Practical Experiment

What are Practical Experiments?

The aim of arranging practical experiments for students is to develop students' general and specific skills to carry out scientific experiments, and to enhance their practical competence in handling experimental instrumentations. Practical experiment constitutes an important part in the research cycle for scientific inquiries, which provides the empirical basis for the establishment and refinement of theories and indications for making predictions. It makes sure that students do not only learn the body of scientific knowledge, but also the methods in which it has been developed from.

Structure of Practical Experiments

The objective of an experiment usually involves testing the validity of hypotheses generated base on theories. In the usual settings, students are normally given the experiment design and procedures, and are asked to carry out the experiment by following the given instructions carefully. When carrying out experiments, teachers and demonstrators would offer help and support to the students with the equipments and give advices regarding their experimental techniques. The students have to deduce the hypotheses being tested from the given experimental design, to collect the data and take measurements accurately in the experimental tasks, to analyze and interpret the results, and also to summarize and evaluate the experiment in a written report.

Some teachers may arrange student-designed experiments in their courses. In this setting, students have to formulate testable hypotheses based on the topics covered in the course. They also have to design, present and explain their experimental methodology to the teachers. The description of the method needs to be unambiguous and concise, and provides sufficient details for someone else to replicate the experiment by merely reading the instructions. The teacher can assess students' experimental design skills at this stage, as well as giving feedback and suggesting precautions and modifications for students. The students will then conduct the experiment based on the modified design.

Y	Declarative	CHARACTERISTICS
Y	Functioning	
Y	Take Time to Set	
Y	Take Time to Answer	
Y	Take Time to Correct	
Y	Take Time to provide Feedback	
	Suitable for Large Class	
	Can substitute with Computers	
	Passive	
Y	Active	
Y	Process Oriented Method	
Y	Product Oriented Method	

P = Possibly Y =Yes

Advantages of Practical Experiments

- Allows students to demonstrate and practice their knowledge and skills of 'how to do something' in action, and to achieve the learning outcomes by themselves, which is not feasible through written assessments such as free-response questions or multiple-choice questions
- Provides a powerful tool for teachers to objectively assess the competence of these manual skills of the students
- Establishes the link between theories and practice; students can learn the scientific attitude of taking and analyzing data patiently and accurately; experiments do not replace textbooks and lectures, but enhance learning with practical experience
- Practical experiments can be extended to become a hands-on experimental skills examination, to be coupled with brief instructions and interactive questions on theories

Disadvantages of Practical Experiments

- It is time-consuming and costly to set up laboratory experiments and the necessary instrumentations along with adequate technical support; close supervision and help may be needed for students who lack confidence in doing practical experiments
- For some experiments, it may not be feasible for the faculty to offer one set of equipments to each student; students will have to perform the experiment as a group, which may give rise to unfair distribution of work in the group
- Teachers may find it difficult to develop uniform, fair, and reliable assessment rubrics to evaluate students' practical skills

How to design a good Practical Experiment Assessment?

1. Before conducting the practical experiment sessions, teachers can offer a briefing session to explain to the class the basic theoretical background, learning outcomes, and the required techniques of the experiment. Precautions, potential problems and hazards, and safety issues must be carefully discussed and explained to students in the briefing session.
2. The experimental sessions can be coupled with active and interactive assessments in relation to the theories. In this setting, instructions can be given to students to carry out the experiment. Upon the observation of results, students need to answer questions to explain the immediate observations based on the principles and theories they have learnt.
3. Teachers should be reminded not to arrange practical experiments that require excessively costly, unrealistic or unfeasible equipments.
4. In the examination context, teachers may consider video-taping the students' performance in the experiment for easier assessment and to allow multiple assessors to rate the students' performance.

Marking Rubrics

MARKING RUBRICS	Excellent	Proficient	Average	Poor
Relevance and feasibility of experimental design:	Hypothesis was stated concisely and specifically; the experimental design can efficiently test the validity of the stated hypothesis	Hypothesis was stated clearly, but was not very specific; the experimental design is valid for testing the hypothesis	Hypothesis stated was ambiguous and not specific enough; the experimental design is weakly linked to the testing of the hypothesis	No hypothesis is stated for testing; the objective of performing the experiment is unknown
Experimental techniques:	Experimental tasks were done in an organized and effective way; apparatus were handled competently with confidence; all given instructions were followed tightly	Most of the experimental tasks were done neatly and satisfactorily; possess knowledge of how to handle most of the necessary apparatus and procedures appropriately; instructions were well-followed	Only some of the experimental tasks were done satisfactorily; have frequent problems in handling some of the apparatus and procedures, and also in following the given instructions	Experiment was done chaotically, without knowledge of how to use and handle the apparatus appropriately; do not follow the experimental instructions
Scientific attitude and safety issues:	Taking the experiment with a serious attitude; data and measurements were made accurately and patiently; having thought carefully about possible improvements of the design while performing the tasks	Taking the experiment with a positive attitude; observations and measurements were made with minor errors; tried to think about limitations of the experimental design	Doing the experiment for fun; results were taken with large errors; did not try to think about the rationale behind the experiment	Fooling around with the experimental equipments; results were estimated without basing on real data

Web Reference and Resources

- An Experiment Designed by a Student, Stage 2 Biology Support Materials, SACE Board of South Australia
  http://www.ssabsa.sa.edu.au/support/science/2bio/documents/2bio-ws-019_000.doc
- Test (student assessment), Wikipedia
  http://en.wikipedia.org/wiki/Test_%28student_assessment%29
- Active Assessment: Small scale experiments for authentic assessment, chymist.com
  http://www.chymist.com/Active%20Assessment%20Small%20scale%20exps.pdf
- Assessment of Practical Skills in Science class 10, myCBSEguide.com
  http://mycbseguide.com/blog/assessment-of-practical-skills-in-science-class-10/
- Assessment of practical skills, UK Centre for Bioscience
  http://www.bioscience.heacademy.ac.uk/ftp/TDF/Assess_practical_skills.pdf

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