

10

Guided-Inquiry Instructional Mode on Students' Achievement in Integrated Science: A Panacea for Economic Development of African States

By

TIM E. AGBOGHOROMA, Ph.D
*Department of Curriculum and Integrated Science,
Delta State University,
Abraka.*

Abstract

The study examined the effect of guided-inquiry instructional mode on integrated science achievement in Delta State, Nigeria. This was done with a view of using this mode of instruction in schools for solving problems associated with economic development of African states. A quasi-experimental design was adopted in the study. Integrated Science Achievement Test (ISAT) was designed by the researcher and was used to collect data from 160 Junior Secondary Students in Delta Central Senatorial District of Nigeria. Two research questions and two research hypotheses were formulated and tested at 0.05 significant levels. Mean and standard deviation were used to answer the research questions while a two-way analysis of variance (ANOVA) was used to test the stated hypotheses. The findings of the study revealed that guided-inquiry instructional mode yielded a better result in teaching Integrated Science than the conventional method used as control. From this, the study recommended amongst others, the use of guided-inquiry as an instructional mode that can enhance students' achievement in Integrated Science in African schools for economic development.

Science no doubt is an indispensable tool for nation building. Nations all over the globe use science both for growth and economic development. Hence, nations all over the world continue to strive to ensure a steady improvement in their science curriculum in classrooms. Globally, science education programmes have afforded tremendous opportunities to young scientist in training in terms of the acquisition of skills for solving, in particular, environmental problems (Agboghoroma, 2009). Among

these skills is the provision of much needed scientific and technological know-how to younger generations.

Integrated Science as a school discipline is relatively new in the Nigerian context and is used as a means of inculcating scientific facts and ideas in students. Its introduction in the school curriculum dates back to 1968 and the teaching of Integrated Science has since gained ground in learning institutions at both Junior Secondary School (JSS) and tertiary levels. Several science educators like Adeyemi (1990), Ughamadu (1990), Urevbu (1990), Umeoduagu (1994) and Agboghorama (2009) have emphasized that the major objectives of science education is the development of science process skills amongst school-aged children.

The objectives of Integrated Science as documented in the JSS curriculum are:

1. To train the student to be able to develop the motivation and ability to work and think in the independent way;
2. To devise skills for solving problems; and
3. To apply previous knowledge to novel situations and to relate his experience in each subject area to another area and relate same to life in his society (FME, 1984).

These objectives has implication for Integrated Science learning. This is necessary if the country to lay solid foundation for scientific and technological advancement.

Integrated Science teaching can only be result oriented when students are willing to learn and the teachers are favourably disposed, to it when using the appropriate methods and resources in teaching the subject (Ibrahim, 2008). This is because affective teaching can lead to the attainment of scientific and technological greatness. With the current increase in scientific knowledge the world over, much demand is placed and emphasis is laid on the teacher, the learner, the curriculum and the environment in the whole process of teaching and learning of science.

Students' knowledge of Integrated Science and the sciences in general (or lack thereof) may be attributed to several learning factors. These may include shortage of scientific equipment, lack of laboratory facilities, cognitive functioning of students, home conditions, peer group behaviour, school conditions, teachers methodology/pedagogy and emotional predisposition (Agboghorama, 2009). Also, the manner in which the subject is presented to students can significantly influence their interest and knowledge of the subject matter. Integrated Science as a school discipline in the Nigerian educational system rely sole on the use of lecture/expository methods of teaching instead of activity-based method of teaching.

Studies like those of Umeoduagu (1994), Okobia (2000), Akpochafo (2001), Arisi (2002) and Agboghroma (2005) and (2009) have pointed out that despite the thirty years of existing learning style theories on how people learn, most teachers still dispense information with traditional lecture methods. These teaching methods are theoretical, extremely didactic and teacher-directed, instead of being experimental or activity-based. Umudhe (1998) identified some teaching methods adopted in Integrated Science classrooms and these are expository methods, project approach, discovery approach, demonstration method, field-trip method, discussion method, games and simulation method, problem-solving method, Guided-inquiry method and individualized learning methods. These methods are either teacher-centered or student-centered. There are many student-centered teaching methods like the discovery methods, Guided-inquiry method and so on. Emphasis would be laid on Guided-inquiry in this study.

Guided-inquiry is a teaching strategy which help students to develop research competence and subject knowledge as well as foster motivation, reading comprehension, language development, writing ability, cooperative learning and social skills (Kuhlthian, Maniotes and Caspari, 2007).

In a review of related literature in the use of guide-inquiry mode of instruction, Agboghroma (2005) in trying to ascertain the knowledge acquisition of urban and rural subjects in Integrated Science, used 360 JSS III students exposed to the guided-inquiry method as well as students not exposed to the guided-inquiry. The finding revealed that students taught with the guided-inquiry mode of instruction had a significant difference in knowledge acquisition over those not exposed to the method. Also, studies carried out by Okobia (2001), Akpochafo (2001), Arisi (2002), Okurumeh (2012) and Saduwa (2013) on the efficacy of instructional mode on students' achievement in school subjects also corroborated with this finding. In a related study on achievement in school subject, Saduwa (2013) affirmed that guided-inquiry mode of instruction yielded better performance in Integrated Science than conventional mode of instruction. In the same vein, Okurumeh (2012) in trying to find out the discussion and invention teaching strategies on students' achievement and retention of chemistry concepts, revealed that there was a significant difference in the treatment groups over the control group.

However, in an attempt to determine the effect of instructional strategy on the biology knowledge acquisition of Nigerian Secondary School students, Ibegbulam (1980) found that there was no difference in knowledge between the two groups who took part in the study. Also, in an attempt to evaluate the biology component of the Nigerian Secondary School Science Project (NSSSP), Adeyemi (1984) compared the effect of instructional methods (activity-centered versus traditional method) on

cognition, achievement and attitude of students towards biology. Part of the result did not favour the use of instructional mode i.e. activity-centered method over those taught with the traditional method.

From the above review, it is clear that the use of certain instructional techniques can promote a better achievement in the sciences while some may not. The present study therefore sought to use the guided-inquiry instructional strategy versus the conventional method of teaching the sciences, this time, with Integrated Science as a school discipline in the Nigerian school system. The study was designed to bridge the gap in existing literature and in the light of conflicting findings on students' achievement in the sciences as well as Integrated Science in particular.

Research Questions

The following research questions were raised in this study:

1. Is there any effect in the use of guided-inquiry instructional mode on students' achievement in Integrated Science?
2. Is there any difference in Integrated Science achievement between students taught with guided-inquiry and those taught with conventional mode of instruction?

Research Hypotheses

Ho₁: There is no significant effect in the use of guided-inquiry instructional mode on students' achievement of Integrated Science.

Ho₂: There is no significant difference between students taught with guided-inquiry and those taught with conventional modes of instruction.

Methodology

The study design is a quasi-experimental non-randomize pretest-posttest control group design. This is made up of one experimental group, the guided-inquiry instructional mode and one control group, the conventional mode of instruction. The independent variable is the guided-inquiry instructional mode while the dependent variable is the students' achievement in Integrated Science

Table 1: The Design is as Shown Below

Treatment	
Experimental group (E) Guided-inquiry instructional mode	Control group (C) Conventional method
O ₁ x O ₂	O ₃ O ₄

Key:

E = $O_1 \times O_2$

C = $O_3 \ O_4$

E = Experimental group exposed to Guided-inquiry method

C = Control group taught with Conventional method

$O_1 \ O_3$ = Pre-test measure

$O_2 \ O_4$ = Post test measure

X = Treatment

The population of the study is made up of students drawn from public junior secondary schools in Delta Central Senatorial District of Delta State, Nigeria during the 2010/2011 academic year. The target population of students is 17,182 drawn from 167 Junior Secondary Schools and with a total of 187 teachers from eight local government areas of the Senatorial Districts. These comprised Ethiope East, Ethiope West, Okpe, Sapele, Udu, Ughelli North, Ughelli South and Uvwie local government areas.

The sample of the study was made up of 160 Junior Secondary School Two (JSS II) students selected from four local government areas by use of purposive sampling techniques. These include; Ethiope East, Sapele, Ughelli North and Uvwie local government areas. 40 students each were drawn from the four (4) local government areas totaling 160 students. In each school, an intact class was used as either the experimental or control group. In this study, no school had more than one treatment group. The decision was taken in order to avoid the problem of contamination, which might occur as a result of having more than one treatment group per school. All the students had an average mean age of 13 years.

Research Instrument

The test instrument used for this study was the Integrated Science Achievement Test (ISAT) designed by the researcher. This scale consist of 50 multiple choice questions which was already validated by the state Ministry of Education. By this, the test items are already validated for the purpose of examination. This is also the case with the Nigerian Integrated Science Project (NISP) textbooks where the test items were drawn. The test items were drawn from the five units in first terms' scheme of work for JSS II. These include human skeletal system and movement, respiratory system, changes in matter, thermal energy and information communication and technology (ICT). The test was intended to measure the effectiveness of guided-inquiry instructional mode on students' achievement in Integrated Science. Teaching instruments were lesson plan for guided-inquiry and conventional instructional modes. The instrument for evaluating the content in the achievement test multiple choice questions is the same for all the subjects.

The instrument was validated by a panel of experts in the field of Curriculum and Science Education to ascertain the content and face validity. The reliability of instrument was by use of test-retest reliability method. This study yielded a reliability coefficient of 0.85 using the Pearson Product Moment Correlation. The treatment procedure was by comparing the guided-inquiry (experimental group) and the conventional method (control group). These were both pre-tested before treatment. The materials to be learned by the students were from a six week instructional unit earlier mentioned. During the treatment, students in guided-inquiry classroom were instructed by the teachers who followed the guideline during the training exercise. The teacher in the guided-inquiry group incorporated the basic elements of guided-inquiry into the group experience. These include positive inter-dependence, face interaction, individual accountability, social skill development and group processing as recommended by Johnson, Johnson and Holubee (1990) in Ajaja and Erawoke (2010). While the conventional method which is the control group were taught with the “chalk and talk” method. The teaching was mainly expository, students read assigned reading materials silently, completed assignment independently and engaged in discussion with teacher and responding to teachers questions.

Data for analysis were obtained from scores obtained from the items from the test on ISAT. The data for pre-test and post test were tabulated in respect of each method group. The use of ANOVA was adopted to test the stated hypotheses at 0.05 significant level. The research question was answered with mean and standard deviation.

Result and Discussion

Results

Research Question 1

Is there any effect in the use of guided-inquiry instructional mode on students achievement in Integrated Science?

Table 2: Pre-test and Post-test Scores of Students Achievement in Integrated Science Following the Use of Guided-Inquiry and Conventional Instructional Mode

Group to which students were assigned	Mean, number and standard deviation	Pre-test score	Post-test scores
Students taught with Guided-inquiry mode of instruction	Mean	60.3875	85.8875
	Number (N)	80	80
	Standard Deviation	5.20830	6.12113
Students taught with conventional mode of instruction	Mean	60.3875	70.6750
	Number (N)	80	80
	Standard Deviation	5.20830	5.19926

The result shows that there was difference in the pre and post-test scores of the students achievement in guided-inquiry and conventional mode of instruction. Both groups of students had better post-test scores. The table also shows the difference between mean pre-test and post-test scores of those taught with guided-inquiry mode of instruction was higher than the difference between the mean pre-test and post-test score of those taught with conventional mode of instruction. It could therefore be interpreted that though conventional mode of instruction had an effect on students' achievement, guided-inquiry mode of instruction had a higher effects on students' achievement. Thus, research question 1 which states that "Is there any effect in the use of guided-inquiry instructional mode on students' achievement in Integrated Science" is therefore answered that indeed guided-inquiry instructional mode had an effect on students' achievement in Integrated Science as against the conventional mode of instruction.

Research Question 2

Is there any difference in Integrated Science achievement between students taught with guided-inquiry and those taught with conventional method?

From table two above, the mean post-test score of the students taught with guided-inquiry mode was 85.89% while the post-test score of those taught with conventional method was found to be 70.68%. Hence, the research question 2 which states that "Is there any difference in Integrated Science achievement between students taught with guided-inquiry and those taught with conventional method?" was answered that there were differences in Integrated Science achievement between students taught with guided-inquiry and those taught with conventional method.

Research Hypothesis 1

There is no significant effect in the use of guided-inquiry instructional mode on students' achievement in Integrated Science.

Table 3: Two-way Analysis of Variance of Pre and Post-test Achievement of Students According to Group to Which Students Were Assigned

Group to which students were assigned		Sum of squares	Df	Mean square	F	Sign.
Pre-test score	Between groups (combined)	14230.830	2	7115.415	267.286	.000
Group to which students were assigned	Within groups	4285.975	161	26.621		
	Total	18516.805	163			
Post-test score	Between groups (combined)	33170.773	2	16585.387		.000
Group to which students were assigned	Within groups	5095.537	161	31.649		
	Total	38266.311	163			

The table shows that there is a significant difference [F (df = 2.161) = 267.286] between the pre and post-test achievement scores among the students taught with guided-inquiry mode of instruction at 0.05 level of significance. Hypothesis 1 which states that “there is no significant effects in the use of guided-inquiry mode of instruction was therefore rejected.

Research Hypothesis 2

There is no significant difference between students taught with guided-inquiry and those taught with conventional method.

Table 4: The two-way Analysis of Variance of Students Post-test Achievement Scores According to Mode of Instruction

Group to which students were assigned	Sum of squares	Df	Mean square	F	Sign.	
Post-Test score	Between groups (combined)	33170.773	2	16585.387	524.036	.000
Group to which students were assigned	Within Groups	5095.537	161	31.649		
	Total	38266.311	163			

The table shows that there is a significant difference [F (df =2.158) = 524.036] between the post-test achievement scores of students taught with guided-inquiry mode of instruction and those taught with conventional method at 0.05 significant level. The hypothesis 2 which states that “there is no significant difference between students taught with guided-inquiry and those taught with conventional mode was therefore rejected.

Discussion

Hypothesis 1 predicted that there would be no significant effect in the use of guided-inquiry instructional mode on students achievement in Integrated Science. The result revealed that there was significant effect on the use of guided-inquiry instructional mode on students’ achievement in Integrated Science. This study corroborates with the findings of Akpochafo (2001), Arisi (2002), Agboghroma

(2005) and (2009), Okurumeh (2012) and Saduwa (2013) who reported that the use of instructional strategies significantly enhances the achievement of students in secondary school. The finding implies that the use of guided-inquiry instructional mode has positive effects on students' academic achievement.

The research hypothesis 2 sought to find out that there is no significant difference between students taught with guided-inquiry and those taught with conventional method. The result revealed that students taught with the guided-inquiry instructional mode scored higher marks in Integrated Science achievement test than those taught with the conventional teaching method. This was achieved by the high level of students' participation in learning activities. The finding corroborates with the study by Leonard (1985) which revealed that university students who completed a semester in introductory biology laboratory design on guided-inquiry base approach achieved higher grades on biology content examination as opposed to the control group which completed a mode traditional transmission modeled laboratory. It also corroborates with study by Kuhlthian *et al* (2007) who hinged their study on the principles that guided-inquiry help students to develop research competence and subject knowledge as well as foster motivation, reading, comprehension, language development, writing ability, cooperative learning and social skills.

Conclusion

The following conclusions were arrived at:

1. Guided-inquiry mode of instruction yielded better achievement in Integrated Science than the conventional method.
2. Guided-inquiry instructional mode is more result oriented than conventional method.

Recommendations

1. Science teachers and particularly Integrated Science teachers should be encouraged to use guided-inquiry instructional strategy in the secondary school level especially at the junior secondary level.
2. Integrated Science teachers should be exposed to workshop on the use of guided-inquiry instructional mode as a means of improving students' achievement of Integrated Science
3. Curriculum planners should provide relevant teaching materials for the teaching of Integrated Science
4. All governments in the globe should encourage the use of guided-inquiry instructional mode in teaching Integrated Science as this would afford them economic freedom and development in their respective countries.
5. The government of indigenous nations should build suitable laboratories and provide scientific equipment for the effective teaching of Integrated Science.

References

- Adeyemi, M. A. (1990). Effects of cognitive style, school setting and instructional mode on students' attitude to biology. *Journal of Nigerian Educational Research*, 9(10): 84-93.
- Agboghoroma, T. E. (2005). *Effects of cognitive style, school setting and instructional mode on students' knowledge of Integrated Science* (Unpublished Ph.D. Thesis, Delta State University, Abraka)
- Agboghoroma, T. E. (2009). Interaction effects of instructional mode and school setting on students' knowledge of Integrated Science. *International Journal of Scientific Research in Education* 6(3): 61-66.
- Ajaja, O. P. & Eravwoke, O. U. (2010). Effects of cooperative learning strategy on junior secondary school students' achievement in Integrated Science. *Electronic journal of Science Education* (South West University) 14(1).
- Akpochafo, W. P. (2001). *Effects of expository, discovery and discussion methods on academic achievement in junior secondary school Social Studies* (Unpublished Ph.D. Thesis, Delta State University, Abraka).
- Arisi, R. O. (2002). *Effects of teaching methods on the learning process amongst Social Studies with varying learning characteristics* (Unpublished Ph.D. Thesis, Delta State University, Abraka)
- Federal Ministry of Education, Science and Technology (1984). *Core curriculum for Integrated Science: Junior secondary schools*. Lagos: Federal Ministry of Education, Science and Technology press.
- Ibegbulam, C. A. (1980). *Effects of orienting stimuli on the attitudes and achievement in biology of a group of Nigeria secondary school pupils*. (Unpublished Ph.D. Thesis, University of Ibadan, Ibadan).
- Ibrahim, B. (2008). The effects of guided-inquiry instruction incorporating a cooperative learning approach on university students' achievement of acid and base concept and attitude towards guided-inquiry research and essay 4(10): 1036.
- Johnson, D.; Johnson, R. & Hobubee, E. (1990). *Cooperative in the classroom*. Edina MN: Interaction Book Company.
- Kuhlthian, C. C.; Maniotes, L. K. & Caspari, A. N. (2007). *Learning in the 21st century*. Librarian unlimited.

- Leonard, W. H. (1985). An experimental study of a B.Sc-O style laboratory for university general biology. *Journal of Research and Science Teaching*, 20: 807-813.
- Okobia, D. O. (2000). *Interaction effects of mastery learning strategy and cognitive style on secondary school students achievement in Social Studies* (Unpublished Ph.D. Thesis, Delta State University, Abraka).
- Okurumeh, E. (2012). *Effects of discussion and invention teaching strategies on students' achievement and retention of chemistry concepts* (Unpublished M.Ed. Dissertation, Delta State University, Abraka).
- Saduwa, N. O. (2013). *Effect of teachers' attitude and guided-inquiry instructional mode on students' achievement in integrated science* (Unpublished M.Ed. Dissertation, Delta State University, Abraka).
- Ughamadu, K. A. (1990). *Interactive effects of formative testing and cognitive style on students' learning outcome in senior secondary school chemistry* (Unpublished Ph.D. Thesis, University of Ibadan, Ibadan).
- Umeoduagu, J. N. (1994). *Effects of cognitive style, gender and instructional strategy on students' performance in integrated science* (Unpublished Ph.D. Thesis, Delta State University, Abraka).
- Umudhe, S. E. (1998). *A guide book for science teachers of Nigeria*. Warri: Abotu Research publishers Nigeria plc.
- Urevbu, A. O. (1990). *Studies in science education: Methodology of Science Teaching*. Benin-City: Juland publishers.