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The Impact of Inquiry Method of Learning Science on the Academic Achievement of Bs8 Students in the Ejisu Juaben Municipality of Ashanti Region of Ghana

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ABSTRACT

The purpose of this study was to identify the impact of using inquiry-based, curriculum in a Basic school on students' academic achievement. The study was developed to determine the impact of inquiry method of learning on the academic achievement of JHS 2 students of Juaben Anglican Basic School in the Ejusu Juaben Municipality. Questionnaire and test items were used to elicit information from a sample of 100 students and 15 teachers obtained through the census technique. The results obtained were analysed using simple percentages. The conclusion drawn from the study was that inquiry based learning is a panacea to discoveries and inventions and thus impact positively on students' academic achievement. Thus, teachers who use inquiry based learning approach in their science lessons open the door of discoveries and inventions to their students are liked by their students. In the light of the conclusion drawn it was recommended among other things that regular in-service training should be given to teachers on the use of the inquiry learning approach to help minimize the use of the traditional approach to the teaching and learning of science and other subjects.

KEYWORDS: Inquiry-based teaching, academic achievement, curriculum

Introduction

Inquiry teaching is allowing students' questions and curiosities to drive curriculum. Inquiry begins with gathering information through applying the human senses: seeing, hearing, touching, tasting, and smelling. Inquiry encourages children to question, conduct research for genuine reasons, and make discoveries on their own. The practice transforms the teacher into a learner with students, and students become teachers. Inquiry teaching honours previous experience and knowledge. It makes use of multiple ways of knowing and taking on new perspectives when exploring issues, content, and questions.

Teachers across the nation are looking for ways to increase students' academic performance in our schools. For many teachers, the traditional ways of teaching are not producing the desired results. Teachers are now looking for other methods, such as constructivism, to increase achievement. The National Science Education Standards states that science teaching must involve students in inquiry-oriented investigations in which students interact with their teachers and peers. Emphasizing active science learning means shifting emphasis away from teacher centered approach to inquiry-oriented approach (GAST Conference, 2010). The Ghana National Association of Teachers of Mathematics 2010 report also encouraged teachers to strive for a more student-centered mathematics classroom that deemphasizes rote memorization of isolated skills and facts and emphasizes problem solving and communication to help students construct mathematical knowledge. Research studies have also emphasized that teachers should shift the present overwhelming emphasis on learning by rote and passive application of learned [facts] to the use of effective critical thinking as the primary tool of learning. (Zoller, Ben - Chaim, & Ron, 2000, p. 572). Students should be encouraged to take an active role in creating understanding and problem solving (Baker et al., 2008; Herman and Knobloch, 2004; Lemlech, 1998). Doolittle and Camp (1999) emphasized that the traditional methods used in career and technical education of transmitting to students a discrete and well established set of skills and knowledge must be called into question. In a world of rapidly changing technologies, the student must be able to construct viable knowledge and adapt to the changing world.

The Ejisu Juaben Municipality is in the Ashanti Region with about 2,300 student population. Teaching in this municipality has been basically through the traditional

approach. With the advent of the new educational reforms, many teachers have started using the inquiry-based learning approach in various classroom lessons especially science lessons. This study is to ascertain the impact of inquiry based learning on BS8 pupils in selected schools in the municipality.

Statement of the Problem

The performance of students in science poor (WAEC, 2009-2015). The performance of students can be attributed to how science is taught. The way science lessons are conducted might at least partly account for learners' perception of the study of science as irrelevant to their lives. Several other researchers (King, 2007; Kyle, 2006; Onwu, 2009; Onwu, 2000; Schwartz, 2006) reported that there is firm evidence that link learner attitude and disposition towards scientific concepts, to the way concepts are taught. It appears that the traditional way of teaching science as rote memorisation of factual knowledge and mastery of abstract concepts (Onwu & Stoffels, 2005; Osborne & Collins, 2001) has failed to excite and attract learners. This is because the traditional approach to teaching portrays the study of science as irrelevant, difficult, and boring (CEI, 2009; EIRMA, 2009). Learners like to be able to relate science and scientific principles to their everyday life. One of the ways of teaching science which may appear to improve the performance of students in science is the inquiry-based instruction.

Inquiry-based instruction is a student-centered and teacher-guided instructional approach that engages students in investigating real world questions that they choose within a broad thematic framework. Inquiry-based instruction complements traditional instruction by providing a vehicle for extending and applying the learning of students in a way that connects with their interests within a broader thematic framework. Students acquire and analyze information, develop and support propositions, provide solutions, and design technology and arts products that demonstrate their thinking and make their learning visible.

It is therefore necessary to carry out a study to find out the impact of using inquiry-method of teaching science on students' academic achievement in science.

Purpose of the Study

The purpose of this study was to identify the impact of using inquiry-method of teaching science on students' academic achievement in science.

Research Questions

The study was guided by the following research questions;

1. What is the impact of inquiry based learning on BS8 students' academic achievement in science?
2. To what extent has the inquiry based learning in science influenced the academic performance of BS8 students in Juaben Anglican School in the Ejusu Juaben Municipality.
3. What differences exist between inquiry based learning of science and the traditional method of learning science?

Methodology

The design used for the study was descriptive survey design. The target population of this study was all BS8 students of Juaben Anglican School in the Ejisu Juaben Municipality numbering 305. The number consists of 150 boys and 155 girls. There were 15 science teachers in the municipality. The simple random sampling technique was used to sample 100 students from the schools for the study. The sample was then divided into two groups of 50 each. The views of 15 science teachers were sought on the use of inquiry based learning approach and the traditional approach for the teaching and learning of science.

Questionnaire and test items were used as the instruments for the study. The questionnaire was used to seek the views of the science teachers on the use of inquiry based method of teaching and the traditional method of teaching. A fifteen closed-ended questionnaire on a four point Likert Scale was used to solicit the views of 15 teachers who teach science in the municipality on the effect of the inquiry learning on students' academic achievement.

Teacher made test was used to ascertain the entry behaviour of students into the research domain. The questions were picked from the Integrated Science Book for Junior High Schools. It was also used to ascertain the impact of the inquiry learning approach on students' academic performance.

Data collection for this study involved three phases. These included requesting teachers' consent for their participation. A letter was sent to the Headmaster of the schools to permit the 15 science teachers to be part of the study. The 15 teachers were also tasked to help in conducting the test items for students based on the inquiry method and the traditional method after the students had been taken through five weeks of intensive teaching using the traditional method for one group and the inquiry based method for the other group. Students were educated on the purpose of the study. They were however promised to be refreshed after the test. The questionnaire was used to seek information from the 15 teachers and their views were analyzed and discussed. Two topics were taught separately using both the inquiry method and the traditional method and inquiry method. This was done for two weeks as shown below:

Lesson One (week 1)

In lesson one the topic "*Identification of Specimens"* was treated. The teaching and learning objectives were that, by the end of the lesson, students should be able to identify the following specimens using their external features: Tridax fruit, Coconut fruit, Mango

seed and Cotton seed. The lesson was based on students' relevant previous knowledge. Students described how seeds of pepper, mango, guava, cotton and coconut fruits are dispersed.

Students – Centered Inquiry Activities

Activity 1

Students observed the following external features of specimen A using hand lens: Size of the specimen, surface of the specimen and nature of the specimen. The students recorded the following features of specimen A after observing closely with the hand lens: Specimen A was small in size, specimen A had large surface area and has parachute hairs. Students determined the weight of the specimen A by weighing it on a top pan balance and also by blowing to see if it could blow away. Students observed that the specimen was light in weight. Hence the students identified specimen A as tridax using the observed external features.

Activity 2

Students observed the following external features of specimen B; weight and nature of the specimen. The students determined mass of coconut and mass of water melon of the same size on a top pan balance. Students observed that the mass of coconut ranged from 1.8kilogram to 1.1 kilogram and that of water melon ranged from 1.2 kilogram to 1.6kilogram. student recorded that the coconut has light weight as compared to the water melon of the same size. Furthermore, the students dropped the coconut in a bucket of water to observe whether it sinks or floats (buoyancy). They observed that the coconut floats hence buoyant in nature. Also the students observed the external strands of the coconut's mesocarp using hand lens. They recorded that the strands of the coconut's mesocarp are fibrous in nature. Students identified the name of the specimen B as coconut.

Evaluation Questions and Students Responses

Students answered the following questions:

Question 1: If the tridax were mixed up with small torn pieces of paper and a fan used to blow over them, which one will fly off earlier and why?

Students Response: The tridax of the large surface area and the parachute – like wings.

Question 2: Explain why when the coconut and mango are dropped in a bucket full of water, the mango sinks and the coconut floats?

Students Response: This is because the coconut has fibrous tissues in its mesocarp. This contains air spaces and gives the coconut a density that is less than water or makes the coconut buoyant and so it floats in the water. The mango on the other hand has a more compact (food filled) mesocarp without any air spaces between its tissues, this makes the mango more densed than water and it tends to sinks in the water.

Question 3: Why does cotton seed fly easily?

Students Response: This is because it is light in weight and easily carried by the slightest force of wind. Again, the seed is winged and this greatly aids in its movement. The wings act as though they were parachutes and this aid in their movement.

Question 4: Why is it difficult to peel of the seed coat of a mango unlike the seed coat of a groundnut using your fingers?

Students Response: The seed coat of a mango is a hard seed coat that looks cemented all round because of the hard material of which it is made, it is therefore difficult to peel of a mango seed coat with your fingers. The seed coat of groundnut is papery and thin and so very easy to peel off with one's fingers.

Lesson Two (week 2)

In lesson two the topic *"Classification of substances as acids or bases"* was treated. The teaching and learning objectives were that by the end of the lesson; students should be able to:

1. Classify substances as acids or bases.
2. Identify physical properties of acids.
3. Identify physical properties of bases.

The lesson was based on students' relevant previous knowledge (RPK). Students defined acid as a substance which produces hydrogen ions (H^+) or proton when it is dissolved in water and base as a substance which produces hydroxide ions (OH^-) when it is dissolved in water.

Students – Centred Activities

Activity 1

Students observed and identified some substances made of acids and bases. These include samples of: vinegar, aspirin soap, tomato juice, palm oil, baking soda, sea water, groundnut oil, tooth paste, and milk of magnesia. Students then classified the substances into acids and bases using litmus paper. The students then observed and recorded that the blue litmus turned red in all acids substances and the red litmus turned blue in all substances that are base.

Activity 2

Students performed the following activities to show some physical properties of acids. They squeezed lime (acid) into water and compared it with chalk powder in water. Students observed that the lime was soluble in water but the chalk powder was insoluble which shows that acids are soluble in water. Students also tasted a drop of natural lime and lemon juice and they observed that both juice had sour taste which indicated that acid have sour taste. Students further dipped blue litmus paper into the lime juice and observed that the litmus paper turned red. This proved that acid turns blue litmus paper into red.

Activity 3

Students performed the following experiment to show some physical properties of bases. They burnt cocoa husk and dry

plantain peels and made a mixture of a small quantity of the ash (tea spoonful) with a small quantity of water. They tasted a drop of the mixture and observed that it tastes bitter. They further took a filtered solution of ashes and water. The students then dipped their fingers into the solution and rubbed them together. Students observed that their fingers felt soapy which made them to conclude that bases have soapy feel. In addition, students dipped red litmus paper into the solution and observed that the red litmus paper turned blue.

Evaluation Questions and Students Responses

Students answered the following questions:

Question 1: Two bottles labelled A and B all contain clear solutions. One of them is an acid and the other a base. Determine which bottle contains the acid and which one contains the base.

Students Response: Dip blue and red litmus papers into each bottle and when the blue litmus paper changes red, it shows the solution is acidic. When the red litmus paper changes into blue, the solution in which it was dipped is a base (an alkaline solution).

Table 1: Comparison of bottle A and bottle B

Bottle A	Bottle B
Contains acid	Contains base
Solution changes	Solution changes
Blue litmus paper red	Red litmus paper blue

Question 2: Propose a solution to the problem of plants in a garden not being able to grow well because the soil is acidic.

Students Response: Lime water [$Ca(OH_2)$] Calcium Hydroxide which is a base is used to treat soil acidity. $Ca(OH)_2$, reacts with the acid in the soil to produce salt and water.

Question 3: Discuss why marble statues in many parts of the world where the air is polluted by Sulphur (IV) oxide (SO_2) gas is damaged.

Students Response: SO_2 gas dissolves in rain water as shown in the equation below:

$SO_2 + H_2O \longrightarrow H_2SO_3$

Sulphur (IV) oxide + water $\longrightarrow$ Hydrogen trioxosulphate (IV)

The rain water becomes slightly acidic as it contains H_2SO_3 [Hydrogen, trioxosulphate (IV)] and this gradually destroys marble statues. Acid is corrosive.

Scoring of the questionnaire

The results of two test items conducted for the use of inquiry based approach and the traditional approach on the topics identification of specimen (dispersal fruits) and acids and bases were lumped together for each side based on a five mark scale scoring and were analyzed based on simple percentages.

Data Analysis Procedure

The method of data analysis used in this study was a descriptive statistics. The scores of the test items were converted into simple percentage and compared for effectiveness of the two teaching methods.

Results/Discussion

Findings from Lesson One

In this lesson, all students had equal opportunity to interact and manipulate the specimens given. In their groups, the students were able to identify the specimens by their external features. Students were also able to answer the evaluation questions appropriately confirming that they had discussed and had settled on an answer.

Findings from Lesson Two

The inquiry based method of learning science enabled the students to have equal opportunity to interact and manipulate the teaching learning materials. Students were able to classify the following substances: vinegar, soap, aspirin, milk of magnesia, tomato juice, baking soda, groundnut oil, sea water, palm oil and tooth paste as acids and bases using the litmus paper. Students further performed simple activities showing the physical properties of acids and bases.

Table 2: Test results of students on traditional method

Marks (x)	Frequency (f)	f(x)	Percentage (%)
1	12	12	24
2	20	40	40
3	10	30	20
4	5	20	10
5	3	15	6
Total	50	117	100

$$\text{Average(T)} = \frac{f(x)}{f} = \frac{117}{50} = 2.3$$

From table 2, the study revealed that majority of the students did not do well in the test after they had gone through the science lessons through the traditional approach. About 64% of the students scored below 3. Only 36% of the students scored above 3 out of five marks. The average mark of the students in the traditional lesson was 2.3. The result showed that students did not do well when the traditional teaching approach was used.

Table 3: Test results of students on inquiry method

Marks (x)	Frequency (f)	f(x)	Percentage (%)
1	1	1	2
2	4	8	4
3	4	12	8
4	23	92	46
5	20	100	40
Total	50	213	100

$$\text{Average(i)} = \frac{f(x)}{f} = \frac{213}{50} = 4.3$$

From table 3, it is observed that majority of the students did very well when they learned through the inquiry approach. It was evident that about 86% of the students had marks above 3 while only 14% of them had below 3. The average mark was 4.3.

It could be deduced from the results that the inquiry approach had a lot of impact on students in terms of academic performance compared to the traditional approach.

Discussion

Answering of Research Questions

Q1. What is the impact of inquiry based learning on students' academic achievement in science?

Research work shows that the number of student learning that occurs in a classroom is directly proportional to the quality and quantity of student involvement in the educational programme (Cooper and Prescott 1989). Yet research studies indicate that teachers typically dominate classroom discussions, consuming nearly 70% of classroom time. Inquiry-based instructional approaches reverse this trend, placing students at the helm of the learning process and teachers in the role of learning facilitator, coach, and modeler.

Comparing the two test results, it was clear that the performance of the students in the inquiry learning approach was better than what was recorded by the students in the traditional class. Several benefits could be derived from using the inquiry learning approach in the classroom. Prominent among them are it;

1. teaches about problem-solving, critical thinking skills, and disciplinary content
2. promotes the transfer of learning for a example concepts to new situational problem.
3. teaches students how to learn and builds self-directed learning skills
4. develops student ownership of their inquiry and enhances student interest in the subject matter.

The aforementioned benefits however can not be traded for anything less since the aim of teaching and learning is to get students to assume the stature of what they learn in their everyday life activities.

It was therefore not surprising when in the responses to the items in the questionnaire, over seventy percent (70%) of the respondents hailed the inquiry learning approach as the panacea to teaching and learning. Education begins with the curiosity of the learner."It is an approach to learning whereby students find and use a variety of sources of information and ideas to increase their understanding of a problem, topic, or issue. It embraces investigation, exploration, research, pursuit, and study.

Q2. To what extent has the inquiry based learning in science influenced the academic performance of Basic Eight students in Juaben Anglican School in the Ejisu Juaben Municipality.

Inquiry-based instruction is a student-centered and teacher-guided instructional approach that engages students in investigating real world questions that they choose within a broad thematic framework. Inquiry-Based instruction complements traditional instruction by providing a vehicle for extending and applying the learning of students in a way that connects with their interests within a broader thematic framework. Students acquire and analyze information, develop and support propositions, provide solutions, and design technology and arts products that demonstrate their thinking and make their learning visible.

The findings of this study indicate that students could easily express themselves in terms of writing. This was evident in the scripts marked after the test items were administered. Comparing the two groups it was clear that the students that were taught through the inquiry method were straight to the point in terms of their answers to various questions. Meanwhile their colleagues in the other group could only present memorized answers in which case some omissions were recorded in the answers. The answers provided by the students who went through the inquiry based approach confirms the statement of Confucius that '*I hear and I forget, I see and I remember, but when I do, I understand'*.

Q3. What differences exist between inquiry based learning of science and the traditional method of learning science?

In general, the traditional approach to learning is focused on mastery of content, with less emphasis on the development of skills and the nurturing of inquiring attitudes. According to Assem (2010), traditional classrooms tend to be closed systems where information is filtered through layers to students. The use of resources is limited to what is available in the classroom or within the school. Use of technology is focused on learning about the technology rather than its application to enhance learning. Lesson plans are used to organize the various steps in the learning process for the whole-class approach.

The inquiry based approach is more focused on using and learning content as a means to develop information-processing and problem-solving skills. The system is more students centered, with the teacher as a facilitator of the learning process. There is more emphasis on "how we come to know" and less on "what we know." Students are more involved in the construction of knowledge through active involvement. The more interested and engaged students are by a subject or project, the easier it will be for them to construct in-depth knowledge of it.

Table 4: Distinction between the inquiry method and the traditional method

Traditional	Inquiry-based
Teacher-centered	Student-directed
Teacher as giver of knowledge	Teacher as facilitator of learning
Content mastery	Content mastery and beyond
Learning follows a vertical and linear path	Learning is more web-like, concept development ranges from linear to spiral
Assessment is teacher-created	Assessment requires student input

The above distinction was clearly noticed in the study. It was found out that students
taught through the traditional approach could not express themselves properly. Meanwhile their counterparts who were taught through the inquiry based approach could express themselves and even defend their answers.

Conclusion

The purpose of this study was to identify the impact of using inquiry-method of teaching science on students' academic achievement in science. It was concluded that JHS students do better if they are put at the centre of learning. Also when basic school students are engaged in inquiry based learning teachers talk less and students learn more. Inquiry based learning of science is a panacea to discoveries and inventions and thus impact positively on students' academic achievement. Thus, teachers who use inquiry based learning approach in their science lessons open the door of discoveries and inventions to their students are liked by their students (Duch, Groh, & Allen, 2001).

Recommendations

In the light of the research findings and conclusions drawn for this study, the following recommendations have been made to facilitate the use of inquiry method of teaching science.

1. Regular in-service training should be given to teachers on the use of the inquiry learning approach to teaching and learning of science. This will help minimize the use of the traditional approach to the teaching and learning of science and other subjects.
2. The Science Resource Centre Programmes must be revisited and enhanced by way of extending to localities to allow teachers and students to get access to information during science lessons.
3. Curriculum developers should design the science curriculum around the inquiry based approach to teaching and learning of science.

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