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Issues in Physics Practicals in an Open and Distance Learning Environment

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ABSTRACT :

This paper reviews the objectives of physics practicals in physics education in relation to the philosophy of open and distance learning programme. The various issues that arise in the implementation of physics experiment based on an existing practical model are presented. Two major concerns are the effectiveness of the practical sessions and sustaining the fundamentals of the open and distance learning programme. A new practical physics model is then proposed, which enables students to experience physics experiments without violating the open and distance learning programme fundamentals.

1. INTRODUCTION :

Experiments or laboratory practical work are indispensable tools in studying physics. It is well known that the essence of science lies in experiencing and observing phenomenon that is, by acquiring the skill to make precise measurements, the ability to analyse data collected and derivation of scientific conclusions. Attempts at specifying the aims of practical-work have been around since the early part of the last century (Brock, 1973). These aims remain true today. An important survey was carried out by Kerr in 1961 to elicit responses from science teachers on the aims of practical work in secondary schools (Kerr, 1963). As a result, he compiled a list of ten aims for practical work. These were ;

- To encourage accurate observations and careful reasoning.
- To promote simple, common sense, scientific methods of thought.
- To develop manipulative skills.
- To give training in problem solving.
- To fit the requirements of practical exam requirements.
- To elucidate theoretical work so as to aid comprehension.
- To verify facts and principles already taught.
- To be an integral part of the process of finding facts by investigating and arriving at principles.
- To arouse and maintain interest in the subject.
- To make phenomena more real through actual experience.

Since 1963, there have many attempts by others to elucidate the aims of practical work. The outcome of their research has been found to be in good agreement with Kerr (Boud, 1973 ; Kempa & Ward, 1988 ; Lynch & Ndyetabura, 1983 ; Wellington, 1998). Even though much of this research has centred around the secondary school setting, they also apply at the tertiary level as well (Bennett & O'Meale, 1998 ; Laws, 1996 ; Meester & Maskill, 1994).

2. OPEN AND DISTANCE LEARNING PROGRAMME :

Education is a fundamental human right (UNESCO report 2000). This is exactly what open and distance learning (ODL) programmes have been striving to provide. ODL is an amalgam of two approaches to education that focuses on expanding access to learning and the use of multimodal delivery systems such as technology and printed modules. It is characterised by two factors ;- its philosophy, and its use of technology. Most ODL systems have a philosophy that aims to remove barriers to education and to allow students to study what they want, when they want, and where they want. This philosophy implies that education should be made available to all, regardless of time, place, and age (Freeman, 2004).

In addition to quality assurance, ODL university programmes offer flexibility that cannot be matched by conventional universities. These assurances have been established to the fullest by recent development in e-learning, especially in the context of online learning via the internet. Non-science-based ODL courses have a longer history compared to science-based ODL courses. In the field of science and engineering, the practical sessions have been conducted by some ODL providers, including the Open University Malaysia, based on an existing practical model and often by renting external university laboratories. However, several constraints and difficulties have been observed in the implementation of science-based practicals.

3. PHYSICS PRACTICALS – THE OPEN UNIVERSITY MALAYSIA EXPERIENCE :

In the Open University Malaysia (OUM), practical sessions are compulsory for adult learners enrolled in the Bachelor of Science Education B.Ed.(Sc) programme. These adult-learners are mostly primary school teachers, and aim to upgrade themselves to become secondary school teachers. All learners take courses in biology, physics, and chemistry. Many of these courses have a compulsory practical component, which means that lab sessions have to be conducted by OUM on a regular basis. However, unlike the practice of other conventional universities, the lab sessions at OUM are not carried out at the learning centers, but at rented university laboratories all over the country.

Thus, the planning and execution for the lab practical session are a tedious affair. The process begins at least two months before a semester commences. Firstly, the precise number of students who are going to take the physics practicals session is obtained from the Registry Unit. The lab space is rented from either private or public universities, hereinafter referred to as ‘practical centers’. The practical centers also provide the manpower and the expertise to prepare, organize and conduct the lab sessions that are designed by OUM academicians.

This is vital as the number of practical centers, and the total expenditure to be borne by the university in renting these centers can be estimated in advance. For instance, in a previous semester, 12 practical centers catered to 1773 students.

A formal letter is then sent to the centers requesting permission to use their physics laboratories. The letter provides all the relevant information needed ; from the student number at that particular practical center, the practical schedule, the apparatus needed to the proposed payment. The practical center is also asked to appoint a laboratory coordinator from the ranks of a Senior Lecturer or an Associate Professor. He or she will be responsible in organizing the practicals, finding enough demonstrators to help out, and mark the student lab reports.

A few weeks before the practical sessions commence, the lab coordinators from the participating centers attend a meeting at OUM. Here they are briefed on their roles and responsibilities and also made aware of OUM’s expectations. The apparatus that are to be used and the procedure to be followed for each experiment are reviewed again and errors in the practical module, if any, are rectified. A matter that is also discussed is the criteria to be used in assessing student practical reports. A standardized marking scheme for grading lab reports, taking into account various criteria, has been used by the lab coordinators for some time now. Apart from these, administrative matters, such as the deadline for the submission of students' marks to OUM, and issues related to payment are also discussed. The more experienced coordinators often suggest ways to improvise in an experiment when certain equipment is not available.

The practicals are run over two days on a weekend. For physics, students have to complete six experiments, each experiment being two hours long.

4. PROBLEMS AND CONSTRAINTS EXPERIENCED :

The present method is very conventional : it relies heavily on physical laboratories. The following are some of the issues that OUM has had to face in running the physics lab practical sessions thus far ;

Space constraint. The number of labs that are used during a practical session depends on the number of students. Obviously, as the student population gets bigger, more labs would be required. Also, it would also be difficult to provide large numbers of students with the individual attention necessary to get started in a science lab. Furthermore, locating new practical centers to cater for these students may not be so easy.

Date constraint. Adult-learners are busy people with many commitments; they work on weekdays and attend tutorials on weekends. Therefore, the practical dates are planned well in advance to avoid 'clashes' with other student activities. However well this is planned, there are times when the dates have to be changed at the last minute as they may not be convenient to the practical center. In such cases, it would be difficult to locate an alternate practical center. Changes made at short notice are bound to disrupt students' already tight schedule.

Remuneration Issue. University lecturers are busy people with many commitments. They are quite unwilling to shoulder another responsibility : it takes a lot of persuasion to get them to become lab coordinators. The organization and planning of the practical sessions must be done with care. Also, the lab coordinator may have to recruit other staff to help out. If that is not enough, the lab coordinator is also expected to grade the students' lab reports. In short, much time and commitment are demanded from the lab coordinator. Therefore, the remuneration package offered must take into account all of these factors.

Problems in rural areas. OUM tries its best to be accommodating by identifying lab centers that are near the student learning centers. However, in reality, this is not achievable in remote areas. In these areas, adult learners may have no other option but to go to the nearest lab center, which could be anywhere from 60 to 600 km away! They have the option of either travelling by car or by air. Each of these option presents its own set of pros and cons in relation to the time spent travelling and the possible expenditure that will be incurred. The learner must then weigh these options carefully before deciding. Either way, it inconveniences the student.

Despite the above issues, interviews with a select group of students and lab coordinators have revealed that the present practical session of 12 hours is useful for the students. The practical session is an activity that most students look forward to. They value the laboratory experience very much as it provides them the opportunity to work with various equipment to discover physics. Furthermore, there is the added thrill of writing-up their findings in the laboratory report, like a bona fide scientist. The performance of students, as seen from their scores in the practical reports, has also been satisfactory.

Nevertheless, the problems and constraints discussed should not detract ODL providers from providing quality laboratory–based science courses. However, the inevitable increase in student numbers is bound to create new problems while compounding existing ones. Thus a reappraisal of the present method of conducting the lab practicals would be timely.

One way of reducing the 'over-dependency' on the physical labs is through the use of Information and Communication Technology (ICT). The importance of ICT in tertiary education is well recognized, and in recent years, there has been tremendous growth in the development of virtual laboratories world-wide. In line with this development, a new model for physics practical is proposed in the next section. This ICT based model also incorporates home experiments and / or the use of experiment kits to enable real-time experience.

5. A NEW MODEL FOR PHYSICS EXPERIMENTS :

To this end, we propose a new model for physics experiments, made possible by recent advances in the field of ICT. The model consists of 5 stages, and reduces the dependency on real laboratories. It offers the possibility of many attractive features including interactive experience that can widen the scope of constructivist learning. Students will be able to study at their own pace and use the resources provided in this model in a flexible way.

We believe that successful implementation can be achieved by following the sequence suggested below.

Stage 1 Interactive CDs

Interactive CDs can feature video clips on physics experiments. The students will learn how physics experiments are conducted and the general rules of conducting an experiment along with the physics observations that are featured. These video clips will also motivate and increase the interest of the students to learn physics. The learning experience can be enhanced by introducing pop-up questions and multiple-choice questions that probe the students to think and test their understanding. In addition, multimedia can - through its power to animate - communicate dynamic information more accurately than a diagram, and can help students visualise phenomena that cannot be seen (Bennett & Brennan, 1996)..

Stage 2 On-line Tutoring

On-line tutoring using an e-learning platform such as the myLMS system at OUM, can also help the learning process and hone critical thinking skills in students through active discussion. It enables tutors and learners to bring the face-to-face classroom into virtual environment. Such activities can generates new ideas and cultivate innovation. This stage will be continued throughout the program.

Stage 3 Virtual Laboratories

This stage involves the introduction to virtual laboratory - an interactive environment for creating and conducting simulated experiments : a playground for experimentation located on the internet at http://algorithmicbotany.org/vlab/environment.html . Physics experiment can be simulated close to a real-world situation in a virtual environment using computer technologies such as JAVA, an interactive multimedia programming language via internet or CD-ROM. The virtual laboratory allows the student to be actively involved in the experimental process and experience a more personalised learning process at their own pace. They can be exposed to various types of experiments involving sophisticated instruments without worrying about the cost or student's safety. The virtual laboratory provides an excellent training ground for the students.

The Virtual Laboratories can either be developed by the university academic staff themselves or obtained from the various commercial providers. There are even a few free Virtual Laboratories on the web that can be utilised. For example, the Johns Hopkins University in the United States has developed virtual lab experiments for students taking its '500.101 What is Engineering?' course, which is at http://www.jhu.edu/~virtlab/index.html .

Stage 4 Home Experiment or Self-built Experimental Projects

Real-time experimental experience is important in addition to the above virtual experience. This can be implemented using simple home experiments and / or low-cost commercial experimental kits. These projects need not be complicated ; rather, they should provide students with the opportunity of learning physics through experiment. Such projects will be more challenging, interesting and train students to be resourceful.

Stage 5 Laboratory Session

Presently, students are required to perform experiments in the labs and are assessed on the quality of their lab reports. Under this model, students will only need to attend a single practical session. The purpose of this session will be to ascertain what the student has learned during the first four stages. A two-fold assessment system is proposed, a 3-hour practical test where the student is required to submit a report at the end of the experiment, followed by a viva session.

6. CONCLUSION :

The proposed model is very much student-centered : the student will be able to study anywhere, anytime at their own pace, and use the resources provided in a flexible way. This is inline with the ODL philosophy. The model also enables incorporation of interactive features that can make the learning process a fascinating experience, especially through usage of 3-D visualisation. In addition, the model can help to alleviate some of the problems faced by ODL providers in providing quality laboratory science practical courses by reducing the dependency on real laboratories.

REFERENCES :

Bennett, S.J., & Brennan, M.J. (1996). Interactive multimedia learning in physics. *Australian Journal of Education Technology, 12* (1), 8-17.

Bennett, W., & O'Neale, K. (1998). *University Chemistry Education, 2* (2), 58.

Boud, D.J. (1973). *Higher Education, 2*, 81.

Brock, W.H. (1973). *H.E Amstrong and the teaching of science 1880-1930*. London : Cambridge University Press.

Freeman, R. (2004). *Planning and implementing open and distance learning systems : A handbook for decision makers*. Vancouver, Canada : The Commonwealth of Learning

Kempa, R.F., & Ward, J.E. (1988). *International Journal of Science Education, 10* (3),275.

Kerr, A. (1963). *Practical work in school science : An account of an inquiry into the nature and purpose of practical work in school science teaching in England and Wales*. Leicester, UK : Leicester University Press.

Laws, P.M. (1996). *Studies in Science Education, 28*, 1.

Lynch, P.P., & Ndyetabura, V.L. (1983). *Journal of Research in Science Teaching,20* (7), 663.

Meester, M.A.M., & Maskill, R. (1994). *Second year practical classes in undergraduate chemistry courses in England and Wales*. London : The Royal Society of Chemistry.

Wellington, J. (1998). *Practical work in school science: Which way now?* London : Routledge.

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