

## Reuse of Web-Based Resources in Technology-Enhanced Student-Centered Learning Environments

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### Technology-Enhanced Learning Environments

For the purposes of this paper, technology-enhanced learning environments refer to those educational settings where some element of instructional technology is being used to support the interaction between the *teacher*, the *learner* and the *educational content*. Students in these educational settings are often required to pursue self-directed and open-ended inquiries. Interest in building these educational environments, where students are immersed in "learning by doing" and where the meaning of knowledge and skills are realistically embedded in authentic problem situations, has been growing since the last decade (see Brown, Collins, & Duguid, 1989). These environments are designed not so much to "instruct" as to provide contexts wherein understanding and insight can be uniquely cultivated. Papert's concept of "microworlds as incubators for knowledge" reflects the philosophical bias of these technology-enhanced, student-centered learning environments (Papert, 1993, p. 120). They are called "student-centered" because the focus in these learning environments is more on learning, and less on the delivery of the content. Examples of these student-centered learning designs are goal-based scenarios (Schank, 1997), and problem-based learning (Koschmann, Kelson, Feltovich & Barrows, 1996).

Suitably designed environments, whether they are technology-enhanced or not, comprise a complex arrangement of several components. Perkins (1991) has labeled these components as *information banks*, *symbol pads*, *phenomenaria*, *construction kits*, and *task managers*.

*Information banks* are sources or repositories of information such as textbooks, teachers, encyclopedia, and other such media. *Symbol pads* refer to learning devices such as surfaces for construction and manipulation of symbols and language. Examples of such devices are index cards, the blackboard (or whiteboard). *Phenomenaria* are areas for presenting, observing and manipulating phenomena. An example of this is a model-based or rule-based simulation. *Construction kits* are similar to phenomenaria, except that they are less closely tied to natural phenomena. Examples of construction kits may include scientific apparatus used in learning laboratories such as LEGO, learning logs and authoring tools (e.g. word processor). *Task managers* are tools, devices or processes that can provide guidance, feedback, and directions as necessary. Examples of task management tools are textbooks, grading programs, assessment devices, devices for conveying rules and expectations, and computer based instructional programs.

## Supporting Use of information in Technology-Enhanced Learning Environments

Perkins' view is not in contradiction with the student-centred, goal-based scenarios and problem-based learning designs as promoted by Schank (1997) and Koschmann, Kelson, Feltovich & Barrows (1996). In a sense, student-centred, goal-based scenarios and problem-based learning designs are generic approaches to learning and teaching, and Perkin's various components can help us map attributes of technology as design components. One of Perkin's notable components is "Information banks". Irrespective of whether the design is based on an information delivery or student-centred model, information is always an important element. Obviously, in the information delivery model, a great deal of effort is put in "creating" educational resources with the sole objective of being used within the course. Technology enhanced learning environments usually incorporate the use of CD-ROMS, the Web and other technologies. These technologies provide learning environment with large amounts of information by way of databases and other resources (making them information-dense). There are significant differences in the way information is presented in most CD-ROMs and on the Web. Information on well-designed educational CD-ROMs is carefully selected, edited, reworked and presented by the designer for specific educational purposes. Information on the Web, on the other hand, may not have been specifically designed for any educational purpose and is not as closed as is the case on a CD-ROM. The student-centred, goal-based scenarios and problem-based learning designs as promoted by Schank (1997) and Koschmann, Kelson, Feltovich & Barrows (1996) are examples of highly structured learning environments based on closed information banks. Role-play activity on the Web (see Linser, Naidu & Ip, 1999) is a situation where learners are confronted with information that is available for purposes other than education. We will use the term non-educationally-focused (NEF) resource to refer to a resource, which was originally created for non-educational consumption. However this name should not imply the appropriateness or otherwise of the use of such material in educational or training situations. Learners in the role-play activity are encouraged to access NEF information on the web, which, in this instance are similar to Perkin's "Information Banks".

Web-based student-centered, learning environments do not, in themselves, lead to learning efficiency or effectiveness. Indeed for some learners, the overwhelming quantity of information (educational resources and NEF resources included), the use of technology and the student-centered nature of these learning environments can be quite daunting, and pose a real threat to their success and motivation to learn. While creating opportunities for student-centered learning, these environments also create demands for new skills in finding information, managing complex information and higher order cognitive processes. The problem is compounded as the information available is not necessarily pre-selected, prepared and customized for use. Being successful in such learning environments requires the ability to use resource discovery services to discover relevant information, organize, evaluate, monitor the progress of one's learning, and also understanding that the information may not have been created for educational use originally. Not all learners have the skills to function efficiently and effectively in such educational settings. Students need help with acquiring learning strategies to enable them to organize and reflect on information they have encountered. They have to be taught the information management skills, learning and self-monitoring (i.e. metacognitive) strategies which would in turn enable them to take advantage of rich information databases, and open-ended inquiries (see Weinstein & Mayer, 1986; Jonassen, 1988).

In information dense learning environments, efficient access to resources implies efficient resource discovery both by the designers of the learning environments and by the learners for their learning needs. Most commercial search engines use an inverted index for searching. This search strategy typically returns thousands of pages covering widely different meanings to the search words. For example, e.g. the word "conductor" could return references to persons who collect fares on a bus or train as well as references to metal that conducts electricity. This is not a very efficient search technique. Many efforts that are currently in progress advocate the use of metadata to support resource discovery. Metadata is data about data. It describes the attributes and contents of an original document or work (Milstead & Feldman, 1999). Ip, Currie, Morrison and Mason (1999) have also described a data framework to understand the different mechanisms in supporting resource discovery. Briefly, resources are denoted as Type-1 data. Typically, Type-1 data are owned by the original intellectual property owners, they are not subject to change, and used directly by end-users, very much like the books in a physical library.

### Current Work Related to Educational Resources Discovery

The use of metadata is not new. For a long time, libraries have been describing resources (such as print and non-print resources in their collections) on their catalog cards with systems such as the Dewey's Number Classification System or Library of Congress Classification Category Index in order to help library users to find appropriate resources. Both these classification systems which are widely used are based on an ontology reflecting the needs of the community using the resources. Other information on the catalogue cards also provides further help for users to determine the relevancy of the resource to their needs. All such information is Type-2 data. In the data model advocated by Ip, Currie, Morrison and Mason (1999), the classification system itself (including the **standards** adopted by a library in its catalogue card but not the information on the card) is known as Type-3 data.

The Web has enabled the separation of the catalogue card service from the resource holding service. These services have traditionally been highly integrated in physical libraries. Search engines or subject gateways are services equivalent to the catalogue card - to help users to locate resources. By way of hyperlinking, search engines or subject gateways do not necessarily hold the resources but provide links to the resources. This means that any educator is able to select any information from the web, create a database and provide mechanisms for learners to search these selected resources without really storing the resources themselves.

Standards setting organizations have already spent a great deal of effort into specifying the standards for describing educational resources but failed to address the specific issues related to the use of NEF resources. The stated objective of IEEE Learning Technology Standards Committee (LTSC) (<http://ltsc.ieee.org/>) is to develop technical standards, recommended practices, and guides for software components, tools, technologies and design methods that facilitate the development, deployment, maintenance and interoperation of computer implementations of education and training components and systems. Of special interest to this paper is the P1484.12 Learning Objects Metadata Working Group. The scope of this working group is to specify the syntax and semantics of Learning Object Metadata, defined as the attributes required to fully/adequately describe a Learning Object" (<http://ltsc.ieee.org/wg12/index.html>). Similarly, the IMS Learning Resources Metadata

specification (<http://www.imsproject.org/metadata>) aims to benefit the learner looking for information.

These efforts attempt to specify what kind of information should be included in the catalogue card as well as the entries in the classification system. This is work in the Type-3 category. Type-3 data is based on a set of the assumptions about the intended use of the standard. The educational metadata standards are focussing on resources, which are originally designed for educational consumption. There is a subtle but significant difference between "educational resources" and "educational aspects of resources". The role-play learning environment (Linser, Naidu & Ip, 1999) calls for a mechanism for enabling educational use of NEF resources.

Some examples of NEF resources, which have significant educational value, are:

- "real-time" information (unlikely to be created for sole educational use). They can be linked by including static URLs of the most current pages of dynamic web resource sites, e.g., in the resource page of "World Politics in Transition" Role Play Simulation, there are links to News sites such as BBC and CNN (see Linser, Naidu & Ip, 1999).
- Aggregation, customization and/or other value-added services such as results pages from appropriate subject gateways, search engines and data sources (for example, the First Fleet Online database hosted by the University of Wollongong has been a useful resource for many schools in the teaching of early white settlers in Australia).

There are two aspects of effective use of NEF resources: by designers so that a wider range of information can be included in learning environments or by learners to meet immediate needs of the learning goals.

While an increasing number of such cognitive tools are being developed to support student-centered learning, the majority of these tools are *content* or *context* specific. In the majority of cases, little thought has been given to the applicability of these tools to handle NEF resources in educational settings or problems. As such, the reusability of NEF Web-based resources in similar or other situations is limited.

### **Issues Surrounding Reuse of Web-Based Resources**

In a role-play simulation, for instance, the Web enables access to a wide variety of information from electronic newspapers and web-sites etc. from all over the world as well as access to facilitators or mentors as and when they need them (see Linser, Naidu & Ip, 1999). In such learning environments, the designer selects the resources in much the same way information is selected and presented on CD-ROMs. The differences are that (1) the information on the Web is live and dynamic, e.g. the news and (2) the designer did not have the opportunity to rework the resource to meet any specific need. Any NEF resource has to be presented as is. So, what is the education-enabling process? A similar example of an access to a wide variety of resources is a visit to the museum, which can be a good learning experience. Many museums pride themselves in displaying the original artifacts - NEF resources! The way the exhibits are presented, the accompanying descriptions and sometimes the activity sheets all help to enhance the learning experience of the visitors.

Based on studies of existing information gateways, Ip, Morrison, Currie and Mason (2000) propose a theoretical model and described two mechanisms to enable NEF resources in a way that is compatible with current educational metadata standards. Using the museum example, the accompanying descriptions and activity sheets have "education-enabled" the NEF resources. This is the type-1 enabling mechanism referred to, or as wrapping of NEF resources with Type-1 resource(s). These type-1 resources are educational resources, which are created with specific educational objectives and hence can be described by the educational metadata standards. Other type-1 enabling may describe a particular view on the educational use of the NEF resources in the form of a comment or suggested use. These enabling resources do not have much value without the NEF resources. Educational metadata standard should acknowledge this particular property of these enabling resources and seek to extend the standards to include a mechanism for locating the linked NEF resources when the enabling resource was discovered first.

The other mechanism is the use of metadata to enable NEF resources. Depending on the nature of the learning environment, Type-2 data can enable highly sophisticated use of NEF resources. The act of creating Type-2 data is equivalent to selecting information in technology-enhanced learning environments.

These solutions are taken from the view of the designer of the learning environment. On the surface, it seems that the education-enabling of NEF resources does not suggest great improvements to the current situation. In fact, the dynamic nature of the web gives us another problem: the dead link problem, making the use of NEF resources in information dense environments a very fragile environment as things may not always work the way they were meant to work. The issue becomes a lot more complicated when we start to enable learners to explore a wider information space, such as the Web by themselves. It is very difficult to provide just-in-time and relevant information to learners. While the minors are learning to discover, manipulate, organize and process information, how they can be protected from insane and indecent material becomes increasingly difficult?

### **Ongoing Efforts with Enabling Reuse of Web-Based Resources**

Type-2 data enabling techniques has been widely adopted by information gateways. One of the information gateways which can be used to allow learner direct access is Education Network Australia ([www.EdNA.edu.au](http://www.EdNA.edu.au)). Central to EdNA's functionality is the EdNA Online website. This features a comprehensive directory of resources relating to Australian education containing some 9,000 evaluated sites and over 250,000 linked sites. These resources have been collected from stakeholder collections and from international sources by Directory Officers and through local contributors (Currie, Morrison & Ip, 2000). Other subject gateways in Australia includes MetaChem, the Australian Electronic Literature Gateway, Agrigate, Lawzone, Performing Arts, Australian Virtual Engineering Library - AVEL, Bright Sparcs & Australian Science at Work (National Library of Australia, 2000). Other international projects include DESIRE (Development of a European Service for Information on Research and Education), RDN (the Resource Discovery Network), Renardus (Academic Subject Gateway Service Europe), IMesh (International Collaboration on Internet Subject Gateways) and The SCOUT project (National Library of Australia, 2000).

Since these information and subject gateways are serving different audiences, the metadata standards that are used vary considerably. Most of these are derivatives of the Dublin Core

Metadata Standard and some are partially compliant with either IEEE LSTC or IMS metadata standards. Novice users may have great difficulty in coping with the vastly different underlying ontologies in the classification systems used by these information gateways and subject gateways. Ip (1999) proposes a mechanism for gradually increasing the interoperability of subject gateways. The proposed mechanism has the potential to lower the overhead for novice users in using information from subject gateways.

Subject gateways add value by gathering and making information available to the users. Such effort is represented by the type-2 data which represents the main asset of the subject gateways. During the process of gathering and describing the information, they are in the position to apply type-2 enabling to NEF resources. Effectively, subject gateways are expanding the scope of their service. Subject gateways derive their competitive advantage by addressing the need of their target audience as reflected in their Type-3 data. Any collaborative framework that attempts to fit subject gateways into the same set of Type-2 data (i.e. forcing a standard Type-3 data) will be limited by its inability to integrate this value-adding attribute. Hence it is not likely to be accepted by owners of subject gateways as this will threaten their existences in compromising their competitive advantage. Any successful approach will need to ensure that gateway developers share the service. Adding the capability of education-enabling NEF resources in the educational metadata standard will provide a level of compatibility and interoperability between subject gateways without compromising the value-adding propositions of subject gateways. Some level of semantic sharing while forcing all subject gateways into the same semantic structure is counter-productive. DESIRE has recently published DESIRE metadata registry framework, which provides a mechanism for expressing subject gateways' Type-3 data in a machine-readable form. This is definitely a step in the right direction. However, we believe that greater immediate benefit can be found by coming to an agreed standard in metadata elements for education enabling NEF resources.

## Summary and Conclusion

We believe it is time to have a closer look at the use and reuse of Web-based resources. While the Web provides an immense amount of useful resources, the vast amount of information available from the Web may be potentially daunting to users if they cannot be efficiently retrieved and effectively used. For instance, not all information available on the Web has been created originally for educational consumption. Effective mechanisms for use of NEF resources should be treated with some urgency.

Ip, Morrison, Currie and Mason (2000) have articulated a theoretical approach for using NEF resources from the instructional designers' perspective. The main contribution of this paper on the subject of reuse of web-based resources is defining and recognizing the potential of the role of information gateways and subject gateways' in supporting the use of NEF resources by learners directly. Information gateways and subject gateways are akin to Perkin's concept of "information banks". Whereas in a technology-enhanced learning environment information is selected with a definite learning goal, the selection of resources in the library follows a much broader agenda. Information gateways and subject gateways have a much smaller yet relevant collection. A group of interoperating information gateways and subject gateways provides a good opportunity for creating the online equivalent of school libraries which comprises a much safer environment for learners to explore. Interest in interoperability by owners of subject gateways is driven by the need for sustainability, and long term viability (National Library Australia, 2000). The result of these efforts, however, may mean smaller local

subject gateways which may act as entry points to a much larger collection of high quality, suitably education-enabled NEF resources. This is another use of the community's investment in subject gateways. Developing understanding, and implementing that understanding in flexible standards can also help distributed collaborative enabling of NEF resources.

It is now time to acknowledge the subtle difference between "educational resources" and "education aspects of resources". We urge the educational metadata standard community to take on board the concept of NEF resources and start the process of extending the standard to enabling the effective use of such a richer resources base.

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