 149 SSI students drawn through purposive and simple random samplings. Through purposive sampling four co-educational secondary schools were drawn because of gender variable. Through simple random sampling four intact classes were drawn, one each from the four co-educational schools. The four intact classes were randomly assigned to experimental and control groups. The students in the experimental group were exposed to Biological concept using hand-on-minds-on instructional approach while those in the control group were exposed to the same Biology content using lecture method. The treatment lasted for four weeks. Data for the study were collected using researcher made Biology Achievement Test (BAT) consisting of thirty multiple choice questions. The internal consistency reliability index of 0.70 was established using Kuder-Richardson (K-R-20). The research questions were answered using mean and standard deviation while the hypotheses were tested using ANCOVA at 0.05 level of significance. The results obtained revealed that the students exposed to Biology content using hands-on-mind-on instructional approach out performed those exposed to lecture method. The result indicated no significant influence of gender on students' achievement in Biology and also no significant interaction effect of method of teaching and gender on students' achievement in Biology. The result implied that use of hands-on-minds-on instructional approach in teaching Biology will promote students' achievement in Biology and could act as an essential tool in developing creativity and innovation skills needed for entrepreneurial ship in learners. The study therefore recommended the use of hands-on minds-on instructional approach in Biology teaching to promote achievement, creativity and innovative for self-employability.

Keywords: *Biology, Hands-on-minds-on Instructional Approach, Innovation and Creativity.*

Introduction

The world population is growing fast resulting to global competition and technological transformation in all spheres of human life. To understand and cope with these challenges, knowledge of and about science is integral to preparing the populace. Science is the systematic study of the environment. It is a powerful way of thinking and provides knowledge to understanding the world. It is an essential factor to unleash the potentials and talents for effective functioning of the populace in the transforming technological economy. Schools are the most important institutions in which learners have the opportunity to engage with structured science learning. This implies that the success in unleashing learners' potentials and talents in science is linked to effective science teaching at schools. European Commission (2015) needed suggested that effective science teaching makes learners to think critically and act as innovators.

Biology is a branch of natural science that studies living things. It is one of the science subjects offered in senior secondary schools (Post Basic Education) that provides learners with the knowledge of living things, life processes and interrelationship between the living things and their environments. It is also one of the prerequisite subjects required by learners to undertake careers in disciplines such as Medicine, Nursing, Pharmacy, Teaching among others (Aniaku & Nzewi, 2015). In spite of the relevance of Biology to citizens, West African Chief Examiners' reports (WAEC) (2018) indicated persistent students' poor achievement in the West African Senior School Certificate Examination (WASSCE). Araoye (2013) posited that students' poor achievement in Biology is linked to the predominant use of lecture method by teachers in teaching the subject.

The lecture method is a unidirectional method of teaching whereby learners are expected to listen to the teacher as the teacher defines or explains concepts, dictates notes, writing out points on the board or use projectors to illustrate diagrams with little or no students' contribution in the learning process. European Commission (2015) noted that the use of lecture method in teaching science makes science teaching predominantly transmissive as it makes students to be passive learners who like sponge soak up knowledge as it comes from the teacher with little or no input. The passivity of learners in the use of lecture method of teaching and learning do not allow learners to think critically to become creative and innovative.

Biology is inquiry in nature and activity-oriented. It deals with non-abstract matter, most of which are readily sourced from the environment. In Nigeria, the secondary school Biology curriculum and instructions are designed to expose learners to both theoretical and practical activities; with the theoretical teaching preceding the practical teaching. The theoretical teaching exposes learners to principles and facts in

the content which are justified during the practical activities. Regardless of these stipulations, teachers prefer and resort to use of lecture method (Opara, 2011 and Ezenwosu & Nworgu, 2013). The predominant use of lecture method may not only affect cognition but may go a long way to affecting learners ability to attain minimum level of core skills necessary for the development of creative and innovative skills needed in this 21st century. This is because how learners are engaged in learning activities influence their access to life opportunities (Eze as cited in European Commission, 2015), Biology students need to be exposed to activity-oriented methods of teaching that could engender critical thinking, creative and innovative skills for self-employability.

The success of the teeming population in the 21st century therefore depends on acquiring key competences rather than memorizing facts and principles. UNESCO (2009) suggested that the way teachers teach science and learners learn science has implication for creativity and innovation. Hence, to produce learners who are critical thinkers and innovators, teachers should inspire learners to be creative and innovative through the use of hands-on- minds-on instructional approach.

Hands-on minds-on instructional approach is a learning approach that promotes learning of science through ‘inquiry’ or the doing of science. It is a kind of active learning that helps learners to engage more deeply with information or skill at hand. It is anchored on the tenets of John Dewey’ Cognitive Theory (1858) which states that active learning takes place when learners are meaningfully engaged in activities that could induce them to apply the concept they have learnt. Hands-on minds-on instructional approach provides multiple modes of learning experiences to different categories of learner (visual, auditory, tactile, kinesthetic and social) learners (Beaty, 2017). It creates learning experiences that are more inclusive for different learners and influence different learning domains. Hands-on-minds-on instructional approach is inquiry- based and therefore exposes learners to learning science through the scientific processes such as observation, asking questions, gathering data from a range of sources and transforming data to make broader generalization, explaining outcomes and justifications among other processes. It helps learners to develop power of logical reasoning and abstraction needed for problem-solving (European commission, 2015). Exposing learners to hands-on minds-on instruction approach could promotes the development of creativity and innovative skills as learners are likely to participate in innovative processes if their studies involved working with practical knowledge that actively engage the hands and mind (Moedas, 2015).

In order to develop creativity, innovative and entrepreneurial skills in learners at post basic Education level (senior secondary school), effective teaching and learning of Biology is supposed to be carried out through hands-on-minds-on instruction which promotes students’ critical thinking that initiate creative skills. Creativity is the ability to conceive new and appropriate ideas and the implication of such ideas in solving existing problems or preventing envisaged problems (Olatoye,

Akintude & Ogunsaya, 2010). It is the ability to bring into existence something new or to proffer new solutions to an existing problem. Okoro (2018) noted that creativity is a transverse skill that could be developed in learners when appropriate teaching method is employed. Thus exposing learners to scientific concepts using hands-on minds on instructional approach could shift learners away from learning discrete scientific facts to understanding how to transform knowledge into usable forms to generate new ideas and solve existing problems. Roth as cited in Opara (2011) suggested that hands-on minds-on based instructions provide learners with the opportunity to think critically to make mental representation of ideas in the real world situation and become innovative irrespective of gender.

Innovation is perceived as the transformation of ideas into useful application. Rogers (2003) defined innovation as a process of generating new ideas and practices applicable in working life. It includes ways in which knowledge can be acquired, transformed to solve existing problems. Problem –solving requires skills and these skills are developed through hands on-minds on based instructional approach which induce critical thinking. Uzoechi (2014) noted that hands-on minds-on instructional approach encourages active engagement, intellectual excitement and cognitive flexibility which are core mental executive functions involved in problem-solving. The author suggested that the more active a science classroom is the more opportunities for developing critical and reflective thinking for creativity and entrepreneurial skills in learners.

Entrepreneurship is the capacity and willingness to develop, organize and manage a business venture along with any of its risk in order to make profit. Entrepreneurial spirit is characterized with innovation and risk taking (Nzewi, Onwuka & Onyesom, 2017). To engender entrepreneurial spirit in learners, science (Biology) teachers at post basic education level (senior secondary school) should emphasize on divergent learning approach such as use of hands-on minds-on instructional approach which could enhance learners' critical-thinking skills and promote risk taking ability to become creative, innovative and entrepreneurs capable of problem- solving. The use of hands-on minds-on instructional approach in the teaching and learning of Biology could be of immense benefit to Biology students, teachers, parents, educators and curriculum planners.

Problem Statement

The predominant use of lecture methods in teaching of secondary school Biology encouraged transmission of knowledge from the teacher to learners rather than construction of meaningful knowledge. The passivity of learners in the learning process discourages the development of creative and innovative skill needed for entrepreneurial skills. To meet up with the global population and technological challenges, there is the need to expose learners to methods of teaching such as hands-on minds-on instructional approach that could encourage the development of

creative and innovative skills for the development of entrepreneurial skills. Hence, the problem of this study in question form is: What is the effect of hands-on minds-on instructional approach on students' achievement in Biology and its implication for creativity and innovation.

Purpose of Study

The main purpose of this study was to determine the effect of hands-on minds-on instructional approach on students' achievement. Specifically the study determined:

1. the effect of hands-on-minds -on instruction approach and lecture method on the mean achievement scores of Biology students,
2. the influence of gender on the mean achievement scores of Biology students and
3. the interaction effect of methods of instruction and gender on mean achievement scores of Biology students.

Research Questions

Three research questions guided the study:

1. What is the mean achievement scores of Biology students exposed to hands-on minds-on instructional approach and lecture method?
2. What is the influence of gender on the mean achievement scores of male and female Biology students exposed to hands-on- minds-on instructional approach and lecture method?
3. What is the interaction effect of instructional methods and genders on Biology students' mean achievement scores?

Hypotheses

The following null hypotheses guided the study:

1. There is no significant difference in the mean achievement scores of biology students exposed to hands-on minds-on instructional approach and lecture method.
2. There is no significant influence of gender on the mean achievement score of male and female Biology students exposed to hands-on-minds-on instructional approach and lecture method.
3. There is no interaction effect of methods of teaching and gender on Biology students' mean achievement scores.

Research Method

The study employed a quasi-experimental design specifically the non-equivalent control groups. Quasi-experiment was used because there was no randomization as intact classes were used. Pre and post tests were also used.

Population for the study comprised 324 senior secondary school one (SSI) students in Nkanu – West Local Government Area of Enugu State; out of which a sample of 149 SSI students were drawn using purposive and simple random samplings. Through purposive sampling four co-educational secondary schools were drawn because of gender variable. Out of the four co-educational schools one intact class were drawn from each of the schools. The four intact classes were randomly assigned to experimental and control groups. The students in the experimental group were exposed to Biological concept using hand-on-minds-on instructional approach whereby the students were engaged in real life activity studies by allowing them to carry out practical activities by themselves following specified practical instructional guide provided by the teacher. The students in the control group were exposed to the same Biology content using lecture method whereby the students listened to the teacher, observed the teacher carry out experiment and copied notes. The treatment lasted for four weeks and two different lesson notes were used for the two groups.

Data for the study were collected through researcher-made Biology Achievement Test (BAT). The BAT consisted of 30 multiple choice Biology questions drawn from SSI Biology scheme: "Cell and its environment". The question items were adapted and modified from WAEC past questions and Biology text book on the topic. The BAT items were dichotomously scored such that correct answer scored one mark while there was no score for wrong answers.

The instrument was face validated by three lecturers in Science Education Department Faculty of Education University of Nigeria Nsukka. The content validity of the test items were ensured through table of specification (Test Blue Print). The internal consistency index of 0.70 for the instrument was established using Kuder-Richardson formular (K-R-20). Data from the study were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA) at 0.5 level of significance.

Results

Table 1: Mean (\bar{X}) and Standard Deviation (SD) on mean achievement scores of students taught Biology using hands-on minds-on instructional approach and those taught using lecture method

Methods Score	Pretest		Posttest		Gain
	N	\bar{X}_1	\bar{X}_2	SD ₂	
Practical	76	11.78	27.1	5.31	15.31
Lecture	73	12.06	21.34	5.50	9.28

Data in table 1 showed that students taught Biology using hands-on-minds on approach had mean achievement score of 27.1 and gain of 15.31 while students

taught Biology using lecture method had mean achievement score of 21.34 and gain score of 9.28. This result indicated that students taught Biology using hands-on minds-on instructional approach performed better than their counterpart taught Biology using lecture method.

Table 2: Mean (\bar{X}) and Standard Deviation (SD) on Influence of Gender on Mean Achievement Scores of Male and Female Biology students Exposed to Hands-on-Minds-on Instructional Approach and Lecture method

Gender	N	Pretest		Posttest		Gain
		\bar{X}_1	SD ₁	\bar{X}_2	SD ₂	
Male	66	11.81	3.58	24.29	6.48	12.48
Female	83	11.99	3.14	23.83	5.56	11.84

Data in Table 2 showed that male students had mean achievement score of 24.29 and gain score of 12.48 while their female counterparts had mean achievement score of 23.83 with gain score of 11.84. The result shows that the male students had higher mean achievement score in Biology than their female counterparts.

Table 3: Mean (\bar{X}) and Standard Deviation (SD) on Interaction Effect of Teaching Methods and Gender on Students' Mean Achievement Scores in Biology

Hands-on minds-on	Method					
	Lecture			Lecture		
	SD	N	\bar{X}_1	SD	N	\bar{X}_2
Pretest						
Male	3.87	34	11.71	3.34	32	11.93
Female	2.96	42	11.83	3.33	41	12.15
Posttest						
Male	6.35	34	27.08(15.37)	5.20	32	21.31(9.38)
Female	4.82	42	26.24(14.41)	5.23	41	21.37(9.16)
Observed Mean	5.50		26.62			21.34
Gain Score			15. 31			9. 3

The results in Table 3 indicated that students taught Biology using hands-on-minds-on instructional approach had gain score of 15.31 and those taught using lecture method had gain score of 9.28. The result revealed a higher gain score of 15.37 for male students taught Biology using hands-on-minds-on instructional approach, while their female counterparts had gain score of 14.41. Male students who were taught Biology using lecture method had gain score of 9.38 while their female counterpart had gain score of 9.16. The result showed that at all levels of gender, male students had higher gain score than their female counterparts in Biology. The result

therefore indicated that there was no significant interaction effect of gender and various teaching methods on students' mean achievement scores in Biology.

Hypotheses

Table 4: Analysis of Covariance (ANCOVA) for Hypotheses

Source of variation	Sum of squares	Df	Mean Square	F	Sig.
Corrected model	14.77.796 ^a	4	369.449	14.033	.000
Intercept	3439.080	1	3439.080	130.631	.000
Pretest	427.705	1	427.705	16.246	.000
Method	1094.835	1	1094.835	41.587	.000
Method	8.613	1	8.613	.327	.568
x Gender	6.824	1	6.824	.259	.611
error	3791.036	144	26.327		
total	91333.000	149			
corrected total	5268.832	148			

*Significant ($p < .05$)

Table 4 showed no statistical significant effect of instructional methods and gender on mean achievement score of students in Biology $F(1, 148) = 41.587$, $p < .000$. The null hypothesis therefore, was rejected, indicating that there is a significant difference in the mean achievement scores of students taught Biology using hands-on-minds-on instructional approach and those taught using lecture method in favour of those taught using hands-on-minds-on instructional approach.

Table 4 showed no statistical significant influence of gender on students achievement in Biology $F(1, 148) = 327$, $p = .568$, > 0.05 . The null hypothesis therefore, was not rejected, indicating that there is no significant difference in the mean achievement scores of male and female students taught Biology using hands-on - minds-on instructional approach and those taught using lecture method.

There is no significant main interaction effect of gender on mean achievement score of students in Biology $F(7, 148) = .259$ $p = .611 > .05$. The null hypothesis therefore, was not rejected, indicating that there is no significant interaction effect of instructional methods and gender on mean achievement score of students in Biology.

Discussion of Results

Result from the analyzed data indicated that hands-on –minds-on instructional approach was superior to lecture method in promoting students' achievement in Biology. This was because the students that were exposed to hands-on-minds-on instructional approach had higher mean achievement scores that those

exposed to lecture method. The result was further validated by the ANCOVA revealed a significant difference in the mean scores of the two groups of students in favour of those exposed to hands-on-minds-on instructional approach. The differences in the students' mean achievement scores could be attributed to the differences in the learning experience. The hands-on –minds-on approach provided a wider active learning opportunity for learners which encouraged meaningful learning more than the passive learning provided by the lecture method. Thus all the students exposed to hands-on minds-on instructional approach had the opportunity of learning and constructing meaningful knowledge whereas the lecture method limited students' participation in the learning process. The real life learning experience gathered by the students as they interacted with materials in the class probably allowed the students to acquire more knowledge and achieved better than those exposed to lecture method who were not provided with such opportunity rather were more passive than active in the learning process.

The finding of this study strengthens Dewey's Cognitive Theory which emphasized that learning is promoted through active engagement of learners' mental process. The finding of the study also corroborates Opara (2011) who found out that students taught using practical activity performed better than their counterparts taught through lecture method. The study is also in line with the findings of Nwagbo and Chukelu (2011) who noted that activity-oriented learning promotes process skill acquisition in Biology teaching more than the lecture method.

Secondly, finding from the study indicated that the male students had higher mean achievement score in Biology than their female counterparts. However, the ANCOVA analysis indicated that there is no significant influence of gender. The slight difference in the achievement of male and female student could be as a result of the difference in socialization processes of male and female students in which the male children are given opportunity to explore the environment while the female children are more encouraged to maintain homes and carry out domestic chores. Nevertheless, the insignificant influence of gender in this study indicated that hand-on minds-on instructional approach promotes learning in both male and female students. The study is in agreement with that of Aniakwu and Nzewi (2015) who stated that activity-oriented methods of instruction promote achievement in learners more than the lecture method irrespective of gender.

The finding of the study showed that there is no interaction effect of methods of instruction and gender on students' mean achievement scores in Biology. Hands-on-minds-on instructional approach was superior to lecture method in facilitating students' achievement in Biology. Consequently, the students exposed to hands-on instructional approach participated more actively in the learning process and performed better in the posttest. Nevertheless, the male students performed better than female students irrespective of the mode of instruction. Hence no significant interaction effect of method and gender on students' achievement in Biology. The

finding also corroborates with that Ezenwosu and Nworgu, (2013) who reported no significant interaction effect of peer tutoring and lecture method on students' achievement in Biology.

Implication of the Study

Findings of the study implies that Biology teachers should resort to the use of hands-on-minds on instructional approach to promoting students achievement in Biology and also promote creativity and innovative skills needed for entrepreneurial spirit. Secondly, since the result indicated no significant gender influence, it also implies that use of hands-on minds-on approach in teaching Biology could promote achievement, creativity and innovative skills in both male and female students for entrepreneurial spirit needed in this era of global unemployment for self-employability.

Conclusion/Recommendations

Based on the results obtained, hands-on-minds-on instructional approach is superior to lecture method in promoting students' achievement in Biology. Although the male students were influenced more than females by hands-on minds-on instructional approach the ANCOVA analysis indicated no significant difference. The study also indicated that there was no significant interaction effects of methods of teaching and gender on students' mean achievement scores in Biology.

Based on these conclusions the following recommendations were made:

- a. In view of the fact that the hands-on-minds-on instructional approach was more effective in promoting students' achievement Biology students should be exposed and encouraged to engage in hands-on minds-on instructional approach to promote their critical thinking and innovation skills.
- b. Biology teachers should be encouraged to use hands-on–minds-on instructional approach in delivering Biology instructions to promote achievement, develop creative and innovative skills for self-employability. This could be achieved through seminars and workshops for Biology teachers in secondary schools.
- c. Biology educators should expose training teacher on the use of hands-on – minds-on instructional approach.
- d. Educational stakeholders such as curriculum planners should promote hands-on-minds-on instructional approach by emphasizing on it in the curriculum

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