



Physics Teachers' Views and Practices on the Assessment of Students' Practical Work Skills

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Abstract

Practical work must be assessed in a way that will promote the development of key skills necessary for destinations beyond the physics school laboratory. This paper reports on a study which sought to find out teachers' views and practices on the assessment of Advanced Level ('A' level) physics students' practical work skills. Individual interviews and focus group discussions were conducted to get physics teachers' views and practices on practical work skills assessment.

The views of physics teachers were that the current method of practical work assessment used by the Zimbabwe Schools Examination Council (Zimsec) is not efficient in encouraging students to develop a variety of practical work skills as students concentrated on mastering presentation and analysis skills at the expense of other crucial practical work skills like equipment manipulation, observational, planning and designing. The study recommends that alternative methods of practical work assessment that integrates both direct assessment of practical work skills (DAPS) and indirect assessment of practical work skills (IAPS) should be used to ensure valid and reliable assessment of practical work skills of 'A' level physics students.

Keywords: assessment, direct assessment of practical work skills, indirect assessment of practical work skills, physics practical work, practical work skills

INTRODUCTION

In Zimbabwe, students who pursue a two year advanced level ('A'-Level) physics curriculum are expected to write a two and half hour practical work examination at the end of the study in addition to a similar examination on theory which takes approximately four hours. This examination is set by the Zimbabwe School Examination Council (Zimsec) - a board responsible for examining candidates at both primary and secondary school levels. Requirements of the 'A' level physics syllabus (9188) include that the students should sit for practical work examination and produce a practical work report. The assessment is based on the submitted practical work report at the end of the practical work examination. During this examination, students are expected to do a total of three practical work activities. The activities are in mechanics, electricity and one design practical developed from any other section of the syllabus. As a way of preparing students for the final

practical work examination during the two year course, students are normally exposed to do practical tests every week or fortnightly. The practical sessions are done under the guidance of a technician with minimum help from the physics teacher. The physics teacher normally will be interested in marking the submitted final report without much to do with the processes of doing the practical work activities. It is against this background that this study would like to find out teachers' perceptions on such a system in developing other practical work skills of 'A' level physics students apart from presentation skills. For the purpose of this study the other skills which students are expected to develop will be broadly categorised under manipulation, observation and designing. Zimsec physics marking guides show that marks are awarded basically for correct tabulation of results, graphical work and analysis of results at the expense of skills such as planning, equipment manipulation and observation among many others. Students therefore miss the opportunity to link

Contribution to the literature

- For students to develop a variety of practical work skills and to reduce chances of cheating, it is important to employ different practical work assessment methods that include DAPS and IAPS.
- Practical work is mainly assessed using IAPS because of lack of adequate time and resources to employ other models of assessment.
- DAPS is too subjective to accurately assign students grades during practical work sessions and also that corrupt and unprofessional examiners can easily inflate marks.

Table 1. A comparison of DAPS and IAPS

	DAPS	IAPS
What is the principle of assessment?	A student's competency at the manipulation of real objects is directly determined as they manifest a particular skill.	A student's competency at the manipulation of real objects is inferred from their data and/or reports of practical work they undertook.
How is the assessment undertaken?	Observations of students as they undertake a piece of practical work.	Marking of student reports written immediately after they undertook a piece of practical work.
Advantages	The validity is very high. It encourages teachers to ensure that students gain expertise at the practical skills that will be assessed.	More straightforward for those who are undertaking the assessment.
Disadvantages	More costly. Requires teachers or others to be trained to undertake the assessment. Has a greater moderation requirement.	The validity is low. Less likely to raise students' level of practical skills.

(Adapted from Reiss, Abrahams, & Sharpe, 2012, p. 6)

results with science process skills as argued by Hodson (2006).

Practical work plays an important role in the teaching and learning of science. As Millar (2004) postulates, practical work helps students to understand how scientists work. Learning needs to be contextualised to produce desirable results. If, and when well planned and effectively implemented, practical work situates students' learning in varying levels of inquiry where the students are both mentally and physically engaged (Lunnetta, Hofstein, & Clough, 2007). The rationale for practical work according to Dillon (2008), includes cognitive development of learners, skills development (manipulation, observation, measurement, prediction and inference), motivating learners, promoting scientific methods of thought and to elucidate theoretical work so as to aid learner comprehension. In addition, practical work also provides a training tool for students – especially in problem solving. This assertion could be corroborated by the postulation made by Stacey and Spielman (2014), who argued that experiments were in fact the essence of science, for studying science without practical work would be tantamount to studying literature without books. These are but some of the highlights on the importance of practical work in science teaching and learning – especially in physics; hence the need to assess practical work in a way that will bring the best results of students' capabilities.

The way in which practical work is assessed in high schools has a major bearing on the development of practical skills such as equipment manipulation, observation and designing. Mathews and McKenna

(2005), and Kennedy and Bennett (2005) point out that assessment of practical work in physics has continuously been a problem. It is important to determine useful skills relevant for real life which students would have to acquire. Reiss, Abrahams, and Sharpe (2012) argue that whilst practical skills in science are clearly valued and often referred to within literature, what has become evident is that there is lack of clarity as to what these skills actually are and how they might, most effectively, be validly assessed. Practical work is an important aspect of physics and its assessment should reflect this importance.

Reiss et al. (2012) identify two distinct ways in which practical work can be assessed, which are the direct assessment of practical work skills (DAPS) where students are assessed as they manipulate real objects to determine their level of competence in that skill and indirect assessment of practical skills (IAPS) where student's level of competency is inferred from their data and/or reports of practical work that they undertook. Table 1 gives a summary of the conceptions of Reiss et al. (2012) on DAPS and IAPS.

A review on the assessment of practical work found that some countries that are counted as high performing, particularly in science make use of substantial portion of direct assessment of practical skills when compared to countries such as Australia, England and Scotland for instance who rely mainly on indirect assessment (Abrahams, Reiss, & Sharpe, 2013).

It has been widely observed and concluded that some teachers – especially in science only teach to prepare the students for examinations. Suggestively, such teachers

failed to develop their pupils' real-life skills. Students from this kind of teaching and learning environment would lack proper attitudinal preparation which would assist them when confronted with real-life challenges – for example, livelihood generation among others. Gopal and Stears (2007) argue that all learning outcomes cannot readily be tapped through tests alone as a means of assessment. Roberts and Gott (2004) note that students have to be engaged in the process that scientists use to construct and apply knowledge. Based on this postulation, student assessment has therefore to be consequently designed and conducted on activities done by the students than to be based on reports. Major observations from reviewed literature postulate that IAPS is basically efficient but not effective and precise as compared to DAPS.

Purpose of the Present Study

The study solicits teachers' views on the development of practical work skills by 'A' level physics students when assessed through IAPS as opposed to DAPS. The study also sought physics teachers' practices on practical work assessment over the two year 'A' level physics curriculum. This study was guided by two research questions:

- How do 'A'-level physics teachers assess practical work skills of students during the course of their programme?
- What are the views of physics teachers on the relevance of practical work assessment practices on students' practical skills development?

RESEARCH METHODOLOGY

The qualitative research methodology was predominantly employed in this study. (Gray, 2011, p.166) defines qualitative research as "an approach that seeks to understand phenomena within its contextual specific settings and uses various theoretical stances and methods including the use of interviews, observations, questionnaires and document analysis." De Vaus (2008, p. 223) defines qualitative research as "an in-depth study of situation or phenomena where often participant observation and in-depth interviews are common". Qualitative research enables researcher to obtain data which upon interpretation brings an in-depth understanding of phenomena.

Research Design

A case study research design was employed in this study. De Vaus (2008, p.9) defines a research design as a "work plan or structure before data collection or analysis can commence including population sample, methods of data collection and analysis." Porta and Keating (2008, p. 226) defines a case study as a "research strategy based on the in-depth investigation of one or a small number of

phenomena in order to explore the configuration of each case and elucidate features of a larger class of similar phenomena". The case study design was suitable to find out teachers' views and practices on the assessment of 'A' level physics students' practical work skills. Views of the physics teachers were also important in determining how the assessment methods employed by 'A' level physics teachers influence the development of practical work skills of their students.

Sample of the Study

Two 'A' Level physics teachers at each school of the three purposively sampled schools in Harare province participated in the study. Purposive sampling was also employed to select a total of six physics teachers from the three schools. This comprised one teacher taking the lower sixth students and another one taking the upper sixth students at each of the three schools. It is important at this juncture to clarify the terms 'lower sixth' and 'upper sixth'. During the first year of the two year 'A' level physics curriculum, the students will be doing lower sixth and in the second year, the students will be doing upper sixth. One physics teacher will normally be teaching the lower sixth while list another one will be assigned to the upper sixth students. Purposive sampling was preferred because the researchers were targeting specific characteristics of the participants.

Research Instruments

Individual interviews were applied as data gathering method. According to Gray (2011), an interview is a powerful tool for obtaining rich data on people's views, attitudes and meanings that underpin their lives and behaviours. Open ended interviews were administered to two physics teachers at each sampled school to solicit their views on the way physics practical work is assessed as per Zimsec requirements. This was done through one on one interview with the physics teacher. The interviews were about thirty minutes long for each physics teacher. The focus of the interview was on the role of the teacher during physics practical work sessions, practical work skills that are developed by students during practical sessions, how these skills are assessed and perceptions of the physics teachers on the assessment of 'A'-level physics practical work and their recommendations.

Interviews were complemented by focus group discussions (FGD) with physics teachers at each school to get further information that could not be obtained during individual interviews. According to Gray (2011), focus group discussions require considerable amount of cooperation and enthusiasm from the participants. This is the reason why these were done at the end when the subjects were now used to the researchers thus were more confident and could easily open up as they had built a good rapport with the researchers. At least four

physics teachers participated during FGD at each of the purposively sampled schools. The group discussions focused on teachers' views and practices on the assessment of students' practical work skills. Some of the issues could not have been highlighted in a case of one to one interview with the teachers. This is so because new or alternative thinking can be triggered by an opinion which could have been raised by another subject. Some of the issues could not have been highlighted in a case of one to one interview with the physics teacher. This is so because new or alternative thinking can be triggered by an opinion which could have been raised by another subject.

Data Presentation and Analysis Procedures

Data analysis can be referred to as the conversion of raw data into useful information that will provide the most value to researchers according to (Jupp 2006, p. 161). A narrative approach (Creswell, 2007) was used in data presentation and analysis. Collected data were transcribed from FGD and interviews administered to 'A'- level physics teachers. This was done through categorising emerging themes from transcribed data in order to answer the research questions:

- How do 'A'- level physics teachers assess practical work skills of students during the course of their programme?
- What are the views of physics teachers on the relevance of practical work assessment practices on students' practical skills development?

A verbatim transcription is important in ensuring internal validity according to Gray (2011, p. 190). This was done for the data which were collected through interviewing physics teachers. The use of multiple cases was important in legitimising the results of the study. In this study representative reliability was catered for through purposively selecting physics teachers from three schools of different social and economic background. The researchers also sought permission from the ministry of primary and secondary education to carry out the research study in the sampled schools. The letter from the ministry was used to get entry into the schools as it is the law in Zimbabwe that one needs to be cleared first by the relevant ministry before carrying out any research study where teachers or students are involved.

RESULTS OF RESEARCH

The results of the study were based on two fundamental aspects as outlined by the research questions. The first aspect is on findings on teachers' practices on the assessment of 'A'-level physics practical work skills. The second aspect of the presentation and analysis is on the views of teachers on the relevance of the current practical work assessment methods in developing practical work skills of 'A' level physics

students. Teachers' views and practices were solicited on the assessment of physics practical work using both DAPS and IAPS. A narrative approach Creswell (2007), was used in data presentation and analysis where in some cases direct quotations of what the respondent would have said were used to present the findings before analysis.

Teachers' Practices on the Assessment of Physics Practical Work Skills

Teachers generally noted that they rarely assessed students during practical work sessions. The physics teachers rather relied mainly on the practical work report as a basis of their assessment. These sentiments were echoed both during individual interviews and FGD. The 'A' level physics teachers had varied views and practices on the aspect of students' skills which they assessed during practical work sessions. Despite the different views, it appears that there were common aspects in their practices. Basically, all the six interviewed teachers noted that they employed DAPS during the first two to three practical work sessions done in term one of the 'A' level physics study. In this case, the physics teachers assessed students' practical work skills during practical work sessions in broad areas of equipment manipulation, designing and observation. The six physics teachers gave feedback orally during practical sessions as a way of assisting students in practical work skills mastery. The aim was also to assist students in areas where they lacked competency. Thereafter the teachers noted that they then resorted to IAPS. IAPS was based on marking the submitted practical work report in order to come up with a grade.

One of the interviewed teachers has this to say when asked about the practical work skills that he assesses his students during practical work sessions:

Yah... basically what I try to do is during the first term of their form 5, the skills which I am concerned with are on planning, manipulation and more importantly data presentation and data analysis because basically at the end of the day you find Zimsec focuses more on these aspects. There after I will simply be marking the practical work report.

The insinuation of this teacher suggests assessment of learners in physics maybe influenced by the desire of the teachers to pass the learners in practical work examinations. This is done at the expense of inculcating basic practical work skills like manipulation, designing, planning and observation in students during the course of their programme. This argument is emanating from the fact that the physics teacher confessed that more emphasis is put on data presentation and analysis as students' assessment of practical work is based on the submitted practical work report.

Another teacher during FGD also noted that, direct assessment of practical work skills during practical sessions was simply done as a corrective measure than

using the scores to contribute to the practical work term mark as this mark was based solely from the mark which was obtained from the marked practical work report. The teacher has this to say when asked about the possibility of scoring students during practical work sessions:

It's a great idea but we rarely practice it because it is not the way at the end of the day how Zimsec assess students' practical work skills. We are under pressure from the school authorities to ensure that students pass examinations and as a teacher, I employ those techniques which I think will assist the student to pass the examination.

This quotation reaffirms the desire by physics teachers to ensure that students master presentation and analysis skills in order to pass examination at the expense of other equally important practical work skills. The teachers thus miss out on the opportunity to link these science process skills with presentation of students' reports. Another teacher was asked about the practical skills that he assesses the students during practical work sessions and he has this to say:

I do assessment on how students handle apparatus not for the purpose of scoring them but assisting them in mastering practical work skills

The teacher does not necessarily score students during practical work sessions but assists them to develop practical work skills that are vital to obtain correct results. The assistance that is given during practical work sessions is to ensure that the students will produce good practical work reports which are used as the basis of assessment. The reasons given by the teacher for not scoring students during practical work sessions were mainly based on the factors of time and manpower. The teacher argued that more time would be needed to effectively assess students. The teacher also pointed out that there was need for more teachers to assist in the assessment as it could not be done by one teacher alone. The teacher however acknowledged the importance of scoring students during practical work sessions in order to develop other practical work skills of an 'A' level physics student.

It was noted that if the student's practical set up is wrong, the teacher simply corrects it without deducting any marks from the report. This is not in line with the practices of Zimsec as marks are deducted on the report if the student is assisted during the practical work session of the final examination. Asked why he was not doing it the Zimsec way, the teacher argued that if this punitive practice is put into effect during weekly practice, practical work sessions, then students will not be willing to ask questions, in the processing demotivating them. The teacher further argued that this was a deliberate move to encourage students to ask questions so that they get prompt assistance. The teacher regarded his action as part of the teaching and learning process. In the constructivist theory assessment is viewed as part of the learning process in which students

play a greater role in judging their own processes. This teacher was in a way protecting constructivist assessment and practices from the onslaught of test driven curricula as argued by Shepard (2000).

Physics teachers noted that though it is a great idea to assess students using DAPS, the teachers did not use the method and resort to IAPS a system which is used by Zimsec at the end of the course. Physics teachers ensure that students master presentation and analysis skills in order for them to pass examination at the expense of other equally important practical work skills. In a nutshell, the research findings reveal that physics teachers employed IAPS where students' level of competency is inferred from practical work reports submitted at the end of the practical work session.

Basically the kind of assessment which is done by the six physics teachers interviewed is almost the same. The teachers put more emphasis on result presentation and analysis than assessing students for the purpose of scoring them during practical work session. The major difference noted however was on the issue of deducting marks on the practical work report for the assistance given during practical sessions. The teachers gave very strong points on either side for their reasons for deducting or not deducting marks for the assistance rendered to students during practical work sessions. Three out of the six interviewed teachers said that they deducted up to two marks for assistance rendered to students during practical work sessions. In a nutshell physics teachers are not much worried about how students perform during practical work session but their scoring is based on the mark obtained by the student from the practical work report as per Zimsec prescription. This was the case both during individual interviews and FGD.

Teachers' Views on Practical Work Skills Assessment

The second aspect of the study as guided by the second research question was to solicit the views of teachers on the relevance of practical work skills assessment practices on students' practical work skill development. In trying to get teachers' views on the relevance of IAPS as is the current practice by Zimsec and generally the method of assessment that is employed by teachers in schools, questions on the advantages of IAPS over DAPS were asked to teachers. Their views on the disadvantages of IAPS were also sought. The same was done on the advantages and disadvantages of DAPS. When one teacher was asked about the advantages of IAPS this is what he had to say:

Uum you see, for example I can talk of cost cutting. I think cost cutting measures because it will be very difficult because maybe you need more resources to really observe students doing practical work and scoring. You cannot look at 8 to 10 students at a go you might need 2 or 3 assistants.

From the statement by the teacher it is clear that despite some disadvantages that maybe obvious, IAPS is employed by teachers as a cost cutting measure considering that more resources are needed in terms of human capital if DAPS is used. These resources according to the teacher may be in form of adequate equipment, time and laboratory space, and among others. The high teacher-student ratio which is typical in most developing countries like Zimbabwe was another reason for employing IAPS.

Asked whether practical work report gives a true reflection of the skills gained by the student during practical work session, another teacher has this to say:

It's a fair indication of following instructions but not of handling equipment or assembling. It's just an indication of how best a student has done but the process of the practical might not be clear, you are just marking someone whom you have not seen doing the practical activity.

It is clear from the teacher's statement that the practical work report is not an accurate document to use to assess students' practical work skills through inference as it does not give a true reflection of students' mastery of all practical work skills.

Asked on the possibility of passing the practical work examination from the assessment of the practical work report even though the student would have struggled during the practical work session, this is what one teacher had to say:

Well for the current Zimsec one, it is possible. It has been a possibility that even if they don't do the practicals well... aah ... and just present their things well, eer they can pass of course. These students can pass the practicals just by the way of presentation. This is because there are no like for the markers, hidden cameras nor video recordings to see that the work that has been presented has some positive relation with the practical activities which were done in the laboratory.

The statement by the teacher serves to show that if students master their presentation and analysis skills, there is a possibility of passing practical work examination from the practical work report marking. The statement confirms the notion that the practical work skills that are assessed and scored to determine the grade obtained by the student are not necessarily a reflection of the skills that are possessed by the candidate. This comment is of concern since it suggests that student can even pass the module without any practical skills at all. These students will be denied the opportunities of engagement and development of process skills provided for by practical work (Hodson, 2006).

During FGD, this is what one teacher had to say when asked about the challenges associated with indirect assessment of practical work skills:

Er, er ... this aah system seriously lacks aah, the hands on assessment practices. The current system of assessment which is being used by Zimsec to assess students is mainly concerned

with the write up. Yes, with a proper write up skills, a student can score even more than 14 out of 18 after failing to properly do the experiment.

The teacher is simply echoing the sentiments previously noted by another teacher that, with the current system of practical work assessment, it is possible for the candidate to pass without necessarily having the basic practical work skills. This shows the invalidity of the current method of practical work assessment used by Zimsec in developing other practical work skills of 'A' level physics students besides presentation and analysis skills. Alternative methods of practical work assessment in light of these concerns by important stakeholders like physics teachers need to be considered. It is not only the duty of these physics teachers alone to think of these alternative methods but it requires a range of stakeholders including the students themselves, parents, tertiary institutions and the industry at large to bring about change. Any change normally comes with a cost hence the need to involve different stakeholders.

It follows therefore that students are drilled on the tricks of passing the examination than being equipped with practical work skills that are crucial at destinations beyond the 'A' level physics laboratory. Students do practical work in order to pass examination than developing practical work skills reading from the statement by the teacher. One teacher also pointed out that, the practical work report does not give a true reflection of the skills gained by the student during practical work session as there is a possibility of cheating. This is what the teacher had to say:

You can still get the correct values without even using the proper skills .Some persons can even cheat, clever students those that are a bit genius, if they got probably two sets of values which are far away from each other, they can theoretically interpolate the other values and they can get away with it . Students can 'cook' results.

The teacher went on to say that some marking schemes just emphasise on getting some results and not necessarily accurate results and if these results are presented according to Zimsec's prescription on result tabulation and analysis, then according to the teacher that student is likely to pass. The teachers' views show that the current way of practical work assessment is flawed hence the need to completely change or argument it with alternative methods of practical work assessment.

Similar sentiments were echoed by the physics teachers during focus group discussions as a follow up on debatable issues that could not be clarified during one on one interview. FGD were also necessary considering the fact that alternative thinking can be triggered by an opinion which could have been raised by another subject. The researchers managed to conduct three FGD with physics teachers from the three schools. Results

from these discussions indicated that, teachers were mainly interested in marking the practical work report that was submitted at the end of the practical session. Physics teachers were more worried about developing in their students the presentation and analysis skills like tabulation of results, graphical work and result analysis than other skills like manipulation, planning and designing. Physics teachers were however aware of the importance of developing a variety of practical work skills to enable their students to develop other crucial practical work skills than simply concentrating on presentation and analysis. More emphasis was put on presentation and analysis of results as teachers were quite aware of the fact that the bulk of the marks were scored from presenting a good report than on following the correct procedure during practical work sessions.

Asked on the practical skills that the teacher assesses from the practical work report, one teacher during FGD has this to say:

Emphasis is on presentation of their work. At the table, I normally look for the presentation, have they drawn a table? Labelled some columns? The columns, do they have correct units ?, the data inside the table, has it been repeated? , is it consistent? Is it precise? On the graph there is labelling of titles, there is line thickness. The student, has he plotted all the points that are in the table or has he jumped some points?

These are similar sentiments that were expressed during individual interviews. The assessment is therefore based on the mastery of presentation and analysis skills than the ability to manipulate, observe, plan and design experimental procedures. Reflections of teachers who participated during FGD indicate that the practical work report is not an accurate document to use to assess students' practical work skills through inference as it does not give a true reflection of students' mastery of all practical work skills.

Asked on the challenges teacher face when marking practical work reports, this is what one teacher had to say:

Aamm, in order for me to mark correctly, what somebody has done I will have to carry out the whole experiment on my own. I will write it up on my own and compare with the marking scheme. Sometimes you will find that what the student would get is not exactly what you are getting and like if you look in the previous practical that you assessed about two students they had negative gradients and they were supposed to be positive gradients. To come up with a marking scheme it's involving. It's like you will also be writing the examination just like students.

The teacher's point is that there is no way a teacher can mark the physics practical work report using the marking scheme from the past examination paper only, without first doing the practical work activity. According to the teacher this system gives a lot of work to the teacher in preparing for the practical, look for relevant equipment and perform the experiment before

one can mark students' practical work reports. This according to the teacher is different when direct assessment of practical work skills is used where the teacher simply relies on the marking scheme. Physics teachers are aware of the problems associated with IAPS but are however pressed to use the method as it is one employed by Zimsec to assess students' practical work skills. Physics teachers noted that DAPS was not used by Zimsec because it was costly. One interviewed teacher had this to say:

DAPS is an expensive way of doing things but it's a good way but though in an expensive way. The student will benefit but for the system now, it's something that must have a good budget for it to be successful. The other issue or disadvantage that can come there is the issue of, ... you know with schools the issue of pass rates that might result in corruption and subjective assessment unlike marking practical work report.

Despite the noted disadvantages of IAPS, to some extent the method of practical work assessment used by Zimsec remains relevant as other options are beyond the reach of the country in terms of time and resources required for implementation.

DISCUSSION

The discussion is also guided by two fundamental aspects as inferred from the two research questions. These aspects are the practices of physics teachers on practical work assessment and the views of the physics teachers on the relevance of the current practical work assessment methods in developing practical work skills of physics students. The results show that the way the physics teachers assess the physics students' practical work skills is influenced by the desire to ensure that students pass practical work examinations. DAPS was simply done by the teachers as a corrective measure than for the purpose of grading the students. The rationale for IAPS was done to ensure that students master their presentation and analysis skills which are crucial for them to pass the final examination at the expense of other equally important practical work skills like manipulation, observation, planning and designing. (Buick, 2010, p.14) emphasises, "the need to assess skills rather than knowledge when assessing practical work". It is not possible to assess a wide range of skills through IAPS.

According to Gopal and Stears (2007, p. 16) "assessment is considered to be one of the most powerful influences on what and how teachers teach and what and how learners learn". It is necessary to come up with assessment techniques that strike a balance between the affective and cognitive domains. A review on the assessment of practical work found that countries considered to be high performing economically and technologically use substantial portion of direct assessment of practical skills as compared to those who

rely on IAPS according to Abrahams, Reiss and Sharpe (2013).

There is need to develop effective and efficient strategies and procedures for practical work assessment according to Bell and Cowie (2001). This can only be achieved if more emphasis is put towards skill based assessment. Nadji, Lachi and Blanton (2003) argue for a holistic assessment of practical work from lab based activities to practical work write ups. The teachers noted that DAPS was more relevant in developing practical work skills of 'A' level physics students than IAPS. Observations by Abrahams, Reiss and Sharpe (2013, p. 12) are that, "China, Singapore, New Zealand and Finland often described as high performing countries all make use of a substantial proportion of direct assessment of their students' practical science skills at some point in their schooling system." Treagust (2008) criticises practical work examinations as a means of assigning students to their grades in a summative manner. There is need to encourage breadth and variety in practical work assessment according to Lavonen and Laaksonen (2009). Mathews and McKenna (2005) concluded that the matter of assessing practical work remains a key issue in Irish education as elsewhere.

To summarise views on the relevance of practical work assessment method on the development of practical work skills of students, Abrahams, Reiss and Sharpe (2013, p. 228) has this to say: "If the intention is to determine competence, then direct assessment is the best, where as if the intention is to determine skill process, then indirect assessment would be the preferred option." Lunnetta, Hofstein and Clough (2007, p. 399) note that "using IAPS, teachers are less inclined to devote time and effort to develop students' practical skills". DAPS creates a product with life skills that are important beyond the 'A' level physics course despite the expenses in implementing it at school level. The views of the physics teachers who participated in the study were generally in line with what was reviewed in literature where emphasis is on DAPS if students are to develop a variety of practical work skills.

CONCLUSIONS AND RECOMMENDATIONS

What has emerged from this study is that teachers recognise the importance of practical work in science. They are also aware that it is not possible to assess a wide range of practical work skills through IAPS. The teachers are aware of the importance of forms of assessment used for practical work in Zimbabwe and have their position on merits and demerits.

The six physics teachers who participated during the study reveal that they rarely assess students' practical work skills during weekly practical work sessions in schools but mainly relied on the submitted practical work report from the views of teachers who participated

in the study, despite their awareness of shortcomings. Instead, practical work is mainly assessed using IAPS because of lack of adequate time and resources to employ other models of assessment, according to findings of this study.

The current method of practical work assessment does not encourage students to develop a variety of practical work skills of 'A' level physics students from the views of teachers who participated in the study. 'A' level physics teachers who participated in the study also noted that DAPS was too subjective to accurately assign students grades during practical work sessions and also that corrupt and unprofessional examiners could easily inflate marks. There is a possibility of cheating by students if IAPS is the only method used to assess students' practical work skills. This according to the teachers who participated in the study could be very difficult to detect from the report. This input from teachers raises concerns that cheating might actually been happening presently.

The physics teachers were of the general opinion that it was necessary to use both IAPS and DAPS when assessing students' practical work skills. Physics teachers also suggested the need to consider course work on the final practical work mark. Physics teachers noted the danger of leaving students poorly equipped in skills required in progression routes in sciences if students' practical work skills are only assessed through practical work reports. From the views of physics teachers, there is need to consider an integrative approach where different models of practical work assessment are combined. (Abrahams and Millar, 2008) refer to this kind of assessment as the embedded system. This idea of integration is supported by Erickson and Meyer (2003), Kennedy and Bennet (2005), Abrahams and Saglam (2010), and Reiss, Abrahams, and Sharpe (2012).

Practical work is an important aspect of the 'A' level physics curriculum and therefore must be assessed in a way that will enable students to develop a variety of practical work skills. The assessment of 'A' level physics practical work skills remains a thorny issue in the Zimbabwean science education system as probably elsewhere. There is need to rebrand the education system where it must be the responsibility of all stakeholders including industrialists, academics and the society at large as a means of value addition to science education.

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