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Learning Strategies and Integrated Science Students Scientific Literacy Level in Colleges of Education, North-Central, Nigeria

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Abstract
The paper examined the impact of Integrated Learning Strategies on the scientific literacy of college science students. The study adopted a quasi-experimental design using intact classes. Two research questions and hypotheses were each asked and tested. The population for the study comprised all colleges of education in north-central Nigeria; two colleges were randomly sampled by the use of table of random numbers. A total of 80 students formed the experimental group and 100 students formed the control group. A science literacy test validated with a reliability index of .74 was administered before and after the intervention and scored for data pool. The data collected were analysed using descriptive and inferential statistics at $p \leq 0.05$ level of significance. Results showed that the scores obtained by the experimental group exposed to the Integrated Teaching Strategy were higher than the scores of the control group on the basis of scientific literacy and that

there was a significant difference in the scores of the experimental and control groups. It was also found out that there was no significant difference in the scores of male and female colleges of education science students with reference to scientific literacy. It was recommended that the use of Integrated Learning Strategies should be encouraged since it can improve scientific literacy and it is gender friendly.

Keywords: Behaviour, Integrated Learning Strategies, Knowledge, Scientific literacy

Introduction

The quest for knowledge has always been man's greatest desire, from the time of the early men through the ice, the middle and the dark ages to the renaissance and industrial revolution, to the jet and finally to the computer ages of the 21st century. Man has searched for and continued to search for knowledge about himself, the world around him and the universe at large. The knowledge generated over the years has been documented and used to benefit humanity and has been taught to the younger generation by specially trained teachers. To effectively pass on the knowledge heritage to the coming generations, it is paramount that the teachers are knowledgeable in the content, pedagogy and methodology of science and technology. For teachers to effectively carry on the process of teaching, it is imperative to establish a standard of teaching strategy in this modern society, because a teacher cannot give what he or she does not have. Science is full of abstract concepts and a thorough understanding of the principles guiding the teaching of science is important. Therefore to teach science effectively, a teacher is expected to have an adequate scientific literacy as the goal of teaching is to produce literate individuals in the society.

Fafunwa (1974), agreed that the main goal of science education is to produce a scientifically literate community. Science teachers are instrumental to the achievement of scientific literacy at all levels of education because of the essential role they play in preparing

scientifically literate individuals (Chin, 2005). To achieve this goal of having a scientifically literate society, it is important to ask how to effectively train teachers for science teaching. The science education community has continually attempted to explore and promote the implementation of new and creative approaches to make the teaching and learning of science a successful endeavour for teachers and students alike, and in doing so, achieve the overreaching goal of developing a scientifically literate society (Bybee, 1997).

Adapting the Integrated Teaching Strategy is a unique way of achieving a scientifically literate society and hopefully bridges the gap in improving students' performance and rekindles the interest of students to study science. This approach provides teachers with ideas and techniques to stimulate their learners to develop their own investigable question plan and execute an investigation in the classroom and present their findings to an authentic audience. Another example of one such significant reform initiative, with the aim of achieving scientific literacy, is the Science-Technology-Society (STS) movement, which began in the nineties, and promoted the teaching of science in a socially contextualised approach. In an STS-based classroom, students investigate issues in a manner that promotes real-world connections between the classroom and society (Rubba, 1991). Understanding the real-world connections and the principles and objectives of science is vital to developing science literacy.

The term scientific literacy as encompassing the basic principles and objectives of science education was coined by Hurd and McCurdy in 1958. Zuzovsky (1997) asserted that "scientific and technological literacy remain vague terms which are defined and interpreted in many different ways. Early definitions refer mostly to the ability of individuals to read about, comprehend and express an opinion on scientific and technological matters." According to Roberts (2007) the modern interpretation of the concept literacy that relates scientiûc knowledge to practice and to fields other than science, did not however, emerge until much later.

Different models have been put forward to define the term scientific literacy, among which includes: Hurd (1958) who interpreted the concept in terms of the role it plays in culture. He lists seven patterns of behaviour required for the interpretation of the relationship between nature and technology. By that, an individual becomes competent in natural sciences: understands the nature of knowledge; applies appropriate science concepts, principles, laws and theories in interacting with his universe; uses the processes of science in problem solving, making decisions, and furthering his own understanding of the universe; interacts with the values that underline science; understands and appreciates the joint enterprise of science, and the interrelationship of these with each other and with other aspects of society; extends science education throughout his or her life; develops numerous manipulative skills associated with science and technology.

Another was put forward by Hackling and Prain's (2008), model, which provides the theoretical background for the Australian National Assessment Program - Science Literacy (NAP-SL), constructs a picture of scientifc literacy from elements reminiscent of Klopfer's model. Hackling and Prain (2008) perceived scientiûc literacy as knowledge constructed from knowledge of the nature of science, from a thorough conceptual understanding allowing applications in everyday life, from scientific competencies, and from a positive attitude towards and interest in science. The International Energy Agency (IEA) and Trends in International Mathematics and Science Study (TIMSS) (2005) international comparative surveys, which have some of the greatest impact on education system development, were designed to gather data for education policy and school subject development, and to monitor the attainment of curricular goals and evaluate the quality of the attained curriculum (Olsen, 2004).

In the surveys of the IEA, science literacy is defined explicitly only in the theoretical framework of the IEA TIMSS study of 2005 designed to assess the performance of final year secondary school students. In that work, science literacy is defined as knowledge of science

suficient for the solving of everyday problems. The document identified three components of knowledge useful in everyday situations: (1) experience with the basic principles of the various disciplines, (2) reasoning in mathematical, natural and engineering sciences, and (3) awareness of the social effects of science and technology, and with the social utility of mathematics, science and technology. Findings revealed that scientific literacy levels were low, most especially for African countries that participated in the survey (Orpwood & Garden, 1998). In view of this, it has become imperative to find out more about the science literacy levels of students and find out ways of improving on it, especially our teacher training institutions. Scientific and Technological Literacy (STL) in its broadest sense means much more than simply being able to read, understand and write about science and technology, so it includes the ability to apply scientific and technological concepts and process skills to the life, works and culture of one's own society (UNESCO 2008). It also embraced attitudes and values enabling one to distinguish between worthwhile or inappropriate uses of science or technology. A teacher is therefore expected to have a basic scientific and technological knowledge and skills needed to understand the physical world, environmental problems and the role and function of technology in a society increasingly marked by global interconnected networks.

Gender issues among the society of scientists have been the concern of many educators and series of researches have been conducted in this regard. Gender refers to socially constructed roles and socially learned behaviours and expectations associated with males and females (Oakley, 2015; World Bank Policy Report, 2001 & Okeke, 2000). In Nigeria, gender gaps occur in treatment of males and females which put females in a corner that has deterred their progress and achievement in schools. Some gender related problems in curriculum implementation has been identified by Nwagbara (2009) as follows: discriminatory attitude of parents, gender stereotyping, cultural and religious factors, gender biased curriculum in favour of males and

females high dropout rates in Nigerian schools. These result to low performance in the classroom on the part of the females which often result to psychological and emotional battering.

However, some studies have indicated that the use of innovative strategies that are inquiry based, can improve achievement in science (Nworgu 2004), skills acquisition (Ibe & Nwosu, 2004) and enhanced scientific literacy (Okoro 2000; Ibe, 2013). The Third International Mathematics and Science Study (TIMSS) had students in 41 countries tested in both mathematics and science in 2002. The results of this study showed males and females in the fourth grade had approximately the same average achievement in Mathematics but a few significant differences observed favored males over females (TIMSS, 2002). Also the result of TIMSS's study in 2005 showed that there was a modest but significant difference favouring boys on average across all countries, although the situation varied considerably from country to country (TIMSS, 2005).

Theoretical Framework

The theoretical framework on science literacy levels in this study is hinged on Ausubels' (1978), prior knowledge theory and Piaget (1936) constructivism. Ausubels' prior knowledge has long been considered the most important factor influencing learning and students' performance. The amount and quality of prior knowledge positively influence both knowledge acquisition and the capacity to apply higher order cognitive problem-solving skills. Prior knowledge is the information and educational context a learner already has before they learn new information. A learner's understanding of educational materials can be improved by taking advantage of their prior knowledge before dealing with the new materials.

Piaget's (1936) theory on constructivism is basically a theory based on observation and scientific study, about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those

experiences. Piaget was of the opinion that cognitive development was a process which occurred due to maturation and interaction with the environment. Both Ausubel's and Piaget's theories can be further explained by metacognition and pedagogical content knowledge.

Statement of the Problem

The level of competition in the society and advancement of scientific applications in our daily lives is on the increase. There is a need for everyone to be scientifically literate as not to be over taken by events in the global markets. Consequently, there is a need to look at the current scientific literacy levels of upcoming student-teachers. This is necessitated by the results obtained from the Programme for International Student Assessment (PISA). In 2006 PISA focused on science literacy and results obtained showed that African participants fell way back. The large scale test was not on how well students have mastered the curricular content, but rather their ability to apply the knowledge and skills in real life situations (PISA, 2006). The findings revealed that while the majority of students showed interest to study science, only 37% indicated that they would like to work in a science-related career.

Emphasis on the reason for poor performance and high dropout rate has most often been placed on methodology, pedagogy, infrastructure, government policy and teachers' qualification as seen by the following researches; Mahmud (2009); Kelly (2010); Ali, Toriman & Gasim (2014); Lebata (2014); Agboghorama & Oyuvwi (2015); Adekunle & Femi (2016) have shown that poor performances in science are attributed to poor pedagogy in science education. Results from the colleges of education are not much different from what is obtainable from the senior secondary school certificate examinations. Gradually over the years, results of students have declined as the number of students with excellent and credit grades have reduced. Also the number of students who graduates at the

end of the study keeps on declining. The performance of the students is gradually getting poorer, despite the fact that some students come in with very good O-level results, their performance in the course of the program is not equitable. This calls for great concern as a majority of these students in the college will end up as teachers in the nation's primary and secondary schools.

Colleges of education students have a major role to play in imparting knowledge to the upcoming generation, due to this important role they play in preparing future scientifically literate citizens it is necessary to critically look at an approach that can improve their scientific literacy. This study therefore exposed colleges of education students' to an Integrated Teaching Strategy to enhance their scientific literacy.

Objectives of the Study

The objectives of this study are to determine the impact of Integrated teaching strategy on the scientific literacy levels:

1. of Colleges of Education Students in North-Central Nigeria.
2. between male and female Colleges of Education Students in North-Central, Nigeria.

Research Questions

For the purpose of this study, the following research questions were formulated to achieve the stated objectives:

1. What is the impact of Integrated Teaching Strategy on the scientific literacy levels of Colleges of Education Students in North-Central, Nigeria?
2. To what extent does Integrated Teaching Strategy imparted on the scientific literacy levels of male and female Colleges of Education Students in North-Central, Nigeria?

The following null hypotheses were tested at $p \leq 0.05$ level of significance:

H There is no significant difference in the impact of Integrated Teaching Strategy on scientific literacy levels of colleges of education students in north-central, Nigeria.

H There is no significant difference in the impact of Integrated Teaching Strategy on the scientific literacy levels of male and female colleges of education students in North-Central, Nigeria.

Methodology

The research design used for this research is the pre-test, post test quasi-experimental design which involved the use of intact classes. The population of the research is made up all the colleges of education in North-central, Nigeria. There are 12 colleges of education in the north-central, Nigeria and two were randomly sampled using table of random numbers. Intact classes of N.C.E. II from the two colleges were assigned as experimental and as control respectively. The instrument used in collecting data was the "Scientific Literacy Test" (SLT) that was adapted from BouJaoude's (2002). The test that contained 20 items of questions drawn from each aspect of the scientific literacy was validated with a reliability index of .74 and administered on the groups. The BouJaoude's (2002) Framework for Scientific Literacy is in line with the Bybee (1997) Levels of Scientific Literacy which are nominal, functional, conceptual and multidimensional literacy levels. Pre-test on the scientific literacy was administered to both groups to determine their level of equivalence, after which concepts taken out of the curriculum were taught to the experimental class using Integrated Teaching Strategy Approach, while the control class was taught the same concept using the conventional lecture method. After classroom interaction which lasted for eight weeks a post-test was also administered to the two groups. The data collected were subjected to descriptive and inferential statistics at a $p \leq 0.05$ level of significance.

Results

Research Question One: What is the impact of the Integrated Teaching Strategy on scientific literacy levels of Colleges of Education Students in North-Central, Nigeria?

Data used to arrive at Table 1 was obtained from the SLT which was administered to the Colleges of Education Students. The test was scored and students were grouped into either high or low scientific literacy levels.

Table 1: Descriptive Mean Statistics of Integrated Teaching Strategy Approach and Scientific Literacy Levels of Colleges of Education Students in North-Central, Nigeria.

Groups	N	Scientific Literacy Level	Mean	Std. Dev.	Mean Diff.
Experimental	23	Low Scientific Literacy	11.6667	.50637	1.67
	57	High Scientific literacy	14.0370	1.60357	
Control	62	Low Scientific Literacy	10. 6154	2.08167	2.67
	38	High Scientific literacy	12. 2857	1.40004	
Total	85	Low Scientific Literacy	10.81252	.98107	10.81
	95	High Scientific literacy	13.67651	1.59013	13.67

Outcome of the descriptive mean statistics in Table 1 showed that difference exists in the mean scores of the scientific literacy levels of colleges of education students in North-central, Nigeria. Their computed mean scores showed that among the experimental group the scores of low scientific literacy levels and high scientific literacy levels are 11.666 and 14.037 respectively, while among the control group the scores of low scientific literacy levels and high scientific

literacy levels are 10.615 and 12.285 respectively. This clearly shows that the scores obtained by the experimental group exposed to the Integrated Teaching Strategy Approach are higher than the scores of the control group on the basis of scientific literacy.

Hypothesis One: There is no significant difference in the impact of the Integrated Teaching Strategy Approach on scientific literacy levels of colleges of education students in North-central, Nigeria.

The data used to arrive at Table 2 were obtained from SLT administered to Colleges of Education Students of the experimental and control groups on the basis of science literacy levels. To test hypothesis one, a statistical tool of Analysis of Covariance (ANCOVA) was used as presented in Table 2.

Table 2: Analysis of Covariance (ANCOVA) of impact of Integrated Teaching Strategy Approach on the Scientific Literacy Levels of Colleges of Education Students in North-Central, Nigeria.

Source	Type III Sum of Squares	df.	Mean Square	F	p-value	Rem.
Corrected Model	108.985[a]	3	36.328	21.387	.001	S
Intercept	4003.092	1	4003.092	2356.715	.001	S
Groups	13.309	1	13.309	7.836	.001	S
SLL	27.666	1	27.666	16.288	.001	S
Groups * SLL	.830	1	.830	.489	.488	NS
Error	78.135	176	1.699			
Total	**8328**	**180**				
Corrected Total	187.120	179				

S = Significant at pd $\leqslant$ 0.05

In Table 2, p-values of 0.001 were observed on scientific literacy levels of Colleges of Education Students in the North-Central, Nigeria. These p-values are lower than the alpha value of 0.05 which shows that

there was a significant difference in the impact of Integrated Teaching Strategy Approach on the Scientific Literacy Levels of Colleges of Education Students in North-central, Nigeria. Therefore, the null hypothesis which says that significant difference would not exist was rejected.

Research Question Two: To what extent does Integrated Teaching Strategy Approach imparted on the scientific literacy levels of male and female Colleges of Education Students in North-central Nigeria? Data used to arrive at Table 3 were obtained from the SLT scores of male and female Colleges of Education Students.

Table 3: Descriptive Mean Statistics of impact of Integrated Teaching Strategy Approach on the Scientific Literacy Levels between male and female Colleges of Education Students in North-central, Nigeria

Variable	Gender	N	Mean	STD	Mean Difference
Literacy Level Scores	Male	52	11.6765	2.54321	0.631
	Female	28	12.3077	2.44572	

According to the descriptive statistics in Table 3, there is no difference between the scientific literacy levels of male and female colleges of education students in north-central, Nigeria. The literacy level scores of male and female college of education students is 11.676 and 12.307 respectively with an insignificant mean difference of just 0.631. This clearly shows that both male and female students of college education benefited equally with the applied strategy.

Hypothesis Two: There is no significant difference in the impact of Integrated Teaching Strategy Approach on the scientific literacy levels between male and female colleges of education students in north-central, Nigeria.

The data used to arrive at Table 4, were obtained from SLT administered to male and female Colleges of Education Students of the experimental and control groups on the basis of science literacy levels. To test hypothesis Two, an Independent t-test Statistics was used.

Table 4: Independent t-test Statistics of impact of Integrated Teaching Strategy Approach on the Scientific Literacy Level between male and female Colleges of Education Students in North-central, Nigeria.

Variable	Gender	N	Mean	STD	Mean difference	df	t	sig (2-tailed)	R
Literacy level scores	Male	52	11.6765	2.54321	0.631	78	0.969	.330	NS
	Female	28	12.3077	2.44572					

Significant at pd⩽0.05 level of significant

Results of the Table 4 of independent t-test statistics shows that a p-value of 0.33 was observed which is greater than the alpha value of 0.05. This showed that there is no significant difference on the impact of Integrated Teaching Strategy Approach on the scientific literacy levels between male and female Colleges of Education Students in North-central, Nigeria. This clearly shows that the integrated teaching strategy approach impacted both male and female college of education students equally. Therefore, the null hypothesis which states that there is no significant difference on the impact of Integrated Teaching Strategy Approach on the scientific literacy levels between male and female colleges of education students in north-central Nigeria, is hereby accepted and retained.

d”

Discussion of the Findings

From the findings above, it could be seen that a significant difference exist, in the scientific literacy level between the experimental and control groups when Integrated Teaching Strategy Approach was used

on college of education students. This means that the levels of scientific literacy of colleges of education students in the north-central Nigeria is not the same despite the fact that they all belong to the same level of tertiary institution. Miller (2004), is one of several experts who provide compelling arguments for the importance of scientific literacy; by and large, his views are in line with the National Science Education Standards (NSES), founded on the belief that all students deserve the opportunity to become scientifically literate. The NSES (2006) states that because science and technology pervade our world, students need a certain level of science literacy to understand and make sound personal choices, engage in rational debate on key issues, develop essential workplace skills and also impact knowledge.

Secondly, there is no significant difference in the scientific literacy level between male and female when Integrated Teaching Strategy Approach was used on colleges of education students. This means that gender wise, female students from all the Colleges of Education in the North-central have the same level of scientific literacy as the male students.

Conclusion

In conclusion, the use of Integrated Teaching Strategy Approach is seen to enhance scientific literacy of colleges of education students and could also be very effective for both academic performance, and interest of student teachers of the colleges of education when used. The approach is equally gender friendly. There is therefore a need to use this approach to build up the scientific literacy of students in colleges of education as these groups of students' will eventually become teachers.

Recommendations

The researcher put forward the following recommendations based on the results obtained:

1. That science literacy level of students can be improved upon through the use of Integrated Teaching Strategy Approach.
2. That Schools should adopt the use of the Integrated Teaching Strategy Approach in the teaching and learning of Science irrespective of the gender as the method is gender friendly.
3. That teachers of Science in both colleges of education as well as secondary schools should be supported to attend seminars and talk shows on the use of modern methods of teaching, especially the Integrated Teaching Strategy Approach. As this would help students boost their science literacy.

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