Effects of constructivist teaching strategies and traditional lecture method on students' learning outcomes in Nigeria's integrated science education

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Abstract

The effect of constructivist-based teaching strategy and traditional lecture method strategy on achievement in integrated science by junior secondary school students in Nigeria was examined. Data were drawn from students' (120) scores obtained from the pretest, posttest, and delayed posttest while exposing groups of these students to the constructivist-based teaching strategy and traditionalist-based teaching strategy. Findings revealed that the constructivist instructed students had higher scores on the posttest and the delayed posttest, compared to those of the traditionally instructed students. Although it is difficult to generalize to other geographical areas, it is anticipated that the study would be replicated in the rest of the country for a more meaningful and informative national picture.

Key words: constructivism, constructivist teaching, traditional lecture method integrated science, science achievement

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. 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. That Nigerian students fail to meet such expectations should not be surprising since the traditional measures of school outcomes, standardized achievement tests, have not required the application of knowledge in new settings.

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 which is driven by the increasing anomalies of the current educational system. 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 student 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. 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.

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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 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.

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.

Additionally, the traditional teaching method of teacher as sole information-giver to passive students appears outdated. In a study carried out by Angelo (1991) 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. 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.

One proposed solution for this 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-give and textbook guided classroom have failed to bring about the desired outcome of producing thinking students. A much-heralded alternative is to change the focus of the classroom from teacher dominated to student-centered using a constructivist approach.

This type of classroom environment could assist Nigerian Integrated Science educators in meeting the future needs of their students and of Nigeria. Research studies on the effectiveness of the constructivist approach that focus on the field of integrated science in Nigeria are difficult to come across. In fact there have been no studies investigating whether the constructivist approach is more effective in Nigerian Integrated Science education when compared to the traditional instructional approach. The aim of the present study was to determine the effects of constructivist instruction and traditionalist instruction on student understanding of Integrated Science concepts. This study provided a systematic comparison of two types of instruction (constructivist and traditionalist instructions) through achievement measures on a pretest, posttest and delayed posttest.

Theoretical Framework

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, Giambatista 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 organisational 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. 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.

What are the underpinnings for a constructivist learning setting and how do they differ from a classroom based on the traditional model (sometimes referred to as the objectivist model)? 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 student. 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).

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 organise 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 thing:

i. All learning, except for simple role memorization, requires the learners to actively construct meaning;
ii. Students' prior understandings and thoughts about a topic or concept before instruction exert a tremendous influence on what they learn during instruction;
iii. 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
iv. Learning in co-operation with others is an important source of motivation, support, modeling, and coaching (Feden, 1995, p. 19).

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, farther than assuming they will automatically absorb and believe what they read in the textbook and are told in the class.

Purpose, objectives and research hypothesis

The main purpose of this study was to determine if there was a difference in knowledge achievement by Nigerian Junior Secondary School students instructed using constructivist instruction (with co-operative learning) and those instructed using traditional instruction (with lectures). Its objective was to compare the achievement of students' taught using the constructivist approach in Nigeria integrated science education with their counterparts taught using the traditional lecture approach. To accomplish this objective, the following hypothesis was formulated to guide the study: "There is no significant difference in the achievement of students' taught using the constructivist approach in Nigeria integrated science education and that of their counterparts taught using the traditional lecture approach."

Literature Review

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 & 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 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 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 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 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 group.

Kurt & Somchai (2004) reported that there was no significant difference in achievement between Thailand students exposed to traditionalist teaching strategy and constructivist teaching strategy in vocational electronics programmes. However, they concluded that the constructivist-instructed students had higher scores on the posttest and the delayed posttest, compared to those of the traditionally instructed students. This implies that students in the constructivist's group retain the concepts taught better than their colleagues in the traditionalist's group.

Methodology

Participants

The study was conducted in two public co-educational secondary schools in a state in South-west Nigeria. 120 Junior Secondary School (III) students participated in the study. Stratified random sampling was used to select the sample for the study.

Material Used

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

(a) 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.

(b) An instructional package with the use of constructivist instruction.

(c) An instructional package with the use of traditionalist instruction.

(d) A set of forty-five multiple-choice integrated science test items on topics covered. This instrument was used as pretest, post-test and delay posttest in order to evaluate students' performance.

The instruments, having been criticized by both colleagues and experts in integrated science for face validity, was subjected to split-half method of estimating reliability, to obtain a correlation co-efficient of 0.84. The content validity of the test items was established by making use of test blue-print.

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-posttest, pretest-delayed posttest, and posttest-delayed posttest scores of the two groups; the independent t-test was used to compare performance of the two groups. Computation for the aforementioned methods of data analysis was done using SPSS 11.00

Procedure

The design used for this study was pretest-posttest control group. One class in one of the two schools, which were exposed to the constructivists teaching strategies, was designated 'Constructivist Learning Environment (CLE)', while the remaining classes were designated 'Traditionalist Learning Environment (TLE)'. The pretest was administered to both groups. The test instrument covered the aforementioned topics (i.e. writing chemical equation, work and energy) which were taught during the period of study to both CLE and TLE classes. At the end of each of the three weeks, the same test was administered to both as a post-test. Two weeks after the administration of the posttest, delayed posttest was administered. At each stage of posttest administration, the items of the test were rearranged to give the impression that the pretest, posttest and delayed post-test were different from one another. A delayed posttest was used 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, posttest and delayed posttest are presented in Table 1. As indicated in table 1, students exposed to constructivist instruction in Topic 1 had higher mean scores for both posttest (31.95, SD = 2.4) and delayed posttest (36.93, SD = 2.22). Also, in topic 2, students in 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 traditional instruction.

Table 1 Means and Standard Deviations of the sample's Pretest, Posttest, and Delayed Posttest scores

		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
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
	Posttest Delayed	Constructivism	60	36.9333	2.2160
		Traditionalism	60	12.8000	2.7047

Table 2 shows the t-test values for the pretest, posttest, and delayed posttest 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(.005). This implies that there is significant difference in the mean score of students in constructivist group (14.57) and students in traditional group (12.55). In topic 2, there is no significant difference in mean scores at pretest level between students in the constructivist group (12.87) and students in traditional group (12.95). The p-value at this level is .834, which is greater than p(.005). At the posttest level, the p-value is .000 (topic 1 and 2) which is less than p (.005). This implies that there is significant difference in mean scores at this level, for both topics 1 and 2, between students exposed to constructivist learning method (31.95 & 37) and students in traditional group (15.18 & 15.40). At the delayed posttest level, the p-value is also .000 (topic 1 & 2) which is less than p (.005). Hence, there is significant difference in mean scores, in both topics 1 & 2, between constructivist group students (36.93 & 38.73) and traditional group students (11.23 & 12.80).

Table 2 Results for the independent samples test on pretest, posttest, and delayed-posttest 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
	Posttest	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

Table 3 Paired Samples Test

			Mean	Std Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
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

Table 3 presents paired t-test for pretest-posttest, pretest-delayed posttest, and posttest-delayed posttest with respect to the two instructional methods. In topics 1 & 2, the p-value for all pairings is .000, except the posttest-delayed posttest pairing which is .001. This implies that there is significant difference in the mean scores, at all levels of pairing, between students in constructivist group and students in traditionalist group.

Discussion

The results of the finding indicate that there was improvement in academic performance of students in constructivist group on pretest and delayed posttest. Their scores in topics 1 & 2, at the posttest level, were higher than their scores at the pretest levels compared to their colleagues in traditionalist group. The same trend occurred at the delayed posttest stage, students in constructivist group were able to retain 80% of the concepts taught compared to their colleagues in traditionalist 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 there was a statistically significant difference for the samples posttests and delayed posttests where the students who received the constructivist pedagogy scored higher than their colleagues in the traditional group. The findings of this study are in line with the research findings of Caprico (1994); Saigo (1999); White (1999); and Brad (2000). Though Kurt & Samchai (2004) found that there was no significant difference in achievement between constructivist instructed students and traditionalist instructed students, they concluded that the constructivist group of students had higher scores on the posttest and delayed posttest compared to those of the traditionally-instructed students. This implies that the finding of this study is also in line with Kurt & Somchai's conclusion.

Consequently, if constructivist approaches to learning could be used by integrated science teachers in Nigerian Junior Secondary Schools, there will be improvement in academic achievement of the Junior Secondary School students in integrated science. 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 traditionalist teaching techniques.

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