Exploring Annotated Drawing For Improving Nigerian Secondary School Students Achievement in Genetics

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Abstract

The search for ways to bring about effective teaching and learning of biology in secondary schools has provided the impetus for this study. Therefore, the study investigated the effect of annotated drawing on the understanding of genetics by secondary school biology students. 110 secondary school students drawn from two intact classes constituted the sample for the study. Quantitative and qualitative methods were used to collect data using the research questions raised and hypotheses formulated for the study. A Genetics Achievement Test (GAT), a 50-item multiple choice test was used to collect quantitative data and an Interview Schedule (IS) was employed to elicit responses which constitute data for the qualitative method. A reliability coefficient of 0.82 was obtained for the GAT using the split-half method. Findings revealed that annotated drawing strategy had a significant positive effect on students understanding and achievement in genetics, male and female students alike benefited from the strategy. The analysis of data also showed that students had some misconceptions in biology which hitherto, hindered their understanding of genetics concepts. Suggestions elicited from biology students on how they could be assisted to learn biology and indeed, genetics meaningfully were obtained from their responses on the Interview Schedule (IS). Implication of the study included that, when appropriate instructional strategies are employed in the dissemination of science knowledge in the classroom, students' understanding of concepts and learning become meaningful.

Key words: exploring, annotated drawing, achievement, genetics

Introduction

The yearning for quality and effective instruction delivery has been a long standing objective of science education. The emerging concern for the poor performance of students in school science and its resultant consequence on the production and development of future scientist, engineers and technologies had led to the search for instructional strategies that promote effective and improved science learning. Consequently, science instruction has become a focus of research for two or more decades. Research on instruction delivery strategies has been undergoing an overturn of its own to promote meaningful science teaching and learning in schools. Contemporary accentuation centred around interactive, minds-on and hands-on learning through constructivist teaching approach. Federal Republic of Nigeria, FRN (2004) in its National Policy on Education stipulates that, Nigerian Education cannot rise above its teachers. Therefore, the success of education depends on the quality of the teachers, biology teachers inclusive. Science knowledge is vast, its scope in each discipline is on the increase. Science educators have come to realize that trying to teach science as a list of facts to be memorized rather than understood is a futile exercise (Danmole and Femi-Adeoye, 2004).

Australian Academy of Science (AAS), (2009) described annotated drawing as visual representation to illustrate an idea, object or concept. AAS, (2009) stresses further, that annotated drawing helps students to spot the differences in diagrams and predict the functions of the labelled parts thereby facilitates meaningful learning of concepts in science. Annotated drawing is hands-on, inquiry based strategy for teaching and learning of science which develops students' knowledge, skills, understanding and capacities in science (AAS, 2009). In Addition, Keogh and Naylor (1996) claimed that annotated drawings present ideas in visually accessible and appealing format, capable of eliciting students' ideas and provide suitable challenges which might lead to the ideas being developed further. According to Zywica and Gomez (2008), annotation is a strategy that students can, do adopt and use in subjects such as Mathematics, Social Studies, Literature and Science. Furthermore, Zywica and Gomez (2008), perceive annotation as one of several cognitive strategies that are used to help students observe structure, analyse ideas, drive meaning and communicate. For instance, Zywica and Gomez (2008) conducted a study to measure the effectiveness of annotative drawing and literacy approach annotation involving students. The findings revealed that identification of main ideas, science vocabulary, and transition words correlated with measures of science achievement. The results of their study suggested that students did benefit from the use of annotated drawing strategy.

It was observed that there is a dearth of empirical focusing on instructional strategies that can enhance teaching and learning of genetics related concepts. Previous studies reported that students have difficulty, many misconceptions, confusion and incoherent knowledge of genetics topics which include many abstract concepts difficult to understand, to learn and to remember. These include inheritance, reproduction, and meiosis (Bahar, Johnstone, and Hansell, 1999; Cavallo, 1996; Knippels 2002; Lewis and Leach, 2004; Lewis and Wood-Robinson 2000; Schwartz and Lederman, 2004). Araz and Sungur (2007) declare annotated drawing a metacognitive strategy. There is an understanding with the efficacy of annotated drawing for meaningful science teaching and learning. Involving students in real science

activities has essential influence on student attainment in science (Ball, 2010; Wolf, 2002). Interaction with annotated drawing enables learners to highlight important main ideas, supporting evidence, key content vocabulary words, definitions, and transitions within the text (Zywica & Gomez, 2008). Annotation assists students see structure, analyse ideas, derive meaning, and communicate understanding (Conley, 2008; Pressley, 2006).

It is shown that when students draw, label and give functions of the labelled parts are able to construct meaning to concepts. This study is set to explore annotated drawing for improving secondary school students' achievement in genetics.

Academic performance of students in science has been persistently low, particularly in Biology. Examiners' reports indicate that students are not favourably disposed towards Biology concepts such as genetics, evolution and variation in population. (WAEC Chief Examiner's Reports 2009 and 2010). Similarly, the reports indict students with poor drawing skills, inability to relate structure with function, inability to make observations and inferences. Manifestation of poor practical skills culminate in the poor performance of secondary school students in biology annually. The need to redress this alarming academic problem necessitated exploring annotated drawing for improving Nigerian secondary school students achievement in genetics.

Purpose of study

The review of literature seems to show that factors of instructional strategies, gender and impediments such as lack of interest and misconceptions may be contributing to the difficulty of students in learning genetics. These are significant areas in biology that merit attention and therefore, constitute the primary purpose of this study. The present study specifically sought answers to the following research questions:

1. Is there a difference in the performance of students taught genetics with annotated drawing (experimental group) and those not (Control group)?
2. Is there a difference in the performance of male and female students taught genetics with annotated drawing?
3. What are the views of students on their teacher's instructional strategy?
4. What do students consider as impediments to learning biology?

Research hypotheses. The following hypotheses guided the study

Ho_1: There is no statistically significant difference in the mean scores of students in the experimental group and control groups.

Ho_2: There is no statistically significant difference in the mean scores of male and female students in the experimental group.

Ho_3: There is no significant difference in the impediments to learning biology given by male and female students.

Methodology

Participants

110 SS III biology secondary students in two of the six education districts in Lagos state participated in the study. Lagos state is located in the south western part of Nigeria. Two intact classes were used as the sample for the study. One intact class constituted the sample for the experimental group taught genetics using annotated drawing, while the second intact class was the control group taught genetics with the traditional method. Three criteria informed the choice of SS III biology students; class, the school and the district. Firstly, the choice of SS III biology class was due to the fact that the selected topic is included in the senior secondary III biology curriculum. Secondly, the biology teachers in the schools are professionally qualified to teach the subject in government schools. The third criterion reflects on the familiarity of the researchers with the terrain and locations of the selected schools.

Exploring Process of Annotated Drawing Instruction

This study presents annotated drawing as a constructivist instruction strategy that is favourable to learners in tackling difficult areas in Biology. Annotated drawing strategy uses diagrams and pictures to situate relationship between the structure and functions. Students work individually, using pencil, ruler and eraser to put textual contents into structure and give functions of the labelled parts. As the student reads the functions of the parts labelled on the diagram, is able to identify the relationship between the diagram and the given functions. Students use the annotated drawing to describe process and hence construct meaning to instruction on their own.

The learning process followed in annotated drawing science classroom instruction is as follows;

1. The teacher/facilitator states or gives the instructional objectives of the interactions
2. He introduces the concept for the interaction and indicates what materials are needed by the students for the instruction process.
3. Facilitator makes well-labelled drawings and gives the functions of the parts labelled
4. Students on individual basis observe the annotated drawing, read the functions and relate the diagram to the function as a whole.
5. Facilitator gives out another topic to the students to depict with annotated drawing and use it to describe the topic/concept
6. The teacher/facilitator uses probing questions to guide learners to associate relationship between the labelled parts and the structure to estimate whether the learners construct meaning from the annotated drawing.

Instruments and procedures

Two researcher designed instruments were used to obtain data in the study. These were Genetics Achievement Test (GAT) and Interview Schedule (IS).The GAT was used to collect quantitative data while the IS was used to collect date for qualitative analysis. The GAT contained 50-items with option A-D. This was administered to students in the experimental

and control groups before and after treatment. The GAT had split-half reliability coefficient of 0.82. It was used to measure the efficacy of annotated drawing strategy on students learning outcomes in genetics. The Interview Schedule was open-ended type of questions to determine the views of students in the experimental group on their teacher's instruction strategy. This also revealed what the students considered as impediments to learning biology.

Results

Descriptive statistics, analysis of covariance and qualitative analyses were employed to analyse data in the study. The qualitative data resulting from the Interview Schedule were recorded and transcribed to show students interest and their views on their teacher's instruction model and what they considered impediments to their learning biology.

Quantitative Analysis

Table 1. *Mean and SD of students' achievement in experimental and control groups*

Group	Mean	Standard Deviation	N
Annotated drawing	23.32	3.64	60
Control	17.76	3.34	50
Total	20.79	4.46	110

Dependent variable: post-test

As shown in table 1, students taught with annotated drawing had a mean score of (M = 23.32; SD = 3.64) while those in the control group had a mean score of (M = 17.76; SD = 3.34).

Ho_1: There is no statistically significant difference in the mean score of students in annotated drawing and control groups.

Table 2. *ANCOVA- students' post-test achievement in annotated drawing and control groups*

Source	Type III Sum of squares	df	Mean square	F	Sig
Corrected Model	99.136	2	495.568	44.897	.000
Intercept	2146.538	1	2146.538	194 470	.000
Pre-test	149.049	1	149.049	13.503	.000
Group	888.580	1	888.580	80.505	.000
Error	1181.055	107	11.038		
Total	49721.000	110			
Corrected total	2172.191	109			

a. R Square = .456 (Adjusted R Square = 446); p<.05

The result in table 2 shows that the effect of Annotated drawing is significant [$F_{(1,107)}$=80.51; P, <.05]. Group (Annotated drawing) accounts for 45.6% of the variance in the achievement means scores. This indicates that the null hypothesis of no significant difference

in the achievement mean scores of students in Annotated drawing group and Control group is not accepted.

Table 3. *Mean and standard deviation of performance of male and female students in the annotated drawing group*

Group	Mean	Standard Deviation	N
Male	24.30	3.51	27
Female	22.52	3.61	33
Total	23.32	3.64	60

The result in table 3 reveals a slightly higher performance mean score of (M = 24.30; SD = 3.51) in favour of the males while the females had (M = 22.52; SD = 3.61).

Ho_2: There is no statistically significant difference in the mean scores of male and female students in the annotated drawing group.

Table 4. *ANCOVA- male and female students performance in annotated drawing*

Source	Type III Sum of squares	df	Mean square	F	Sig
Corrected Model	88.159[a]	2	44.079	3.616	0.33
Intercept	3869.414	1	3869.41	317.43	.000
Pre-test	41.048	1	41.048	3.367	.072
Gender	45.065	1	45.065	3.697	.060
Error	694.825	57	12.190		
Total	33403.000	60			
Corrected total	782.983	59			

a. R Square = .133 (Adjusted R Square = .081); p<.05

The result in table 4 [$F_{(1,57)}$= 3.70; P >.05, revealed a no statistically significant difference in the performance of male and female students taught genetics with annotated drawing. This is an indication that the hypothesis that states: no statistically significant difference between male and female students taught genetics with annotated drawing. Therefore, the hypothesis is accepted.

Qualitative Analysis

In order to make for qualitative analysis to further support and buttress the emerging quantitative result, three students in the experimental group were selected with the use of simple random technique. The three students were interviewed with the designed open-ended interview questions. These extrapolated information on students' interest in the instruction and what they considered impediments for learning biology. The interview took place after the treatment had been carried out in the classroom. Data emanating from this instrument were recorded and transcribed as shown below.

Researcher: Good afternoon, how did you feel with the lesson just concluded by your teacher?
John: Thank you sir, I find this lesson interesting than any one I have received from him before.
Researcher: What is it that made the lesson interesting to you?
John: The teacher used diagrams that are labelled on the board; he also gave the functions and meaning of the parts that he labelled to the diagram.

The subjects claimed they found the teacher's lesson interesting because they were able to read the parts of the diagrams that were labelled and this made them to understand the topic taught better.

Researcher: Good afternoon, what is your name?
Student: My name is Ada
Researchers: What are things that make learning biology difficult for you?
Ada: I like to learn biology but the notes are plenty and sometime I do not understand the teacher. The lesson used to be dull. I have to draw and label all the time and I am not good in drawing.

Researcher: What is your name?
Students: My name is Dauda
Researcher: What are your problems in learning biology?
Dauda: Most of the lessons are confusing, not interesting and I don't use to understand the lessons.
Researcher: What should be done to make you learn biology well?
Dauda: Teachers should find a way to make teaching interesting, give simple and not too much notes.

The subjects also expressed misconceptions, their lack of interest, lengthy notes and poor drawing habit and suggested that teachers should look for a way to make learning interesting and give simple and short notes.

Discussion

This study focused on assisting students' to understand genetics with the use of annotated drawing. Four tables emerged from the analysis and computation of data. The first question raised in the study is whether there a difference in the performance of students taught genetics with annotated drawing and the control group. The result showed that students in annotated drawing group had a higher mean score of 23.32 against 17.76 of students in control group. This suggests that the annotated drawing had proved superior over the traditional method of teaching. The significant difference was due to the capability of the strategy in aiding the ability of the experimental group to identify and establish links with the functions of the label parts thereby enabling the students understand each genetic concept better than the control

group. Hence, the experimental group performed better than the control group. The control group had no exposure to annotated drawings.

The strategy a metacognitive example such as problem – solving and concept mapping also has the potency to improve students learning and indeed, understanding of concepts. Abstract concepts such as in genetics have consistently proved difficult for secondary school students to understand the concept.

When the question of whether there is a difference in the mean score of male and female students exposed to annotated drawing was raised, the result emerging from (table 3) revealed a higher achievement mean score of 24.30 in favour of the males than females 22.52. However, results of Analysis of covariance showed that the effect of Annotated drawing accounts for significant [$F_{(1,109)}$= 80.503; P, <.05]. In addition, the experimental group accounts for 45.6% of the variance in the achievement mean scores of students. This signifies that the null hypothesis of no significant difference in the mean scores of students in the annotated drawing and control groups was not accepted. Also, indicates that the use of annotated drawing had improved the understanding of genetics among the students exposed to it. The finding corroborate prior findings that had shown causal links between instructional strategies and achievement in science and biology (Danmole and Adeoye, 2004; Danmole and Adebayo, 2005; Zywica and Gomez, 2012, Lameed, 2002, Novak and Gowin, 1984). This result lend support to the finding of Zywica and Gomez (2008) who, in their study found out that students benefited from the use of the annotated strategy. This may be throwing more light into the efficacy of annotated drawing in making students learn and make meaning out of what is learnt in their own way which is the constructivist approach.

With regards to gender, the results of analysis of covariance indicated no significance in the achievement of male and female students in biology (table 4) show [$F_{(1,59)}$= 3.697; P >.05, that is, no statistically significant difference in the achievement of male and female students treated with annotated drawing (Danmole and Adebayo, 2005) Therefore, the hypothesis that states there is no statistically significant difference between the male and female students taught genetics with annotated drawing is therefore accept. This is also an indication that both male and female students understood the content better with the use of annotated drawing. This finding supports prior findings that had shown that gender has no significant influence on achievement of students taught science using metacognitive strategies (Danmole and Femi-Adeoye, 2004; Uhumuavhi and Eromosele, 2006, Lameed, 2002, Igbokwe, 2010). Therefore, gender has no effect on achievement as both male and female students benefited alike from the annotated drawing strategy used.

It is important that biology teachers illustrate their lessons with annotated drawing and encourage students to do likewise with their drawing assignments. This is to ensure that students understand the concepts. Emphasis should be laid by biology teachers on the links between the labelled parts and the functions. The biology teachers as facilitators should ask probing questions to guide students as they make their own individual annotated drawing and construct their own meaning of the concept.

In addition, two questions came up to collect qualitative evidence in the study. What is the view of students on the instructional strategy their teachers' used? Students interviewed on this aspect, admitted that the lesson was interesting, easier to understand and enjoyable. When they were asked of their views about their teacher's instructional strategy, they admitted that the labelled diagrams used by the teacher during the lesson drew their attention to the lesson from the beginning to the end of the lesson. This qualitative evidence lends credence to the fact that when teacher employs student-centred instructional strategy, students are actively involved in the teaching/learning process and develop interest in the lesson.

In order to find out what students consider as problems to their learning biology, the researchers used open-ended questions were used in the interview and the corresponding responses revealed that the subjects expressed prior to the use of annotated drawing misconceptions, their lack of interest, lengthy notes and poor drawing habit. This calls for the attention of the teacher in this aspect to remove the misconceptions while teaching, give notes and involve students more in the drawing activities. This can be achieved with the aid of students-centred appropriate instruction strategies. When the issue of what should be done to make students learn biology well was raised, the students suggested that teachers should look for a way to make learning interesting and give simple and short notes.

Conclusion

The efficacy of annotated drawing, a metacognitive strategy to improve understanding of genetic concepts and achievement has been established in this study. Drawing is an important process skill and an integral part of biology. Genetics is an aspect of biology that is considered to be abstract and difficult to understand yet an important concept in the senior school biology curriculum.

Consequently, annotated drawing provided more explicit and in-depth representation of knowledge of the process of inheritance of characteristics and related concepts. Annotated drawing strategy provided the medium for critical thinking during the minds-on as well as the practical experience of the hands-on activities students were exposed to during the development of students drawing skills in the study.

Implication of the results of the study

The results revealed that when approved instructional strategies are employed in the dissemination of science knowledge in the classroom, students' understanding of concept and learning become meaningful. Also, when there is active participation of student learning becomes easier and elicits interest of students in the content even when it seems difficult students also would express themselves freely in a classroom with the conducive environment for meaningful learning as has been established in this study

Suggestions for further research

The need for further research into annotated drawing to enhance conceptual understanding in biology cannot be overemphasized. There are still many concepts considered difficult not only by students but also biology teachers. Hence, further research on annotated drawing is required to make students understand concepts in ecology, evolution and more concepts in genetics.

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