

RESEARCH ARTICLE

OPEN ACCESS

An Investigation into Weaknesses Exhibited by High School Students on Biological Drawing

Abigail Fiona Dzidzinyo ¹, Ebenezer Appah Bonney ^{1*}, Comfort Korkor Sam ²

¹ Department of Science Education, University of Cape Coast, Ghana

² Department of Science Education, University for Development Studies, Ghana

* Corresponding author: eappahbonney@gmail.com

Abstract: This study was intended to examine the weaknesses biology students exhibit when required to make biological drawings of specimen they are presented with. The explanatory sequential mixed methods design was used for the study. The target population was all SHS 3 students offering biology as an elective in senior high schools in Cape Coast Metropolis of Ghana during the 2020/2021 academic year. The accessible population, however, was elective biology students from six schools in the metropolis. A sample size of 230 students was used. An achievement test and an interview schedule were the research instruments used. Kuder-Richardson-20 value for the achievement test calculated after pilot testing was found to be 0.43. Descriptive statistics such as frequencies and percentages were used to analyse the students' scores on the achievement test, while data from the interview were analysed using themes. Students' weaknesses were on the provision of appropriate headings, avoiding shading, ruling guidelines without arrowheads, and accuracy of features drawn. It was recommended that biology teachers should ensure that the rubrics of biological drawing are at students' fingertips by giving lots of drawing exercises, marking and discussing shortfalls with students.

Keywords: biological drawing, high school students, weaknesses

INTRODUCTION

Biology, the study of life, requires careful observation and description. One excellent way to describe an object is to draw it. The goal of the observer is to move beyond simple, mental images of what he/she believes a particular living thing looks like, and instead concentrate on the unique identity of that specimen (Leslie, 1995). For example, we all have in our mind an image of a tree that might be represented by a child's "lollipop" tree drawing, but most of us have not taken the time to notice subtle differences that characterize each tree.

Oddly, biology teachers spend little or no time on students drawing skills or on how their work will be assessed and graded. As a result, many students are intimidated by drawing exercises and resort to copying drawings from laboratory manuals and textbooks (Dempsey & Betz, 2001; Rogers, 2008). Careful observation and interpretation of nature, both key components of the scientific process (National Research Council, 1996; Dimitrijevic et al., 2016), are lost unless time is devoted to drawing skills. Dimitrijevic et al. (2016) also found that when science students are taught by a team of teachers, including even the art teacher, they tended to do better on biological drawings.

Biological Drawings – Rules and Regulations

Scientific drawings are an important part of the science of biology and all biologists must be able to produce good quality scientific drawings regardless of their artistic ability. Drawings not only allow one to record an image of the specimen observed, but more importantly, they help one to remember the specimen as well as the important features of the specimen.

Drawing a specimen requires one to pay attention to detail so that s/he can recreate it on the sheet. While doing this, the brain is recording these same features in such a way that they can be recalled if necessary (for example in an examination). Simply observing pictures of specimens in a book or on a computer screen is less effective when it comes to remembering and understanding what you observed (Debarati & Gowramma, 2017).

A drawing is said to be a picture or diagram made with a pencil, pen, or crayon rather than paint, especially one drawn in monochromatic mode. The ability to draw accurately and neatly is a useful skill, especially in science (Debarati & Gowramma, 2017). Most artists follow some basic rules to make their drawings attractive and easy to read; and according to West African Examinations Council (WAEC, 2000), the following details are expected in biological drawings:

1. The diagram should be reasonably large.
2. Features should be accurately drawn, maintaining the relative sizes as observed in specimen.
3. Lines should be smooth, unbroken and of even thickness.
4. Guidelines should be ruled and they should have no arrow heads.
5. Guidelines should not cross each other.
6. Guidelines could be of any angle but the labels should be HORIZONTAL (p. 134).

The following are also to be taken cognizance of when making biological drawings:

1. The drawing should cover approximately 1/3 of the page or more.
2. Leave at least a one-inch margin on all four sides of the paper. Keep the drawing to the left of the center.
3. The title of the drawing is simply the name of the object you are looking at. Please use CAPITAL letters and center it at the top of the page (If it is the transverse section, dorsal view, etc. of a specimen, it should be captured in the heading. Also if the drawing is to highlight some aspects of a specimen, it must reflect in the heading).
4. Center the drawing on the page.
5. Labels are to line up on the right hand side of the page.
6. Never use the plural form of a word when pointing to a single object or part.
7. Do not shade or sketch. All lines should be solid and complete. Use stippling in place of shading when necessary.
8. When using the scientific name of an organism in places other than the title, remember that the first letter of the genus or first part of a scientific name is always capitalized. The first letter of the species or second part of a scientific name is not (Iloeje, 1997).

Either one or two drawings can be done on a single page, but never more than two. If only one drawing is to appear on the page, it is to be centered in the upper two thirds of the page. The drawing must be large enough to allow for small details to be clearly shown and labeled.

Students Weaknesses on Biological Drawings

1. Diagrams – drawn out of proportion, labeled poorly, relative position of structures or organelles in most cases were not correct (WAEC, 2000, 2001).
2. Headings of drawings are not done properly (WAEC, 2004).

3. "The major weakness encountered this year is poor diagrams drawn by the majority of candidates. The standard of drawing was generally poor. The drawings of many did not represent grass shoot they were given to draw, and it was impossible to find a drawing with clean lines" (WAEC, 2003). "The standard of drawing was extremely poor" (WAEC, 2005, 2018, 2019).

After the list of Summary of Candidates Weaknesses, a list of "Suggested Remedies" is always given. These are suggestions on ways that the weaknesses noted could be addressed in order to minimize or obliterate the problem altogether. Yet the perpetual exhibition of the same weaknesses every successive year is an indication that those suggestions are not being put into practice.

Biology Teachers' Competence in Identifying Errors in Biological Drawings

As has been aptly said, it is what a person has that he/she is able to give. In other words, what one lacks cannot be imparted to another. In the light of this, if biology teachers are lacking the skill of making biological drawings, it will be difficult for them to impart such to the students. More so, it will be difficult for them to pinpoint students' weaknesses (or errors) and help them address same. It is thus significant that Bello's (2022) study which surveyed Nigerian biology teachers knowledge of errors in biological drawings found out that out of the ten types of errors considered, it was only two that more than 50% of the teachers readily recognized. The remaining eight errors had less than 50% of the teachers recognising them – for one particular error (i.e., drawing without magnification) none of the teachers was able to recognize it as an error.

In a similar vein, Nugraha (2018) assessed biology student-teachers' competence in making biological drawings of human internal organs. The study revealed that although the student-teachers generally were in level 5 of the 7 levels used for the study, they had difficulties with accurate positioning of organs, proportions and specific details of organs drawn. These are would-be teachers. Thus, if they are exhibiting these weaknesses, it presupposes that, if left unchecked, their future students may also have similar weaknesses with respect to making biological drawings. If biology teachers (or potential biology teachers) are themselves unable to identify errors with biological drawing, then it is not surprising for students to continuously exhibit weaknesses on biological drawings as the chief examiner's reports consistently point out.

Criteria for Assessing Biological Drawings

1. Accuracy of the drawing - resemblance to the specimen, distinctive biological features, proportion of various parts.
2. Smooth, clear lines and overall neatness.
3. Labels, title and magnification.

Reviewed WAEC Examination Questions on Biological Drawings

Question 1: Make a drawing, 8–10 cm long of the lateral view of specimen F and label it fully (WAEC, 2006).

Comments: This question required candidates to:

- (a) make a relatively large drawing (which means that they should devote a whole page to it),
- (b) make the drawing at the centre of the page with space on all sides for labeling, and
- (c) place labels horizontally.

In short the question is clear and unambiguous, requiring students to observe all the rubrics of biological drawing. It is not above their level either. However, the Chief Examiner reported that for majority of candidates the standard of drawing was very poor. Proportion of parts was wrong, the position of features was wrong and the drawing in many cases was untidy. It was further reported that the style of labeling marred an already poor substandard drawing. Many candidates failed to place labels horizontally and used the plural forms in naming single features.

Question 2: Draw and label a diagram of the transverse section of a dicotyledonous leaf as seen under the low power of the microscope (Presentation of cells not required, WAEC, 2001).

Comments: With this question, candidates were required to draw the low power view of the transverse section of a dicotyledonous leaf. The instruction on the question paper that “Presentation of cells not required” was most appropriate since it makes the question quite precise, warning students not to draw textbook diagram of the transverse section of a leaf. Yet in spite of the warning, the Chief Examiner still reported that many candidates drew the textbook diagram.

Purpose of the Study

The study examined specific weaknesses exhibited by SHS 3 elective biology students on biological drawings, and the reasons accounting for the exhibition of the weaknesses.

Research Questions

The following research questions guided the study:

1. What specific weaknesses are exhibited by SHS 3 students on biological drawings?
2. What reasons account for students’ weaknesses on biological drawings?

Significance of the Study

The study findings will be of much benefit to teachers. This is because it enlightens biology teachers on the various weaknesses their students exhibit in the making of biological drawings. It is also of significance to biology students since it would help them identify their own strengths and weaknesses on biological drawings. The West African Examinations Council will equally benefit if it gives consideration to the information on the dissemination and use of their Chief Examiner’s reports by teachers, in order to strive to find the best means of ensuring that those the reports are intended for are accessing them.

RESEARCH DESIGN

The explanatory sequential mixed methods design was used for the study. Data collected was used to describe the nature of SHS biology students’ difficulties with biological drawings, as well as to investigate details of the recurrent weaknesses found in SSSCE candidates’ scripts with regards to biological drawings, their difficulties associated with drawing, and the reasons why they exhibit such weaknesses.

A one shot achievement test was given and was followed right after with focus group interview (that is, after the papers had been scored and those who made the mistakes had been identified). Also the risk of non-response associated with the use of questionnaires and others was not encountered as intact classes of SHS 3 elective biology students were used and scripts collected on the spot.

An achievement test formed the first stage of the study. The second stage involved focus group interviews of students who exhibited the weaknesses reported on by the chief examiners. The teachers of these students were also interviewed one-on-one afterwards using the structured interview guide. This was done to solicit responses from both the students and the teachers on reasons for the making of mistakes noted on the achievement test. The information obtained from the interviews helped describe and interpret what was observed as the reasons for students’ weaknesses in the areas concerned (Best & Kahn, 1989).

Population

The target population was all SHS 3 students offering elective biology in Cape Coast Metropolis during the 2020/2021 academic year. However, the accessible population was elective biology students from seven schools in Cape Coast Metropolis. The accessible population consisted of 939 students.

Sample and Sampling Procedure

A multi-stage sampling technique was employed to select six schools, six classes, six teachers and 230 students. There are eight public senior high schools in Cape Coast Metropolis which offer elective biology. Two of the schools are single-sex female (SSF) and were selected conveniently. Three are single-sex male (SSM) schools, and using computer generated numbers, two were randomly selected to participate in the study. The remaining three are co-educational (CE) schools. As such two of these were also randomly selected to be part of the study. All the four

single-sex (SS) schools are Category A schools whereas the two coeducational schools are both Category B schools. These categories are assigned depending on the available facilities and not according to academic performance.

At each school an intact class was randomly selected (using computer generated numbers, obtained from Microsoft Excel) and used since each of the six schools had more than one science class (both CE schools had three science classes each, while one SSF school had five, one SSM had four, with the remaining two SS schools (one SSF one SSM) each having three science classes).

Of the two intact classes selected from the two SSF schools one had 35 students and the other consisted of 32 students. However, of the classes selected from the SSM schools one was made up of 40 students and the other of 41. The classes selected from the CE schools were made up of 46 (that is 29 females and 17 males) and 36 students (14 females and 22 males). In all a sample size of 230 students was used. In all the schools the intact classes can be said to be equivalent in terms of numbers, since the differences in the number on roll were just plus/or minus five. Overall, the sample was made up of 110 females and 120 males.

For the focus group interviews, in each school, students who were identified as having exhibited the documented weaknesses on the achievement test were singled out and organized for the interviews. (In four of the schools, all the students in the classes selected were involved in the focus group interviews). The six teachers whose classes were sampled and used for the study were purposively selected and interviewed one-on-one.

Validity of the Instruments

The face validity of the achievement test was determined by giving copies of the test to experts in biology education in the Department of Science and Mathematics Education of the University of Cape Coast for their perusal and comments. A biology teacher in one of the schools was also given a copy for comments on any ambiguities, confusing terminologies or statements. Comments and inputs from the experts were used to fine-tune the test into the final one used for the actual study.

The content validity was ascertained by using the biology syllabus as a form of table of specification to check whether the questions covered all aspects in biological drawings as stipulated.

The construct validity was assumed since the questions were all culled from past WAEC SSSCE biology papers (all WAEC examination questions are supposed to have gone through various tests of validity as a team of experts in assessment are employed to check all that).

For the interview schedule, only the face validity was considered. This was done by giving copies to experts of biology education in the Department of Science and Mathematics Education of the University of Cape Coast. They read through and gave their comments. After making the required changes (such as changing in wording), the schedule was used for the study.

Reliability of the Instruments

The instruments were administered as a pilot test to a school in Cape Coast Metropolis which was not used for the actual study. A marking scheme was developed for scoring the items dichotomously. The inter rater reliability coefficient was found to be 0.93. Kuder-Richardson-20 (KR-20) was used to determine the reliability of the other items which were scored objectively. The KR value for the drawing was $r = 0.43$.

Data Analysis

Both quantitative and qualitative analyses were employed in this study. Quantitative analyses were used to analyze the results from the achievement test in the form of descriptive statistics such as frequencies and percentages. The qualitative analysis was used for data from the interviews where the responses were pure descriptions.

A marking scheme was prepared for scoring the BAT items. The scoring, in the most part was done in the form of a checklist, where a mark was given for the required competency indicated and '0' was for absence/incorrect competency demonstrated.

To answer research question one, descriptive statistics (such as percentages and frequencies) were used. The frequencies and percentages of students who failed to exhibit the competencies required were then compared, and

Table 1. Frequencies and percentages of students' weaknesses on biological drawing (N = 230)

| Competency | Frequency | Percentage (%) |
|---|-----------|----------------|
| Wrong/missing heading | 179 | 77.8 |
| Size of drawing less than 1/3 of page | 38 | 16.5 |
| Drawing lines rough, broken, of uneven thickness | 24 | 10.4 |
| Any form of shading | 60 | 26.1 |
| Guidelines of labels not ruled, having arrowheads | 64 | 27.8 |
| Orientation of labels not horizontal | 17 | 7.4 |
| Inaccurate features drawn | 129 | 56.1 |

the areas where students failed most (i.e., where more than 20% of students had it wrong) were considered to be the most difficult ones and were therefore labeled as the specific weaknesses of the students.

The descriptive statistics were most appropriate since it helped pinpoint students' specific weaknesses with drawing. Responses from the interview were analysed thematically and used to explain students' answers on the test. To help answer research question two, a pure description of both the teachers and students' responses on the interviews were given thematically. This was most appropriate since the interview responses were used for this.

RESULTS

Research question 1 sought to find the specific weaknesses students have on biological drawings. To answer this, students' scores on the BAT were analysed using frequency counts of the competencies that students were required to exhibit. The percentages of students who had the individual competencies were then calculated. The results are presented on **Table 1**. From **Table 1**, it can be seen that four of the competencies (*Wrong/missing heading*, *Inaccurate features drawn*, *Guidelines of labels not ruled, having arrowheads*, and *Any form of shading*), proved to be very difficult for the students.

This is because each of these had a percentage above 25, with *Wrong/missing heading* being the most difficult for students as 77.8% of the students did not exhibit that competency. With the remaining three competencies (*Size of drawing*, *Drawing lines*, *Orientation of labels not horizontal*), less than 25% of students had them wrong. This is an indication that these areas are not too difficult for the students.

The specific weaknesses of students on biological drawings from the study were:

- (1) difficulty with providing an appropriate heading,
- (2) shading,
- (3) not ruling guidelines as well as using arrowheads, and
- (4) drawing inaccurate features.

Reasons Why Students Exhibited the Weaknesses Noted

The second research question sought to find out the reasons accounting for students' weaknesses with regards to biological drawings. Data from interviewing a cross-section of the sampled students (six from each school, totaling 36) and six teachers (one from each school), were used to answer this question. These were presented thematically as follows: Biological drawing, Provision of an appropriate heading, No shading, Guidelines ruled with no arrowheads, Accurate features drawn.

Biological drawings: According to the Chief Examiners, candidates continue to display weak drawing skills and lack of knowledge of the conventions of biological drawings, such as the inclusion of magnification and titles of the drawings. In addition, far too many candidates present untidy drawings with crooked labeling lines (WAEC, 2004). The reasons given by students as to why they fell short on the biological drawing are presented in themes as follows.

Students Views on Why They Made Mistakes on Biological Drawing

Provision of an appropriate heading: While 17 of the students said they wrote the name of the flower for the heading thinking that was what was required, the rest said they forgot to provide a heading. For those who thought writing the name of the flower suffices for the title of the drawing, it appears that is what they have been doing with the biological drawings they have been making in school.

No shading: 21 of the students shaded because they wanted some parts of the drawing to stand out. The remaining 15 students said they had seen some drawings in textbooks with parts shaded and thus they thought it was alright to do same.

Guidelines ruled with no arrowheads: On ruling guidelines with the free hand, and adding arrowheads, 17 of the students thought how the guidelines was made was irrelevant, only the correct label was needed. Four of them forgot to rule the lines because they were in a hurry. Still 15 of them were imitating the teacher who uses the free hand in making guidelines on the writing board.

Accurate Features Drawn

On their inability to draw accurate features, all the students said it was because they simply are not good at drawing. Also they said drawing is difficult for them, thus they drew anything to represent what they saw.

Teachers Views on Why Students Made Mistakes on Biological Drawing

Teacher' views on why students exhibited weaknesses on the drawing are presented in themes below.

Provision of an appropriate heading: Three of the teachers said students' laziness is the reason why they did not provide any heading for the drawing; or did it wrongly. The remaining three teachers said they could think of no reason why the students should not provide an appropriate heading for the drawing since they had taught them that it is very important.

No shading: While four of the teachers could not give any reason why the students shaded their drawings two of them said some students are just plain stubborn. No matter what you say or do, they will always make that mistake. They are just irresponsible.

Guidelines ruled with no arrowheads: All the teachers interviewed said the students did not rule the guidelines for the labels and some went further to add arrowheads due to simple negligence. They could not give any other reason for this since they said they had taught them the correct thing to do.

Accurate Features Drawn

In confirmation of what the students said as to why they could not draw features of the specimen accurately, all the teachers also said some students find drawing difficult. Thus, they just draw anything to represent what they see. Furthermore, during the interviews, when asked whether they used the Chief Examiners' reports to inform their teaching, all the six biology teachers interviewed responded in the negative, giving varied reasons. The first teacher said she did not because she could not lay hands on them the few times she tried. According to her, those in authority kept the reports to themselves and it was futile searching for them. The second teacher, on the other hand, did not use the reports because he could not get the current issues. He attributed this to the fact that WAEC tends to release the reports about three years after the examinations had been taken.

The third teacher does not use them because she feels the syllabus is alright for her in ensuring that she teaches the students what is required for the examinations. To her, if a teacher is able to complete the syllabus with the students before they sit the examinations, it should be enough for the students to perform creditably.

The fourth teacher admitted not having considered the matter. He thus agreed that it would be quite beneficial to the students if he consults the reports, at least, from time to time.

Teacher number five was of the view that if WAEC wanted them to use them in their teaching they would release the reports to the schools on time. Thus he also did not use the reports because he finds them redundant.

Teacher number six, however, occasionally used ideas from them when prompted to do so by the Head of Department. Otherwise he rarely used it on his own initiative.

DISCUSSION

The results on the research question one pinpointed four competencies that students find very difficult. These were labelled as the specific weaknesses students have with biological drawings, namely, *Wrong/missing heading*, *Inaccurate features drawn*, *Guidelines of labels not ruled, having arrowheads*, and *Any form of shading*. All these weaknesses have been cited frequently by the Chief Examiners as specific weaknesses of students. For instance, both the 2000 and 2001 WAEC chief examiner's reports indicated that candidates who sat for biology in those years, drew diagrams that were out of proportion, labeled poorly, had the relative position of structures or organelles in most cases incorrect. The latter meaning that the candidates drew inaccurate features. The poor labeling of drawings reported by the Chief Examiners included using the free hand to make guidelines, giving guidelines arrowheads, as well as not orienting labels horizontally to the top of the page. All these weaknesses were observed in the students' scripts. With shading, some students may feel justified since some features need to be made to stand out. However, in such cases stippling (i.e., using dots) is recommended, instead of any form of shading (Iloeje, 1997).

The results from answering research question two indicated that the reasons given by both students and teachers for the exhibition of the specific weaknesses exhibited on the biological drawing were varied. Whereas some of the reasons from the two parties overlapped, others were at variance. For instance, on the provision of heading, whereas students said they thought writing the name of the specimen drawn sufficed because that is what they had been doing in class, the teachers said they had taught the proper thing to do. In this instance, since no correction of the mistake had been made by the teachers, the students had taken it to be the correct practice. [The biology syllabus advises teachers to help students practise giving appropriate headings to biological drawings in class when teaching biological drawings (Ministry of Education, Science and Sports, 2008)]. If the teachers are able to do so, such mistakes will not be repeated on external examinations like the SSSCE/WASSCE.

On the no shading competence, students said they shaded because they found such in textbooks or they felt they had to make portions of the drawing stand out by shading. This is not surprising since some students even copy textbook drawings when they are required to observe the specimens and draw them. This may mean that either the teachers are not telling them not to shade their biological drawings, or they have been taught but they stubbornly stick to what they consider to be right, where students have to make some parts stand out on the drawing it is recommended that stippling be used (stippling refers to the use of dots to distinguish between parts on a drawing). Apparently the students were not aware of any such thing and thus felt justified in using shading instead. The teachers, however, on this subject attributed students' weakness to stubbornness or irresponsibility.

With regards to not ruling guidelines with a rule, a section of the students said they were imitating their teachers who tended to rule guidelines with the free hands on the board. This group of students do have a case on the point. It is well known that students emulate teachers in what they do, especially when it comes to how they present information to the students. Thus the teachers should practice what they teach the students in class. When they make any drawing on the board and have to label, they should use the chalkboard rule to make the guidelines. The teachers, however attributed this weakness simply to negligence on the part of the students. Since the students do not agree with the teachers on this, it is possible that the teachers do tell the students to use rulers, but contrary to what they say, they (the teachers) use the free hand when demonstrating it on the chalkboard. Thus, since we learn best by imitating, students copy what they see the teacher doing and somehow unconsciously ignore what the teacher tells them.

On the competence of drawing accurate features both teachers and students agreed that students simply lack that skill. However, such students should not be left to their own whims and caprices. They need to be helped to draw by helping them practice constantly. This could be achieved when the teacher gives students a lot of practical exercises that include drawings. This is quite necessary because drawings are obligatory in biology (WAEC, 2000).

A look at the weakness and reasons for their exhibition by students shows that if teachers consult chief examiner's report and use the prodding therein, it will go a long way to forestall most, if not all, of the weaknesses. However, teachers reasons for not using the reports are quite worthy of note. In a nutshell, some biology teachers do not use Chief Examiners reports to inform their teaching for varied reasons. Some of the reasons are as follows:

- a) the reports are not available when needed,
- b) late release of reports making them redundant,

- c) not necessary, the syllabus is enough, and
- d) the importance of the reports has not been considered.

If teachers who are supposed to be using the reports in their teaching are not getting them to use, then the information provided can be said to be going to waste. Indeed, the Chief Examiners' reports are actually addressed to the teachers. In most cases the examiners specifically state: 'teachers should ...' indicating that the report is specifically for the information of the teacher.

In the past, many people in our part of the world were not too concerned with expiry dates. However, in recent times people are now much aware of the significance of expiry dates. Thus, when something is said to be old, many do not pay much attention to it. As such it will be expected that Chief Examiners' reports for a particular year should be released together with the results of the year to be deemed current by the prime users, i.e., teachers. Failure to release them on time may lead some to view them as somewhat 'outmoded', or 'expired'.

The importance of the reports should be made very clear to both teachers and students, (especially to the teachers). Also it should be emphasized to the teachers that no matter how old a report is, once it is on your subject/area, they need to be reviewed and the information therein used to supplement the teaching. For instance the weaknesses that are pointed out in every report could be most enlightening. When considered they will help a teacher to know aspects of topics that need to be hammered or given more attention. It will also help the teachers to better prepare the students for the examinations. Indeed, teachers should combine the Chief Examiners' reports with the syllabus to ensure their students are well prepared for the WAEC examinations.

CONCLUSIONS

It was the objective of this study to examine specific weaknesses exhibited by SHS 3 elective Biology students on biological drawings in the light of what WAEC Chief Examiners have been reporting. Also, the study investigated the reasons for the exhibition of the weaknesses students had on the biological drawing.

The study confirmed what the literature report to be the weaknesses of students on biological drawings. According to literature, biology students' weaknesses on drawings include diagrams drawn out of proportion, labeled poorly, with relative position of structures or organelles in most cases not correct. However, in addition to what the literature report to be students' weaknesses on biological drawings, the study found out that students had the most difficulty with providing an appropriate heading for the drawing, avoiding any form of shading, and making ruled guidelines with no arrowheads.

The findings of the study are of much importance to teachers. This is because they serve as enlightenment for biology teachers on the various mistakes their students make in the areas of biological drawings. They are also of significance to biology students, since they help them identify their own strengths on biological drawings and address them to the best of their knowledge.

Recommendations

Biology teachers and their students should go the extra mile in ensuring that the rubrics of drawing are at students' fingertips. Teachers can do this by giving students lots of exercises on drawing and ensuring that such exercises are marked and discussed in class with students.

Limitation of the Study

The use of only self-report data on the part of the teachers involved in the study may be said to be the limitation of this study. Their responses on the interviews with respect to what they actually taught the students on the rubrics of biological drawings were not corroborated with first-hand information from classroom observations. Even though, asking students similar questions during the interviews and comparing their responses were intended to help triangulate the data, if teachers actual practice had been observed and compared with what was self-reported, it would have been laudable. It is thus suggested that a future study should include classroom observations to look into how teachers teach biological drawings.

REFERENCES

- Bell, J. F. (1999). *Investigating gender differences in the science performance of sixteen-year-old pupils: University of Cambridge local examination syndicate* [Paper presentation]. BERA, University of Sussex, Brighton.
- Bello, G. (2022). Assessment of Nigerian biology teachers knowledge of errors in biological drawing. *Aquademia*, 6(1), ep22004. <https://doi.org/10.21601/aquademia/12183>
- Best, J. W., & Kahn, J. V. (1989). *Research in education* (6th ed.). Englewood Cliffs: Prentice Hall, Inc.
- Debarati, D., & Gowramma, I. P. (2017). An analysis of students' drawings and labelling skills in science at the elementary level. *Indian Educational Review*, 55(2), 108-123.
- Dempsey, B. C., & Betz, B. J. (2001). Biological drawings: A scientific tool for learning. *The American Biology Teacher*, 63(4), 271-272. <https://doi.org/10.2307/4451099>
- Dimitrijevic, J. D., Filipovic, S. B., & Stanisavljevic, J. D. (2016). An analysis of students' drawings for purpose of considering the efficiency of teamwork (Programme content: Marine life community). *Journal of Subject Didactics*, 1(1), 25-38.
- Iloje, S. O. (1997). *Senior secondary certificate practical biology*. Lagos, Nigeria: Academic Press P/C.
- Leslie, C. W. (1995). *Nature drawing: A tool for learning*. Dubuque, IA: Kendall/Hunt Publishing Company.
- Ministry of Education, Science and Sports. (2008). *Teaching syllabus for elective biology*. CRDD, GES, Accra, Ghana.
- National Research Council. (1996). *Inquiry: National science education standards*. Washington, DC: National Academy Press.
- Nugraha, I. (2018). The use of drawing as an alternative assessment tool in biology teaching. *Journal of Physics: Conference Series*, 1013, 012016. <https://doi.org/10.1088/1742-6596/1013/1/012016>
- Rogers, M. (2008). Learning by drawing. *Symmetry Magazine*. <http://www.symmetrymagazine.org/breaking/2008/05/21/learningbydrawing>
- WAEC. (2000). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2001). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2003). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2004). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2005). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2006). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2018). *Chief examiner's report on West African secondary school certificate examinations*. Accra: Wisdom Press.
- WAEC. (2019). *Chief examiner's report on West African secondary school certificate examinations*. Accra: Wisdom Press.

Please cite: Dzidzinyo, A. F., Bonney, E. A., & Sam, C. K. (2022). An Investigation into Weaknesses Exhibited by High School Students on Biological Drawing. *Journal of Research in Didactical Sciences*, 1(1), 12730. <https://doi.org/10.51853/jorids/12730>

Received: 06 October 2022 • Accepted: 18 December 2022