Need for Quality in Assessment – Part I: Concept of Assessment of Science Laboratory Courses in Open Learning System

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Abstract : *This paper traces the role of assessment in science education as available in developing countries. It stresses the need to redefine the assessment system in order to infuse a sense of professionalism and competence in Science graduates. The method of assessment must integrate with the instructional objectives through criterion referenced testing. To improve the teaching - learning process, due weightage need to be given for both formative assessment and summative assessment. In order to measure the attainment of experimental skills and cognitive abilities, both process assessment and product assessment are to be utilised. Although the principles of assessment are mentioned in this part with special reference to a Science laboratory course offered in tertiary level through Distance Education mode, we shall explain the application of the suggested methodology of assessment in the next part.*

Introduction

A basic question may arise as to the relevance of Science laboratory courses in the era of globalisation, since economic forces of consumer demand are not quite evident for basic Sciences at least among the developing countries. It is a part of a larger issue of relating economies of the developed and developing countries to their levels of Science and Technology education and research. According to an empirical law enunciated by Prof. Jolla Price of Yale University, a nation's GNP is related to its total spending on Sciences (Salam, 1989: 33). The role of Science and Technology in the rise and fall of nations is a relatively neglected subject. Science and Technology education for developing countries is need driven - from political, economic and sociological angles.

It is encouraging to see that such a need, of late, is being realised among some developing countries and vast literature in this regard is available as policy documents of their Education, Science and Technology Ministries, Science Academy reports and UNESCO reports. The policy document of Zambian government stating its action plan for improving Technical Education and Vocational Training (TEVET Policy, 1996) is a recent example; another can be found in the words of Prof. T.R. Odhiambo, Director of the International Centre for Insect Physiology and Ecology, Nairobi, Kenya:

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> "Africa has by far the fewest scientists and engineers compared to other regions of the world. Because of the small size of the African scientific community in relation to enormous agenda for science-driven development in the continent, the African people and their leaders need to create an enabling environment for the scientific community to develop and grow. There must be a conscious, definitive action arising from a committed political decision" (Salam, 1989:40).

Quality Science Education and Role of Assessment

A science graduate from most of the developing countries is not fully equipped for the modern world. A sense of professionalism and competence is generally absent probably due to the inadequacy of the science curriculum implementation rather than its content. Although many aspects need to be considered in the context of curriculum implementation, it is worth examining the role of assessment in curriculum as practised in developing countries. Until recent times, the main purpose of assessment has been performance-based certification and classification. The certification role of assessment has disproportionate value in the educational system as a whole. That the tail of examination wags the educational dog producing a backwash effect on curriculum is of common occurrence in the developing countries (Hawes and Stephens, 1990). The situation has boiled down to such a state that 'we teach what is tested rather than test what is taught' (Dore, 1976). In Indian context, University Grants Commission reports (UGC, 1973) and Association of Indian Universities monographs (AIU, 1977a & b) have time and again indicated the disproportionate power of examination on the curriculum. The 'Jobs and Skills Programme for Africa' Study conducted in 80's in eight African countries reports that the examinations serve the purpose of only testing limited skills (Somerset, 1982). The study conducted by Lewin points to the same situation prevailing in Sri Lanka as well (Lewin, 1984).

Examinations operating to decide the life chances and the job opportunities rather than fostering knowledge, skills, attitudes and dispositions are ascribed by Somerset (1982) to the economic and social context in which the developing countries must operate. Somerset identifies four aspects that determine this reliance.

i) Limited educational resources
ii) Intense competition for jobs among the similarly qualified
iii) Employment opportunities related to number of examinations passed
iv) Starting salary related to examination success

According to Boud (1995), students can with difficulty escape from the effects of poor teaching but cannot escape the effects of poor assessment. If teachers and educational developers want to exert maximum leverage over the changes in higher education, methods should be devised to confront the ways in which assessment seems to be undermining learning. Redefinition of assessment system could even give direction in designing instructional objectives. Let us now examine the issue of assessment in the context of Science laboratory courses offered in tertiary level through distance mode. Formulation of credible assessment criteria for science laboratory courses offered through distance mode is considered a challenging job as was experienced at the workshops on Laboratory Technicians Training

Programme conducted at New Delhi for South Asian countries during May '96 (Commonwealth Secretariat, 1996) and at Luanshya (Zambia) for African countries during November, '96.

Variables Deciding Assessment Methodology

In general, assessment is related to the progress of students in their learning process. The method of assessment as enunciated by Eisner (1985) depends on context, content, process and product. The 'context' is a Science laboratory course conducted at a study centre where the distance learners from different parts of a state or a district gather for laboratory counselling. The onus of conducting the laboratory course is on the academic counsellors. The academic counsellors are a short-term force and have full-time faculty position in the host institution. The academic counsellor in the lab counselling enjoys the dual role of an advocate (by guiding the learners through the experimental procedures) and a judge (through assessment). The laboratory counselling and assessment must be finished in specific time. The 'content' refers to the study materials provided to the learners. The 'process' of learning could be better understood if one goes through the following list of functions of a lab course academic counsellor.

i) Familiarity with the course content and the assessment criteria
ii) Planning the experimental activities
iii) Making laboratory preparations
iv) Briefing and guiding the students
v) Observing the students at work
vi) Scrutinising the lab records of students
vii) Awarding marks with reference to the criteria
viii) Communicating the award list to the University

The 'product' of learning is a derivative of curriculum implementation. There is a need to exercise particular care in designing the curriculum objectives and accordingly plan the curriculum content and, implementation and assessment procedures. The product of learning through science laboratory courses should include the desirable learning outcomes such as experimental skills, cognitive and non-cognitive abilities. The immense potential of laboratory curriculum in developing cognitive abilities (Bloom, 1956) such as application, analysis, synthesis and evaluation should be exploited properly; it is lamentable that in developing countries, much of the available curriculum content, implementation and assessment procedures restrict to knowledge and understanding aspects of the cognitive domain. Some of the desirable non-cognitive abilities are - interest in experimental work, open mindedness, team spirit, scientific attitude, sense of appreciation, tolerance to criticism etc. In order to exhibit professionalism and competence, a science graduate needs to possess many of these skills and abilities.

Planning a Science Laboratory Course for Distance Mode

Deciding what to teach and assess is one issue and not two (Erwin, 1991); hence, these two activities could be integrated as shown in Table 1 for a science laboratory course which is planned for 34 sessions (over 17 days) each session being for 4 hours. This is a model suggested as a modification of one of those followed in Indira Gandhi National Open University for B.Sc Programme.

Table 1: A science laboratory course under distance education mode

S.No.	Type	No. of sessions	Counselling and assessment
1.	Introductory session	1	Discussion on lab environment, experiment cycles etc.
2.	Guided activities i) Short experiments and activities ii) Long experiments	26	All experiments and activities to be performed under guidance.
3.	Experiments for formative assessment	2	Experiments same or similar to those in (2) are to be performed under examination conditions, assessed and feedback given to students; marks not counted for certification.
4.	Experiments for summative assessment	5	Experiments same or similar to those in (2) are to be performed under examination conditions and assessed for certification.

The activities mentioned in Table 1 refer to the part of the curriculum required to be included for attaining higher level cognitive abilities and non-cognitive abilities along with experimental skills. These activities have the aims of enabling a science graduate feel better as a person with self-confidence and competence; an employee with a professional approach; and, a member of the society with awareness of the science related issues. To mention a few, a science graduate needs cognitive abilities for solving problems ('application'), analysing relationships ('analysis'), producing a comprehensive report ('synthesis') and evaluating a material or a process with reference to some criteria (evaluation). Further, these activities should also inculcate the non-cognitive abilities as mentioned earlier.

To plan these activities, the course teams may involve faculty members from the Schools of Education and Humanities. Details of such activities along with qualitative testing methods (including self-assessment and peer group assessment) are widely covered in literature (IGNOU, 1991). There is a need to plan these activities in a hierarchical way among all the laboratory courses of a discipline for a judicious combination of experimental work and other activities. The activities could be fitted into the science laboratory curriculum taking the following into consideration:

i) distance learner opting for science programmes gather in a study centre and carry out work for an extended specified period, whereas those in the non-science programmes do not have this opportunity,

ii) time should be available at the rate of half an hour to one hour over five to eight days during evenings and, the activities can be coupled with short experiments of the laboratory curriculum,

iii) the learners from different background and age group may find these activities as a variation from otherwise routine experimental work, and

iv) such activities could help in well-rounded development of the science learners.

Method of Assessment Suggested

There is a need for using formative and summative assessment. Formative assessment is for the improvement of teaching - learning process and the summative assessment is for deciding learners' grades or marks (Scriven, 1967). The formative assessment has diagnostic value and provides the feedback to the students and teacher, thereby improving teaching-learning process. The formative assessment provides opportunity for the learners to have free and fair discussion on both the laboratory procedures and the marking scheme; this adds to the transparency of the assessment system and the confidence of the learners. The formative assessment is not to be counted for grading.

A few of the experiments may have to be offered during the session and, at the end to serve the purpose of summative assessment; this facilitates awarding marks for certification. Same criteria may be applied for assessment under formative and summative conditions. The experiments under formative and summative assessments are to be done without the guidance of the academic counsellors whereas others are guided. Also the attendance at laboratory courses must be made compulsory to facilitate effective laboratory training of learners.

In the present model, care is taken to avoid too much assessment, which could result in too little teaching (Fairbrother, 1989:113). Frequent testing may give more chances for students to score better, but an optimum level has to be thought of, keeping in view the workload of the counsellor, the effective feedback to learners, more opportunities for learners to learn free of examination fear and greater possibility of repeating the experiments. Even out of the five sessions suggested under summative assessment, the best four could be chosen for declaring the results.

Criterion-Referenced Testing

Criterion referenced testing is used to ascertain individual's status with respect to a desirable standard; it is the favoured type of assessment. The academic counsellors must be provided with well-defined criteria in order to ensure objectivity in marking. The criteria are to be evolved by the course team infusing the instructional objectives. The criteria can be arrived at using the table of specifications (Thorndike and Hagen, 1977). The criteria so formed obtain their validity to the extent to which an assessment instrument measures what it is intended to measure. Each entry in the table of specifications may be given mark weightage to arrive at the scheme for marking.

A simpler model would be to make a two-column list, with-skills, processes and abilities to be measured in one column, and criteria of measurements in another column. The marking for each experiment could be prepared by giving mark weightage to each of the relevant criteria.

Process Assessment and Product Assessment

The criterion-referenced scheme is used for process assessment and product assessment. Product assessment is associated with skills connected with recording and reporting that produce permanent evidence and can be evaluated after the event. But manipulative skills of doing an experiment involve processes and are more ephemeral; these are to be measured as the processes occur and this method is called process assessment (Fairbrother, 1989:111).

Monitoring and Feedback Mechanism

There is a need to have an effective monitoring mechanism which could help in overseeing the conduct of laboratory courses, adherence to stipulated assessment procedure and avoidance of malpractice. The feedback may be obtained from the academic counsellors on the course content, relevance of the assessment system to the instructional objectives, its diagnostic value and usability with respect to time requirement, marking weightage, and feasibility of implementation. The feedback from the learners may help in understanding the difficulties faced with respect to the content, their apprehension about the assessment system, utility of formative assessment, activities etc.

Any change in system needs careful scrutiny concerning its worth, advantages, and the facilitating factors and, the model suggested above for assessment is no exception. The implementation of the modified version needs intervention at different levels - the educational policy makers, course teams and counsellors (Race, 1995).

In this paper, we have discussed the need for integrating the assessment procedure with the course content and making it transparent to the students. We have suggested a model for planning laboratory courses and discussed the need for an assessment pattern consisting of criterion-referenced testing, formative assessment, summative assessment, process assessment and product assessment. In Part II of this series, we shall discuss the methodology of assessment relevant to Science laboratory courses applying the principles mentioned above.

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