Strategies Used By Teachers to Improve Students’ Mastery of Drawing Skills and Performance in Biology in Bungoma West District, Kenya

Eric Temba Wekesa
School of Biological Sciences, University of Eldoret, P. O. Box, 1125-30100, Eldoret, Kenya.

Abstract
This paper discusses the problems that students encounter in making biological drawings and the strategies used by teachers in helping students master drawing skills and improve performance in Biology in the Kenya Certificate of Secondary Examinations (KCSE). The paper is based on a study to determine the effects of drawing skills on students’ performance in Biology in Bungoma West District in Western Kenya. A descriptive survey research design was used in the study, in which 15% of the schools in the District were selected using stratified random sampling. Thirty-three percent of the target population, Form Three students, was selected using simple random sampling technique. In mixed schools the subjects were obtained using stratified sampling technique to ensure gender equality. The teachers for the study were obtained using purposive sampling technique. Three instruments were used to collect data: the teacher’s questionnaire (TQ), Student’s questionnaire (SQ) and students’ test (ST). The data obtained from the study was analyzed using both descriptive and inferential statistics using the computer software, Statistical Package for Social Science (SPSS). The study found that the strategies used in helping the students to master biological drawing were inadequate. Moreover, the problems students encountered in making drawings and strategies used by teachers to develop drawing skills in students, had significant effect on performance. The problem of making proportional drawing and assistance of learners at individual level as a strategy to develop drawing skills in learners had greatest effect on performance. It was recommended that continuous in-service of practicing teachers and participation in workshops and conferences is required to update them on new innovations in science teaching. The study is of practical significance to scholars and education stakeholders as it forms a basis of the need to work for effective teaching and learning in the Biology subject in secondary schools.

Keywords: strategies, teachers, students, mastery, drawing skills, biology, Bungoma west district, Kenya.

INTRODUCTION
Drawing as a skill is one of the basic science process skills which have not received due emphasis and yet are very fundamental for effective instruction. Stake and Easley (1978) have found out that teachers do a great deal of telling and demonstrating at the expense of engaging learners in activities which will foster learning and even make the process enjoyable. According to Muindi (2008), learning in mathematics and sciences is mostly rote learning which makes it a passive affair where the student is not engaged in the process. Muindi (ibid.) notes students are taught according to how questions in the examinations are framed, leaving no room for creativity. This means that teaching has been and is still teacher-centred with very minimal learner participation. In such a state learners hardly learn and practice drawing skills. This could be one of the reasons for the dismal performance in the sciences and mathematics at national level. The poor performance in Biology has several negative implications which include:

i) Reduced overall transition rates from secondary schools to tertiary colleges and universities

ii) Reduced number of students joining training in related scientific fields like medicine, agriculture, pharmacy among others

iii) Reduced resourcefulness and demonstration of relevant technical skills and scientific thinking which is necessary for socio-economic development.

These implications retard socio-economic development and negatively impact on the achievement of the Kenya Vision 2030.

Biological knowledge can be communicated via written, speech elements, diagrams, and drawings as seen in contemporary instructional materials especially text-books. In Biology examinations, students are required to draw and label or to fill in identifications in pictures or drawings. Such questions reinforce the use of drawings by students primarily as a means of demonstrating their content of biological knowledge. Sandra et al. (2007) note that students might be missing valuable learning opportunities if teachers are not prepared to take advantage of the rich evidence of students’ thinking
that comes from their use of drawings as a problem solving strategy in sciences and mathematics. According to educational psychologists, participatory learning is the most effective method of learning science. It has many advantages over other methods such as reading of principles and concepts of science and their application and observing others do experiments (Das, 1985). By observing the specimens, asking questions, engaging in discussion and making of annotated drawings of specimens during Biology practical sessions, the students get involved in the learning process. This makes learning effective apart from promoting the development of other science process skills.

STATEMENT OF THE PROBLEM

Drawing forms an integral part in both Biology practical and theory work. Practical work in Biology like in other science subjects is very essential in making concrete the otherwise abstract subject matter. In KSCE Biology, the score in practical examination heavily bears on the overall grade obtained by a candidate. The Kenya National Examinations Council reports indicate that performance in Biology has been below average for many years. For a candidate to get a grade of B- (minus) and above, he/she must obtain a minimum grade of D+ (plus) in the practical paper (KNEC, 2006).

Several initiatives have been put in place to improve the situation. These include in-servicing of Biology teachers through the Strengthening of Maths and Sciences in Secondary Education (SMASSE) programme and provision of guidelines from the Ministry of Education through the Kenya Institute of Education (KIE) and the quality assurance and standards division. In spite of these elaborate initiatives for teachers on how to implement the Biology curriculum, performance in this subject has continued to be below average both in theory and practical papers. One of the reasons for this dismal performance in Biology, especially in the practical, is thought to be the lack of drawing skills in the candidates. Analysis of KNEC reports from 1999 to 2008 indicate that virtually all questions on diagrams and drawings are poorly performed both in theory and practical papers (KNEC, 1999-2008). This calls for a decisive intervention to reverse the trend.

Given that drawing skills in Biology underlie the ability to communicate results in terms of observations and inferences, it is therefore necessary to examine the extent to which secondary school teachers assist their students to use the drawing skills to communicate scientific results in Biology.

Difficulties Students Encounter in Learning Drawing Skills in Biology

The ability to make accurate drawings of specimens like any other learning task requires patience and practice (Billiet, 2003). Interpretation and construction of images are core skills students must master in order to understand concepts in Biology and this is not an easy task. Hoese and Casem (2007) and Frith and Law (1995) say that to make a drawing of an object one is looking at, he or she must first convert the information being received with the eyes into a new form that will control the muscles of the hands. The way this information is processed and transformed is best described in cognitive terms. This is difficult to most learners, especially those with low cognitive level. They add that drawing depends upon the combination of a number of simple and yet independent processes.

What makes a good biological drawing is more complicated than simply its accuracy. The hardest part of a drawing is not, as many assume, controlling one's pencil, rather it is the act of observing with precision and consciousness of the specimen before the observer (Amelia, 2007). Amelia (ibid.) continues to say that many things hinder the act of observation, for example the schemata already in place in the mind of the learner. If the schemata are not in line with what is to be drawn, they have to be altered. The changing of the schemata may be difficult to some students. Another major problem at the present is that Biology textbooks approved by the Ministry of Education are passive on principles of biological drawings. A close analysis of these textbooks reveals that they lack explicit literature on how drawings are made in Biology. For those which try to shed some light, the literature is scanty and in most cases contradictory and confusing. They also take Biology drawings to be synonymous with Biology diagrams and in some of the text books the drawings and diagrams are not based on biological principles. This confusion could be one of the factors contributing to lack of drawing skills in the majority of secondary school students in Kenya.

LIMITATIONS OF THE STUDY

In mixed schools the composition of respondents was to be in equal proportion in terms of gender. However, in some schools the number of girls or boys in form three was less than 23. This was in schools which were in the process of facing out either girls or boys. To make up a sample of 46 per school as intended, either more boys or girls were selected as per the need. Despite these challenges, the study successfully managed to capture and document valuable data on the strategies used by teachers to enhance the level of students’ competence in drawing and the impact of this mastery on performance in Biology as a science subject offered in Kenya’s secondary schools system.

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MATERIALS AND METHODS
The study was conducted in Bungoma West District, Western Province, Kenya. It was conducted using a descriptive survey design. The research population comprised the Form Three Biology students in the District. The Form Three students were selected because they have covered substantial Biology syllabus thus assumed to have been taught drawing skills in biology. On the other hand, Form Fours were left out because they were busy preparing for their Kenya National Examination Council examinations.

The sample schools were obtained using simple random sampling technique. The six sampled schools had a population of 460 Form Three students. Where necessary, balloting was used to select the required number of students from each sampled school. Balloting was used because the characteristics of the students to sample were assumed to be homogenous since they are at the same cognitive level. Therefore, 273 respondents out of the 950 Form Three students were to be selected. However, for purposes of having equal number of respondents in each school category 276 respondents were selected. Forty-six students and one biology teacher were sampled in each school.

To collect data, the study employed a students’ questionnaire (SQ) and teachers’ questionnaire (TQ) as well as a students’ test (ST). The test focused on the dependent variables, performance in Biology. The students’ test was used to obtain first-hand information on drawing skills mastered by students in Biology, the difficulties they encountered when making drawings of specimens and to find out if they can relate structure to function of the parts of the specimen. Both qualitative and quantitative data were generated from the field. The data were coded and analyzed using descriptive and inferential data analysis techniques. The analyses were presented in tabular form. For quantitative data, one-way ANOVA was used to test hypotheses, because in each there was a comparison of more than two categories. The Statistical Package for Social Science (SPSS) computer program was used in data analysis.

RESULTS AND DISCUSSION

Problems Students Encounter in Making Biological Drawings

The students’ questionnaire was used to investigate the problems students encounter when making biological drawings. The questionnaire aimed at investigating the problems from the students’ perspective. This is because students as learners are the main focus in all instructional activities. The items were structured in a simple form requiring the respondents to tick either ‘YES’ or ‘NO’. Ticking ‘YES’ meant they experienced the stated problem and by ticking ‘NO’ meant they did not experience the stated problem.

Making Neat Drawings

One of the main sources of error in students’ drawings is untidiness. A large number of the
respondents (70%) faced the problem of making neat drawings (Figure 1). Untidiness is frequently due to:

i) Use of incorrect materials like non-recommended pencil, eraser and paper
ii) Lack of competence in drawing of specimen which leads to unnecessary erasing
iii) Lack of attention to detail

Calculating Magnification
The results in Figure 1 indicate that 75% of the respondents in the sampled schools could not correctly calculate magnification and were unable to indicate this for the drawings as required. Indication of magnification is important for keeping an accurate record of the organism’s size. Lack of the skill could be attributed to lack of practice or negligence on the part of the teacher in inculcating the same to in the students

Drawings Continuous Outline
Majority of the respondents (75%) had a problem in making simple, clear and continuous outline of drawings as indicated in Figure 1. Gaps in biological drawings are undesirable. This problem indicates lack of information on how biological drawings are made.

Indicating the Title of Drawings
Figure 1 indicates that 55% of the respondents in the sampled schools did not indicate the titles of their drawings. The title of a biological drawing should be underlined and must indicate the view of the drawing made (Geoff, 2000). This makes future reference to the drawing by other biologists difficult. Negligence to indicating titles to drawings could be due to lack of guidance by the teachers or forgetfulness on the part of the learners

Shading of Drawings
From Figure 1, 61% of the respondents had no problem with shading of biological drawings. However, 39% indicated they had a problem. The shading obscures some of the structures hence lead to congestion of structure in the drawing apart from making the drawings untidy.

Drawing Labelling Lines
A large number of respondents could not draw straight labelling. This made the drawings untidy. Figure 1 indicates that 45% of the respondents drew label lines which crossed and 43% used arrows as labelling lines. Crossing labelling lines and ones which do not touch the structures being labelled confuse the labels. Arrows normally show directions of flow hence are not used as labelling lines. Labelling of biological drawings in an unacceptable way which is leads to poor performance in biology.

Selection of Appropriate Pencil
HB or 2B grade pencils are recommended for making biological drawings. They produce thin, visible outline with uniform thickness. Results of Figure 12 indicate that 66% of the respondents had no idea about the type of pencils recommended for making biological drawings. The use of inappropriate pencil leads to drawings untidy drawings with unclear outlines. Lack of knowledge in selection of appropriate pencil can be attributed to lack of guidance from teachers.

Selection of Appropriate Eraser
From results of Figure 1 indicate that 43% of respondents had no idea on recommended eraser for correction of mistakes in drawings. Use of low quality erasers makes the drawings untidy, thus lowering the quality of the drawing. This observation indicates that learners are not adequately supervised and given opportunities by the biology teachers to practice these skills.

Students’ Responses on the Strategies used by Teachers to Develop Drawing Skills
The students’ questionnaire and teachers’ questionnaire were used to find out the strategies used by teachers in developing drawing skills in learners.

Continuous Assessment Tests
From the students’ perspective, the most common strategy used to impart drawing skills in learners is use of continuous assessment tests (48%) as indicated in Figure 2. In this case, the students are asked to draw and label drawings especially during practicals. In some cases, the theoretical tests contain items testing the learners on their competence in drawing skills. In some occasions test items may be on photographs in which case the learners are asked to label certain structures in the photograph.

Use of Textbooks and Teacher Demonstration
The second most popular strategies used were provision of textbooks and teacher demonstration. In the case of textbooks, learners are asked to draw diagrams and drawings from textbooks. Though this strategy is very effective, without proper guidance and monitoring, it can be misused. The main objective of learning drawing skills may not be achieved. Students with basic understanding of a
visual concept may reproduce a drawing in the same style as they have observed in the textbook.

To avoid this, teachers should closely monitor the acquisition of drawing skills by students, allowing them to use textbooks appropriately, for example labelling of drawings. Demonstration by the teacher to students on how to observe and make biological drawings is a powerful strategy of developing drawing skills in learners. However, it is unfortunate that only 30% of the teachers use this strategy. This can be attributed to:

i) Insufficient time; demonstration is time consuming hence it is avoided by many teachers

ii) High workload

iii) Incompetence; teachers who lack drawing skills avoid demonstrating to learners on how to make biological drawings

Class Discussions
Only 22% respondents reported that teachers used class discussion as a strategy for developing drawing skills in students. Class discussion, if allowed and well utilized is a powerful approach in developing any desired skill in the learners. Class discussions allow learners to interact at individual level freely hence learning from one another drawing skills. From students perspective this approach is under utilized in secondary schools. This makes the learners to be deficient in drawing skills which impacts negatively on their performance in examinations.

Use of Charts
From Figure 3, only 28% of the respondents indicated that teachers used charts in trying to instil drawing skills in learners. Charts can be drawn by teachers or commercial ones can be bought. This low percentage indicates that teachers rarely drew charts for use in the teaching of biology in secondary schools. This could be due to lack of information on the importance of charts in the teaching and learning of biology. It could also be attributed to lack of drawing skills in the teachers. Commercial charts can be used in the place of teacher produced ones; however, care should be taken to ensure that the charts purchased meet the specifications agreed on.

Assistance of Learners at Individual Level
Assistance of learners by teachers at individual level was the least used approach. Only 7% of the respondents indicated use of this method by teachers. Paying attention to each learner is a very effective approach because individual differences are catered for. However, this approach is time consuming. Over-enrolment in secondary schools due to subsidized fees makes it harder for teachers to take into account the special needs of each student. The limited manpower in terms of teachers worsens the problem. The few available teachers are over burdened hence cannot attend to each learner’s needs. These reasons explain why this strategy is rarely used.

Marking and Correction of Drawings
As indicated in Figure 19, only 16% of the respondents indicated that teachers mark and correct biological drawings made by students. This is an indicator that students carry misconception about making of biological drawings from one level of learning to the next. This culminates in poor performance in biology KSCE.

Teachers’ Responses on the they Used Strategies
Table 1 shows the level of use of different strategies by teachers in developing biological drawing skills in learners. The results indicate that only 1 teacher out of the six sampled teachers intentionally planned and actually taught learners biological drawing skills. A large number (4) occasionally taught drawing skills. This is an indicator that they do not often plan and teach the learners biological drawing skills. They only mention to learners in passing how to draw biological drawings made by students. This is an indicator that students carry misconception about making of biological drawings from one level of learning to the next. This culminates in poor performance in biology KSCE.

The number of teachers who were not teaching learners drawing skills was 2 out of the six sampled teachers. This is a very large number considering the importance of drawing skills in biology education. This could be due to low morale, amongst other factors. From the results shown in Table 1, none of the following approaches was specifically used by the teachers in developing biological drawing skills in learners:

i) Deliberate instruction on drawing of biological drawings

ii) Use of charts

iii) Class discussions

iv) Help of learners at individual level

From Table 1, majority of the teachers (4) in sampled schools occasionally taught how to make biological drawings and 2 totally did not. As mentioned earlier, this could be due to lack of knowledge on significance of drawing in the teaching and learning of Biology. A large number of them (5) occasionally used charts with good biological drawings and 1 did...
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Mean
Using group discussions to teach drawing of specimens
Testing on drawings
Assistance of students at individual level
Marking and correction of students' drawings
Teacher demonstration on how to draw specimen
Class discussion on drawing
Provision of charts with good drawings
Provision of text books with good drawings
Teaching learners how to draw specimen

The strategy used by most teachers was continuous in
enrolment and heavy work load amongst other
factors.

The strategy used by most teachers was continuous assessment tests. Those who reported to be using it
occasionally were 5 and only 1 used it occasionally in
the sampled schools. This indicates that at least all teachers evaluate learners on drawings and diagrams in one way or another. However, it is ironical to evaluate what has not been taught. Majority of the teachers (5) in the sampled schools occasionally used
strategy in developing any skill. It gives a chance to learners to interact and share ideas freely. From Table
1, four of the teachers in the sampled schools occasionally used this strategy and 2 did not. From teachers’ perspective, the least used strategy was assistance of learners at individual level. Only 1 of
the respondents occasionally used this strategy and 5 did not use it at all. The results agree with those from
the students. This could be attributed to over enrolment and heavy work load.

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occasionally were 5 and only 1 used it occasionally in
the sampled schools. This indicates that at least all teachers evaluate learners on drawings and diagrams in one way or another. However, it is ironical to evaluate what has not been taught. Majority of the teachers (5) in the sampled schools occasionally used
demonstration on how to make biological drawings; only 1 used this strategy often. This indicates that
Biology teachers do not give the teaching of drawing skills the seriousness it deserves. This could be due to
the assumption that learners know how to make biological drawings; hence there is no need to put
emphasis on it. This assumption is impacting negatively on student’s performance in Biology, especially in practical examinations where a lot of drawing is required.

From the results it is evident that majority of the learners go through the secondary school system
without having developed biological drawing skills. This laxity in developing drawing skills is
detrimental to the development of scientific skills like observation inference, interpretation, among others. Laxity in developing drawing skills in learners is one of the major factors contributing to dismal performance in biology examinations at national level.

Table 1: Strategies used by Teachers to Develop Drawing Skills in Biology

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Yes</th>
<th>Sometimes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching learners how to draw specimens</td>
<td>00</td>
<td>04</td>
<td>02</td>
</tr>
<tr>
<td>Provision of text books with good drawings</td>
<td>01</td>
<td>04</td>
<td>01</td>
</tr>
<tr>
<td>Provision of charts with good drawings</td>
<td>00</td>
<td>05</td>
<td>01</td>
</tr>
<tr>
<td>Class discussion on drawing</td>
<td>00</td>
<td>04</td>
<td>02</td>
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<tr>
<td>Teacher demonstration on how to draw specimen</td>
<td>01</td>
<td>05</td>
<td>00</td>
</tr>
<tr>
<td>Marking and correction of students’ drawings</td>
<td>02</td>
<td>03</td>
<td>01</td>
</tr>
<tr>
<td>Assistance of students at individual level</td>
<td>00</td>
<td>01</td>
<td>05</td>
</tr>
<tr>
<td>Testing on drawings</td>
<td>01</td>
<td>05</td>
<td>00</td>
</tr>
<tr>
<td>Engaging learners in practicals requiring drawing</td>
<td>01</td>
<td>04</td>
<td>01</td>
</tr>
<tr>
<td>Using group discussions to teach drawing of specimens</td>
<td>04</td>
<td>02</td>
<td>03</td>
</tr>
<tr>
<td>Mean</td>
<td>0.7</td>
<td>3.7</td>
<td>1.6</td>
</tr>
</tbody>
</table>

CONCLUSIONS
The study has shown that majority of the students lack biological drawing skills and that this is
negatively impacting on their performance in Biology. In addition, the strategies used in helping
students develop drawing skills in Biology are not adequate. For any one given strategy, less than 50%
of the respondents were deliberately exposed to it in an effort to develop drawing skills. In some schools,
the strategies are not used at all. The author of this paper, therefore, recommends that there should be a
continuous in-service of practicing teachers and participation in workshops and conferences is
required to update them on new innovations in science teaching. Such forums are also important as
they enable participants to share their expertise with colleagues. Moreover, teachers should use a variety
of approaches in helping students develop drawing skills. This is because students have different learning
rates. Some are slow and others are quick to learn.
REFERENCES


