The State of Science Practical Work in some Ghanaian Senior Secondary Schools

Joseph Ghartey Ampiah
Department of Science and Mathematics Education
University of Cape Coast

Abstract

The study investigated how schools organise science practical activities for students, and the constraints under which they were organised. Completed questionnaires were received from 50 science teachers in 9 out of the 18 senior secondary schools in the Central Region of Ghana offering elective science subjects. Twenty students and Heads of Science Departments were also interviewed in four case study schools. The information obtained suggests that there are inadequate exposure of students to laboratory training and practice in the schools as a result of time constraints, overloaded curricula and inadequate equipment. Hence West African Examinations Council must emphasise science process skills which do not require extensive use of the laboratory with its attendant constraints.

The literature on science practical activities shows that laboratories for the conduct of scientific research have existed at least since the seventeenth century. However, according to Jenkins (1998), the use of the science teaching laboratory, designed and equipped to teach science to students, is essentially a nineteenth-century phenomenon. The world war I in 1914-1918 opened the eyes of people to the importance of science teaching, and so since the beginning of the 20^{th} Century, there has been continuous increase in facilities and equipment suitable for practical science teaching. Currently, science practical activity has become an integral part of most new science programmes in developing countries Lockard cited in Lewin (1992).

The science syllabuses for Ghanaian Senior Secondary Schools (SSS) issued by the Ministry of Education (1990) and the West African Examinations Council (WAEC, 1998) have practical activity components to be conducted in a laboratory setting. The Curriculum Research and Development Division (CRDD) document is a teaching syllabus whilst the WAEC document is an examination syllabus. The WAEC syllabus from 1998 to 2000 for example, emphasizes students' acquisition of practical skills in biology, physics, and chemistry. For biology, students are expected to acquire (a) adequate laboratory and field skills in order to carry out and evaluate experiments and projects in biology and (b) the necessary scientific skills for example, observing, classifying and interpreting biological data.

For physics students are to (a) carry out experimental procedures using apparatus; (b) develop abilities, attitudes and skills that encourage efficient and safe practice; and (c) make and record observations, measurements and estimates with due regard to precision, accuracy and units. In chemistry the purpose of practical activity is to enable students (a) develop laboratory skills, including an awareness of hazards in the laboratory and the safety measures required to prevent them; (b) appreciate the scientific method which involves experimentation, accurate observation, recording, deduction and interpretation of scientific data.

To achieve some of these objectives, students must of necessity use the conventional approach of doing science in a laboratory. According to Osborne (1998), this kind of emphasis on laboratory work is "strongly associated with the conception that scientific knowledge is lying around out there to be discovered by the curious" (p. 171). This idea of tying science education to the laboratory has been the practice and culture of science teaching and learning since the nineteenth century (Hodson, 1990). It is therefore not surprising that the WAEC and CRDD syllabuses place emphasis on the manipulation of standard apparatus, the gathering of experimental data and the acquisition of laboratory skills. However, some of these skills are not tested directly by WAEC in a practical examination at the Senior Secondary School Certificate Examination (SSSCE).

Since the SSS science syllabuses (WAEC and CRDD) emphasize the acquisition of scientific skills, it is expected that students would go through the science practical activities to acquire the necessary skills and prepare for the final WAEC science practical examinations. With the provision of Science Resource Centres (SRCs) by the Ministry of Education (MOE), it is also expected that schools which do not have enough apparatus would have the opportunity to undertake more practical activities.

However, a variety of specific students' weaknesses in the science practical examinations have been reported by Chief Examiners over the past five years and this has cast serious doubts on SSS students' involvement in science practical activities in schools. The following are some of the persistent weaknesses which have been identified over the past seven years by Chief Examiners (WAEC Chief Examiners' report, 1995, 1996, 1999, 2000, 2001):

1. candidates have not been having adequate practical activities was shown by the answers provided;

2. it was clear from the answers that some candidates had not done any experiments along the lines tested at all;

3. candidates generally made statements of facts which clearly demonstrates that the suggested activities in the syllabus are not being carried out with any seriousness

4. most candidates did not show any sign of having done a simple recrystallisation in their lives;

5. candidates were incapable of critical analysis and interpretation of biological data.

These reports give the impression that students are either not taken through practical activities or do not take them seriously. The purpose of this study was therefore to find out how schools organise science practical activities, and also whether there were constraints under which they were done.

Participants

The Central Region had 49 SSS, with 18 of them offering all three elective science subjects (physics, chemistry and biology) at the time of this study. Of the 18 schools, 11 were SRC schools with the remaining seven constituting satellite schools. The schools categorized as SRC schools were locations, which hosted the SRCs. The satellite schools were schools which went to the SRCs for some of their science practical activities. Each school was assigned an identification number and proportionate simple random sampling was used to select four satellite schools and five SRC schools yielding a total of nine schools.

Fifty science teachers who were at post at the time of the research completed and returned their questionnaires. These were made up of 30 teachers from SRC schools and 20 from satellite schools. Four case-study schools were purposively selected from nine schools in order to gain more insight into teachers' views about science practical activities that emerged from the survey. Factors such as proximity and time constraints influenced the choice of schools. The four schools were named X, Y, W and Z. Schools X and Y had SRCs whilst schools W and Z were satellite schools.

In each of the four case study schools, four to six science students (depending on the number of streams in the school) were selected for focus group interview. Focus groups in each school were made up of the class prefect, assistant class prefect and two to four other students selected through simple random sampling. Schools W and X were categorised by the Ghana Education Service (GES) in the Central Region as well-endowed schools, whilst schools Y and Z were considered to be poorly endowed.

Instruments

The Questionnaire on the Organisation of Science Practical Work (QOSP) was designed after small-scale investigations on how science practical lessons were organised in three SSS in the Cape Coast Municipality. Discussions between me and nine science teachers (one each in biology, chemistry and physics) in the three schools who had been organising practical activities in their schools enabled me to formulate the questions for the QOSP. This also ensured that major areas of concern to teachers on the organization of science practical work were addressed in the formulation of the questions. The formulated questions were pre-tested in two schools (an SRC school and one of its Satellite schools in the Central Region) with the aim of ensuring that the QOSP fairly and comprehensively covered the items on science practical activities in the schools. The responses of the teachers were used to improve the questions. The questionnaire was validated by two experienced science educators in the Department of Science Education, at the University of Cape Coast. The final questionnaire used for the study had several parts. These included sections on biographical information (e.g. teaching experience, subject(s) taught at the SSS level), organisation of science practical activities (e.g. support given to students, number of times practical work was done on the average each week).

Semi-structured interview protocols were used to collect data from students and Heads of Science Departments (HODs) in the four case study schools. The semi-structured approach to interviewing was used, mainly to gather descriptive data in the subjects' own words to confirm or refute findings from the teachers' questionnaire. Since the study was based on a multi-site case study approach, it was necessary to ensure that data collected was of a comparable nature across interview subjects. Semi-structured interview schedules were therefore prepared for each category of respondents so that key issues were not overlooked and that similar agenda were covered in the interviews. This format also helped to raise issues of particular concern to the study. The interview schedules served as a guide so that interviews could proceed as naturally as possible.

Methods

I administered the QOSP with the assistance of Heads of Science Departments in the nine selected schools. Questionnaires were distributed to 60 science teachers of which 50 were returned. As much as possible, all questionnaires administered were collected by the third day. Expected respondents were reminded thrice after which they were abandoned if they had not still responded. This procedure resulted in an 83% return rate.

All interviewees were given assurances of confidentiality and anonymity at the beginning of each interview session. Students' interviews took place in a quiet and comfortable environment with little possibility of distraction or intrusion, so that students could talk freely. All interviews conducted in the study were recorded using an audio tape-recorder supplemented by note-taking with the permission of the interviewees. The Heads of Science Departments of the four selected schools were also interviewed. The purpose of the interview was to seek deeper insights into issues, which emerged from teachers' questionnaire and students' interviews. To ensure consistency and preserve the validity of the study, similar data collection techniques were used in all the four case study sites. In each of the four schools, focus group interviews were conducted with four to six science students (depending on the number of streams in the school).

The physics, chemistry and biology practical write-ups of all 20 students who took part in the interview sessions were examined to find out the type of practical activities they had undertaken, their frequency and their relationship to the science syllabuses.

The teachers' questionnaire was analysed using percentages of responses to the questions asked. Data gathered during interviews were analysed by reducing them to categories and themes, and interpreted to provide insights into laboratory science practical activities. All the interviews were transcribed. Even though this was time consuming, it helped to create familiarity with the data and hence aided the process of analysis.

Results and Discussion

Performance of science practical activities

A look through students' science practical notebooks in all four case study schools and subsequent interviews with them revealed that much attention was not paid to practical work in physics, chemistry and biology in the first two years of science teaching. It was not possible to ascertain the number of practical activities performed by science students just by looking at the records in their science practical notebooks. This is because in all the case study schools, students did not keep proper records of practical work done. It came to light during interview with students that data collected during practical activities were sometimes not recorded into their practical notebooks, or when recorded, no final write-ups were done. Also, students were allowed by their teachers to use pieces of paper to record and write up practical work they had done. Some of the few practical exercises that had been marked did not show dates and/or titles of the practical activities. The impression from students' practical notebooks was that teachers and students did not pay much attention to the write-ups and marking of practical work.

Table 1 shows the number of practical activities performed by students over a period of two and a half years at the time of this study (students' interviews were conducted in the last half of the third term of the academic year). What appear in Table 1' are the number of practical activities recorded in notebooks, pieces of paper. Zero means students did not perform any practical activities during that year. It can be seen from Table 1 that generally, students in SRC schools performed more practical activities than their counterparts in satellite schools. This is to be expected as SRCs have relatively better equipped laboratories for practical activities than satellite schools.

Table 1: Number of practical activities performed and recorded in physics, chemistry and biology by two school types

School/Subject		Number of practical activities per class			
		SSS1	SSS2	SSS3	Total
Physics	School Type				
W*	SAT	1	0	10	11
X*	SRC	2	5	6	13
Y	SRC	4	0	5	9
Z	SAT	1	0	2	3
Chemistry					
W*	SAT	1	0	9	10
X*	SRC	5	5	6	16
Y	SRC	0	2	6	8
Z	SAT	0	6	4	10
Biology					
W*	SAT	1	0	0	1
X*	SRC	3	5	5	13
Y	SRC	2	5	14	21
Z	SAT	0	0	10	10

*In the case of schools W and X with more than one stream, the number of practical activities recorded in the table is the highest among the streams.

A look at students' practical notebooks revealed that generally, over half the number of practical activities was not marked. The picture portrayed is that students performed very few practical activities during the first two years in the case study schools. As students in schools X and W put it

> In this school, we normally suspend the practical to SSS2 third term and SSS3. So in SSS1 and SSS2 we seldom do experiments. So we didn't do a lot of practical…the teacher was saying that because of our number we can't be doing practical with the SSS2 and the SSS3 students when we were in SSS1. At least we've got more time so our practical work could be suspended for some time so that when we get to SSS3 we will do more practicals (Student, School X).

> We were not going to the lab very often to do practical. Some of the students and the teachers did not take the practical classes seriously. Most of us thought that since we were in SSS2 maybe there was more time ahead so it is actually in SSS3 that we started practical so we didn't take the practical seriously from the beginning (Student, School W).

Since students had to be prepared for the WAEC practical examinations at the end of the third year, it was not surprising that more practical activities were done during the third year. Thus Table 1 shows that in all the schools except school X, students did not perform any physics and chemistry practical activities in SSS2. At least school Y could not complain about lack of apparatus, because it had an SRC. Students in schools Y and Z did not also perform any chemistry practical activities in SSS1. Also there were virtually no biology practical activities for students in school W. The situation in biology was not different in school Z in SSS1 and SSS2, except that the teachers decided to make up for practical work not done by doing more practical activities (10) with their students in SSS3. The situation for physics practical work in school Z was the worst.

According to students in school Z, when they were in SSS1, they performed only one physics practical activity which was on "Finding the refractive index of a glass block". Their notebooks confirmed this but they could not even complete this practical activity. In SSS2, they did not perform any practical activities in physics at all. In fact, at the time of this study, the students who were then in SSS3 had performed only two practical activities in Physics. The second practical activity conducted in SSS3 was done in the second term of the academic year. This was on the "Determination of the refractive index of glass using illuminated objects" as indicated in their notebooks. This was marked by the teacher and discussed with the students. Both practical activities done in SSS3 were on light experiments leaving experiments on mechanics, electricity, heat, and sound undone at the time of the study. According to the students, the first experiment in mechanics they performed took place during the mock practical examination in the third term of the academic year in SSS3. Speaking on behalf of her colleagues, a student in school Z remarked:

> The teacher told us to go and read about it. So we read about it and came to apply it in the examination. Some were able to take the readings

> and tabulate the results but how to come out with the graph was difficult. So we couldn't plot the graphs. Another problem we got was that as we swing the pendulum we wasted more time on it so some of us couldn't finish the experiment. (Student, School Z).

In the mock examination, students were asked to measure the diameter of a pendulum bob but they were not provided with vernier callipers because they were not available. The account of one of the students on how he tackled the measurement of the diameter of the pendulum bob is quite revealing:

> I have not seen vernier callipers before...I don't know whether we had it. I didn't do the measurement (Student, School Z).

The case study also produced comments from students which seem to suggest that end-of-term science practical examinations were rarely conducted by the schools either at the end of the term or year. Apart from school Y where students said they took an End-of-Term Practical Examination on two occasions, none of the other three schools organized any science practical examinations apart from the mock practical examination in SSS3. Some comments from students attest to this.

> The mock examination was the first practical examination we took (Student, School Z).
> Our first practical exam was the mock exam in April. This was the second term in the third year. In SSS2 we were told that we will do practical exams but they kept postponing it (Student, School X).
> Here we only have practical exams during mock, because the mock is supposed to be like the final exam (Student, School W).

The lack of practical activities in school Z, being a poorly resourced school, may seem to be an extreme case, but it was not very different from School W, which in comparison was better equipped. Table 1 shows that in a whole year in school W, there was only one practical activity each in physics, chemistry and biology in SSS1. According to the students, the chemistry practical activity in SSS1 was based on a past WAEC practical examination question, but they could not make much of it at that time. One student remarked:

> I remember our chemistry teacher gave us the question but he didn't show us anything about it. He just gave us the practical question to do. (Student, School W).

The only physics practical performed by students of school W in SSS1 was on finding the "Density of an irregular object". Again a student remarked:

> He showed us how to do the practical, and we wrote the instructions in our notebooks. We did the practical, but we didn't write it up for him to mark (Student, School W).

Students in school Y (SRC school) who had done relatively more practical work than those in school Z (satellite school) were worried that even though they had done more experiments in SSS3 than in SSS1 and SSS2 combined, they still had a lot more practical activities to do in order to gain enough experience and have better confidence before the final WAEC practical examination.

Teachers were asked in the teachers' questionnaire to indicate whether students were able to complete laboratory work and the subsequent write up within the period allocated for science practical. The responses are presented in Table 2. It can be seen from Table 2 that only one-half of the teachers (52.0%) indicated that students normally completed their laboratory work and write-up within the time allocated for practical activities. This ranges between 45 minutes to two hours. From Table 2, 88.0% of the teachers indicated that more often than not, students only completed the laboratory work. This means that the write up of the practical work had to be pushed to "after school" as data collection dominated the practical time.

Table 2: Percentage teachers' responses in each category on completion of laboratory work and write-up (N=50)

Items	Always	Very Often	Often	Never/Rarely
Students complete their lab work and write up	8.0	14.0	30.0	48.0
Students complete only lab work	20.0	50.0	18.0	12.0
Students do not complete lab work	0	4.0	12.0	84.0

Even though the emphasis on collecting data provides perspective and context for the students according to Wardle (1998), it is the ability to interpret and reason, which are higher order skills in science, that develop the understanding of the concepts and procedures involved. It is therefore clearly invalid and unconvincing in terms of developing students' understanding of science for them to just collect data in the name of carrying out practical work without allowing them to question, reason and draw conclusions from the data collected. It seems the main concern was for students to go through the practical activity and take some readings. What students did with the results and graphs plotted seemed not to be very important. This seems to be a common practice in all the four case study schools. Driver as cited in Wardle (1998) rightly reflected on this common approach to practical work when he stated that:

> Practical lessons end abruptly when the prescribed task is complete and little, if any, time is given to the interpretation of the results obtained, although this is just as important as the activity itself (p. 272).

As one student in school X put it:

> When we do the practical, the main concern is just how to get the values. That is the main thing we do towards the SSSCE. So in many cases we don't do a complete write-up. So far as we get our values and plot our graphs, we are okay. The main thing they are concerned with is the graph or how we get the table. So we don't normally write up the practical systematically (Student, School X).

According to the students in school Z, the lack of a biology teacher accounted for their not performing any biology practical activities in SSS1. But the same cannot be said for the lack of physics practical activities in the same school in SSS1. The students had a physics teacher, but he did not conduct any practical sessions with them. Similarly, the other schools had teachers but practical sessions for students were scanty. In school W, the HOD agreed to the observation that emphasis was not put on science practical work for SSS1 students. He however, defended this practice by saying:

> We have a reason for that. The time table doesn't cater for science practical work. We have six periods for physics, and within those six periods, which is two periods a day, you cannot organize science practical. So it is not the fault of the teachers that the students do not do physics practical. At the same time if you look at the syllabus there are so many things to cover, and so you have to rush. So you are forced to cover most of the syllabus in the lower forms and later towards SSS3 then you do science practical with the students
> (HOD, School W).

According to the HOD, an attempt was always made in the final year to make up somehow, for practical work neglected the first two years, so that at least students would be able to take the WAEC science practical examinations. It is therefore fair to conclude from the multi-site case study evidence, that emphasis was not placed on the performance of science practical work in schools, especially in the first two years.

The nature of the questions in the WAEC practical examination seems to promote this lack of emphasis on regular practical work according to the HODs. One HOD indicated that some areas in the WAEC Biology practical examination for example, could be handled by students once they were conversant with the theory aspect. The WAEC biology practical examination is made up of the following five areas: (a) graphs (drawing and interpretation) (b) classification (c) identification of specimen (d) description of experiments (supposed to have been conducted by students) and (e) drawing of specimen. According to the HODs and students interviewed, (a) to (c) constitute techniques which are taught with virtually no practical activities. According to the HODs it is only (d) and (c) that students needed to have some practice, to be able to describe or draw during the practical examination. If this is the case, then it means some of the practical activities relevant to the WAEC biology practical examination do not relate strictly to laboratory tasks but to general cognitive competencies. Since teachers seem to be aware of this, they do not put so much emphasis on practical activities in all five areas. Fortunately for teachers and students, in physics and chemistry, practical work constitutes only 20% of the total score, and so poor performance in the practical examination may not adversely affect students' final grades; provided they perform very well in the theory papers. In biology, practical work takes up almost a third (30%) of the total marks for the biology examination. Students' performance in biology is therefore more likely to be affected by poor performance in biology practical activities compared to physics and chemistry. However, if the claim by HODs that a sizeable amount of the biology practical examination could be handled by students without necessarily going through practical work, then the lack of practical work may also not adversely affect students who have mastered the theory work in biology and could handle (a) to (c).

One way of reducing frustration on the part of students during science practical work is supporting them before and during practical activities. In the teachers' questionnaire and during focus group interviews, teachers and students were asked to indicate the kind of support they received and the source of that support. About 42.0% of science teachers indicated that they and their laboratory assistants gave support to students whilst 20.0% of the teachers indicated that students received support from only science teachers. Another 22.0% indicated that students received support from science teachers, laboratory assistants and their fellow students. Asked to state who students received most support from, 76.0% of the teachers stated that they provided the most support to students.

The survey of teachers' views in the nine schools shows that 76% indicated that they conducted pre-laboratory discussions with their students whilst 24% did not do so. Case study evidence shows that pre-laboratory discussion in the schools depended on which teacher was involved. In some schools, teachers organised pre-laboratory discussions whilst others did not. Also, teachers sometimes organised pre-laboratory sessions on some occasions but did not do so on other occasions. There was therefore no standard practice across the schools on the organisation of pre-laboratory sessions for practical activities. According to Hodson (1993) the "only effective way to learn to do science is by doing science, alongside a skilled and experienced practitioner who can provide on-the-job-support" (p. 120). Responses to the teachers' questionnaire show that all the teachers indicated that they give support to their students during science practical activities. However, the evidence from the case study schools shows that professional support for students differed from one science subject to another, and also from one school to another. In fact, in some cases, students indicated that no support at all was given to them contrary to the responses given by the teachers. When students were asked how helpful their teachers were when it came to practical work, and whether their teachers were always present to give them support, those in school Z, for example, indicated that they did not receive much support during practical activities in physics. In biology and chemistry however, their teachers together with laboratory assistants, and their own colleagues gave them a lot of support. Students in school W also indicated that they received a lot of support from their chemistry teachers but not from their physics teachers. The following comments from different schools express students' views on support given by teachers during practical work.

> In chemistry the teacher will explain everything to us and give us an example, and set up the apparatus for us to do. When we have any problems the teacher is there to help us (Student, School Z).
>
> For the few physics practical we have done the teacher was very helpful. He went round and showed us how to do things. But for chemistry, he just gives us the apparatus and expects us to be able to go through and later we discuss (Student, School X).
>
> In my class the science teachers are not too helpful, whether physics, chemistry or biology. Even though they are always present when we do our practical they do not come to see what we are doing (Student, School W).

Students cherished support from their fellow students as the following quotations from students show:

> When you can't do an experiment and you see that someone has been able to do it you call him to come and help you. The teacher would still be in the laboratory. Sometimes we call the teacher. But we have seen that sometimes if we call our colleagues they are able to explain it to us better. This happened in the glass block and titration experiments. (Student, School Z)
> Sometimes we receive more help from fellow students than the teachers. When we need help during practical we call the teacher or our friends to help us. I understand it better from my friends. (Student, School W)

The comments from these students in the case study schools seem to suggest that their teachers did not always give them the needed support during science practical activities. This lack of support is likely to breed frustration, which could even result in dislike for science practical work.

Science teachers from both SRC and satellite schools enumerated problems in two areas. These are (a) lack of apparatus and equipment needed for some of the practical activities and (b) time constraint coupled with work overload. These will be discussed in detail in the next two sections.

Time allocation for science practical work

Time allotted for science practical activities constitutes a critical dimension of the problem of lack of practical work in the schools as seen in the previous section. In this section, the issue of time is explored using responses and comments from both case study schools and teachers' survey data.

Asked whether practical periods were officially allocated on time tables, 38.0% of science teachers who responded to the questionnaire stated that their time tables did not show any time for science practical work. The remaining 62.0% who indicated that their time tables had periods allocated for science practical work gave a range of two to four periods per week for science practical activities. Science practical periods therefore differed from one school to the other as well as from one subject to the other. Periods for science practical work were seen to be inadequate by 68.0% of the teachers.

In schools where practical periods were allocated on the time table, teachers indicated that they usually used them for theory work. In school X for example, there were three periods for practical work and five periods for theory but HODs indicated that teachers used all the eight periods for theory. According to the teachers, the eight periods were even not sufficient and some teachers had to resort to afternoon classes for the teaching of more theory. Some teachers even used some afternoons and weekends to enable them conduct practical activities with their students. The HOD of school X felt that there was inadequate time even for the coverage of science theory prescribed by the syllabuses and this affected practical work.

> We have not been able to cover the syllabus using the normal time. We have to use afternoon classes. That is what we have been doing over the years. If you use the normal time you will not finish and those who are not prepared to go into extra classes are those who are not performing the practical (HOD, School X).

All the HODs shared this opinion. According to them, the number of periods allocated for science lessons (ranging between 6 to 8 periods a week) was not enough. The priority was therefore for teachers to concentrate on the theory part of science and make up for the practical work later. This is what leads to science practical activities not being emphasized in SSS1 and SSS2. Time constraint appears to be a particularly serious problem as the HODs used it to justify the inability of science teachers to conduct adequate science practical activities with students. The reasons given by the HODs suggest that teachers were not ignorant of the need for practical work, but the constraints of time among other factors made them put more emphasis on the theory aspect.

> Sometimes when you look at the coverage of the syllabus I am sure that with time, teachers have realized that they should rather spend time giving the students theory, then when they have gotten enough theory they can take them through the practical (HOD, school X).

According to the HODs, teachers believe that somehow students would be able to perform the practical activities in the final examination once they get some little exposure. To enable students get exposure, practical activities are organized during the third term of the final year as Table 1 seems to portray. This state of affairs required that students perform a number of practical activities within a period of one or two hours. In all the case study schools, students indicated that they were made to perform more than one practical activity during any practical session especially during the final year. Half of the students will be in one room performing one set of practical activity, whilst the other half would be in another room performing a different set of activities and after an hour or so students will swap. Science teachers used the limited time available to conduct as many practical activities as possible in SSS3, to enable students prepare for the science practical examinations. According to students in school X for example, sometimes they performed as many as four practical activities in groups within two hours.

> Sometimes for only three periods we are made to do so many different practical activities sometimes four different practical; one on resonance tube, sonometer box, one on heat, one on electricity (Student, School X).

This situation led to students not writing up the practical activity for marking by their teachers. The purpose this kind of exercise serves is only to enable students become familiar with a number of different practical activities. During this period, emphasis on practical work is examination driven, as the following comment seem to portray:

Essentially, what is happening now is that we are only training the students to go and pass the practical examination. Honestly, if the practical is supposed to serve a purpose then it is supposed to complement the theory. But here is the situation where you have done the theory and you are now coming to do the practical so it's not serving any purpose. The practical is supposed to help them pass the examination (HOD, School W).

Also students were made to work in groups due to lack of adequate number of equipment and space. This made participation in practical activities by all members of a group impossible. Many students therefore end up not benefiting from practical activities due to insufficient time to set up the apparatus themselves and take their own readings. Consequently, students have difficulty handling glassware and working independently when it comes to practical examinations. HODs also indicated that students get frustrated with practical work due to faulty apparatus. It is therefore not surprising that students' attitude to science practical work is influenced by the use of science equipment (Ampiah, 2004).

Analysis of the teachers' questionnaire shows that 88.0% of teachers indicated that their school laboratories were not equipped with adequate apparatus considering the number of students pursuing science. In school Z, the HOD admitted that the school did not have enough apparatus to do practical work. In physics, items such as cells, metre rule, calorimeters, vernier callipers, weights, micrometer screw gauge among others were not available in the school, and had to be borrowed from another school over 20 km away. School Z was therefore a typical poorly resourced school and clearly did not meet the conditions set by the science syllabuses of having a well-equipped laboratory in order for the school to offer science. The situation in school Z was indeed very discouraging, and put a limit on the number of practical activities students could perform. Students in this school were expected to go to the SRC about 20 km away since their laboratory was poorly equipped for performing basic science practical activities. However, this was not for free as the school had to pay for fuel for the bus to convey the students as well as pay for consumables for the practical activities especially in chemistry and biology. According to the HOD, the school did not have the money to pay these bills for students to go to the SRC. Also since the number of students in SSS3 was only 15, it was not cost effective transporting this small number of students in a big bus, which takes over 70 students. Due to this situation, students in SSS3 had never been to the SRC for the two and half years they had been in the school. The HOD of school Z indicated that where apparatus were available for the kind of science practical activities teachers wanted students to perform, students were made to do them. However, during mock and final WAEC practical examinations they always borrowed apparatus from other schools to enable students take the examinations. This could however, not be done for normal school practical work. One therefore wonders how students could out of the blue and with very little experience in practical work be able to perform experiments in WAEC science practical examinations. Instructions from WAEC to the science teachers categorically state that the purpose of the practical test is to find out whether the candidates can carry out simple practical work themselves.

Even for SRC schools, sometimes the inability of students to conduct practical activities was due to the cost involved in purchasing equipment and consumables. For example, the HOD of school X indicated that for chemistry practical alone, the school had to purchase about five to six million cedis worth of equipment before students could take the final WAEC practical examination. According to him, even though conducting practical activities was very expensive, students did not necessarily pay more for offering science. Due to this, expensive practical work could not be done on regular basis. Similar sentiments were expressed by the other HODs.

Conclusion

The case of these four schools has provided considerable evidence to confirm allegations made by Chief Examiners over the years that the nature of students' weaknesses in the practical examination cast serious doubts on students' involvement in practical activities. This has been acknowledged in the comments and views expressed by students, science teachers, and HODs in the case study schools. It would however, be misleading to suggest that science teachers were unappreciative of the need for practical activities to be performed by their students. The wider picture from this study suggests that mitigating circumstances (lack of equipment, overloaded curriculum) constrain schools and teachers to organise science practical activities to be performed by students. In the SRC schools, teachers complained about insufficient apparatus for some of the practical activities they wanted to conduct. In most cases therefore, it was not a question of non-availability of equipment or apparatus but rather adequacy. If apparatus are either not available or insufficient in some SRC schools, then teachers do not know where else to turn for help. In the satellite schools, teachers complained about poorly equipped laboratories

The finding that time allocation problems and inadequate equipment which results in most students not playing active roles in the performance of science practical work suggests that the organisation of practical work in the schools faces a lot of challenges. There is ample evidence from interviews and observation of students' record of practical work to conclude that practical activities were not organized regularly for students, particularly, in the first two years. However, attempts were always made in the final year to make up somehow for practical work neglected in SSS1 and SSS2 to enable students take the WAEC science practical examinations. Students were therefore, not given enough opportunity to use laboratory based practical activity to solve problems, construct relevant science knowledge, undertake scientific investigations, and promote inquiry in the lower forms and at regular periods. This could make students feel less confident when it car to practical work. The result of this inadequate exposure to practic activities and lack of adequate practice give credence to Chief Examine observation about students not performing enough practical activities.

In the final year, most of the practical activities were organised prepare students particularly for the final WAEC practical examinatic Even where practical periods were fixed on the timetable, teachers norma used them to teach science theory. Similar findings have been reported b Caillods, Gottelmann-Duret and Lewin (1996) in a study of scien education in some African, South American and Asian countries.

Implication

Undoubtedly, the acquisition of laboratory skills will requi laboratories equipped with all the necessary equipment for students to b able to practice and gain the necessary manipulative and recording skill However, given the organisational problems associated with practical wo faced by these schools which could be a reflection of what may b happening in other schools, it should be possible for the WAEC not to p heavy emphasis on the collection and recording of raw data during th examination. It is pertinent to note that the external WAEC practic examination does not directly assess laboratory skills. Laboratory skills a necessary only for the collection of raw data by students during the WAE practical examinations. The rest of the skills are not laboratory-based. Th WAEC practical examination could focus on observation, usin photographs and graphs, processing and interpretation of data, experimen design, reasoning, and problem solving skills using appropriate diagra and charts without students first collecting raw data and recording the The CRDD elective science syllabus could put emphasis on the use demonstrations, simulations, video presentations, and science kits necessary and sufficient means of teaching these skills at the SSS level.

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