THE EUROPEAN EDUCATIONAL RESEARCHER
DOI : 10.31757/euer.411

http://www.eu-er.com/

A Novel Approach to Integrated Science Teaching and Learning in a Selected Ghanaian Junior High School

Geoffrey Yao Klutse
University of Education, Winneba, Ghana

Abstract: The study was about a novel approach to Integrated Science teaching and learning in a selected Ghanaian junior high school. In this study, the approach to teaching and learning Integrated Science has been made entirely new and meaningful in the sense that the four learning behaviours (acquisition of knowledge, comprehension, application of knowledge and experimental skills) which constitute profile dimensions were incorporated into the objective-stating, lesson-delivery and assessment of lessons. The researcher made use of profile dimensions in preparing lesson plans, taught students with the new strategy and assessed the impact of the new approach on students in terms of teaching and learning of science. The students were highly interested in answering low order question. About 80% of the questions were high order questions which were poorly answered. They actually showed very little interest in answering high order questions. However, as the weeks went by and the approach to teaching the new strategy was improved, students' interests were aroused and sustained leading to students demonstrating high ability to answer high order questions conveniently. By the end of the study, the students were able to set up and conduct experiments, observe the outcome and draw their own conclusions. The students could classify items based on their characteristics and discuss issues (like balanced diet) and outline the effect of malnutrition in animals. Students' scientific drawings were neater and clearer with less woolen lines. The implication of the finding is that, with these learning behaviours and skills, students could do analytical thinking and have the capacity to apply their knowledge to problems and issues.

Keywords: *Application of Knowledge (AK); Experimental and Process Skills (EPS)*; *Knowledge and Understanding (KU);* Novel approach; *Profile dimensions* and Science teaching .

Introduction

Teaching, according to Boyer (1990), is not simply a matter of dissemination of knowledge, but of scholarship, transforming and extending knowledge by a process of classroom debate and a continual examination and challenging of both content and pedagogy. Ghanaian Integrated Science Teaching Syllabus for junior high schools provides criteria for making judgments about progress toward the vision. It describes what teachers of science at all levels should understand and be able to do. In the vision of science education portrayed by the syllabus, effective teachers of science create an environment in which they and their students work together as active learners. While students are engaged in learning about the natural world and the scientific principles needed to understand it, teachers are working with their colleagues to expand their knowledge about science teaching. To teach science as portrayed by the syllabus, teachers must have theoretical and practical knowledge and abilities about science learning and teaching. Roberts (2007) indicated that all students need scientific literacy so as to be fully-fledged citicens who will be able to work with and learn about science related matters in their professional and private endevours.

Teachers plan to meet the particular interests, knowledge, and skills of their students and build on their questions and ideas. Such decisions rely heavily on a teachers' knowledge of students' cognitive potential, developmental level, physical attributes, affective development, and motivation and how they learn.

It is apparent, what students learn is greatly influenced by how they are taught. The decisions about content and activities that teachers make, their interactions with students, the selection of assessments, the habits of mind that teacher must have theoretical and practical knowledge and abilities about science, learning, and science teaching. This demonstrates and nurtures among their students, and the attitudes conveyed wittingly and unwittingly all affect the knowledge, understanding, abilities, and attitudes that students develop. The syllabus for science teaching is grounded in the profile dimensions. According to Olawale (2013), using instructional resource saves time, helps teachers in making use of different tesching and learning methods and it enables students to pick concepts faster and more effectively. It is in this light that the study has decided to use different and a novel approach to teaching and learning of science.

Profile Dimensions

The Ghanaian junior high school science curriculum emphasizes a very essential component of the science syllabus called *profile dimensions*. Profile dimension is considered the central aspect of the syllabus and the basis for instruction, learning and assessment.According to 2007 junior high school integrated science syllabus of Ghana, *dimension* is a psychological unit for describing a particular learning behaviour such as *knowledge, application,* and so on. More than one dimension constitutes a profile of dimensions. Profile dimension which is the basis for instruction and assessment according to the syllabus, forms a central aspect of the junior high school curriculum. The four learning behaviours; *knowledge, understanding, application* and *processes* which are referred to as dimensions of knowledge describe the underlying behaviours for teaching, learning and assessment. Each dimension has been given a percentage weight that should be reflected in teaching, learning and testing.

The dimensions for teaching, learning and testing in Integrated Science at junior high schools and their respective weights are as follows:

- Knowledge and Understanding (KU) 20%
- Application of Knowledge (AK) 40%
- Experimental and Process Skills (EPS) 40% (MOE, 2007, p. x).

The weights indicated on the right of the dimensions show the relative emphasis that the teacher should give in the teaching, learning and testing. From the above profile dimensions and their respective percentage weight, it shows that *application of knowledge* and *experimental and process skills* have been given greater weight than the other dimension.

According to the syllabus, the use of some action verbs will indicate which dimension is being emphasized. Use of verbs like; describe, explain, identify, state, define, list, summarise, and so on, in objectives, teaching, learning and testing emphasizes knowledge and understanding. Verbs like; create, plan, design, produce, compare, distinguish, and so on, emphasise application of knowledge, while attitude and process skill are expressed in verbs such as; measure, predict, observe, evaluate, infer, and so on.

Statement of the Problem

There is this assertion that schools still teach the low ability thinking skills of knowledge and understanding, and ignore the higher ability thinking skills. Instruction in most cases has tended to stress knowledge acquisition to the detriment of the higher ability behaviours such as application, analysis and so forth. This persistent situation in the school system according to MOE (2007), means that students will only do well on recall items and questions and perform poorly on questions that require higher ability thinking skills.

Secondly, Ampiah (2006) did a study in which he tried to find out which profile dimensions is emphasized in teaching and learning of science in the basic schools. The study revealed considerable evidence that, far more emphasis is put on knowledge and understanding in the junior high school than the curriculum developers had intended. The study, therefore decided to develop this new approach of teaching and learning in order to balance the emphasis fairly on these learning behaviours in accordance of the provisions of the profile dimensions.

Objective of the Study

The objective of this study was to design a new strategy to demonstrate the use of the four learning behaviours (acquisition of knowledge, comprehension, application of knowledge and experimental skills) which constitute profile dimensions in the objective-stating, lesson-delivery and assessment of lessons. Profile dimensions was used in preparing lesson, students were taught with the new strategy and the impact of the new approach on students was assessed in terms of teaching and learning of science.

Research Questions

The study was guided by the following research questions:

- How could profile dimension be used in planning lessons?
- How is the new strategy used in lesson delivery?
- What impact does the new approach have on students' learning of science?

Significance of the Study

It searches new ways to develop and improve the usage of profile dimensions in teaching and learning of science in junior high schools and to prepare students for modern life. This study examines issues that are related to science teaching and learning in junior high school of the country, through the use of the profile dimensions. This is to move teaching and learning from the didactic acquisition of knowledge and rote memorization to a new position where students would apply their knowledge. Thus, the findings of this study would provide feedback for Ghana Education Service (GES), Ministry of Education (MOE) and curriculum developers on the effective use of profile dimensions. This study would provide valuable insights into the effective use of profile dimensions. The study would develop in students a solid and meaningful quest for analytical thinking and the capacity for applying their knowledge to problems and issues. The study could serve as a frame of reference for other researchers and a lens through which the "blind-spot" in application of profile dimensions could be illuminated.

Delimitations

The study was confined to only one class, and that was 2B class. This was due to the fact that the new approach was being tried so as to assess its success or otherwise. It was an action research which couldn't have been carried out in more than one class at the same time.

Methods

This has to do with the methodology employed in carrying out this study. The study employed action research and chose qualitative research methodology because it is interested in finding and describing ways of improving teaching and learning rather than documenting statistics about teaching and learning. Thirty (30) second year students of the selected junior high school were used in the research. The main method was teaching with five lessons to introduce a new strategy of teaching junior high school science. Reports on each lesson taught were presented and analysed to determine the success or otherwise of the new approach. The participants' ethical issues were addressed as they were informed of the researcher's assurance of confidentiality concerning their identity and their responses to questions and discussions.

Research Design

The study, being action research, offered the opportunity to engage in continuous cycles of *planning, acting, observing and reflecting*, which generally characterise action research approaches. McNiff and Whitehead (2002), elaborate on these cycles to describe spontaneous, self-recreating system of enquiry as a systematic process of *observe, describe, plan, act, reflect, evaluate, modify*, but they stress that the process is not linear, but transformational, which allows for greater fluidity in implementing the process.

The action research cycle is generally given as a four-step cycle of *reflect* → *plan* → *act* → *observe* That is: *reflecting* on one's practice and identifying a problem or concern, *planning* a strategy or intervention that may solve the problem, *acting* or carrying out the plan, and finally, *observing* the results or collecting the data. It is common for practitioners to follow the observation phase with reflecting anew, planning and carrying out another intervention, and, again, observing the results, continually repeating the cycle, continually seeking improvement (Higher Education Academy, 2009).

The study chose to use qualitative rather than quantitative research methodology because it is aimed at finding and describing ways of improving teaching and learning rather than documenting statistics about teaching and learning. Miles and Huberman (1994) assert that words, especially organised into incidents or stories, have a concrete, vivid, meaningful flavour that often proves far more convincing to a reader than pages of summarised numbers.

Population and Sampling

Population refers to the name for the large general group of many cases from which a researcher draws a sample and which is usually stated in theoretical terms (Neuman, 2003). Population is the entire group that has the characteristics that interest the researcher.

The population for this study consists of all students of Bankoe R. C. Junior High School of Ho municipality of Volta Region of Ghana. The school is made up of 210 students, made up of 109 girls, 101 boys.

The second year group of Bankoe R. C. Junior High School was made up of two streams. Each stream had 30 students made up of boys and girls. 2B, which is one of the streams of the school, was chosen as the sample. According to Patton (2002), there are no rules for determining the sample size in a qualitative study. The sample size in qualitative study depends on what the researcher wants to know, what is at stake, the purpose of the research, what will be useful, what will have credibility and what can be done with the available resources. Taking into account Patton's view, the sampling type is judgmental (or purposive), hence form 2B was selected. The research school was selected because it comprised a mixture of rural and urban settings and the schools also had mixed population made up of male and female teachers. Other conditions such as textbooks, syllabus, and qualification of teachers were typical of most school in Ghana.

Instrument

The study employed teaching and assessment of the teaching outcome as the main instrument. The main method was teaching with five lessons to introduce a new strategy of teaching junior high school science. An-hour long lesson was taught each week by the Researcher to introduce the new teaching strategy. In the course of these lessons, the procedure adopted the kind of activities and interactions that took place and the progression of the lessons were assessed and taken note of. The lessons were generally given a four-step cycle of *reflect → plan → act → observe.* That is: *reflecting* on one's practice and identifying a problem or concern, *planning* a strategy or intervention that may solve the problem, *acting* or carrying out the plan, and finally, *observing* the results. After each lesson, areas which needed to be modified were modified and the process was repeated.

Results

In this section, reports on the five-week teaching were analysed. The reports were presented in five different segments (lessons) and were analysed accordingly. The analysis of the reports was based on the teaching and learning activities that went on in the classroom, the procedure, the interaction and progression. Students' responses and attitudes towards the lesson were also factored into the analysis. The outcome of the teaching was presented in the form of findings.

Lesson 1: Procedure and Interactions

Lesson 1 treated the topic *Circulatory System in Humans* as this was the topic to treat for that week, according to the integrated science syllabus. The teaching and learning objectives of this lesson were that, by the end of the lesson, students should be able to:

- draw the human heart (EPS).
- name the parts of the human heart (KU).
- outline the functions of the parts (AK).
- differentiate between veins and arteries (AK).
- put together the parts of a model heart provided (EPS).

The lesson was based on students' relevant previous knowledge (RPK); *students' hearts beat faster after strenuous activities.*

During the introductory stage, teacher in attempt to increase the frequency of students' heartbeat asked them to jump up several times which students did. Teacher then engaged students in a discussion.

Teacher: put your hands on your left chest and describe what you feel.
Students felt their hearts beat faster.
Student 1: my heart wants to jump up my chest.
Student 2: my heart moves faster.
Student 3: my heart beat faster than usual.

Teacher then explained to students that what they felt was their pulse, which came as a result of the vigorous expansion and contraction of the heart, resulting in the heart pumping blood through the body. That led the discussion to the topic of the day. Teacher then introduced the topic.

Teacher then brought out a model heart and explained how the heart works. Teacher then named the parts as students listened and asked questions. Teacher then drilled students in naming the parts and asked a number of them to come forward and name a few part.

Teacher displayed a card bearing a large diagram of the human heart on the chalkboard as he called the students forward to name the parts. Teacher then asked some students to assemble the model heart using the diagram of the heart on the chalkboard as a guide. Students came forward and attempted to assemble the model heart. (These activities were centred on acquisition of *experimental and process skills-EPS*.)

Teacher then guided the students to draw and name parts of the heart using the drawing on the card as a guide. Students drew as teacher went round giving individual attention. (These activities were centred on acquisition of *experimental and process skills-EPS* and acquisition of *knowledge and understanding-KU*.)

Students were led by teacher to discuss the vein, the artery and their functions. Students take part in the discussion. At the tail end of the lesson, teacher decided to evaluate the lesson by posing questions which were based on 20% knowledge and understanding, 40% application of knowledge and 40% on experimental and process skills. Five questions were posed orally to the students to assess the success or otherwise of the lesson. The excerpts were presented as follows;

Teacher: Name the parts of the human heart drawn on the chalkboard.

Students named all the parts. (This activity was centred on acquisition of *knowledge and understanding-KU*.)

Teacher: Outline the functions of the parts named above. (This activity was centred on *application of knowledge-AK*)

Student 1: Right ventricle for stopping the blood
left ventricle ………………….
pulmonary artery…………………
the aorta…………………………..

Student 2: Superior vena cava……………….
right atrium pumps blood to every part of the body.
tricuspid valve……………………..
mitral valve…………………………

Student 3: The aorta is the vessel that carries blood to all parts of the body.
inferior vena cava is the upper part of the heart.
superior vena cava
right atrium

Teacher then guided the students to answer the question correctly. Teacher then asked the third question.

Teacher: Differentiate between the veins and the arteries (This activity was centred on *application of knowledge-AK*).

Student 1: Veins are small while arteries are big.

Student 2: Veins carry oxygenated blood while arteries carry deoxygenated blood.

Student 3: Veins carry deoxygenated blood while arteries carry oxygenated blood.

Student 4: Veins are weak while arteries are strong.

Teacher then guided the students to answer the question correctly. Teacher then went on with other question to enhance their understanding. Having the drawing of the human heart on the chalkboard, students were asked to draw and label the human heart. (This activity was centred on acquisition of *experimental and process skills-EPS.*) Students drew poorly. Students were asked to assemble the pieces of the model heart provided. (This activity was centred on acquisition of *experimental and process skills-EPS.* Only a few were able to do it. Teacher then took them through these exercises again.

Progression and Analysis

From the objectives stated, it could be observed that one (1) out of the five (5) objectives stated forming 20% were based on acquisition of *knowledge and understanding-KU*. This objective, *name the parts of the human heart*, was classified as *knowledge and understanding-KU* because, according to the 2007 junior high school integrated science syllabus (MOE. 2007), *naming* constitutes acquisition of *knowledge.*

Again, from the objectives stated, two (2) of the objective making up 40% were centred on *application of knowledge-AK.* These objectives: *Outline the functions of the parts* and *differentiate between veins and arteries,* were classified as *application of knowledge-AK* because, according to the 2007 junior high school integrated science syllabus (MOE. 2007), the use of verbs such as *outline* and *differentiate* constitute *application* of *knowledge.*

The rest two (2) objectives making up 40% were centred on *experimental and process skills-EPS.* These objectives: *Draw the human heart* and *put together the parts of a model heart provided,* were classified as *experimental and process skills* because, according to the 2007 junior high school integrated science syllabus (MOE. 2007), the use of words such as *draw* and *put together* constitute *experimental and process skills.*

A look at reports on the activities and interaction presented earlier showed that, 20% of all the activities and interaction that took place in the classroom were centred on acquisition of *knowledge*, 40% on *application* of *knowledge* and 40% based on acquisition of *experimental and process skills.*

The new approach was assessed after the teaching by asking students questions that were based on the recommendations of the profile dimensions. The questions posed and the dimensions they were based on were summarized in Table 1.

From Table 1, 20% of the questions (question 1) was based on *knowledge and understanding (AK)* which was a low order question. Two questions (questions 2 and 3), representing 40% of the questions posed to the students were based on *application of knowledge (AK)*.These questions were high order questions. The other two questions (questions 4 and 5), constituting 40% were high order questions which were based on *experimental and process skills (EPS).*

Table 1

Profile Dimensions-based Questions Asked during Lesson 1

Profile Dimensions	Questions
Knowledge and Understanding (KU) = 20%	1. Name the parts of the human heart drawn
Application of Knowledge (AK) = 40%	2. Outline the functions of the parts named above. 3. Differentiate between the veins and the arteries.
Experimental and Process Skills (EPS) = 40%	4. Draw the human heart. 5. Put together the parts of a model heart.

Lesson 2: Procedure and Interactions

Lesson 2 took students through the concluding part of *circulation in humans* for eighty (80) minutes and had the following teaching and learning objectives; By the end of the lesson, students should be able to:

- outline the components of the blood (AK).
- classify the functions of the blood (EPS).
- list the blood-related diseases (KU).
- discuss any 2 blood-related diseases (AK).
- plan and design ways of preventing and managing some blood-related diseases (EPS).

Student had already learnt in the previous lesson about the heart and its function, this formed the relevant previous knowledge of the students.

Having noticed how poorly the students performed in answering questions related to the application of knowledge and experimental and process skills, teacher decided to revise the previous lesson with special emphasis on high order learning behaviours. The revision took the form of questions and answers.

Teacher then led students to discuss the nature and component of the blood. The four components of the blood; blood plasma, red blood cells (erythrocytes), white blood cells (leukocytes), and blood platelets (thrombocytes) were discussed. Students contribute to the discussion and ask questions (These activities were centred on acquisition of *knowledge and understanding-KU and application of knowledge-AK*).

Teacher then discussed the functions of the blood with students and put them in groups of 5 as he asked them to classify the functions of the blood (These activities were centred on acquisition of *experimental and process skills-EPS*). Students brainstormed. Teacher went round and guided students.

Students brainstormed and presented their findings in groups. The following are some excerpts of their findings.

Group 1: Blood carries oxygen from lung to other parts of the body. -----Transport

Blood carries hormones and antibodies round the body. -------- Transport

Blood regulates body temperature. --------Regulation

Group 2: Blood controls amount of water and chemicals in the body. ------ Regulation

Blood carries waste product to the kidney to be excreted in the urine. ----- Transport

Group 3: Blood carries heat to and from all parts of the body to maintain body temperature. ----Transport.

Blood supports erection. --------Reproduction

Teacher leads students to collate the facts.

Teacher then guided students in discussing blood-related diseases such as hypertension, stroke, piles, heart attack and leukaemia. Causes, prevention and managements of these diseases were discussed. (These activities were centred on acquisition of *knowledge and understanding-KU and application of knowledge-AK.*) Students contributed and asked questions.

Teacher then asked the students to brainstorm on the possible ways of preventing and managing some blood-related diseases. (These activities were centred on acquisition of *knowledge and understanding-KU and application of knowledge-AK.*) Teacher then went round and guided students in their group work. Students brainstormed and presented their findings in groups. Teacher led them to collate the facts. The following are some of their answers.

- Regular physical exercises
- Checking one's blood pressure regularly
- Avoid eating too much fatty food.
- Avoid taking too much salt

At the end of the lesson, teacher decided to evaluate the lesson by posing questions which were based on 20% knowledge and understanding, 40% application of knowledge and 40% on experimental and process skills. Five questions were posed orally to the students to assess the success or otherwise of the lesson. The excerpts were presented as follows;

Teacher: Outline the components of blood (AK).

Student 1: Plasma, water, red and white blood.

Student 2: Red blood cells, white blood cells, plasma and platelets.

Student 3: Red blood cells, white blood cells, plasma. Hormones and platelets.

Teacher: List 3 blood-related diseases (KU).

Student 1: Hypertension, stroke, piles,

Student 2: How blood pressure, heart attack and leukaemia

Student 3: Stroke, leukaemia and red blood cell.

Teacher: Classify the functions of the blood as protective, regulatory or circulatory (EPS).

Student 1: Blood carries oxygen from lung to other parts of the body. -----Transport

Student 2: Blood supports erection. --------Protective
Student 3: Blood controls amount of water and chemicals in the body. ------- control

Teacher then guided the students to answer the question correctly. Teacher then asked the fourth and fifth questions, where he asked the students to discuss any 2 blood-related diseases and ways of managing them. (These activities were centred on *application of knowledge-AK*). Students' answers to these questions were poor. Just a few could answer these questions. Teacher then took them through these exercises again.

Progression and Analysis

From the objectives stated, it could be observed that one (1) out of the five (5) objectives stated forming 20% were based on acquisition of *knowledge and understanding-KU*. This objective, *list the blood-related diseases*, was classified as *knowledge and understanding-KU* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), *listing* constitutes acquisition of *knowledge.*

Again, from the objectives stated, two (2) of the objective making up 40% were centred on *application of knowledge-AK.* These objectives: *Outline the components of the blood* and *discuss any 2 blood-related diseases,* were classified as *application of knowledge-AK* because, according to the 2007 junior high school integrated science syllabus (MOE. 2007), the use of verbs such as *outline* and *discuss* constitute *application* of *knowledge.*

The other two (2) objectives making up 40% were centred on *experimental and process skills-EPS.* These objectives: *Classify the functions of the blood* and *plan and design ways of preventing and managing some blood-related diseases,* were classified as *experimental and process skills* because, according to the 2007 junior high school integrated science syllabus (MOE. 2007), the use of verbs such as *classify* and *plan* constitute *experimental and process skills.*

Looking at reports on the activities and interaction presented, it could be deduced that 20% of all the activities and interaction that took place in the classroom were centred on acquisition of *knowledge,* 40% on *application* of *knowledge* and 40% based on acquisition of *experimental and process skills.*

The new approach was assessed at the tail end of the lesson by asking students questions that were based on the recommendations of the profile dimensions. The questions asked and the dimensions on which they were based were summarized in Table 2.

From Table 2, 20% of the questions (question 1) was based on *knowledge and understanding (AK)* which was a low order question. Questions 2 and 3, representing 40% of the questions posed to the students were based on *application of knowledge (AK)*.These questions were high order questions. Questions 4 and 5, constituting 40%, were high order questions which were grounded in *experimental and process skills (EPS).*

Table 2

Profile Dimensions-based Questions Asked during Lesson 2

Profile Dimensions	Questions
Knowledge and Understanding (KU) = 20%	1. List 3 blood-related diseases.
Application of Knowledge (AK) = 40%	2. Outline the components of the blood. 3. Discuss any 2 blood-related diseases.
Experimental and Process Skills (EPS) = 40%	4. Classify the functions of the blood as protective, regulatory or circulatory. 5. Design 2 ways of preventing and managing hypertension.

Lesson 3: Procedure and Interactions

The response to the high order questions in the previous lessons was so poor that it got the teacher thinking of a change in pedagogy. The teacher needed to decide on which areas of deficit to concentrate on and ways to increase proficiency in that area. Some means of positive reinforcement was design where teacher decided to respond immediately to students' answers and involve them in more of mixed-ability group work.

The third week of the teaching took the students through the topic *diffusion and osmosis* as this was the topic to treat for that week, according to the integrated science syllabus. In this lesson, the relevant previous knowledge was based on the fact that students use perfume on their body. The objectives of this lesson were that, by the end of the lesson, students should be able to;

- define diffusion and osmosis (KU).
- demonstrate the process of diffusion (AK).
- demonstrate the process of osmosis (AK).
- differentiate between diffusion and osmosis AK).
- set up experiment on osmosis (EPS).
- make observations from the set up EPS).
- interpret and make inferences from the observations (EPS).
- draw and label the set-up (EPS).
- identify two conditions necessary for osmosis (AK).
- state two applications each of diffusion and osmosis (KU).

In the introduction, teacher had all the windows of the classroom closed, moved to one corner of the classroom, sprayed a little perfume in the air and moved to the opposite corner and asked students if they could scent the perfume. Students scented the perfume from all corners of the classroom.

Teacher: How did the scent get everywhere in the room?

Student 1: The nose picked it.

Teacher: How did it get to the nose?

Student 2: The nose picked it on its own.

Teacher: That‘s not right, the nose couldn’t have pick the scent like that. Try again.

Student 1: The scent got carried by the wind.

Teacher: Not really, but the windows were closed to prevent the wind. You’ve tried.

Teacher: Any other answers?

As students could not give any other answers, teacher then explained the whole process as he introduced the topic, hence the lesson.

Teacher helped students to define diffusion and further discussed it with some examples. (These activities were centred on acquisition of *knowledge and understanding-KU*). Students did the discussion and gave examples of diffusion.

Teacher then set up experiment to demonstrate diffusion and explains to the students as they observe and asked questions. A number of students were asked to come forward and try their hands on the experiment. Two group members of each group came and demonstrated diffusion (These activities were centred on acquisition of *experimental and process skills-EPS*).

Teacher introduced osmosis and guided students to define it (These activities were centred on acquisition of *knowledge and understanding-KU*). Students form their definitions as they were guided by teacher.

Teacher then set up experiment to demonstrate osmosis and explains to the students as they observe and asked questions. A number of students were asked to come forward and try their hands on the experiment. Two group members of each group came and demonstrated osmosis.

Teacher then put students in mixed-ability groups of 5, and instructed them and provided them with pieces of yam, salt solution and two bowls of water for experiment. (These activities were centred on acquisition of *experimental and process skills-EPS*). Teacher then went round guiding them to set up experiment on osmosis. Students did group work. Teacher asked students to observe their experiments and report on their findings. (These activities were centred on acquisition of *experimental and process skills-EPS*). The following were some excerpts of their contributions:

Teacher: So what are your observations?

Student 1: The level of the salt solution went high.

Teacher: Good! The volume of the salt solution increased.

Student 2: The water in which the salt solution was put reduced.

Teacher: That’s right.

Student 3: Nothing happened to the other experiment (control experiment).

Teacher: True.

Student 4: Was it because we did not do it well?

Teacher: There will not be any observable change in the control experiment because these two waters are of the same concentration.

Teacher guided students to interpret their findings and made inferences. (These activities were centred on acquisition of *experimental and process skills-EPS*). Student interpreted their findings and drew conclusions.
Teacher displayed card bearing a set-up of osmosis and asked student to draw it. He went round guiding students to do the drawing. (These activities were centred on acquisition of *experimental and process skills-EPS*). Students drew.

Teacher: Would the experiment have produced the same result if a plastic cup had been used instead of yam or cassava cup?
Student1: No!
Teacher: Explain.
Student 2: Yes!
Teacher: Explain.
Students could not explain their answers. This led teacher to discuss the conditions necessary for osmosis.

Teacher then asked students to identify conditions necessary for osmosis. (This activity was centred on *application of knowledge-AK*). Students attempted answering the question. Students were guided to discuss and identify conditions necessary for osmosis as they asked questions.

At the end of the lesson, teacher decided to evaluate the lesson by posing questions which were based on 20% knowledge and understanding, 40% application of knowledge and 40% on experimental and process skills. Five questions were posed orally to the students to assess the success or otherwise of the lesson. The excerpts were presented as follows;
Teacher: Define diffusion and osmosis (KU).
Student 1: It is the movement of molecules from a region of higher concentration to a region of lower concentration to form a uniform mixture. Osmosis is the movement of solvent molecules from a region of lower concentration to a region of higher concentration through a semi permeable membrane.
Teacher: That is correct. Now, differentiate between diffusion and osmosis. (AK)
Student 2: Diffusion involves the movement of solid, liquid and gaseous molecules while osmosis involves the movement of only liquid molecules.
Teacher: Good. Now, let somebody else continue.
Student 3: In diffusion, molecules move from a region of higher concentration to a region of lower concentration while in osmosis molecules move from a region of lower concentration to a region of higher concentration.
Teacher: That's excellent! Now, let somebody else continue.
Student 4: A semi permeable membrane is always involved in diffusion while in osmosis, semi permeable membrane is not needed.

Teacher: That is not right. Organise yourself and come again.

Student 4: In diffusion, no semi permeable membrane is needed, while in osmosis, semi permeable membrane is always involved.

Teacher: Identify two conditions necessary for osmosis. (AK)

Student 5: Water

Teacher: No, that is not correct. Try again. What makes osmosis possible?

Student 5: It is the piece of yam.

Teacher: Yes, the yam. The yam provides the semi permeable membrane. Any other?

Student could not answer, teacher then discussed the rest of the conditions with the students.

Teacher then set up an experiment on osmosis asked the students to observe the set-up provided and report on your observations. (These activities were centred on acquisition of *experimental and process skills-EPS*). The following were some observations made by the students:

Student 1: The level of the salt solution went high.

Teacher: Good! The volume of the salt solution increased.

Student 2: The water in which the salt solution was put reduced in reduced.

Teacher: That's right.

Student 3: Nothing happened to the control experiment.

Teacher: That's excellent!

Teacher then asked students to draw and label the set-up. (These activities were centred on acquisition of *experimental and process skills-EPS*). Student then drew the set-up. Teacher went round to assess the drawings.

A few students had some difficulty; teacher then took them through these exercises again.

Progression and Analysis

From the objectives stated, it could be observed that two (2) out of the ten (10) objectives stated forming 20% were based on acquisition of *knowledge and understanding-KU*. These objectives: *Define diffusion and osmosis* and *state two applications each of diffusion and osmosis,* were classified as *knowledge and understanding-KU* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), *defining or stating* constitute acquisition of *knowledge.*

Again, from the objectives stated, four (4) of the objective making up 40% were centred on *application of knowledge-AK*. These objectives: *Demonstrate the process of diffusion, demonstrate the process of osmosis, differentiate between diffusion and osmosis* and *state two applications each of diffusion and osmosis*, were classified as *application of knowledge-AK* because, according to the 2007 junior high school integrated science syllabus (MOE. 2007), the use of verbs such as *demonstrate, state* and *differentiate* constitute *application* of *knowledge.*

The other four (4) objectives making up 40% were centred on *experimental and process skills-EPS.* These objectives: *Set up experiment on osmosis, make observations from the setup,interpret and make inferences from the observations* and *draw and label the set-up,* were classified as *experimental and process skills* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), the use of verbs such as *set-up, make observation, interpret* and *draw* constitute *experimental and process skills.*

Looking at reports on the activities and interaction presented, it could be deduced that 20% of all the activities and interaction that took place in the classroom were centred on acquisition of *knowledge,* 40% on *application* of *knowledge* and 40% based on acquisition of *experimental and process skills*

The new approach was assessed after the teaching by asking students questions that were based on the recommendations of the profile dimensions. The questions posed and the dimensions they were based on were summarized in Table 3.

Table 3

Profile Dimensions-based Questions Asked during Lesson 3

Profile Dimensions	Questions
Knowledge and Understanding (KU) = 20%	1. Define diffusion and osmosis
Application of Knowledge (AK) = 40%	2. Differentiate between diffusion and osmosis. 3. Identify two conditions necessary for osmosis
Experimental and Process Skills (EPS) = 40%	4. Observe the set-up provided and report on your observations 5. Draw and label the set-up for osmosis.

From Table 3, 20% of the questions (question 1) was based on *knowledge and understanding (AK)* which was a low order question. Two questions (questions 2 and 3), representing 40% of the questions posed to the students were based on *application of knowledge (AK)*.These questions were high order questions. The other two questions (questions 4 and 5), which constitute 40%, were high order questions based on *experimental and process skills (EPS).*

Lesson 4: Procedure and Interactions

Lesson 4 treated the topic *Photosynthesis* as this was the topic to treat for that week, according to the integrated science syllabus. The teaching and learning objectives of this lesson were; by the end of the lesson, students should be able to:

- explain photosynthesis (KU).
- outline the elements of photosynthesis(AK).

- write a balanced chemical equation of photosynthesis (KU).
- use a hand lens to observe the surface of a leaf (EPS).
- outline external factors that aid the process of photosynthesis (AK).
- set up experiment to test for starch (EPS).
- observe the outcome of the experiment (EPS).
- interpret the observation made and draw conclusion (EPS).
- discuss how plants manufacture food (AK).
- discuss the importance of photosynthesis (AK).

The lesson was based on this relevant previous knowledge (RPK); *Students prepare food at home.* By way of introduction, teacher engaged students in a discussion on feeding.

Teacher helped students to define photosynthesis. (These activities were centred on acquisition of *knowledge and understanding-KU*). Students contributed to the discussion and asked questions.

Teacher then wrote the elements of the photosynthesis on the chalkboard and discussed the role each of the elements plays in the process of photosynthesis with students. Teacher then guided students to put all these elements together in the form of chemical equation. (These activities were centred on acquisition of *knowledge and understanding-KU*). Students were made to come forward and write the equation on the chalkboard.

Teacher asked students to break into their groups made up 5 members with mixed ability and gave them hand lenses and leaves to observe the surface area and report their findings. (These activities were centred on acquisition of *experimental and process skills-EPS*). Teacher then went round the groups to guide them.
Teacher: What did you observe?
Student 1: I could not see anything.
Teacher: You have to observe it again.
Student 2: I can see spots that are like small openings.
Teacher: That's good. These small openings are called stomata which allow carbon dioxide into the leaf for photosynthesis to take place.

Students could observe small openings. These small openings, according to the teacher, are called stomata which allow carbon dioxide into the leaf for photosynthesis to take place.

Teacher discussed the external factors that aid photosynthesis with students. (This activity was centred on *application of knowledge-AK*). Students contributed to the discussion and ask questions.

Teacher set up experiment to test for starch. He gathered the students forward and demonstrated it and explained to the students as they observed and asked questions.

Students were provided with Iodine solution, source of heat, water, test tube and alcohol as they were asked to break into their groups and set up the experiment to test for starch. (These activities were centred on acquisition of *experimental and process skills-EPS*). Students performed experiment in group.

Students were asked to observe their experiments and report on their findings. The following were students' observations.
Group 1: The experiment turned black.
Teacher went there and realised that they poured too much iodine solution. Teacher guided them on how to use drops and asked them to repeat the experiment.
Group 2: There is no colour change.
Teacher went to their aid and took them through the experiment until they got the desired result. Teacher then asked them to repeat the experiment on their own.
Group 3, 4. 5 and 6: The colour of the experiment turned blue-black.
Teacher: That is correct.
(These activities were centred on acquisition of *experimental and process skills-EPS*). Teacher guided students to interpret their findings and make inferences. (These activities were centred on acquisition of *experimental and process skills-EPS*).

Teacher asked students to brainstorm on the importance of photosynthesis. (This activity was centred on *application of knowledge-AK*). Students brainstormed and teacher guided students to come out with the importance of photosynthesis.

At the end of the lesson, teacher decided to evaluate the lesson by posing questions which were based on 20% knowledge and understanding, 40% application of knowledge and 40% on experimental and process skills. Five questions were posed orally to the students to assess the success or otherwise of the lesson.
Students did experiment as teacher went round to observe and assess what the students were doing. Teacher then guided students to interpret their findings and they drew conclusions. (These activities were centred on acquisition of *experimental and process skills-EPS*).

Progression and Analysis

From the objectives stated, it could be observed that two (2) out of the ten (10) objectives stated forming 20% were based on acquisition of *knowledge and understanding-KU*. These objectives: *Explain photosynthesis, and write a balanced chemical equation of photosynthesis*, were classified as *knowledge and understanding-KU* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), *explaining* and simply *writing* constitute acquisition of *knowledge.*

Again, from the objectives stated, four (4) of the objective making up 40% were centred on *application of knowledge-AK.* These objectives: *Outline the elements of photosynthesis, outline external factors that aid the process of photosynthesis, discuss how plants manufacture food, and discuss the importance of photosynthesis,*were classified as *application of knowledge-AK* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), the use of verbs such as *discuss* and *outline* constitute *application* of *knowledge.*

The other four (4) objectives making up 40% were centred on *experimental and process skills-EPS.* These objectives: *Use a hand lens to observe the surface of a leaf, set-up experiment to test for starch, observe the outcome of the experiment* and *interpret the observation made and draw conclusion,* were classified as *experimental and process skills* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), the use of words such as *set-up, make observation, interpret* and *using hand lens* constitute *experimental and process skills.*
Looking at reports on the activities and interaction presented, it could be deduced that 20% of all the activities and interaction that took place in the classroom were centred on acquisition of *knowledge,* 40% on *application* of *knowledge* and 40% based on acquisition of *experimental and process skills*

The new strategy was assessed at the tail end of the lesson by asking students questions that were based on the recommendations of the profile dimensions. The questions posed and the dimensions they were based on were summarized in Table 4.

Table 4

Profile Dimensions-based Questions Asked during Lesson 4

Profile Dimensions	Questions
Knowledge and Understanding (KU) = 20%	1. Explain the process of photosynthesis.
Application of Knowledge (AK) = 40%	2. Outline the elements of photosynthesis.
	3. Outline external factors that aid the process of photosynthesis.
Experimental and Process Skills (EPS) = 40%	4. You are provided with Iodine solution, source of heat, water, test tube and alcohol, test tor starch.
	5. What are your findings in question (4) above and what conclusions can you draw?

From Table 4, 20% of the questions (question 1) was based on *knowledge and understanding (AK)* which was a low order question. Questions 2 and 3, representing 40% of the questions posed to the students were based on *application* *of knowledge (AK)*.These questions were high order questions. Questions 4 and 5, constituting 40%, were high order questions which were grounded in *experimental and process skills (EPS).*

Lesson 5: Procedure and Interactions

Lesson 5 treated the topic; *Nutrition in Animals* as this was the topic to treat for that week, according to the integrated science syllabus. The teaching and learning objectives of this lesson were; by the end of the lesson, students should be able to:

- classify food items based on their nutritive value (EPS).
- test for carbohydrate (EPS).
- discuss balanced diet and its importance (AK).
- state the importance of food nutrients (KU).
- outline the effects of malnutrition in animals (AK).

Student had already learnt in the previous lesson about how plants feed. The lesson was based on this relevant previous knowledge (RPK); *students eat food*. Teacher revised the previous lesson which was on photosynthesis with students, with special emphasis on high order learning behaviours. The revision took the form of questions and answers.
Having revised the previous lesson on photosynthesis, teacher then introduced the lesson on *nutrition in animals*. Teacher then wrote the topic on chalkboard and then explained the topic as he guided the students to discuss the topic "Nutrition in Animals"

Teacher then discussed the six food substances with the students as he displayed the food items that contained these nutrients and helped students to classify them. (These activities were centred on acquisition of *experimental and process skills-EPS*).

Teacher set up experiment to test for carbohydrate. He gathered the students forward and demonstrated it and explained to the students as they observed and asked questions.

Students were provided with a pelvic dish, dropper, freshly prepared iodine solution and starchy food. (yam or cassava) as they were asked to break into their mixed ability groups of 5 and set up the experiment to test for carbohydrate. Students performed experiment in group. (These activities were centred on acquisition of *experimental and process skills-EPS*).

Students were asked to observe their experiments and report on their findings. The following were students' observations.
Group 1: The experiment turned black.
Teacher went there and realised that they poured too much iodine solution. Teacher guided them on how to use drops and asked them to repeat the experiment.

Group 4: There is no colour change.

Teacher went to their aid and took them through the experiment until they got the desired result. Teacher then asked them to repeat the experiment on their own.

Group 2, 3, 5 and 6: The colour of the experiment turned blue-black.

Teacher: That is correct.

Teacher guided students to interpret their findings and make inferences.

Teacher helped students to define diet and further discussed a balanced with some examples. Students did the discussion and gave further examples of balanced diet.

Teacher asked students to brainstorm on the importance of balanced diet and food nutrient. Students brainstormed and teacher guided students to come out with the importance of balanced diet (This activity was centred on *application of knowledge-AK*).

Students brainstormed on the possible effects of malnutrition in animals. Teacher then went round and guided students. Students brainstormed and presented their findings in groups. Teacher led them to collate the facts (This activity was centred on *application of knowledge-AK*).

At the end of the lesson, teacher decided to evaluate the lesson by posing questions which were based on 20% knowledge and understanding, 40% application of knowledge and 40% on experimental and process skills. Five questions were posed orally to the students to assess the success or otherwise of the lesson. The excerpts were presented as follows;

Teacher: Classify food items into the six main groups. (EPS)

Student 1: carbohydrate, protein, water.

Teacher: that is right but these are not all.

Student 2: vitamins, fats and oil.

Teacher: Good. Now, who completes it?

Student 3: Mineral salt

Teacher: Good. State two importance of food nutrient. (KU)

Student 1: It helps the body to acquire energy.

Teacher: OK, next person,

Student 2: It helps protect the body against diseases.

Teacher: Good. Let the next person continue.

Student 3: It helps the body to maintain and repair worn out cells.

Teacher: that is right but these are not all.

Student 4: It helps the body to grow and develop.

Teacher: Beautiful. Outline the effects of malnutrition in animals (AK)

Student 1: It leads to kwashiorkor and development of goiter.

Student 2: It leads to night blindness and rickets in children.
Teacher: That is good.

Teacher later asked students to discuss what they think forms balanced diets and their importance. Students discussed as teacher probed (AK).
Teacher: You are provided with a pelvic dish, dropper, freshly prepared iodine solution and starchy food that is a piece of yam, test tor carbohydrate (EPS).

Students did experiment as teacher went round to observe and assess what the students were doing. Teacher then guided students to interpret their findings and they drew conclusions.

Progression and Analysis

From the objectives stated, it could be observed that one (1) out of the five (5) objectives stated forming 20% were based on acquisition of *knowledge and understanding-KU*. This objective, *state the importance of food nutrients,* was classified as *knowledge and understanding-KU* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), *stating* constitutes acquisition of *knowledge.*

Again, from the objectives stated, two (2) of the objective making up 40% were centred on *application of knowledge-AK*. These objectives: *discuss balanced diet and its importance* and *outline the effects of malnutrition in animals,* were classified as *application of knowledge-AK* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), the use of verbs such as *outline* and *discuss* constitute *application* of *knowledge.*

The other two (2) objectives making up 40% were centred on *experimental and process skills-EPS.* These objectives: *Classify food items based on their nutritive value* and *test for carbohydrate*, were classified as *experimental and process skills* because, according to the 2007 junior high school integrated science syllabus (MOE, 2007), the use of verbs such as *classify* and *test* constitute *experimental and process skills.*

Looking at reports on the activities and interaction presented, indicated that 20% of all the activities and interaction that took place in the classroom were centred on acquisition of *knowledge,* 40% on *application* of *knowledge* and 40% based on acquisition of *experimental and process skills*

The new strategy was assessed at the tail end of the lesson by asking students questions that were based on the recommendations of the profile dimensions. The questions posed and the dimensions, on which they were based, were summarized in Table 5.

Table 5

Profile Dimensions-based Questions Asked during Lesson 5

Profile Dimensions	Questions
Knowledge and Understanding (KU) = 20%	1. State two importance of food nutrient.
Application of Knowledge (AK) = 40%	2. Discuss balanced diet and its importance. 3. Outline the effects of malnutrition in animals.
Experimental and Process Skills (EPS) = 40%	4. Classify food items into the six main groups. 5. You are provided with a pelvic dish, dropper, freshly prepared iodine solution and a piece of yam, test tor carbohydrate.

From Table 5, 20% of the questions (question 1) was based on *knowledge and understanding (AK)* which was a low order question. Two questions (questions 2 and 3), representing 40% of the questions posed to the students were based on *application of knowledge (AK)*.These questions were high order questions. The other two questions (questions 4 and 5), which constitute 40%, were high order questions based on *experimental and process skills (EPS).*

Discussions

Summary of Findings

The study was about a novel approach to integrated science teaching and learning in a selected junior high school of Ghana. The uniqueness of this strategy is derived from the fact that the profile dimensions were regulated according to the expectations of Ghanaian junior high school integrated science syllabus (2007). There is no record that Ghanaian science teachers design their lessons in this way. The study has made this approach to teaching and learning integrated science entirely new and meaningful in the sense that the four learning behaviours (acquisition of knowledge, comprehension, application of knowledge and experimental skills) which constitute profile dimensions were incorporated into the objective-stating, lesson-delivery and assessment of lessons. The provisions of profile dimensions were used to plan the lessons. The findings have it that, the students were not initially interested in answering high order questions. They saw high order questions as time wasting and a deviation from the Basic Education Certificate Examination (B.E.C.E.) question trends. Simple recall and memorisation of knowledge were all that the students were interested in, resulting in superficial understanding of scientific concepts. Science teaching and learning in junior high schools is heavily weighted towards the lower order thinking skills. This was evident, when the new teaching strategy was put in place, the students performed poorly initially in demonstrating their ability to answer high order questions. After each lesson, the teacher reflected over the lesson, planned ways of correcting the flaws, hence, planning new strategies, acted on it by implementing it and observed the output. The process would start all over with reflection and move on leading to continual improvement on each lesson hence the strategy. As the weeks went by and the approach was improved and intensified, the amount of learning in the area of process skills and attitudes, and application of knowledge had progressively increased and the students' performance in high order exercises improved greatly to match those of low order ones. The students were generally enthusiastic, motivated and eager to engage in high order activities. This interest was sustained throughout the period of teaching. The students were able to set up experiments, test for starch, observe the outcome and draw their own conclusions. The students could classify items based on their characteristics and discuss issues like balanced diet, and outline the effect of malnutrition as indicated in lessons four and five. Students' scientific drawings were neater and clearer with less woolen lines.

Discussions

The entire study took five (5) weeks and lasted for 60 minutes a week. It covered topics such as circulation human, diffusion and osmosis, food and nutrition in plants and animals as these were the topics to treat for those weeks, according to the integrated science syllabus. The success or otherwise of the new approach was based on the amount of interest generated and sustained by the lessons and the number of students who demonstrated the ability to answer questions correctly or otherwise. This was done during lessons and at the tail end of it where more oral and written questions were given to students. The questions cut across the subject matter and covered all the learning behaviors based on the recommendations of profile dimensions; that is 20% for questions related to *Knowledge and Understanding* (KU), 40% for questions related to *Application of Knowledge* (AK), and 40% for *Experimental and Process Skills* (EPS).

The students are generally enthusiastic, motivated and eager to learn, but quickly got tired of the method, as that was not demonstrably relevant to their urge to answer Basic Education Certificate Examination (BECE) questions correctly and pass. The students performed poorly in going through high order activities, hence could not answer such questions. According to Trabasso and Bouchard (2002), to implement strategy instruction in the classroom will require more than providing students with opportunities to practice the comprehension and more than knowing the value of the strategies and how to use them. They were also critical of this teaching method and material that they perceived to be above their level, or a clear deviation from what they were used to. The assessment of the new strategy produced high levels of anxiety and fatigue in the students. The assessment was designed to place the student under pressure to simulate operational conditions. This anxiety and fatigue could not change their preference for surface learning as the default learning approach, and this was captured in the reports on lessons 1and 2. Science pedagogy in schools is heavily weighted towards the lower order thinking skills which promotes surface learning and results in superficial understanding of scientific concepts. According to Biggs (1987), surface learning is an undesirable approach to learning science, and deep learning approaches therefore needed to be encouraged. The study however, indicated that in the heat of those pressures, it was possible to promote and encourage students to adopt deeper learning approaches. This inspiration was derived from the findings of Ramsden (2003) where he suggested that it would not be possible simply to instruct students to adopt a deep approach to learning instead, if a deep approach was considered essential to achieve the desired academic outcomes from a task, teaching and learning strategies should encourage and reward students who adopted that approach to learning. After thorough reflection over the first two lessons, this strategy for promoting and encouraging deeper learning was designed to guide teacher and students in their quest to overcome this problem. Promoting deeper learning approaches in this course was possible because generally, the students all had the desire to do well in the course. For the study to advance to the ‘next step’ in the development of this science teaching and learning strategy, there had to be a shift towards more student-centered discussions which engaged them effectively and where the students felt no restriction in exploring possible rather than probable answers to problems. Only in a climate where student-teacher interactions and student-student interactions were prevalent. They were usually academically capable of adopting deeper approaches to learning if this is shown to be the key to success. Authentic learning, according to Newmann, Wehlage and Secada (1995), is directly related to meaning-making and hence to levels of engagement of the students in the classroom. Accordingly, the level of student engagement in the classroom would determine the degree of transfer of learning to issues and problems faced outside of school. The pace at which the study was run, the level and teaching style employed, prompt response to their questions and answers, and the assessment format were critical in promoting deeper approaches to learning. Other factors used in this approach to help promote deeper learning included providing motivational context where they were rewarded verbally and materially while increasing student activity and interaction, using a well-structured knowledge base. This finally produced a desirable output, where students’ interests were aroused and sustained leading to students demonstrating high ability to answer high order questions conveniently.

Finally, the five-week time frame designated for implementing the strategy was not adequate enough. It is therefore recommended that the strategy be given an extended length of time for a higher and better achievement.

Conclusion

In view of the fact that the study was done in only one school, and the intervention in one class, the findings of the study cannot be generalized, but some conclusions could be drawn regarding the effective use of all learning behaviours to promote holistic science teaching and learning. On the basis of the results obtained in this study, it is concluded that there are lots of operational difficulties with effective use of all learning behaviours in science teaching and learning. Instead, enormous emphasis is put on knowledge and understanding at the expense of development of scientific attitudes and process skills. The study however wishes to conclude that it is possible to effect a change as achieved in this study through the use of this approach.

Limitations

Since it was a one-school study, findings from this study are statistically not generalizable to all junior high schools beyond Ho Municipality, however, Hammersley (1992) proposes an apology that qualitative studies may still have implications for larger aggregates if anyone is interested in the similarities.

Again, the study considered just a few topics which according to the junior high school science syllabus were due for teaching at that time. These few units and topics covered happened to be just a few Biology topics, so the study could not try all the topics in the junior high school science syllabus. If there had been enough time, all the units in the junior high school science syllabus could have been tried.

References

Ampiah, G. J. (2006). Towards scientific literacy for basic school pupils: Which profile dimensions are emphasised in the Ghanaian basic science curricula? *African Journal of Educational Studies in Mathematics and Sciences*, *4*(2), 55-76.

Attipoe, C. K., & Fudzagbo, E. K. (2009). *Integrated science for junior high schools.* Accra: Nyansapow Publishing and Printing.

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ: Carnegie Foundation.

EFA Global Monitoring Report. (2005). *Education for all: The quality imperative*. Paris: UNESCO.

Hammersley, M. (1992). *What's wrong with ethnography?* London: Routledge.

Higher Education Academy, (2009). *Action research cycle*. Retrieved September 26, 2009 from http://www.heacademy.ac.uk/assets/hlst/documents/heinfe_exchange/act_ .

McNiff, J., & Whitehead, J. (2002). *Action research: Principles and practice* (2nd ed.). London: Routledge.

Miles, M.B., & Huberman, A.M. (1994). *Qualitative data analysis*, London: Sage Publications.

MOE. (2007). *Teaching syllabus for integrated science, (Junior High Schools).* Accra: Ministry of Education, CRDD.

Neuman, W. L. (2003). *Social research methods: Qualitative and quantitative approaches*, (5th ed.). Whitewater: University of Wisconsin A and B Publishers.

Newmann, F. M., Wehlage, G. G., & Secada, W. G. (1995). *Authentic achievement: Restructuring schools for intellectual quality.* San Francisco: Jossey-Bass.

Olawale, S. K. (2013). The use of instructional materials for effective learning of Islamic studies. *Journal of Jihat al-Islam*, *6*(2), 29-40.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). London: Sage Publications.

Roberts, D. A. (2007). Scientific literacy/Scientific literacy. In Abell, S. K., & Lederman, N. G. (Eds.). *Handbook of research on science education* (p. 729-780). New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Trabasso, T., & Bouchard, E. (2002). Teaching readers how to comprehend text strategically. In C. Block, & M. Pressley (Eds.), *Comprehension Instruction: Research-based best practices* (pp. 176-200). New York: Guilford Press.

Corresponding Author Contact Information:

Author name: Geoffrey Yao Klutse

Department: Science Education

Faculty: College of Education

University, Country: University of Education, Winneba, Ghana.

Email:geoffreyklutse@yahoo.com

Please Cite: Klutse, G. Y. (2021). A novel approach to integrated science teaching and learning in a selected Ghanaian junior high school. *The European Educational Researcher, 4*(1), 1-27. DOI: 10.31757/euer.411

Received: May 25, 2020 ▪ Accepted: November 29, 2020