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# Towards a Framework for Evaluating ICT-Based Materials

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## INTRODUCTION

Information and communication technologies (ICTs) present interesting challenges for educators and ICT designers, not the least of which is the evaluation of learning. Syverson and Slatin (1995) argue that software and hardware have evolved into a bewildering range of programs and peripherals while networks innovations add still another layer of complexity. As a result, teachers must not only continuously learn how to use these rapidly changing technologies, but they must also rethink their teaching practices, design new activities for teaching and learning, and try to evaluate the learning of students as they engage those activities.

What makes the evaluation of ICT-based learning more problematic is the issue of just what is being evaluated. For example, although there is an extensive and ever-growing literature about "learning objects" (LOs), the clarity of the term continues to be elusive (McGreal, 2004). The various approaches to defining LOs attempt to meet two common objectives: to reduce overall costs of digital resources and to obtain better learning resources (Wiley, 2003), but these two objectives often receive differing emphases. For example, Downes (2001) stresses efficiency while Duval, Hodgkins, Rehat, and Robson (2003) focus on effectiveness. Further, while some writers (Mortimer, 2002) claim that most LOs have clearly defined characteristics, there is ongoing disagreement about the nature of these components (Merrill, 2002).

Nevertheless, irrespective of how LOs are defined, there are "great expectations for [them to] transform teaching and learning practices" (Moore, 2003-2004, par. 2), and their raison d'être is their ability "to improve student learning" (Moral & Cernea, 2005, p. 3) by engaging students with the designed learning material, the subject content, and the delivery system. Hence, any discussion on criteria for evaluating ICT-based materials needs to acknowledge the complexity of the concept of student engagement (Clarke, 2004) and how it is operationalised in LOs to enhance learning outcomes.

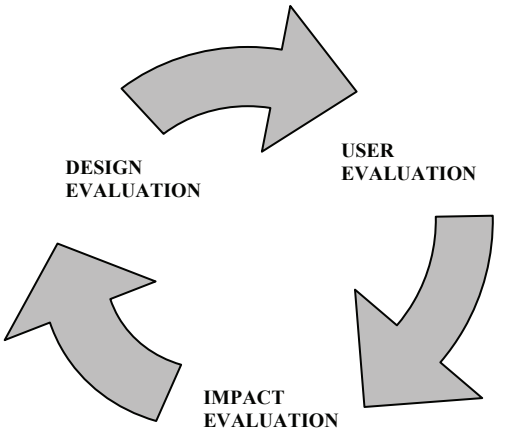
## EVALUATING ICT-BASED MATERIAL

The evaluation of ICT-based materials requires the development of criteria for judging them, entities that are not readily available (Currier & Campbell, 2002). Haughey and Muirhead (n.d.) claim that attempts to evaluate such materials are "fraught with complexities not found in assessing other non-digital educational content" (p. 13) because such materials differ from more traditional learning materials in significant ways: They use a variety of media such as text, graphics, sound, video, and music; the content has to be disaggregated to a optimal size and both the content and structure have to be flexible enough to maximise reuse in a variety of contexts (pp. 13-15). Furthermore, the ICT infrastructure has to have sufficient capacity to run the materials.

It is not surprising then that most current evaluation processes (e.g., Carr, 2000; Griffin, 2003; The Le@rning Federation, 2002) concentrate on being sensitive to the overall goals that designers and developers have for such digital assets as well as the constraints upon designs imposed by the subject content and the infrastructure capacities. However, this "design and development" phase is only the beginning. Like most product development, there is a cycle which includes:

- The design and development phase of the LO
- The intended audiences' reaction and uptake of the LO
- The actual impact and outcomes facilitated by the LO

*Figure 1. The beginnings of a framework for evaluating ICT-based materials*




When these three phases of the product development cycle are considered, any framework that proposes to evaluate LOs will need to incorporate criteria for judging them at each phase. These evaluation foci are referred to here as:

- Design evaluation
- User evaluation
- Impact evaluation

These foci provide the beginnings of a framework for evaluating ICT-based materials as summarised in Figure 1.

Before dealing with each of these foci and the criteria associated with them, it is necessary to discuss the pedagogical principles underpinning the framework that guide the educational soundness of the design, use, and impact of ICT-based materials.

## PEDAGOGICAL PRINCIPLES FACILITATING STUDENT ENGAGEMENT

A recent comprehensive list of criteria with a specific focus on how online curriculum materials may facilitate the engagement of students has been generated by The Le@rning Federation (TLF).[2] The criteria are designed to provide specifications for the educational soundness of online curriculum materials (TLF, 2002) where "educational soundness" is defined as "the capacity of online curriculum content to successfully promote student learning" (p. 4). The criteria "provide the broad framework for the design and development of ... online content" (Atkins & Jones, 2004, p. 2). The criteria, which have received international recognition (Haughey & Muirhead, n.d) and are metatagged to Australian school curricula, are underpinned by the four principles of learner focus, integrity, usability, and accessibility. These principles, all of which articulate with the notion of engagement, are defined and discussed in detail in TLF (2002) but are summarised below.

### Learner Focus

This will be achieved by designing a LO that:

- Reflects the relevant learner profiles based on intended users (e.g., age and stages of schooling; socio-economic status) and enables learners to interact with, organise, represent, interpret, and manage the process of learning and the information flow (e.g., making choices and decisions, inquiring, investigating, and problem solving)
- Makes explicit and consolidates the process of learning (e.g., structuring informational content in order to scaffold student learning)
- Contextualises student learning (e.g., establishing connections with prior and likely future learning; supporting communication, activity, and collaborative action, both online and off-line)
- Maintains learner focus through the interaction between users and the learning content (e.g.,

content assemblage, generation, conversion, and publishing)

### Integrity

This will be achieved by designing a LO that:

- Accurately represents the ways of knowing and conceptualising of the content domain
- Uses the language and symbols of the content domain and its ways of representation and supports students in developing and using them
- Presents controversial issues with balance and fairness and in accordance with mandated curriculum policies, where these apply
- Supports students' deepening of knowledge within the content domain
- Assists the learner with identifying and differentiating between different points of view and perspectives presented
- Incorporates content area advice supplied by expert representatives from relevant domains and practice areas.

### Usability

This will be achieved by designing a LO in which:

- The purpose, process, and intended outcomes of the learning are explicit
- Learning and information design is intuitive (i.e., the user knows what to do and how to do it)
- The time and effort needed to use it is reasonable
- The media is exploited to maximise the opportunities for learners to achieve the learning outcomes
- Content is constructed in manageable and meaningful concept chunks to facilitate learning.

### Accessibility

Online content will be accessible when it:

- Complies with accessibility standards for students with disabilities and for rural and remote communities
- Utilises the capacity of multimedia to support student acquisition of standard Australian English or standard New Zealand English
- Provides specific language support for students whose first language is not English
- Is appealing to and inclusive of students of all genders, socioeconomic groups, ages, races, and cultures

The application of these criteria to design, use, and impact evaluation is now discussed.

## DESIGN EVALUATION

Based on these criteria, TLF has developed a detailed iterative process for evaluating LO prototypes to provide feedback into the design and development phase, which they call an "in school evaluation" (ISE). The ISE process is built around cognitive task analysis methodology (Hall, Gott, & Pokorny, 1995), which involves a very detailed and close scrutiny of each screen and is linked to individual students' learning profiles. The ISE is carried out with a sample representative of the intended audience, in this case, primary and secondary school students, and focuses on technical issues such as the aesthetics of the design, the interaction, the navigational processes, the links between screens, the challenging nature of the tasks, and the language difficulty and understanding of meaning. The ISE focuses on evaluating the design specifications and has the ultimate purpose of determining the potential of the proposed learning design to support the targeted users in achieving the learning objectives and outcomes.

## USER EVALUATION

The evaluation of ICT-based learning materials often ends after the design and development stage when the LOs are put out to the market. However, the user uptake depends not only on the educational soundness of the LOs but also on the capacity of the end users to engage with them. Quantitative criteria such as number of teachers choosing to use the LO and the frequency of use are good indicators of user uptake. Further, how the LOs are being used will provide authentic feedback and also evaluate in a realistic manner some of the macro issues of equity and utility identified in the education soundness criteria. Such evaluation supplements the ISE feedback and adds to the appreciation of the full potential of the LO to be integrated into everyday classroom learning activities and to engage students.

LOs are instructional artefacts which can be integrated into classroom learning activities in a variety of ways. However, there is very little research to date investigating this aspect of ICT-based learning materials, although recently, there has been recognition of this hiatus with the beginnings of the exploration of the professional competencies that teachers use to engage with and develop innovate learning activities using ICT-based materials (Atkins & O'Conner, 2005; Muirhead & Haughey, 2005). "The outcomes of using learning objects rely not just on the intrinsic properties of the learning objects but on the teaching and learning processes adopted in the classroom" (Freebody, 2006, p. 21). How the teacher interprets and integrates the LOs into the teaching-learning situation needs to be evaluated.

## IMPACT EVALUATION

Perhaps the ultimate test for the large investment in the development and deployment of ICT-based learning materials is the impact they have on learners—the quality of the learning outcomes. A number of evaluation criteria have been developed as indicators of the quality of learning outcomes (Nesbit, Belfer, & Leacock, n.d.; also see www.merlot.org). Typical of these are relatively simple tracking of such aspects as attention given to the buttons, menus, text, and types of user-object navigation. The approach used here, consistent with the complexity of the student engagement notion central to the effectiveness of LOs, is to go beyond that to evaluate the quality of the knowledge acquired by learners. To do this requires the melding of structural and design characteristics with qualitatively different conceptions of respective discipline knowledge and thinking.

There are a plethora of taxonomies that reflect the complexity of thinking (Anderson, 2001; Linn & Miller, 2005), but the structure of observed learning outcomes (SOLO) taxonomy (Biggs & Collis, 1982) offers a vehicle against which the students' structural and functional aspects of knowledge may be matched. Its superiority to other taxonomies as an indicator of student learning outcomes has been cogently argued by Hattie and Purdie (1998). It provides a means of evaluating the complexity of thinking facilitated by the LO by classifying it as either:

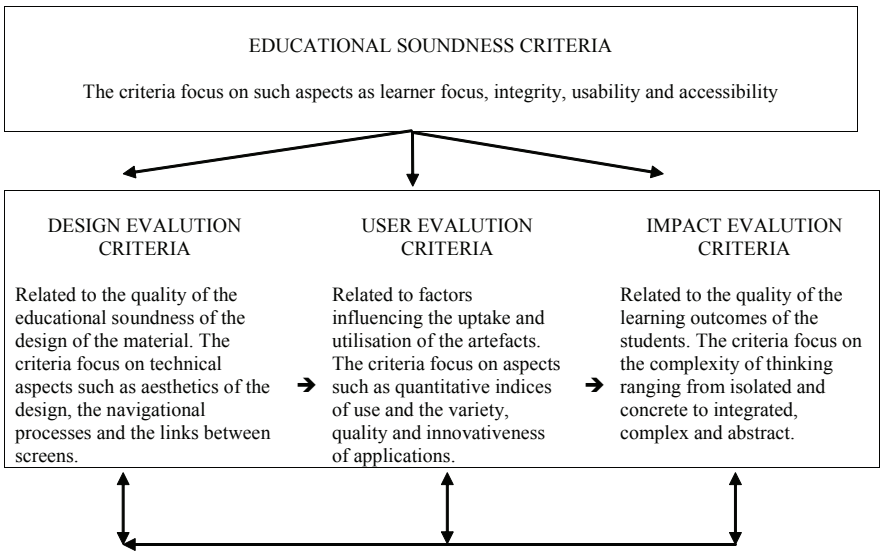
- **Prestructural:** Incompetence; nothing is known about the area of knowledge
- **Unistructural:** One relevant aspect is known but there is no relationship of facts or ideas
- **Multistructural:** Several relevant independent aspects are known but are not interrelated
- **Relational:** Several aspects of knowledge are integrated into a structure that has coherence and meaning
- **Extended abstract:** That coherent whole is generalised to a new domain/topic area to a higher level of abstraction

The levels are ordered in terms of characteristics such as from concrete to abstract, an increasing number of organising dimensions, increasing consistency and the use of organising or relating principles and can be considered as criteria for evaluating the quality of student learning outcomes. There are two general approaches to this. The first approach is to analyse existing outcomes. It has been used in poetry, history, mathematics, science, economics, chemistry, geography (Hattie & Purdie, 1998), and, more recently, in the evaluation of student-developed Web pages in English and history (Kimber, Pillay, & Richards, in press). Extending the work of Kimber et al. offers the exciting development of challenging students to identify a problem and to create a solution. Similar strategies are being explored by TLF (S. Atkins, Director of TLF Online Initiatives, personal communication, February 24, 2006) where "students" become "designers" (Murphy, Harvell, Sanders, & Epps, 1999). The range of content areas is testament to the robust applicability of the taxonomy. The second approach is to construct test items reflecting the levels.[1] This can be done using traditional test item construction procedures (Biggs, Holbrook, Ki, Lam, Li, Pong, & Stimpson, 1989) or, in the context of an LO, "repurposing" the LO to assess learning (Atkins & O'Connor, 2005).

## PROPOSING AN INTEGRATED FRAMEWORK

By combining the design evaluation, user evaluation, and impact evaluation criteria, it is possible to provide an inclusive framework for the comprehensive evaluation of ICT-based materials. By integrating the TLF criteria with an evaluation of the level of knowledge

*Figure 1. A framework for evaluating ICT-based learning materials*




demanded by the LO, and by evaluating the degree and quality of uptake, it is possible to produce a set of evaluation criteria that is multidimensionally comprehensive and addresses the complexity of student engagement. This framework for evaluating ICT-based materials is summarised in Figure 2. The total evaluation process is iterative in that relevant information from later stages can be recycled back into earlier stages as required.

## CONCLUSION

In beginning to develop a framework for the evaluation of ICT-based materials, it was necessary to draw on the product development cycle that led to the identification of design, user, and impact evaluation criteria. Relevant design and impact evaluation criteria based on the ISE work of TLF (2002) and with the SOLO taxonomy, respectively, were put forward as quality examples of ways to evaluate the design and development of online learning materials and their manifestation as learning outcomes. Linking these and elements are the user evaluation criteria which address how the teacher interprets and integrates the LOs into the teaching–learning situation and it has been posited that this process is the key to the quality of the learning outcomes in students.

There is significant evidence relating to the reluctance of teachers to take on new technologies (Russell, Lucas, & McRobbie, 2003; Syverson & Slatin, 1995). For there to be any chance of successfully integrating ICT-based materials into mainstream classroom learning, there is a significant need for the professional development of teachers in this area at both the preservice and in-service levels.

## NOTES

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2. The Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) established The Le@rning Federation in 2001 to produce online curriculum materials and supportive infrastructure to ensure that teachers and students in Australia and New Zealand can use

these materials to widen and enhance learning experiences. For more information, please see http://www.thelearningfederation.edu.au

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## KEY TERMS

**Evaluation:** The development and implementation of a plan to assess a program in a systematic way through quantitative and qualitative measures, and the use of that information to improve the program. This involves collecting information about a prototype resource that will help in its development and ensure it works effectively and also collecting information at the end of the developmental phase to estimate the success and quality of the resulting resource.

**Learning Objects:** Bodies of digital material specifically designed to engage and motivate student learning. Each learning object has a learning objective, content, and activities that support the objective and assessment activities that reflect that expectation; they usually take less than 15 minutes to complete; the

content is metatagged to some set of standards; and the object can exist on its own and be provided to the learner in a just-in-time and as-needed fashion.

## ENDNOTE

[1] Only four levels are measured as the Prestructural is not considered.