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A Test of the Efficacy of Field-Trip and Discussion Approaches to Teaching Integrated Science within a Constructivist Flavour

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Abstract
Discussion method of instruction and field trips, by their nature can be adjudged interactive teaching approaches. But it can be speculated that the discussion method, because of its additional characteristic of providing for negotiation/argument during instruction, can potentiate constructivist instructional strategy to produce superior achievement by integrated science students. This speculation was experimentally investigated in this study by using 47 (22 boys and 25 girls) junior secondary school students (grade 8) in Warri Municipality of Nigeria and a non-equivalent control group design. These students were randomly assigned to treatment and control groups and taught energy concepts. Analysis of posttest scores using a 2 x 2 (two levels of method of instruction and gender) ANOVA indicated that there was no significant effect of method ($F_{(1,44)} = 3.88$, $p > 0.05$), gender ($F_{(1,44)} = 0.14$, $p > 0.05$) and interaction of method by gender ($F_{(1,44)} = 2.98$, $p > 0.05$). The implications of these results for integrated science teaching are addressed in this article.
Keywords: Discussion method; field trips; integrated science; constructivist instructional strategy; achievement.

1. Introduction

Integrated science teaching emphasizes fundamental unity of scientific phenomena by dissolving artificial boundaries that compartmentalize such phenomena. One of the advantages of this unity is that the subject matter of study is related to real-life problems. Another advantage is that it agrees with the psychological nature of primary and junior secondary school students which allows them to see events and phenomena from a holistic perspective. A number of methods of teaching can be used for presenting integrated science lessons to express this fundamental unity. They include: discovery-inquiry method; project method, simulations and games, field trips, discussion, programmed instruction and e-instruction. But only two of them-field trips and discussion methods are the focus of this study.

Discussion method, according to Larson (1997) citing Wileen and White, is characterized by a structured conversation among participants who present, examine, compare and understand similar and diverse ideas about an issue. In a teaching/learning situation premised on discussion, the learner is not a passive recipient of corpus of scientific knowledge but on active participant. It enables the learner to exercise his critical thinking capacity and logical system of reasoning which are imperatives of meaningful learning of integrated science. Omatseye (2007) supports Larson (1997) by saying that discussion teaching method is a design that provides opportunity for exchange of views between teacher and students, and students and students. She says further that the method emphasizes the process of "coming to know" as valuable as "knowing the right answer" and that the students in such a class are not passive listeners and the teacher is not a sole performer.

This teaching method is important in at least three ways. The first is that it helps a student to learn how to develop value processing skills that relate to changes that occur in his society (Omatseye, 2007). The second is that it encourages team work between all the participants in the class leading to cooperative learning which Okebukola (1986) endorses as a facilitator of cognitive and affective outcomes. The third which is speculative, is that it can help the student develop social intelligence since it involves listening to others and respecting their opinions and contributions. These characteristics and advantages of the discussion method converge to indicate that it is "useful adjunct to constructivist epistemology for organizing integrated science instruction.

Field trip, as a method of teaching, provides outdoor learning experiences for the students. Teaching and learning outside the classroom and within the tenets of field trip, transcend the use of models, theories, principles and concepts. It emphasizes the use of real-life objects, phenomena and events in an integrated manner. This agrees with the philosophy of integrated science teaching.

There are several advantages of field trips. The first is that it presents a holistic and panoramic view of the phenomenon under study in its natural and real setting and this is in accord with the philosophy of integrated science. The second is that it provides an opportunity for the students to engage all the five senses; sight, hearing, smell, taste and touch in the learning process. The third is that it provides the much needed link between theory and reality during the teaching/learning process. The fourth is that, principally because of its interactive nature and the break of monotony of studies in the classrooms, students remember what they learn

during field trips.

Constructivism is based on an epistemology which sees a learner's prior knowledge as very crucial, not just tangential, to meaningful learning. Another important tenet is that learners are purposive (Driver & Oldham, 1986) and this implies that they cannot learn meaningfully by being passive. Construction of meaning or sense-making cannot take place if the teacher perceives his role as that of authoritarian disseminator of the subject matter of integrated science. It can take place if the teacher organizes conducive learning environment for negotiation, which according to Jegede and Taylor (1998), enables him and the learners to arrive at some consensus of meaning.

A typical sequence of instructional events using this epistemology is given as follows:

- Determine students' or pupils' prior knowledge (alternative conceptions, see Abimbola, 1988), using different methods (see Igwebuike, 2012).
- Catalogue the alternative conceptions according to types;
- Determine the conflict or dissonance level (see Igwebuike, 1991);
- Present the subject matter of study;
- Carry out conflict resolution through negotiation which will lead to consensus building (Jegede & Taylor, 1998);
- Test, with the students, the usefulness, fruitfulness and intelligibility of the students alternative conceptions vis-à-vis the subject matter of study;
- Discussions about application of the knowledge (meaning constructed, developed);
- Determination of the students affective state after they have discarded their dissonant alternative conceptions.

Strands of research evidence converge to endorse the efficacy of the constructivist instructional strategy (Rowell & Dawson, 1985; Trumper, 1990, 1991; Asim, 1999; Bajah & Asim, 2000; Igwebuike, 2012; Ndioho, 2007) for science teaching.

Authentic learning in science is much more likely to occur from an instructional strategy that is based on constructivist epistemology. This type of learning is achieved, according to Cey (2001), if instruction is designed to facilitate, stimulate, and recreate real-life complexities and events. Taber (2006) suggests that science teaching is more effective if existing ideas are considered because learners' existing ideas impact learning of science.

Fittell (2010) concluded in his study that the constructivist model implemented in the study brought about desired result. Although O'Donnell (2000) is of the opinion that not all learners benefit from having unlimited control over their own learning, Karagiorgi and Symeou (2005) strongly suggested that accommodating constructivist perspective by instructional designers can help them respond to the learning requirement of the 21st century.

Discussion method appears to be more closely related to the constructivist epistemology than the field trip. This is mainly because discussion and constructivist epistemology reject authoritarian dissemination of subject matter by the teacher and the perception of teacher as the sole performer in the learning situation. The second reason is that discussion as a method of teaching is akin to negotiation in the class to arrive at a consensus of meaning which is a major aspect of instruction premised on constructivist epistemology. It can be conjectured, from the foregoing, that discussion method of teaching integrated science will be superior to field trip when they are used within constructivist flavour. The intention in this study, therefore, was to examine the efficacy of these two methods within constructivist learning environments. Okebukola (1992) observes that despite its appeal, the issue of boy/girl differences in concept-mapping and achievement has hardly been addressed. Similarly, this issue has not been addressed with respect to application of constructivist instructional strategy or discussion method of teaching.

Three research questions were addressed in this study.

1. Is there a difference in cognitive achievement between integrated science students taught using discussion method within constructivist learning environment and their counterparts taught using field trip?
2. Is there a difference in cognitive achievement in integrated science between boys and girls?
3. Is there a significant interaction effect of method by gender in cognitive achievement in integrated science?

2. Method

2.1 **Subjects**. A total of 47 integrated science students of Dom Domingos Secondary School Warri, Nigeria were involved in this study. The subjects (22 boys and 25 girls) ranged in age between 12 years, 4 months and 15 years, 5 months. One intact class was randomly selected for the study from 7 classes that constituted junior secondary 2 (grade 8) in the school.

2.2 **Instruments**. Data on meaningful learning were collected using a test referenced to the content of the lessons. The test has 30 multiple-choice items drawn from energy concept as in the table of specification used. A sample of the items is provided below:

1. Energy is ….
   a. a concrete object
   b. something that moves
   c. something that is invented to help us study change sin object
   d. gas used for cooking
2. Energy is crude oil comes from the ....
   a. soil
   b. sea
   c. sun
   d. oil mineral companies.
3. A bulb connected to a battery lights because ….
   a. electric energy is converted into light energy
   b. heat energy is converted into light energy
   c. mechanical energy is converted into light energy
   d. kinetic energy is converted into light energy
4. When a boy is riding a bicycle the chemical energy he possesses is converted into ….
   a. heat energy
   b. mechanical energy
   c. sound energy
   d. solar energy

According to Ausubel, Novak and Hanesian (1978), Novak (1981), and Okebukola (1990), to assess meaningful learning, a test must be at the comprehension level and beyond. But because of the level of development of the students, it was ensured that approximately 50% of the items on the test was at the comprehension level, 30% at the application level, 10% at the analysis level, 6% at the synthesis level and 3% at the evaluation level in the table of specification. Consequently, the original (39 items prepared for the test was submitted to a validation panel made up of 2 experts in test construction and 3 experts in integrated science teaching. Their suggestions with respect to content validity of the items were used in the selection of the 30 items in the test. Psychometric integrity of the test was determined using a pilot sample of 44 grade 8 students from another junior secondary school in two ways. The first is that the discriminatory power and difficulty indexes of the items were determined using suggestions by Mehrens and Lehmann (1975). The difficulty index was found to be between 0.31 – 0.73 while the index of discriminatory power is between 0.29 – 0.68. These measures are within acceptable ranges. The second is that the split-half reliability coefficient stepped up by the Spearman-Brown formula was determined as 0.89.

Another instrument, Interview-about-Instances (IAI) designed and popularized by Osborne and Gilbert (1980a, b) was used for probing students alternative conceptions. Instances of the sub-concepts studied were presented on different cards by means of line drawings. Guides for the interview protocol suggested by the Learning in Science Project of the University of Waikato, New Zealand were followed. The content coverage of the IAI cards was also ascertained by the panel of 2 experts in integrated science teaching mentioned in the last paragraph.

2.3 **Design and Procedure**. A non-equivalent control group design with random assignment of the two groups to experimental (those taught using discussion) and control (those taught using field trips) groups was carried out to examine any possible treatment effect due to exposure to the methods. The two groups shared common curriculum content. IAI was organized for 12 randomly selected subjects from the two groups using the cards with line drawings of the sub-concepts. This was done to determine their alternative conceptions of the sub-concepts. The alternative conceptions were compared with the scientific conceptions and used as bases for organizing instruction based on a constructivist epistemology as outlined in the typical sequence of instruction in introductory section of this paper. This instructional strategy was common to discussion and field trip methods of teaching used for experimental and control groups respectively.

Discussion method was used by organizing series of structured and free conversation among the subjects in the experimental group. They were made to examine and compare the similarities and differences between their alternative conceptions and the scientific conceptions of study. There was free exchange of views among the subjects and the teacher (one of the researchers) participated as one of the discussants. The teacher also provided the guidelines and prompted the subjects during the discussion sessions. His role deviated from the traditional role of authoritarian disseminator of knowledge of subject matter or concepts studied to that of assisting the students to assess and express their observations about competing or confliction ideas and to arrive at a

consensus of meaning. The teacher provided appropriate instructional media, where applicable to prompt assessment and discussion.

Field trip method of teaching was used by providing out- door learning experiences of the concepts studied. The subjects were taken out to suitable sites for first hand experiences with the phenomena under study. They were assisted by the teacher to compare their alternative conceptions with the scientific conceptions of study with respect to the observations they made using their sense organs.

A pretest was given to the two groups before the commencement of treatments which lasted for 9 weeks with 2 lessons per week. After this period of treatment, the two groups were given the posttest. The pretest and posttest were administered in the same manner.

3. Results

The subjects in the experimental and control sub-sample were found to be equivalent with respect to their knowledge of the concepts before treatment commenced. This is shown by the results of the t-test conducted on the pretest scores ($t_{(45)}$ =0.94, p>0.05) (see Table 1).

Table 1

Means, Standard Deviations and t-test comparing Discussion and Field trip Groups on the Pretest

	N	Mean	SD	t
Discussion	23	10.43	2.12	0.94*
Field trip	24	11.27	2.41	

* Not significant at 0.05 alpha level

Table 2

Means and Standard Deviations of the Groups according to Levels of the Variables (Posttest)

N		Method		
		Discussion	**Field trip**	**Row**
Gender	Male	n = 12	n = 10	n = 22
		$\bar{x}$ = 20.08	$\bar{x}$ = 15.25	$\bar{x}$ = 17.67
		SD = 3.61	SD = 3.37	SD = 3.52
	Female	n = 11	n = 14	n = 25
		$\bar{x}$ = 18.05	$\bar{x}$ = 17.64	$\bar{x}$ = 17.85
		SD = 4.02	SD = 4.26	SD = 4.13
	Column	n = 23	n = 24	
		$\bar{x}$ = 19.10	$\bar{x}$ = 16.34	
		SD = 3.81	SD = 3.81	

Table 3

Summary of the 2 x 2 ANOVA on Posttest

Source	df	SS	MS	F
Main effect				
Method	1	245.18	245.18	3.88*
Gender	1	9.07	9.07	0.14*
Interaction				
Method x Gender	1	188.06	188.06	2.98*
Error	42	2652.42	63.15	

* p > 0.05

With a mean score of 19.10 on the posttest, the experimental group students who were taught using discussion method did not demonstrate significantly superior performance ($F_{(1,44)}$ =3.88, p>0.05) over the control group (taught using fieldtrip) that had a mean score of 16.24 (see tables 2 and 3). This means that the difference observed between the two groups was due to chance factors. Boys with a group mean of 17.67 on the posttest did not show significantly superior performance ($F_{(1,44)}$ = 0.144, p > 0.05) over the girls that had a mean score of 17.85 (see Tables 2 and 3) there was no significant difference between boys and girls. Table 2 also indicates that there was no significantly gender by method interaction effect ($F_{(1,44)}$ =2.98, p>0.05).

4. Discussions, Implications and Conclusions

The purpose of this study was to determine the efficacy of discussion and field trips methods of teaching

integrated science with a constructionist flavour. The study also determined if there would be gender differential in the achievements by boys and girls in addition to interaction effect of gender and method. The data from the study do not provide support for superiority of the discussion method over fieldtrips in enhancing the achievement of students in integrated science lessons ($F_{(1,44)} = 3.88$, $p>0.05$).

This result contradicts the characteristics of the discussion method which make it closer to the constructivist epistemology than the field-trip method. One of the characteristics, according to Omatseye (2007), is that it provides opportunity of exchange of views between the teacher and students, and students and students. She says further that it helps a student to learn how to develop value processing skills that relate to changes that occur in his society. Exchange of views and development of value processing skills needed by the students for testing the fruitfulness, intelligibility and plausibility of their alternative conceptions are major tenets of the constructivist epistemology. It was expected that the discussion method would potentiate the constructivist epistemology when used within a constructivist flavour.

Another characteristic of the discussion method that is noteworthy is the observation that it encourages team work between all the participants in the class leading to cooperative learning which facilitates cognitive and affective achievement (Okebukola, 1986). This second characteristic converges with the first to upgrade the expectation of superiority over the fieldtrip in facilitating achievement in integrated science.

Speculatively, this result indicating no significant differences in achievement in integrated science among grade 8 students taught using discussion method and their counterparts taught using fieldtrip method within constructivist flavour, can be explained by two factors. The first is the nature of pretest/posttest used in this study. It is made up of a number of multiple-choice test items. This factor has been implicated in some studies (Igwebuike & Oriaifo, 2012) aimed at determining the efficacy of constructivist epistemology of teaching integrated science to grade 8 student and in which cognitive achievement were assessed using multiple-choice test items. Assessment of the impact of the use of discussion method for teaching integrated science cannot be effectively carried out with only multiple-choice items. Affective aspects of achievement, for instance, should be included in the assessment.

A second plausible factor is associated with the nature of discussion as a method of teaching. This is contrary to the didactic or teacher-dominated lessons which the students are used to. It was possible that the students thought that such discussions would not be for purpose of test or examination. Fieldtrips are more teacher-dominated than discussion method.

Tables 2 and 3 show no remarkable difference in means of boys and girls ($F_{(1,44)} =0.144$; $p>0.05$).This result contradicts Okebulola's (1992) findings that achievements by boys and girls was task dependent. For instance, he observes, the boys displayed significantly better problem-solving abilities than the girls. But with a type of problem that requires cognizance of animal behavior, ecological concept of food chain and the nutritional concept of vitamins to solve, the boys underachieved. But Ogunleye's (1996) study aimed at determining the levels of acquisition of process skills among physics students following instruction in physics provided evidence which indicated that male students gained more that female students.

Lack of a remarkable difference between boys and girls in this study can be explained by the fact that the stereotypical image of feminine behavior within the cultural milieu in which the study was carried and which restricted competitive zeal among the girls is beginning to dwindle. Girls are beginning to psyche themselves up to believe that they can beat the boys in different endeavours.

It is mind-bogging to observe that there was no significant interaction of gender by method in this study ($F_{(1,44)}$ 2.98; $p>0.05$). It was expected that discussion method and fieldtrips would facilitate achievement in integrated science by boys or girls. This expectation is predicated on the results of study by Isyaku and Kalgo (1996) that there was gender difference in the academic achievement in maths of female field independents and female dependents, and male field-independents and male field dependents in favour of the females.

A major implication of the result of this study for integrated science teaching is that science teachers, as well as science teacher educators, should have no special preference for either discussion method of field trips for teaching integrated science within a constructivist flavour. The seemingly closer relationship between discussion method and constructivist epistemology does not make it superior to the field trips for teaching integrated science within constructivist framework.

Another implication of the result is that integrated science teachers should pay equal attention to boys and girls while teaching integrated science to grade 8 students. In addition, they should pay equal attention to the levels of both gender and method used in this study since there was no remarkable interaction effect of gender by method.

The overarching prediction of this study was that discussion method of teaching within a constructivist flavour will lead to more superior achievement in integrated science by grade 8 students than the fieldtrips. But data obtained from the study do not support this prediction. This study should be replicated because of two major reasons. The first is that the design used in the study (non-equivalent control group design) does not provide strict control, and as a result, probable effects of some confounding variables may tamper with external validity.

Secondly, the measurement of cognitive achievement which involved only objective test items is lopsided. There may be the need also to measure affective achievement of students while comparing the efficacy of the discussion and field trip methods within a constructivist flavour. Other studies whose designs will incorporate triangulation within this rationale are suggested to further pursue this line of inquiry aimed at improving integrated science teaching.

On the basis of the foregoing, cautious interpretation and application of the conclusions of this study to integrated science teaching are encouraged. Nevertheless, the desirability of the rationale and the general direction of enquiry attempted in this study cannot be controverted.

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