

Full Length Research Paper

Effect of constructivist-based teaching strategy on academic performance of students in integrated science at the junior secondary school level

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Integrated science plays vital role in Nigerian science education programme because it prepares pupils at the Junior Secondary School level for the study of core science subjects at the Senior Secondary School level which in turn brings about students' interest in science oriented courses at the tertiary institutions. Despite government's efforts to encourage science teaching and learning among Nigerian students right from the Junior Secondary School level, the enrolment of students in core science subjects and science oriented courses at the Senior Secondary School level and tertiary institutions level respectively, is not encouraging. This is as a result of Junior Secondary School students' negative attitude towards integrated science. Research reports indicate that this negative attitude was caused, majorly, by teachers' conventional (lecture) method of teaching integrated science. Research reports on the effectiveness of constructivist-based teaching strategy revealed that the strategy enhanced students' academic performance. In view of this, this study examines the effectiveness of constructivist-based teaching strategy on academic performance in integrated science by Junior Secondary School students in South-West Nigeria. Quasi-experimental research design was used to achieve the purpose of this study. Participants were 120 Junior Secondary School Students randomly selected from four out of the 25 co-educational Junior Secondary Schools in Ijebu-ode local government area of ogun state, South-west Nigeria. Findings revealed that the constructivist instructed students had higher scores on the post test and the delayed post test, compared to those exposed to conventional (lecture) method of teaching. We concluded that if integrated science teachers could incorporate constructivist-based teaching strategy into their teaching methods, there would be an improvement in academic performance of Junior Secondary School Students in integrated science. The researchers recommended that integrated science teachers should incorporate constructivist-based teaching strategy in their methods of teaching.

Key words: Nigeria, constructivism, conventional (lecture), integrated science, academic performance, junior secondary school III students.

INTRODUCTION

Critics of public education have argued that many Nigerian students do not possess the depth of knowledge or skills to assure either personal life success or national economic competitiveness (Akpan, 1996). A particular

concern of the critics has been the apparent inability of many students to engage in complex problem-solving activities and to apply school knowledge and skills to real-life problems in workplace settings (Akpan, 1996). What teachers and schools face is a fundamental redefinition of what it means to be a student or a teacher and what it means to learn or to teach. Educators are confronted with a paradigm shift in teaching and learning

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which is driven by the increasing anomalies of the current educational system (Kim, 2002). High drop-out rates, low skill and knowledge levels among many students, low levels of student engagement in school work and poor international comparisons suggest that the current educational paradigm is weak or inappropriate.

Educators must understand that changes in students' outcomes must be supported by parallel changes in curriculum and instruction. However, it is apparent that many of today's teachers are caught in the midst of a change for which they may not have been professionally prepared (Dogru and Kalender, 2007). Many teachers were educated in the classrooms where the role of the student was to memorize information, conduct well-regulated experiments, perform mathematical calculations using a specific algorithm and were then tested on their ability to repeat these tasks or remember specific facts. The ideas which are central to an education which defines competence as the ability of the student to apply knowledge and skills to unfamiliar problems are not new. These ideas were found in traditional apprenticeship programs, where daughters and sons learned life sustaining skills from parents and they were central to the successes of all traditional peoples. Theorists in cognition, curriculum and instruction (e.g. Di Vesta, Vgotsky, Von Glaserfeld, etc.) are now providing the underlying rationale and language for discussing this fundamental change in teaching and learning which is at the heart of the current school improvement agenda. Constructivist theory provides a framework through which the emergent ideas about teaching, learning and assessment can be unified (Young and Collin, 2003). The difficulty and challenge confronting classroom professionals is that the reform strategies in curriculum, instruction and assessment organized around the theory of "constructivism" are informed by different assumptions and beliefs about the nature of knowledge and about the human capacity to learn than are traditional classroom practices (Kim, 2005).

Additionally, the conventional (lecture) teaching method of teacher as sole information-giver to passive students appears outdated. In a study carried out by (Colburn, 2000) on undergraduates in a large lecture hall setting, it was found that only 20% of the students retained what the instructor discussed after the lecture. They were too busy taking notes to internalize the information. Also, after a lecture has passed eight minutes, only 15% of the students are paying attention. Furthermore, the present curricula in integrated science are overstuffed and undernourished (Olawaju, 1987). The integrated science curricula emphasize the learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understanding in context, recitation over argument, reading in lieu of doing. The curricula also fail to encourage students to work together, to share ideas and information freely with each other, or to use modern instruments to

extend their intellectual capabilities (Olawaju, 1987).

One proposed solution to the afore mentioned problem is to prepare students to become good adaptive learners. That is, students should be able to apply what they learn in school to the various and unpredictable situations that they might encounter in the course of their work lives. Obviously, the traditional teacher as information giver and textbook guided classroom has failed to bring about the desired outcome of producing thinking students (Young and Collin, 2003). A much heralded alternative is to change the focus of the classroom from teacher dominated to student-centered using a constructivist approach.

The aim of the present study was to determine the effects of constructivist-based teaching strategy on students' understanding of Integrated Science concepts by Nigerian Junior Secondary School students instructed using constructivist instruction (with co-operative learning approach). To accomplish the afore-mentioned purpose, the following objective was established: Compare students' academic performance of the constructivist approach in Nigeria integrated science education with the students in conventional (lecture) instructional approach.

THEORETICAL FRAMEWORK

Constructivism is a psychological theory of knowledge which argues that humans construct knowledge and meaning from their experiences. Constructivism is a set of beliefs about knowledge that begins with the assumption that reality exists but cannot be known as a set of truth (Tobin et al., 1993). Constructivism is not accepting what you are told but your prior knowledge about what you are taught and your perceptions about it. Active involvement of students is emphasized in constructivism, hence knowledge gained last long in their memory. Constructivism is not a new concept. It has its roots in philosophy and has been applied to sociology and anthropology, as well as cognitive psychology and education. Perhaps the first constructivist philosopher, Giambattista Vico, commented in a treatise in 1710 that "one only knows something if one can explain it" (Yeager, 1991). Immanuel Kant further elaborated this idea by asserting that human beings are not passive recipients of information. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek, 1992).

Five basic themes pervade the diversity of theories expressing constructivism. These themes are (1) active agency, (2) order, (3) self, (4) social-symbolic relatedness, and (5) lifespan development. With different language and terminological preferences, constructivists have proposed, first, that human experiencing involves continuous active agency. This distinguishes constructivism from forms of determinism that cast humans as passive pawns in the play of larger forces. Second comes

the contention that much human activity is devoted to ordering process – the organizational patterning of experience by means of tacit, emotional meaning-making processes. In a third common contention, constructivists argue that the organization of personal activity is fundamental self-referent or recursive. This makes the body a fulcrum of experiencing and it honors a deep phenomenological sense of selfhood or personal identity. But the self is not an isolated island of Cartesian mentation. Persons exist and grow in living webs of relationships.

The fourth common theme of constructivism is that individuals cannot be understood apart from their organic embeddedness in social and symbolic systems. Finally, all of this active, meaningful and socially-embedded self organization reflects an ongoing developmental flow in which dynamic dialectical tensions are essential. Order and disorder co-exist in lifelong quests for a dynamic balance that is never quite achieved. The existential tone here is unmistakable. Together, then, these five themes convey a constructive view of human experience as one that emphasizes meaningful action by a developing self in complex and unfolding relationships. Focusing on a more educational description of constructivism, meaning is intimately connected with experience (Mahoney, 2004). According to Mahoney, students come into a classroom with their own experiences and a cognitive structure based on those experiences. These preconceived structures are valid, invalid or incomplete. The learner will reformulate his/her existing structures only if new information or experiences are connected to knowledge already in memory. Inferences, elaborations and relationships between old perceptions and new ideas must be personally drawn by the student in order for the new idea to become an integrated, useful part of his/her memory. Memorized facts or information that has not been connected with the learner's prior experiences will be quickly forgotten. In short, the learner must actively construct new information onto his/her existing mental framework for meaningful learning to occur.

Conventional (lecture) method of teaching is the process of transmission of knowledge from teacher to student (Rhodes and Bellamy, 1999). It is essentially a one-way process. The current Nigerian classroom, whether primary, secondary or tertiary institutions level, tends to resemble a one-person show with a captive but often comatose audience. Classes are usually driven by "teacher-talk" and depend heavily on textbooks for the structure of the course. There is the idea that there is a fixed world of knowledge that the student must come to know. Information is divided into parts and built into a whole concept. Teachers serve as pipelines and seek to transfer their thoughts and meanings to the passive students. There is little room for student-initiated questions, independent thought or interaction between students. The goal of the learner is to regurgitate the accepted explanation or methodology expostulated by

the teacher (Caprico, 1994). This teaching method can hinder the development of individual student's active and creative abilities, and students who experience only this model of education may no longer be considered sufficient for the needs of a future educated citizenry (Zhao, 2003).

In a constructivist setting, knowledge is not objective, mathematics and science are viewed as systems with models that describe how the world might be rather than how it is. These models derive their validity not from their accuracy in describing the real world, but from the accuracy of any predictions which might be based on them (Postlewaite, 1993). The role of the teacher is to organize information around conceptual clusters of problems, questions and discrepant situations in order to engage the student's interest. Teachers assist the students in developing new insights and connecting them with their previous learning. Ideas are presented holistically as broad concepts and then broken down into parts. The activities are student-centered and students are encouraged to ask their own questions, carry out their own experiments, make their own analogies and come to their own conclusions.

Cognitive theorists believe the role of the teacher is to provide learners with opportunities and incentives to learn, holding that among other things:

1. All learning, except for simple rote memorization, requires the learners to actively construct meaning
2. Students' prior understandings and thoughts about a topic or concept before instruction exert a tremendous influence on what they learn during instruction
3. The teacher's primary goal is to generate a change in the learner's cognitive structure or way of viewing and organizing the world and
4. Learning in co-operation with others is an important source of motivation, support, modeling, and coaching (Feden, 1995).

The constructivist theory of learning supports cognitive pedagogy, for opposing that humans have an innate sense of the world and this domain allows them to move from passive observers to active learners. Carlson (2003) supports a strong emphasis on identifying, building upon and modifying the existing knowledge (prior knowledge) students bring to the classroom, rather than assuming they will automatically absorb and believe what they read in the textbook and are told in the class. Research (e.g. Caprico, 1994) indicates that better exam grades were obtained by students taught using constructivist methodology. Supporting this finding, Saigo (1999), White (1999) concluded that "the constructivist model has been found to slightly influence students' achievement in a positive way". The constructivist model is capable of getting students more involved in learning. Kurt and Somchai (2004) in their own research study on constructivism also found that students used for their study participated more in the classroom activities and gained in content knowledge when a constructivist approach was

used. Brad (2000), in his study, found that students in the constructivist instruction showed higher degree of academic achievement than students in the traditional (lecture) instruction in all conditions. In a research study by Gatlin (1992) he found that there was no significant difference in students' scores at the posttest between students of the constructivist group and traditional (lecture) group. He reported that students' scores of those who received the constructivist approach showed a slight decrease on the delayed posttests, while students taught using the traditional (lecture) approach showed a greater decrease over time. Students who received the constructivist instructional approach have a higher relation over time. It can be said that students taught by traditional (lecture) means, who rely on memorization to pass tests, over time often do not remember much of the information learned.

Makanong (2000) corroborated Gatlin's finding in his research study when he found that there was no significant difference in achievement between students in constructivist group and traditional (lecture) group. Kurt and Somchai (2004) reported that there was no significant difference in achievement between Thailand students exposed to traditionalist (lecture) teaching method and constructivist teaching strategy in vocational electronics programmes. However, they concluded that the constructivist-instructed students had higher scores on the post test and the delayed post test, compared to those of the traditionally (lecture) instructed students. This implies that students in the constructivist's group retain the concepts taught better than their colleagues in the traditionalist's lecture group.

RESEARCH HYPOTHESIS

H₁: There is a significant difference in students' knowledge of integrated science concepts between Nigerian students who were instructed using constructivist instruction and conventional (lecture) instruction.

METHODOLOGY

Design and procedure

Quasi experimental research was used to achieve the purpose of this study. The study was conducted in four randomly selected public co-educational Junior Secondary Schools in Ijebu-ode local government area of Ogun state, South-west Nigeria. 120 Junior Secondary School (III) students participated in the study. In selecting the four schools, all the co-educational Junior Secondary Schools (J.S.S.) were assigned numbers which were written on pieces of paper. These papers were rolled and put into a container. One rolled paper was picked after mixing up the papers. The picked one was replaced before picking another one. This method of random sampling lead to selection of four schools (two for experimental group and the remaining two for control group). Intact class was used in each of the schools because most of the school principals did not want distortion in their normal school timetables. The intact classes in each of the schools were randomly selected from the arms of the J.S.S. III in the school.

Material used

The researchers and their assistants carried out the teaching of the students on each topic for three weeks respectively. The materials used were as follows:

1. A scheme of work consisting of selected integrated science topics (writing chemical equation, work and energy) which were taught for a period of three weeks. The students had not been exposed to these topics before the study.
2. An instructional package with the use of constructivist instruction.
3. An instructional package with the use of conventional (lecture) instruction.
4. A set of forty-five multiple-choice integrated science test items on topics covered.

The instrument in (d) above was used as pretest, post-test and delayed post test in order to evaluate students' performance. The test items were selected from the Junior Secondary School Certificate Examination (J.S.S.C.E.) past questions. The JSSCE questions are standardized in nature because the Questions were written by the experienced test and measurement experts in the ministry of education using an approved table of specification. Moderating Committee edited and selected good items. To confirm the reliability of the test items, the achievement test was administered to a set of JSS III students different from the ones selected for the study. Split-half method of estimating reliability was used to obtain a correlation co-efficient of 0.84.

Data analysis

Paired t-test and independent group t-test were used to analyze the data collected. The paired t-test was used to analyze the pretest-post test, pretest-delayed post test and post test-delayed posttest scores of the two groups; the independent t-test was used to compare performance of the two groups. Computation for the afore mentioned methods of data analysis was done using SPSS 13.00 package.

Procedure

Two intact classes in two of the four schools were designated 'constructivist learning environment (CLE)', while the remaining two intact classes in the other two schools were designated 'conventional lecture learning environment (CLLE)'. The pretest was administered to both groups. The test instrument covered the afore mentioned topics which were taught during the period of study. At the end of each of the three weeks, the same test was administered to both CLE and CLLE classes as a post-test. At each stage of post test administration, the items of the test were rearranged to give the impression that the pretest, post test and delayed post-test were different from one another. Two weeks after the administration of the post test, delayed posttest was administered to answer the question of whether there was student memorization of facts and information or whether understanding of the integrated science concepts taught by the teachers, using different instructional methods, affected retention.

RESULTS

Means and standard deviations for each method with respect to pretest, post test and delayed post test are presented in Table 1. As indicated in Table 1, students exposed to constructivist instruction in topic 1 had higher mean scores for both post test (31.95, SD = 2.4) and delayed post test (36.93, SD = 2.22). Also, in topic 2, students in

Table 1. Means and standard deviations of the sample's pretest, post test and delayed post test scores.

Tests	Method	N	Mean	Std. Deviation
Topic 1				
Pretest	constructivism	60	12.8667	2.1350
	Traditionalism	60	12.9500	2.2203
Posttest	constructivism	60	37.0000	3.0865
	Traditionalism	60	15.4000	1.9063
Delayed Posttest	constructivism	60	38.9833	1.7378
	Traditionalism	60	11.2333	1.3823

Std – Standard, N – Number.

Tests	Method	N	Mean	Std. Deviation
Topic 2				
Pretest	constructivism	60	14.5667	2.2801
	Traditionalism	60	12.5500	2.1267
Posttest	constructivism	60	31.9500	2.4036
	Traditionalism	60	15.1833	2.1193
Delayed Posttest	constructivism	60	36.9333	2.2160
	Traditionalism	60	12.8000	2.7047

Table 2. Summary table for the independent samples test on pretest, pos ttest and delayed-post test scores from groups 1 and 2.

t-test for equality of means			
Tests	t	df	Sig. (2-tailed)
Topic 1			
Pretest	5.010	118	.000
Post test	40.530	118	.000
Delayed posttest	53.463	118	.000
Topic 2			
Pretest	-.210	118	.834
Posttest	46.122	118	.000
Delayed posttest	96.103	118	.000

Std -Standard, N - Number, df - degree of freedom.

constructivist group had the highest mean scores for both posttest (37, SD = 3.09) and delayed posttest (38.78, SD = 1.74). Generally, the lowest mean scores of all tests, except the pretest in topic 2, belonged to the students who were exposed to conventional lecture instruction (Table 1). Table 2 shows the t-test values for the pretest, post test and delayed post test with respect to the two

methods of teaching. At the pretest level, the exact probability level is .000 (topic 1) which is less than p ($p < .05$). This implies that there was significant difference in the mean score of students in constructivist group (14.57) and students in conventional lecture group (12.55). In topic 2, there was no significant difference in mean scores at pretest level between students in the constructivist group (12.87) and students in conventional lecture group (12.95). The p-value at this level is .834, which is greater than p ($p > .05$). At the post test level, the p-value is .000 (topics 1 and 2) which is less than p ($p < .05$). This implies that there was significant difference in mean scores at this level, for both topics 1 and 2, between students exposed to constructivist learning method (31.95 and 37) and students in conventional lecture group (15.18 and 15.40). At the delayed post test level, the p-value is also .000 (topics 1 and 2) which is less than p ($p < .05$). Hence, there was significant difference in mean scores, in both topics 1 and 2, between constructivist group students (36.93 and 38.73) and conventional lecture group students (11.23 and 12.80) (Table 2). Table 3 presents paired t-test for pretest-post test, pretest-delayed post test and posttest-delayed posttest with respect to the two instructional methods. In topics 1 and 2, the p-value for all pairings is .000, except the post test-delayed post test pairing which is .001. This implies that there was significant difference in the mean scores, at all levels of pairing, between students in constructivist group and students in conventional lecture group.

DISCUSSION

There was no statistical significant difference in the mean scores and standard deviation of the students in constructivist group (12.8667, 2.1350) and conventional lecture group (12.9500, 2.2203) in respect of topic 1, suggesting that the students had the same entry level before the treatment. Contrarily, there was a significant difference in the mean scores and standard deviation of the students in the constructivist group (14.5667, 2.2801) and conventional lecture group (12.5500, 2.1267) suggesting that the students had different entry level before the treatment. At the post test levels of topics 1 and 2, there was statistical significant difference in the mean scores and standard deviation of students in constructivist group (37.0000, 3.0865; 31.9500 and 2.4036) and conventional lecture group (15.4000, 1.9063; 15.1833 and 2.1193) suggesting that students in the constructivist group gained significantly after treatment compared to their colleagues in the conventional group whose mean scores was slightly different from their mean scores at the pretest levels. At the delayed post test levels of topics 1 and 2, there was statistical significant difference in the mean scores and standard deviation of students in constructivist group ((38.9833, 1.7378; 36.9333 and 2.2160) and conventional lecture group (11.2333,

Table 3. Paired samples test.

	Paired Differences			t	df	Sig. (2-tailed)
	Mean	Std Deviation	Std. Error Mean			
Topic 1						
Pair 1 pretest-posttest	-10.0083	7.7106	.7039	-14.219	119	.000
Pair 2 pretest delayed –posttest	-11.3083	11.3802	1.0389	-10.885	119	.000
Pair 3 posttest delayed –posttest	-1.3000	4.1294	.3770	-3.449	119	.001
Topic 2						
Pair 1 pretest-posttest	-13.2917	11.1645	1.0192	-13.042	119	.000
Pair 2 pretest delayed –posttest	-12.1000	14.0356	1.2813	-9.444	119	.000
Pair 3 posttest delayed -posttest	1.1917	3.4282	.3130	3.808	119	.000

1.3823, 12.8000 and 2.7047) implying that students in the constructivist group retained the facts and information on the integrated science concepts taught more than their colleagues in the conventional lecture group.

The results of the finding indicate that there was improvement in academic performance of students in constructivist group on pretest and delayed post test. Their scores in topics 1 and 2, at the post test level, were higher than their scores at the pretest levels compared to their colleagues in conventional lecture group. The same trend occurred at the delayed post test stage, students in constructivist group were able to retain 80% of the concepts taught compared to their colleagues in conventional lecture group who could only retain 10% of the concepts taught.

In view of the afore-mentioned findings, this study has been able to establish that the hypothesis is acceptable because there was a statistically significant difference for the samples' post tests and delayed post tests where the students who received the constructivist pedagogy scored higher than their colleagues in the conventional lecture group. The findings of this study are in line with the research findings of Saigo (1999); White (1999) and Brad (2000).

Consequently, if constructivist approaches to learning could be used by integrated science teachers in Nigerian Junior Secondary Schools, there will be improvement in academic performance of the Junior Secondary School students in integrated science, hence they will develop positive interest in the core science subjects at the Senior Secondary School level which will eventually to students' interest in science oriented courses at the tertiary education level. In view of this, integrated science teachers should incorporate constructivist based teaching strategy into their methods of teaching. The sample in this study showed a lack of representation in gender. Hence, additional research is needed to determine if there is a difference between how male and female students in Nigerian Junior Secondary Schools respond

to constructivist and conventional lecture teaching techniques.

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