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Assessing the Reasoning Skills of Biology Students in Selected Senior High Schools in Ghana

Charles Agyei Amoah
Department of Science, OLA College of Education, Ghana
Nathan Ohene Gyang
Department of Science, Akrokeri College of Education, Ghana
Akorfa Akosua Agbosu
Department of Science, Akrokeri College of Education, Ghana

Abstract
This study is on assessing laboratory skills of biology students in selected senior high schools. One public/government science school offering biology was selected randomly and one private science school offering biology was also selected purposively for this study. A task was developed to assess the laboratory skills in reasoning. Mann-Whitney U tests was used to analyze the scores. On gender difference in the achievement of the reasoning skills, males scored higher than females but the result was not statistically significant. On school type, private school students scored higher than public school students but the results were however not statistically significant. It was recommended that students from both private and public school must be made to perform more science activities that require them to do more reasoning in order to develop their reasoning skills.

Keywords: *Assessment, reasoning skills*

1. Introduction

One of the general aims of the teaching syllabus for Biology at the Senior High School in Ghana states that"The syllabus is designed to help students develop science practical skills required to work with scientific equipment, biological materials and living things" (Ministry of Education, Science and Sports[MOESS], 2008, p1). Some of these science practical skills include reasoning, inferencing, planning, observing and many others.The curriculum also states that laboratory work should include inquiry skills: identifying problems, generating research questions, planning and conducting investigations, formulating hypothesis, communicating, reasoning and defending explanations (Hofstein &Lunetta, 2003). However, most laboratory work does not cover these goals.

2. Theoretical Framework

Reasoning skills are major contributors to academic and everyday life success. Science education reform document have long emphasized helping students develop scientific reasoning skills as a major goal for science education. Educators believe that reasoning skills play an important role in students' ability to develop scientific understanding and conduct scientific investigation (Lawson, Banks & Logvin, 2007). Scientific reasoning skills mark the development of adolescent cognition and are often demanded for effective decision-making and problem-solving (Holyoak & Morrison, 2005). There have been several research studies in science education and in the field of cognitive and developmental psychology which indicates that students' reasoning in both academic and everyday life context is inadequate (Zimmerman, Raghavan & Sartoris, 2003).

In other research studies, a number of factors have been enumerated as having influence on students' ability to reason scientifically. These include cognitive, motivational and contextual.

Lawson (2005) regarded formal or advanced reasoning as largely hypothetico-deductive in structure and consisting of a number of interrelated aspect or schemata that functions independently depending on the situation or task. Sungur and Tekkaya (2003) revealed that boys and girls do not differ significantly in their reasoning ability in human circulatory system even though boys scored higher than girls.

3. Statement of the Problem

From the Chief Examiners' report of West African Examination Council (WAEC, 2001-2008) it is clear that the poor West African Senior Secondary Certificate Examination (WASSCE) results in biology can be attributed to lack of students'

competence in the skills of reasoning during practical work. Reid and Shah (2007) also found in their study that students do not show satisfactory competence when confronted with practical issues in the laboratory. This was also confirmed by Ossei-Anto (1996) in his study in optics. The biology students in SHS in the Birim Central Municipality are no exception to the situation. It is of concern therefore to assess the reasoning skills of science students in SHS biology to determine whether they have the skills of reasoning.

4. Purpose of the Study

The purpose of the study was to determine whether Senior High School Form 3 Biology students have the skills of reasoning.

4.1. Research Questions

Specifically, the study was guided by the following research questions:

1.Is there a significant difference between the male and female elective biology students in their proficiencies in the laboratory skills of reasoning?

2.Is there a significant difference between private and public school elective biology students in their proficiencies in laboratory skills of reasoning?

5. Methodology

In this study a survey design was used but the study adopted the "Basic Skills Assessment" approach or method. All SHS year 3 elective biology students in the Birim Central Municipality of the Eastern Region of Ghana were used. Each class was made up of an average of 45 students. There are four schools offering biology with an estimated population of 180 students offering elective biology. This constituted the target population.Three of the schools are government /public schools and the other one a private school.Students from two schools were used for the study. The two schools consisted of one public and one private school. The private school was purposively sampled. This was because it was the only private school offering biology in the district. One public school was selected from among three schools using the computer generated random numbers.There was only one science class in the private school that was used for the study. In the public school, there were three science classes but students from one class who were available during the day of the study were used. In all, 86 students were used consisting of 30 students from the private school and 56 students from the public school.

5.1. Instruments

Performance task instruments were developed and were non-traditional. The task was for reasoning. The task was to show osmosis in a living tissue. Each student was given three yam tubers and they were asked to perform an experiment to demonstrate osmosis in a living tissue. The task was given background information relevant to the problem posed. Students were given three minutes to read the task and 25 minutes to complete it.

6. Findings

Results of the Mann- Whitney U Test of the Sex Differences in the Reasoning Skills

Sex	N	Mean Rank	Z	P-value
Male	25	52.79	-2.71	0.07
Female	61	37.93		
Total	86			

Table 1

Significance: P<0.05

A Mann-Whitney U test was conducted to find out which of the sexes is more proficient in the skill of reasoning. The result of the test for the reasoning skill was not statistically significant, z = -2.707, p = 0.07(two-tailed), Mann-Whitney U = 528.00. The males had a mean rank of 52.79, while the females had a mean rank 37.93. This therefore indicates that the students (males and females) were performing at similar levels.

The results from Table 1 indicate that the mean rank of the males is higher than those of the females in the skill of reasoning. This suggests that the males scored higher than the female. Even though females have acquired the skill of reasoning, males can do it better and be more critical. This result is consistent with the result of the study conducted by Sungur and Tekkaya (2003). Their study revealed that boys and girls do not differ significantly in their reasoning ability in human circulatory system even though boys scored higher than girls. This result seemed to be not surprising considering the findings in the literature that shows that boys perform better than girls in the physical sciences whiles the difference is not very large in other subject areas (Young & Fraser, 1994).

One reason that could be assigned to the lower reasoning skills of the females in this study is that during the reasoning stage, most of them were not confident and they even wanted to discuss with their peers especially the males. This outcome or observation is similar to that of Baker and Leary (2003) who found that girls in their study expressed strong feelings for more interaction with their peers in their repeated request for group work, partners and more discussion.

Results of Mann-Whitney U Test of the Difference between Public and Private School Students in Reasoning Skills.

School type	N	Mean Rank	Z	P-value
Private	30		-0.75	0.45
Public	56			
Total	86			

Table 2
Significance: P < 0.05

A Mann-Whitney U test was conducted to find out students from which of the school type (public/private) is more proficient in the skill of reasoning. The result of the test for the reasoning skill for school type (public/private) was not statistically significant, z = -0.75, p = 0.45 (two-tailed), Mann-Whitney U = 745.500. The students from the private school had a mean rank of 45.65, while the students from the public school had a mean rank 41.55. This therefore indicates that the students from both private and public school were performing at similar levels in the skill of reasoning. However, a look at the mean ranks indicates that the students from the private school scored higher than the students from public school on the skill of reasoning.

The result from the Table 2 indicates that students from private school scored higher than the students from public school on the skill of reasoning. The outcome implies that when students from private schools and public schools are taken through the same set of tasks in reasoning, the performance of the private school would be better than the public schools but the difference in their performance will not be significant. This result indicates that students from the private schools can carry out more scientific activities that require scientific reasoning than students in the public school even though the difference will not be significant. This could be attributed to the fact that private schools have the ability to provide better learning circumstances, such as a more extensive curriculum or fewer pupils per teacher. This situation enables the teacher to teach with meaning and insight and because the number of pupils per teacher is few, teachers therefore teach using the activity method of teaching where the students are placed at the centre of teaching and learning. With this, students carry out their own learning and the teacher only serve as a guide. Therefore, students discover knowledge on their own and for that matter are able to assign reasons to them. More so, since better learning circumstances are provided in the private schools' students have access to science kits and therefore hands-on science is done with ease. Hands-on science is also associated with eliciting higher-order thinking; students from the private schools are more likely to perform better when it comes to reasoning skills. Teachers must therefore teach science using the activity method or hands-on in order to stimulate students to think and reason more logically. Educational administrators must also admit fewer students in a class so that teachers can control them and teach them very well. The result of this study is however, not consistent with the result of the study conducted by Beaumont-Walters and Soyibo (2001). They found out in their study that government (public) high school students performed substantially higher and the difference was statistically significant than that of private high school students. They explained that students from the public schools performed better than students in the private school because many of them were probably academically superior, based on their mode of admission to their schools and also probably they enjoyed better teaching facilities and the services of the teachers are of better quality.

7. Conclusion

It can be concluded that males scored higher than females in the skills of reasoning but the difference in their scores was not statistically significant.Students from the private school scored higher than students from the public school in the skills of reasoning even though the difference in their score was not statistically significant. It is recommended that students from both private and public school must be made to perform more science activities that require them to do more reasoning in order to develop their reasoning skills.

8. References

i. Baker, D., & Leary, R. (2003). Letting girls speak out about science. Journal of Research in Science Teaching, 40(Suppl.), 5176-5200.
ii. Beaumont-Walters, Y., & Soyibo, K. (2001). An Analysis of High School Students' Performance on Five Integrated Science Process Skills. Research in Science and Technology Education, 19(2),133-145.
iii. Hofstein, A., & Lunetta, V. N. (2003). The laboratory in science education: Foundations for twenty-first century. Science Education, 88, 28-54.
iv. Holyoak, K. J., & Morrison, R. G. (2005). Thinking and reasoning: A reader's guide. In the Cambridge Handbook of Thinking and Reasoning. Cambridge: Cambridge University Press.
v. Lawson, A. E., Banks, D. L., & Logvin, M. (2007). Self-efficacy, reasoning ability and achievement in college biology. Journal of Research in Science Teaching, 44(5), 706-724.
vi. Lawson, A. E. (2005). What do test of formal reasoning actually measure? Journal of Research in Science Teaching, 42, 716-740.

vii. Ministry of Education, Science and Sports (MOESS), (2008). Teaching Syllabus for Biology (SHS). Curriculum Research and Development Division (CRDD).

viii. Ossei-Anto, T. A. (1996). Assessing Laboratory Skills of Students in Selected High School Physics Topics on Optics. Unpublished Doctoral Thesis. New York, Buffalo State, University of New York.

ix. Reid, N., & Shah, I. (2007). The role of laboratory work in University chemistry. Chemistry Education Research Practice, 8 (2), 172-185.

x. Sungur, S., & Tekkaya, C. (2003). Students' achievement in human circulatory system unit: The effect of reasoning ability and gender. Journal of Science Education and Technology, 12 (1), 59-64.

xi. West Africa Examination Council (2001). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press.

xii. West Africa Examination Council (2002). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press.

xiii. West Africa Examination Council (2003). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press.

xiv. West Africa Examination Council (2004). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press.

xv. West Africa Examination Council (2005). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press.

xvi. West Africa Examination Council (2006). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra. Wisdom Press.

xvii. West Africa Examination Council (2007). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press.

xviii. West Africa Examination Council (2008). Chief Examiners' Report on Senior Secondary School Certificate Examination. Accra: Wisdom Press

xix. Young, D. J., & Fraser, B. J. (1994). Gender differences in science achievement: Do school effects make a difference? Journal of Research in Science Teaching, 31 (8), 857- 871.

xx. Zimmerman, C., Raghavan, K., & Sartoris, M. L. (2003). The impact of the MARS curriculum on students' ability to coordinate theory and evidence. International Journal of Science Education, 25, 1247-1271.