PROJECT TRAINING FOR GRADUATE STUDENTS IN HEALTH PHYSICS

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ABSTRACT

The Royal Naval College has conducted graduate training in health physics for over 10 years and has developed a system of project training which gives students practical experience in the context of the formal theoretical course. The purpose of project training is to provide realistic radiological protection problem solving at a time when the student is consolidating his theoretical knowledge.

This paper describes the procedures used to introduce, supervise, and assess these projects.

The projects are initiated early in the course by presentation of a package which includes a statement of the aims of the project, copies of relevant papers, apparatus manuals, radioactive source calibrations and guide lines for progression of the project. The student is required to write a report on his project which is presented orally and staff appraisal takes account of all aspects of the students project work.

The paper evaluates the success of this approach against the cost in staff and equipment resources required to achieve realistic and effective training.

INTRODUCTION

The Royal Naval College, Greenwich, has conducted graduate courses in health physics for over 10 years in association with other specialist post-graduate courses. The Department of Nuclear Science and Technology, which is responsible for these courses, was founded in 1959 to provide a centre for Naval Nuclear Education and Training of officers and now offers over 18 courses per year to a total of about 250 students. All these courses contain an element of health physics. The necessity for health physics in the training of reactor engineers is already well recognised[2] since they must understand the hazards of radiation and, as reactor operating personnel, they will receive the largest doses during reactor plant down time for repair or preventative maintenance. The experience on which this paper is based was gained over the last 10 years in two specific graduate courses, one of 12 weeks duration and the other 24 weeks.

GRADUATE COURSES

The first course, the Nuclear Radiation Protection Course (NRPC) has already been reported[3] but more recently another graduate course, the Nuclear Reactor Course (NRC), has been extended to include radiological protection as an essential qualification. The NRPC is recognised by the British Institute of Physics and the successful NRC candidate also receives the Postgraduate Diploma of the Council for National Academic Awards.

DEPARTMENT FACILITIES

The facilities available for training in the Department of Nuclear Science and Technology include the 10 kW training and research reactor JASON[4] which was the first to be installed in any educational establishment in the United Kingdom. This has given the staff considerable first hand experience and set a pattern in terms of safety documentation, procedures and applications to other Universities. The Reactor is used to bridge the gap between simulator training and full power reactor training and provides a source of radiation which is used in many supporting training experiments and projects. In particular it provides a realistic environment for students to learn how to handle, survey and control sources of ionising radiation. The reactor is used for 49% of the time for student training and diverges to power over 480 times per year. Over 2000 students have been trained and currently the Department provides 8 different types of courses. The research utilisation of the reactor includes several applications of activation analysis and reactor dynamics in addition to specific health physics studies such as reactor shielding[5] and the study of radioactive aerosols[6] and some dosimetry studies.

PROJECT TRAINING

The interdisciplinary nature of environmental health engineering has been emphasised by the World Health Organisation[7] in their booklet on The Education and Training of Environmental Health Engineers, which states that many disciplines may be required for the solution of complex environmental health problems.

This generalisation is specially true in health physics; team operation is the rule and the individual member must be familiar with the vocabulary, techniques and goals of other members of the team.

This paper describes an approach to graduate training in health physics which is designed to develop the student's awareness of other disciplines, and to give him practice at problem solving under realistic conditions. The two courses on which the experience was gained are being reviewed by objective training analysis which requires the definition of an Operational Performance Standard. This is translated into a Training Performance Standard which provides the basis for the detailed course design. All this demands effective feedback on performance of past students and also of the reactor plants on which they have worked. The replacement of conventional set practical sessions by a smaller number of set practicals and project work has emphasised the need for careful attention to the objectives of the course. The projects themselves must be well organised to ensure full benefit for the student and effective appraisal of his success.

PURPOSE OF PROJECT TRAINING

DEFINITION OF A TRAINING PROJECT

A training project is a supervised task set by the students' tutor to meet some objectives of the course. A good project must be interesting to the student but limited in scope so that it can be completed within the time allocated. The project must be realistic to permit the student to recognise a 'real problem'; novelty and relevance provides the necessary motivation. To achieve these conflicting features the development of training projects relies to a large extent on feedback from operational establishments and spin off from departmental research projects.

The purpose of project training must be examined in relation to the overall objectives of the course. A common feature in the objectives of health physics courses is the achievement of three important attributes which the successful student must possess. The student must:

a. have a sound knowledge of the process which produces the hazard,

b. understand the hazards of radiation,

c. have sufficient appreciation of practical problems to be rapidly accepted into the operating team.

The development of these attributes is an important objective of the course but it can not be met entirely by classroom instruction, especially when the students themselves are practical men. Conventional practical work can be designed to re-inforce classroom instruction or to help students familiarise themselves with equipment and techniques, but it may stultify the students interest. When practical work has to be allocated in short periods of a few hours at one time, the student will rarely have the opportunity to use an interdisciplinary approach and the sterotyped exercise limits his scope for problem solving. On the other hand, set practicals are straight forward to administrate, and it is comparatively easy to assess the students performance against that of his colleagues because the work expected is identical.

PROJECT OBJECTIVES

The approach described in this paper replaces most of the set practical sessions by more broadly specified projects designed for the following purposes:

(1) To apply the student's theoretical knowledge acquired from the course work to problems associated with the operational situation.

(2) To give direct experience of relevant health physics practice.

(3) To emphasise the interdisciplinary nature of health physics.

(4) To assess the student's ability to solve problems under realistic conditions and his ability to communicate his observations and recommendations.

The first two objectives replace the set practical but added motivation can be imparted when the project contains an element of novelty. The third objective requires an input from other disciplines such as reactor physics, reactor engineering, chemistry, metallurgy and radiobiology. This is important to ensure that the student is made aware of the relevance of his work to overall plant safety. The last objective reveals the special advantage of project training and, to achieve it, the class have to share experience gained on the individual projects by participation in a formal presentation of the project reports.

PROJECT MANAGEMENT

The introduction of project work and its subsequent extension to become a significant proportion of Course time necessitates the designation of a Project Manager. The Project Manager is responsible for coordinating individual project supervisors to ensure the satisfactory progress of the projects. These supervisors are required to carry out the following tasks:-

(1) The production of the project outline (in association with the Project Manager).

(2) The day to day supervision of the project.

(3) The timely presentation by the student of a project report and the provision of guidance as to the required standard.

(4) The assessment of the report in conjunction with at least one other member of staff.

PROJECT PACKAGE

The project work described in this paper is given to students undergoing relatively intensive training in which the duration of projects is strictly controlled. It is therefore essential that the objective and project outline are clearly defined. The use of a 'project package' has been developed in an attempt to maximise the benefit to the student.

The project package is required to:

(i) Provide the student with sufficient information on which to make his choice of project.

(ii) Ensure that sufficient staff work has been undertaken to permit the completion of a worthwhile project.

(iii) Enable a comparison of the project proposals to be made in terms of the level of the work involved.

(iv) Provide the Project Supervisor with the basis for monitoring the progress of the project.

The project package includes:

(i) The background information necessary to place the project in context.

(ii) The objective of the project.

(iii) The schedule of apparatus to be made available and the apparatus manuals.

(iv) The guide lines for initiation of the project.

(v) Selected reference material.

Having made his choice, the student is provided with sufficient information to commence some basic reading and planning before any further discussions are held with the supervisor. In this way the student is able to take some part in the initiation of a project. A typical project package is summarised in Appendix 1.

PROJECT SELECTION

Three factors are considered in the selection of the individual projects:

(1) The previous experience of the individual student;

(2) the future task in which student will be engaged;

(3) the student's performance.

It is sometimes possible to remedy obvious deficiency in the student's past experience by the selection of an appropriate project. Alternatively the students best interests may be served by completing a project relevant to his future commitment. The student is encouraged to discuss the various projects with the supervisors so that the selection also reflects his personal interests.

PROJECT SUPERVISION

The responsibilities of the project supervisor would appear to diminish once the project is launched since the student has sufficient background information. Experience has shown that the supervisor must act in an advisory capacity, reviewing progress at intervals determined by the duration of the project. In this context the student-supervisor relationship is important, and an informal approach has been found to provide the ease of communication which is an essential part of project work.

In the event of a major equipment failure, or a particularly interesting unforeseen development, the supervisor may redirect the project to capitalise on the situation. The project work culminates in a formal report and the supervisor is required to review the draft report and make constructive suggestions and query any doubtful aspect of the student's work.

PROJECT APPRAISAL

Within one course all the projects may have different main topics and therefore different supervisors. Although the expected work content can be assessed by the Projects Manager, the problems arising in the execution of the project may require a different work content and the demands of the individual supervisors cannot be standardised. This situation may generate some difficulties in achieving a fair comparison of each project. The supervisor is therefore made responsible for the preparation of a written summary of the report which takes account of these variable factors.

The project which carries up to one third of the course marks is finally evaluated under the following three headings:-

a. Methodology and Practical Work. The orderliness of the approach adopted by the student and the design and execution of the project is examined to establish his penetration of the problem.

b. Written Report. This is examined to provide further appreciation of the student's reasoning powers and orderliness in presentation.

c. Oral Presentation. This reveals the student's ability to exercise judgement in the selection of the important aspects of the work and his performance in answering questions on the project demonstrates the depth of knowledge and comprehension. Since all the Course members and the examiners are present at the oral presentation, it serves to acquaint the other students with the subject and helps to share particular lessons that have been learnt.

EVALUATION OF PROJECT WORK

STAFF RESOURCES

At first sight the project approach to training appears to be more costly in both time and resources than formal practical work. This depends on the size of the course and the degree of utilisation of the laboratory equipment. For example, 6 groups of students could perform a set practical either (a) simultaneously and therefore requiring 6 sets of equipment, or (b) in three separate sessions requiring 2 sets. The solution adopted is usually constrained by the overall course programme, which determines the timing of the practical sessions. Since the RNC courses involve practical work in several topics it has been policy to arrange several different practical sessions in parallel, the students completing each experiment in the various laboratories. Hence the laboratory utilisation achieved is dependent on the size of the Course, but on the average is equivalent to 3 sessions per experiment per course. This policy has ensured that, with the exception of the very low cost equipment, only a limited number of sets of equipment are required.

The development, documentation and updating of the conventional practical training also requires considerable resources and Tables 1 and 2 compare for the same allocation of practical time, the total man-hours of staff time for formal practical and project work. The Tables are based on 8 students on the course with the breakdown of laboratory work being typical, rather than specific to any one course: development costs are calculated on the assumption of a review of all experiments after every 2 to 3 courses.

TABLE 1. CONVENTIONAL PRACTICAL

TASK	STAFF HOURS	SESSIONS	NUMBER OF PRACTICALS	TOTAL TIME HOURS
Administration	20	1	-	20
Development	3	20	-	60
Basic Radiation Protection	6	2	10	120
Basic Radiation Physics	6	2	4	48
Basic Reactor Physics	8	2	4	64
Simulator	4	2	2	16
Examination of Practical work	1/5	8	20	32
			TOTAL TIME:	360 hours

The calculation for the project work is based on 8 students each undertaking a different project, with the support of some basic introductory experiments and is chosen to illustrate the maximum staff effort. Some formal practical work must be included to ensure that the student is familiar with the basic radiation laboratory procedures and techniques. These costs could be reduced by combining students into groups of 2 or more for each project but this removes some of the advantage of project training.

TABLE 2. PROJECT WORK

TASK	STAFF HOURS	SESSIONS	NUMBER OF PRACTICALS	TOTAL TIME HOURS
Project Administration	3	1	8	24
Development and Consultation	2	1	6	12
Planning and Preparation	10	1	8	80
Supervision	15	1	8	120
Assessment	4	1	8	32
Presentation	3	1	8	24
Basic Radiation Protection	6	2	2	24
Basic Radiation Physics	6	2	2	24
Basic Reactor Physics	8	2	2	32
Examination of Practical work	1/5	2	6	3
			TOTAL TIME:	375 hours

These figures which are based on several years experience demonstrate that the cost in terms of man hours differs little between the two alternative schemes. In the planning and preparation of projects the specialised experience of the supervisor is used and this is more stimulating for him than the development of set practicals to achieve more limited objectives. A survey of the equipment resources required for mounting the work described in Table 2 has shown that as a result of the extensive use of project equipment in research and the flexibility in planning a reduction of 25% in the capital equipment cost was possible compared to conventional practicals.

COMMENTS ON THE STUDENTS RESPONSE

STUDENT REACTION

The total time allocated for participation in practical work in set practicals and in projects is the same. However, the student reaction to the laboratory work in each scheme is noticeably different.

The students on intensive courses will quickly form opinions on the relevance and necessity of the practical work and will reject unnecessary duplication in the presentation of the material. Set practicals with the usual close relation to the lecture material are frequently rejected as repetitive. In contrast projects have stimulated student interest and participation and help to ensure that the objectivity of the course stands up to close scrutiny by the students. One measure of the success of the project is the amount of additional time a student may be prepared to devote to the work; in fact it is common for the supervisor to have to ensure that the student does not spend an excessive amount of time on the project.

STUDENT ATTAINMENT

The effectiveness of any instructional technique in attaining some part of the course objective cannot easily be objectively assessed and subjective assessments tend to vary widely. The ultimate test is to follow up the students when they have moved on to their operational role. If the staff effort is available the students are interviewed in their work area at least one year after completing the course. Students do appear to move smoothly into their operational task, in some cases continuing to follow up the project topic as a centre of interest in their new job. This itself is a convincing demonstration of the value of this approach to the student.

CONCLUSIONS

The procedures described in this paper are offered as a product of systematic course design which could be applied to other graduate courses in health physics. The two courses on which this work has been developed are relatively long - 12 weeks and 24 weeks respectively - but it is considered that the method can be applied with success to shorter courses. The reliability of the apparatus used and the provision of guidelines for the project becomes important if the student is not to waste valuable time coping with instrument faults or re-discovering relatively unimportant information. In all cases the supervisor must ensure that there is sufficient scope for problem solving and that the project does not relapse into meaningless collection of data. The experience and judgement of training staff are taxed more heavily in the project supervision than the more passive role of monitoring a set practical. In many cases the student gains his first rigorous experience in scientific communication when he prepares his project report and presents it to his colleagues and the examiner. It is probably this increased demand on the supervisor and student which ensures the success of this approach to health physics training.

APPENDIX I

PROJECT PACKAGE

The package contains the following main items:-

1. Objective of Project
2. Background information
3. Equipment and Services supplied
4. Guide lines for progress
5. Literature references and Instrument Manuals

To illustrate this the following is an abbreviated package for a Thermoluminescent Dosimetry Project:-

1. Objective: To investigate factors affecting the precision of TLD-700 for dosimetry in low level photon and neutron fields.

2. Background: The operation of a nuclear reactor involves the staff in radiation exposure to mixed photon and neutron radiation fields. Whilst the radiation levels may be low compared to the legal limits there are both ethical and practical reasons for aiming at high precision in these measurements. For example, the success of a shield design may be judged by the man rem accumulated by the operating staff or a new reactor plant may be surveyed by short duration exposures of TL dosimeters.

3. Equipment and Services Supplied:

    i. Access to the research reactor
    ii. One Dynatron TLD reader modified to give a graphical display of glow curves
    iii. Annealing ovens
    iv. Dispensing equipment for powder, extruded chip and disc forms of TLD

4. Guidelines:

    i. Delineate radiation fields to be studied taking account of operational conditions on a power reactor against the closest approach available on the research reactor.
    ii. Gain familiarisation with TLD equipment by trial runs on irradiated samples
    iii. Assess the number of tests feasible in the time available and schedule test points
    iv. Execute selected measurements, read and analyse data for precision
    v. Run subsidiary experiments after discussing (iv) with Supervisor
    vi. Write draft report

5. Literature References and Instrument Manuals:

References and manuals are revised and amended for each project.

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