SCIENCE PRACTICALS MANUAL

ZIMSEC

For Performance Measurement

INTRODUCTION

There is general agreement among educators that science plays a critical role in the development of a nation. This is more so with the proliferation of Information and Communication Technologies (ICTs). In recent years there has been a growing focus on the need to better prepare students for higher education and arm them with the skills and knowledge they will need to be successful innovators in a 21st century workforce. Science Education has gained popularity among educators, parents, corporates and institutions, as well as a way to fulfill this need

Previously, learning was centred on imparting theoretical knowledge, but the demands of the global economy as well as technology revolution led to the realization that there is an urgent need to focus on hands-on skills if our learners are to survive competitively in the global village. Teaching relevant, in demand skills that will prepare students to become innovators in an ever evolving world is paramount, not only for the future of these students but for the future of the country. Therefore, education should not be solely the ingestion of information, but the development of skills so that students can adapt to an uncertain world.

The lesson that needs to be learned here is that, if we want our learners to succeed in life, we must teach them how to think critically and solve problems. The best way to do that is to provide them with a good foundation in science education. We are all familiar with the adage "give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime." Too often we are feeding our students instead of teaching them how to feed themselves.

BACKGROUND

In the Science discipline at ordinary level, the outgoing syllabi assessed practical skills mainly through an alternative to practical component. The practical papers were there on the scheme of assessment but had low takers. In 2016 the majority of learners (213 983) studied Integrated Science as compared to 7 194 for Chemistry. The trend is similar when compared with other pure sciences for the past 30 years. Of the 7 194 Chemistry candidates only 431 took the practical test.

It has to be noted that Integrated Science denied many learners to proceed to Advanced level or to a science related career. The majority of schools (learners) taking the pure sciences were opting for the alternative to practical component. The question then was "were we really teaching/assessing science for economic and technological advancement or were we teaching the History of Science?"

Alternative to practical assessments have been criticised for assessing learning at lower levels of intellectual complexity, higher levels such critical thinking and analysis are not fully assessed. Other critiques argued that the education system was producing half backed science graduates who could not wire a three pin plug for example.

Graduates who lack science practical, technical and investigative skills will be ill equipped for progression to higher education, employment in science related fields, and for solving real life problems. Currently, Zimbabwe relies mainly on developed countries such as China, Japan, Korea and Malaysia on Technology in spite of the large number of learners taking Science at Ordinary level. Toothpicks for example are imported from China as if there are no trees in Zimbabwe.

Educating students in Science, if taught and assessed correctly, prepares students for life, regardless of the profession they choose to follow. Science is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world.

In a world that's becoming increasingly complex, where success is driven not only by *what* you know, but by what you *can do* with what you know, it's more important than ever for our youth to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information. These are the types of skills that students acquire when they are exposed to science practicals.

What is Science Practical Work?

Practical work is defined as a "hands-on" learning experience which prompts thinking about the world in which we live. Other scholars define it as teaching/learning activities which involve learners in observing and manipulating objects and materials. The Practical activities are made up of two major phases: Data collection and data interpretation.

The term, Practical work is more applicable than "Laboratory work" because location is not a critical feature in characterizing this kind of activity. Observing and or manipulation of objects does not necessarily require a Laboratory, this can be done anywhere, in an out of school setting, in the field or an ordinary classroom. Laboratories are expensive to construct and equip. Most of our Centres do not have adequate resources to acquire standard school laboratories hence the need to use ordinary classrooms.

Examples of typical practical activities that can be done in an ordinary classroom are:

- **Investigating the effect of temperature on the time taken for sugar to dissolve in water**
- **Investigating the immediate effects of exercise on heart rate**
- **Does a falling object keep speeding up during its fall?**

Non practical activities such as video recordings of events, photographs, diagrams, verbal accounts or computer simulations can only be used to let learners see events that cannot be done practically. Learners can get more complete data on what happens when a piece of magnesium is placed in dilute hydrochloric acid , or when two solutions are mixed and a precipitate is formed by doing and observing under Teacher supervision, than they could obtain from a verbal account or any other form of representation.

The Rationale for Practical work

Research has reported that, when done well, practical work can:

- stimulate and engage learners
- improve learners' scientific knowledge
- encourage learners to be independent and more self reliant
- enable learners to participate confidently and effectively in the modern world *"scientific literacy"*
- enable learners to acquire an understanding of hazard, risk and safe working
- provide the foundation for further study

- enable learners to acquire a range of practical (*planning, manipulation of equipment, observation ,data collection, recording and presentation, analysis, evaluation)* analytical and critical thinking skills

Developing and Implementing Practical Work

- it is time-consuming and costly to set up practical experiments
- teachers should **not** prepare experiments that are excessively costly, unrealistic or unfeasible. It must work. *Did you try it*!!!!! *you must not end-up saying but it should have been like this….*there are many variables that may cause experiments to fail e.g improper storage of chemicals resulting in contaminations, use of expired chemicals, failure to prepare solutions correctly, failure to follow procedures correctly etc
- close supervision and help may be needed for learners who lack confidence in doing experiments
- safety issues must be carefully discussed and explained to learners in the briefing session - the *use of acids, alkali and flammable liquids may present hazards* use of safety (epoxy coated) cabinets for storage is recommended
- list a few clear learning objectives for the task
  …What do I expect the students to learn by doing this practical task that they could not learn at all, or so well if they were merely told what happens?
- prepare work sheets with clear simple instructions/procedures for the class, identifying reagents and equipment needed per learner and gauge the time required for the activity a pre-practical exercise may be required to prepare learners for the activity
- get all the reagents and equipment required in advance and make sure they are working
- practical work should be followed up by a write up, discussion of the observations, links between observations and scientific ideas that account for the findings

Figure 1.1 shows four stages in the development and implementation of a practical task.

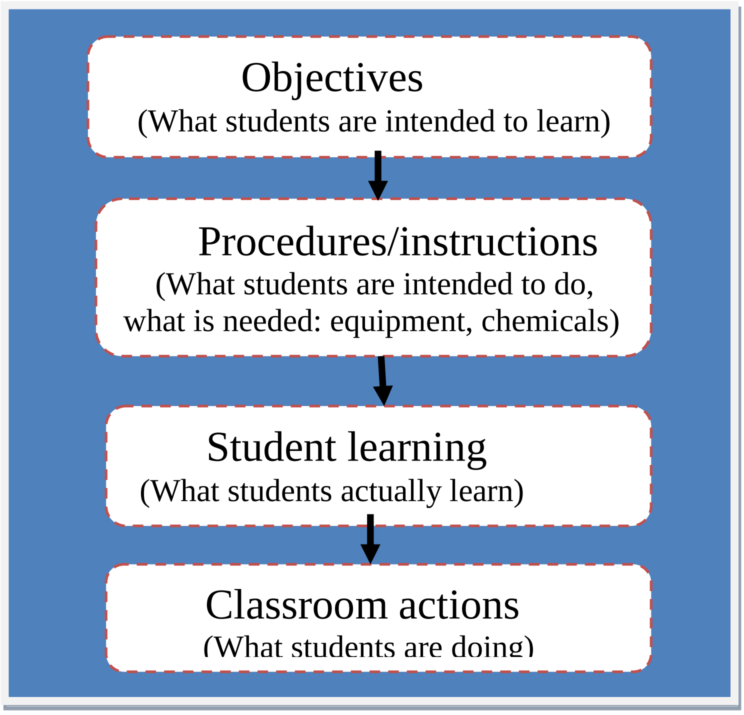

Fig 1.1 The process of developing and implementing a practical task

ACTIVITY:
Design a practical task that students can use to investigate the effect of temperature on the time taken for sugar to dissolve in water

Procedures for handling advance information and administration of Science Practical Tests (examination security)

Advance information in the form of instructions to Supervisors for Science Practical Tests will be sent to examination centres in advance of the examination period. The instructions inform the Supervisors on the equipment and reagents required for the test. The supervisor should make use of the instructions to prepare and make orders of the required material in advance.

The information should be treated as live examination material which should **not** reach candidates directly or indirectly before the examination date and time.
Refer to Section 3.1 parts 3.1.1a-h; 3.1.2a-c; 3.1.3; 3.1.4a-d of the ZIMSEC Hand book for Centres which explain how confidential examination material should be handled.

THE ROLE OF THE SUPERVISOR IN SCIENCE PRACTICAL TEST EXAMINATIONS

The supervisor is the teacher(s) whose class (es) are writing the Science practical test examination or any Science teacher(s) assigned by the school administration to run the practical test examination.

- Organises procurement of materials and chemicals as indicated in the '**Instructions to Supervisor'** advance information from ZIMSEC. It is very important that this information does not reach candidates directly or indirectly.
- To set up the examination room(s) in which the practical test is going to be conducted
- Prepare adequate solutions and reagents for candidates as specified by the 'instructions to supervisor'.
- Ensures there are enough non consumable materials for use by candidates during the practical test examination as specified in the **'instructions to supervisor'**.
- Set up work stations from which each candidate will work from during the examination.
- Check that all materials, solutions and reagents to be used during the examination are working.
- Takes candidates through a check list of materials and consumables to be used during the practical test.
- Provides technical support during the course of the examination.
- Divides the candidates into groups/sessions where it is not possible for all the candidates to seat at once.
- Carries out the experiments in the examination at the same time as the candidates **but** out of sight of the candidates and provides Supervisor's results together with the candidates' scripts for each group or session.
- Writes a report on any difficulties faced by a candidate(s) including any assistance given. The assistance given should be necessary and **not** undue.
- Completes the Supervisor's Report and signs the declaration documents.

COMMON APPARATUS IN A LABORATORY

- Medium boiling tubes
- Medium test tubes
- 250 *ml* beakers
- 250 conical flasks
- Thermometers
- Stop watches
- Ammeters
- Voltmeters
- Cell holders
- Variables resistors
- $50cm^3/100cm^3$ measuring cylinders
- Balances
- Reagents bottles with lids
- 10*ml* graduated syringes
- 20*l* plastic containers
- 5*l* plastic containers
- Burners

Nb. These supervisory roles must be interpreted together with the ZIMSEC Handbook for Centres that governs the administration of public examinations in Zimbabwe.