Frames of reference for evaluating new learning technologies

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New educational technologies provide opportunities for gains in resource efficiency and in educational effectiveness. Are the anticipated benefits realised? This paper reports on an attempt to apply a frame of reference to the selection of criteria for evaluating technological innovations in higher education.

Defining the types of innovation to be evaluated is an issue but establishing evaluation criteria is the major challenge. Four positions are considered. One is oriented to the stated objectives of the particular educational innovation; one to comparison with alternative educational approaches; one to the benefits and costs anticipated from a knowledge of the state of the art of learning technologies; and one to criteria developed from a particular educational and/or social theory.

These four approaches to are interactive rather than exclusive zones of reference, each of which has a place in selecting criteria for evaluation of educational innovations employing learning technologies. To engage all four, exposes contests between theoretical foundations, public policy, local pragmatics and individual objectives. Evaluation in this context, then, identifies dialectical relationships and provides a transformative tool for the construction and reconstruction of technology in education. In the background are issues of causation in complex educational contexts. Attaining generalisable conclusions from the evaluation of educational technologies, however, is problematic and beyond the scope of an evaluative approach.

The paper reports on an evaluation of an innovation that combined the introduction of problem-based learning with Web-based tuition in a post-graduate course conducted at an Australian university.

FRAMES OF REFERENCE FOR EVALUATING EDUCATIONAL TECHNOLOGIES

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In a world of technological development evaluating innovations employing educational technology is a challenge confronting both educators and educational administrators. New educational technologies and new uses of existing ones provide opportunities for gains in resource efficiency and in educational effectiveness. Are the anticipated benefits realised and are the benefits worth the effort? What of the wider implications such as the social impact of technologies in a knowledge-based society? This paper addresses evaluation of educational technologies. It focuses upon how to establish the criteria for evaluating innovations employing
new learning technologies. There are several available frames of reference for evaluating educational technology.

SOME ISSUES

Why focus on evaluation criteria?

Evaluation textbooks consider evaluation philosophies, evaluation methodologies, analysis of data and evaluation instruments or a combination under the label of approaches to evaluation. Guba (1989) details criteria by which an approach to evaluation might be evaluated but the range of ways in which criteria for judging the subject of evaluation might be derived is seldom explicitly addressed. Some approaches (e.g. program evaluation, Owens & Rodgers, 1999) present a specific means of determining criteria but do not consider alternative means. This paper focuses on the derivation of criteria, establishing a typology and indicating the imperatives which guide the type of criteria selected.

One might ask whether it is necessary to have criteria for evaluation. The positivist answer is affirmative. For constructivists, the issue is more problematic, the interpretation of any such criteria varying between individuals. The position adopted here is a structurationist one (Giddens, 1984). This position allows that meaning is individually derived but understandings have some commonality from individual to individual and over time. The stipulation of criteria can be worthwhile though one would not expect the criteria to be interpreted identically by different individuals.

Why focus on innovations?

Educational technology, is not susceptible to an embracive evaluation. Educational technology cannot be defined in absolute terms. It cannot be separated from the human element and the concept embraces many technologies which will be used differently by different educators. Educational technology implies the use of something more than human resources of speech and action in the generation of learning. That something might be a multimedia package, the internet, print-based open learning materials, a computer aided learning program or a computer managed learning system. There must always be the components of intent and design in the engagement of educational technology, even in the absence of an educator at the time the learning takes place. The terms presence and absence have been made - by available technologies - relative rather than absolute terms. The point, therefore is to evaluate a teaching and learning innovation which involves educational technology, not to evaluate educational technology, per se. The boundaries of the types of innovation to be evaluated need to be defined. Use of educational technologies can be more or less innovative or innovative in some contexts while established in others.

The relationship of the use of educational technologies to approaches to learning

The use of educational technology does not imply any particular learning process informed by a particular learning theory. It could involve teacher driven construction, based on behaviourist theory or on information processing precepts. On the other hand it may be premised on individualisation of learning consistent with humanistic or with cognitive structural approaches. It may involved design catering for graded or alternative conceptualisations. The student may be largely passive or active and learning may take place through discovery or through direct instruction.

CRITERIA FOR THE EVALUATION OF INNOVATIONS EMPLOYING EDUCATIONAL TECHNOLOGY

There are several available means by which criteria for making judgements about innovations employing educational technology might be derived. These are typed here goals based criteria, comparative criteria,
criteria based upon conventional wisdom on or ‘best practice’ in the use of educational technologies, and theoretically-based criteria.

Goals or Objectives Based Criteria

If the goals or objectives of the project can be identified they are frequently used to provide the criteria for evaluation. This approach is a satisfactory approach if the objectives of the particular innovation have been accepted as being worthwhile, if any unanticipated outcomes are seen as irrelevant and if costs are seen as given and acceptable. This is, at least prima facie, the case for some specially funded projects, such as projects funded by a university or by an outside agency which calls for submissions for projects meeting certain criteria and provides support to a predetermined level. Even in these situations, evaluating a project against its own objectives is limiting. This method of evaluation will give no indication of unanticipated outcomes that may be as educationally or practically important as the intended outcomes. It does not allow for shifts in objectives. Focusing on project objectives can lead to costs being ignored or at least taken as given, being those specified in a project submission. In fact there are likely to be costs, both direct and indirect, which were not identified in project submissions. To ignore extraneous benefits, costs and other effects limits understandings that could inform future actions.

Comparative Criteria

An alternative approach is to compare the outcomes of an initiative with the pre-existing condition of the learner or with the effectiveness of an existing approach to the learning task; that is to compare learning under the innovation to a prior or concurrent approach that does not employ the media innovation.

There are two sets of issues in attempting a comparison based on the latter approach. The first is how it could be operationalised? What needs to be kept constant for comparative purposes? If the innovation had very wide application it could be trailed in a variety of circumstances and an inferential approach taken to its outcomes in comparison to traditional approaches, provided a consistent measure of outcomes was used. Wide application is not generally available which suggests the alternative approach of trying to keep as many factors constant as possible. This is likely to prove difficult. Cohorts of students will not be identical. Innovations are complex, changing many elements at once. The learning environment is likely to change in multiple ways.

The second set of issues in comparing old approaches with new educational media approaches is whether there is a commonality that should be compared. It would be unusual for educational and training initiatives using new learning technologies to simply change the form of teaching without impact on other aspects of the educational transaction. Initiatives are likely to arise from reconceptualisation of learning in the subject area as much from the availability of new teaching technologies. The nature of teaching and the role of the teacher may change from instructing expert to guide, facilitator, mentor, fellow learner, resource manager, while the role of the learner may change from passive recipient to client, explorer, problem solver, creative manipulator, cognitive apprentice, or evaluator. Even what constitutes the subject area, the definition of its boundaries, relationships between disciplines, who owns the knowledge, who can add to it, who can challenge it, all become open.

It would not then be appropriate to measure the success of approaches using new learning technologies against traditional approaches by using traditional student assessment tools such as a standardised test based on a set text. One could expect the objectives, processes and learning experiences to differ. Take for example a new learning technologies innovation which replaces expository teaching derived from a notion of transfer of information with discovery-based learning which values development of discovery techniques as much or more than the information acquired in the process. To apply a test of information acquisition alone as
a means of comparison between approaches would be inappropriate.

Criteria Based on Conventional Wisdom

A further alternative in establishing criteria is to use benefits and costs anticipated from the literature or experience as a basis for evaluation. The result is to evaluate innovations employing digital technologies against benefits which could, on the basis of a conventional wisdom, be expected to flow from them and to likewise evaluate them on the basis of costs which could be expected to be incurred.

The rationale for this approach is that it can take into account a wider range of benefits and costs than those identified by the designers of a particular project. It takes on board broader experience in the field. It also gives a basis for a broader comparative evaluation than that available when individual project objectives are used to evaluate new learning technologies innovations. Expectations that arise from conventional wisdom may be that innovations will: provide new educational experiences; offer greater options for student selection of learning activities; extend information resources; extend opportunities for exchanges between students and between students and teachers; provide better opportunities for monitoring individual student progress; and provide wider access to learning.

On the cost side, costs relating to hardware requirements and staff time required for development could be anticipated along with some training and facilities costs.

Theoretically-Based Criteria

This approach to evaluation criteria requires, not just a theoretical position on evaluation, but a theoretical position in relation to the realm being evaluated. For example where learning outcomes are evaluated you need a theoretical understanding of learning processes. If organisational costs and benefits are an issue then a theoretical position on management is required. Where access to education is an issue a position on equity is needed.

To take learning theories as an example, the criteria that one would use to evaluate an education or training innovation would differ according to the understanding of learning held by the evaluator. If you have a behaviourist understanding of learning you might look for a systematic, step by step approach, with frequent testing that resulting in positive or negative reinforcement as appropriate to produce the prescribed learning outcome. An evaluator with a constructivist view of learning might be looking for the opportunity for the learner to engage with the material, bring personal experiences and needs, apply their own meaning and emerge with something applicable to their own situation.

As for any of the approaches to establishing criteria the theoretical approach has its limitations. It may not address issues of the accountability of innovators to meet agreed objectives, in itself it says nothing about the comparative value of the innovation, and it will not be suitable for a decision maker who holds different ideals or theoretical understandings to those of the evaluator.

Frames of Reference for Selecting Evaluation Criteria

A model for selection of evaluation criteria based on the alternative frames of reference outlined above is tabulated in Figure 1. Each of the approaches to establishing evaluation criteria has its use and its limitations. The approaches can be combined. For instance for accountability purposes one may be obliged to take an objectives based approach to evaluating an innovation yet still wish to report on unintended outcomes. In combining criteria purposes need to be consistent or at least, if they are inconsistent, then the inconsistency needs to be highlighted when reporting.
A CASE STUDY

The issues outlined above were confronted in attempting to evaluate an educational technology initiative in computer science at the Royal Melbourne Institute of Technology (RMIT). Staff in the Computer Science Department observed that students undertaking a study of artificial intelligence (AI) using lecture and textbook inputs and supported by tutorials had a number of difficulties. They had difficulty in gaining an overview of the subject or even of particular topics such as search or logic, they focused on the detail. Students failed to see the application of the topics to real life situations. The problems they dealt with in practical exercises seemed apart from the world of work for which their course was intended to prepare them. Teaching difficulties were compounded by the fact that the AI subject could be undertaken by students with a range of academic backgrounds in computer science.

The staff proposed an alternative approach to give students a framework for exploring the subject which would allow them to locate their learning within the subject as a whole, to relate the subject to possibilities for application in the real world and to have greater facility to move in the direction and at the pace preferred by the individual student, or by groups. The two basic premises of the approach taken were to generate learning from the exploration of problems; and to allow, within some specified expectations, for individual or team decisions about the areas to be explored and the pace and depth of the exploration. Features of the approach adopted were the generation of learning from a focal problem; the location of the learning in a conceptual map of topics; and the use of computer based learning located on internet to present problems, to provide learning resources and to track progress.

A focal AI problem - the operation of a fully automated taxi system - was used with a view to prompting students to envisage the types of problems faced in developing AI systems, that is to obtain their own overview of the subject. The idea was to allow students to then define and explore sub problems. Texts, references and course materials placed on internet provided some learning resources, though students might also use their peers, experts and tutors as resources. The computer based learning program comprised two related elements: a course web of learning resources constructed by topic but accessible though hypertext and a problem web which assisted students - as they subdivided the focal problem into sub problems - to locate helpful learning resources housed in the course web.

Evaluation was used at each stage to observe student behaviour with elements of the program and to get feedback on attitudes, difficulties and preferences of students. For example, prior to the construction of any element of the computer program students were broken into small groups (of three) and asked to define sub-problems which they would need to address if confronted with the focal AI problem - the operation of a fully automated taxi system. Three levels of tutor intervention - tutor directed, tutor assisted and tutorless - were employed with different groups as they worked with the problem. The groups varied in ethnic composition, gender, and computer science backgrounds as well as in terms of tutor intervention so that likely causes of differences between them were hard to isolate. Outcomes, however, in terms of the capacity to subdivide the focal problem outcomes were encouraging.

Plans for summative evaluation focused on a number of possibilities including evaluation against the project objectives and evaluation against the previous approach. It was intended that the evaluation should take an open format allowing for unexpected outcomes.

A number of observations can be made about the evaluation plans. Firstly that there was an undertaking to evaluate but no detailed plan for evaluation at the time the project submission was drafted. To some extent an evaluation plan has to emerge and adapt as projects move through stages - from submission to design to trial, etc. Secondly the form of the project objectives did not allow them to readily translate into evaluation measures. Thirdly costs and disadvantages were not originally envisaged as a component of the