Learning Objects: Resources for Teacher Design?

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Abstract

This paper presents an image of teaching as design, in which teachers take advantage of the abundance of high quality, online educational resources to design and enact locally relevant learning activities. Toward this end, we describe a software tool, the *Instructional Architect*, and a professional development model intended to increase teachers' capacity for the design of learning activities using such resources. We also report preliminary empirical investigations by presenting quantitative analyses of users' design activities, complemented by qualitative analyses involving 52 mathematics and science teachers who participated in the professional development program. Quantitative analyses suggest that active use and design with online resources is relegated to 'early adopters'. These users designed significantly more instructional projects with more content and more online resources than less-active users. Users in general appeared to value online resources, and preferred those of smaller granularity. Qualitative analyses of workshop participants' comments indicated that they appreciated the convenience and currency of online resources, and their use to enrich classroom activities. Participants also mentioned accessing online resources for research purposes.

Introduction

Recent widespread availability of educational resources on the World-Wide Web holds great potential for transforming education. In science education, for example, students can now access real-time images from space exploration (Marlino, Sumner, Fulker, Manduca, & Mogk, 2001), while in mathematics, students can interact with virtual tools and manipulatives that help make abstract concepts more concrete (Dorward & Heal, 1999). In short, through interacting with Web content, students can now engage in highly personalized learning experiences, instead of relying on the one-size-fits-all textbook.

In recognition of this potential, several large-scale initiatives have been launched, focusing on developing repositories (or, *digital libraries)* containing cataloged collections

of high-quality online learning resources (or, *learning objects)*. The federally-funded National Science Digital Library is a prominent example (www.nsdl.org) (Wattenberg, 1998; Zia, 2001). The National Science Digital Library (NSDL.org) currently offers access to over 1 million learning resources from over 500 partner educational digital libraries (Lagoze, Krafft, Payette, & Jesuroga, 2005).

Despite the existing capabilities and implications for teaching and learning, little is known about how teachers view their roles in terms of adapting, designing, and using learning resources in diverse classroom situations, or how teachers' knowledge and skills are changed as a result of their interactions with these resources. Indeed, an implicit assumption of these initiatives is that teachers and learners will access and use these technologies in unproblematic and seamless ways. Unfortunately, the history of educational technology suggests that this is seldom the case (Cuban, 2001). Instead, systems that must cross many institutional boundaries (such as school settings) rarely do so in transparent ways (Agre, 2003).

In this paper, we take the view that teaching can be a creative, constructive process in which the use of learning resources, such as those found in the NSDL, can play an important role. Teachers with ready access to abundant, high-quality learning resources become designers who use learning resources to fit their local needs and context (Brown & Edelson, 2003; Dede, 2003). In this context, learning resources can become *catalysts* for creating locally relevant instructional approaches to support learning.

To support teacher design with these resources, we developed a simple, end-user authoring service, called the Instructional Architect (IA.usu.edu). With the IA, teachers can *find* and *gather* NSDL and Web resources, *create* personal collections of instructional activities, and *share* these with students and peers (Recker, Dorward, & Reinke, 2003). To support diffusion, we have also developed and conducted teacher professional development workshops intended to increase teachers' capacity for and identity in designing learning activities using learning resources.

This paper first briefly describes the IA, and then reports preliminary empirical investigations by presenting quantitative analyses of users' design activities with learning resources. Against this backdrop, the paper reports qualitative analyses from a study of 52 mathematics and science teachers who participated in professional development workshops that centered on designing instruction using online learning resources and the IA. The research focus was on two related questions: 1) what are users' design activities with online resources, and 2) what are the attitudes of workshop participants regarding the use of learning resources in support of teaching and design?

A Note About Language

In the remainder of this paper, we avoid using the term 'learning object'. We do this for several reasons. First, the term has no single, clear, and unambiguous definition (Friesen, 2003). Second, the term implies that the learning is solely a property of the object. Finally, the term is unfamiliar to most practitioners.

Instead, we prefer the term 'learning resource,' as its meaning seems better understood by teachers (Recker et al., 2005; Recker, Dorward, & Nelson, 2004). More importantly, it implies that learning is jointly constituted in terms of the resources, people, practices, and values of the embedding context.

Similarly, we prefer using the term 'digital library' in lieu of 'repository'. This term better highlights the institutional nature of the enterprise, comprised of both managed, cataloged, and curated content, as well as the different social roles of the people involved (Agre, 2003). For example, digital libraries often provide access to online reference librarians, as well as discussions spaces.

Theoretical Framework

Our proposed image of teaching is one in which teachers take advantage of the great wealth of online resources to design and enact learning activities. Resources become the building blocks of learning activities, as teachers adapt and implement them in ways suitable to their local context. This view is not necessarily novel, and is generally aligned with a constructivist philosophy. However, what has changed is the abundant and widespread availability of high-quality, online resources for learning.

However, not all teachers naturally view elements of their practice as design. For example, teachers' beliefs and their pedagogical philosophies will impact their use of such resources (Becker, 2000). Teachers with little teaching experience or a low comfort with subject matter will perhaps be less likely to adapt resources, and more likely to use them unchanged.

In addition, the nature of the resource provides affordances and constraints on its adaptation and use. For example, the granularity (or size) of a resource impacts adaptation (Wiley, Recker, & Gibbons, 2000). Large resources are intended to be used with little modifications, and the number of contexts in which they can be applied is small. Conversely, small, self-contained resources afford greater teacher improvisation and adaptation in a wider range of situations. For example, a simple graphing calculator applet can be used in a wide range of mathematical contexts.

In sum, complex relationships exist between users, their social practices, attitudes, and values, and affordances of learning resources. Too often, a narrow focus on tool development tends to obscure these interconnections and, as a result, oversimplifies design problems (O'Day & Nardi, 2003).

Research Activities

For the past 1.5 years, we have been offering professional development workshops for K-12 educators, called **DLConnect**. The workshops help teachers learn to *use* and *search* digital libraries and tools, and *design* instructional activities by adapting learning resources to fit their local needs and context. In 2005, over 300 educators participated in professional development activities. In this paper, we focus on two workshops, involving 52 in-service mathematics and science teachers.

As part of workshop activities, participants learn to use the **Instructional Architect** (IA), an end-user authoring service primarily designed to support use of digital library and Web resources in instructional contexts. The IA offers several major usage modes. First, users can **register** and create a free account. Second, with the '**My Resources'** tool, users can search for and save desired NSDL resources for further use (see Figure 1). Users can also add any Web resource by entering its URL.

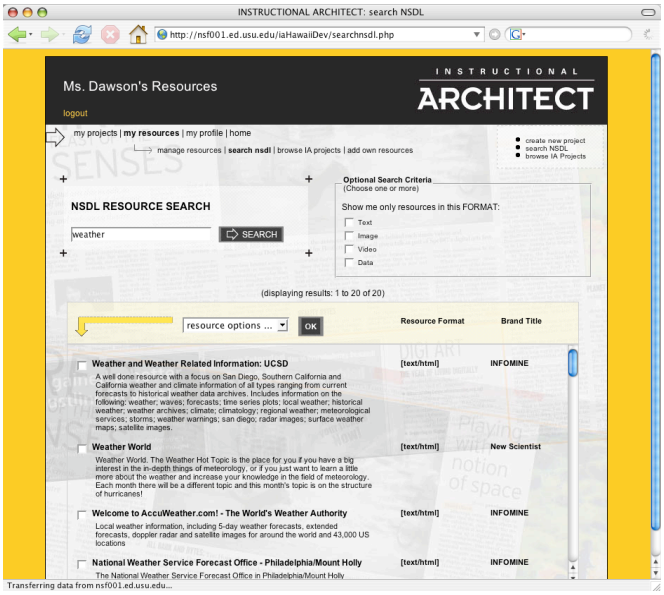

Figure 1. Searching for and selecting NSDL learning resources

Third, with the '**My Projects'** tool, users can create web pages in which they sequence and annotate their selected resources in order to create instructional projects (Figure 2). Finally, users can '**Publish'** their projects to share them with their students (*student* view), or anyone browsing the IA site (*public* view).

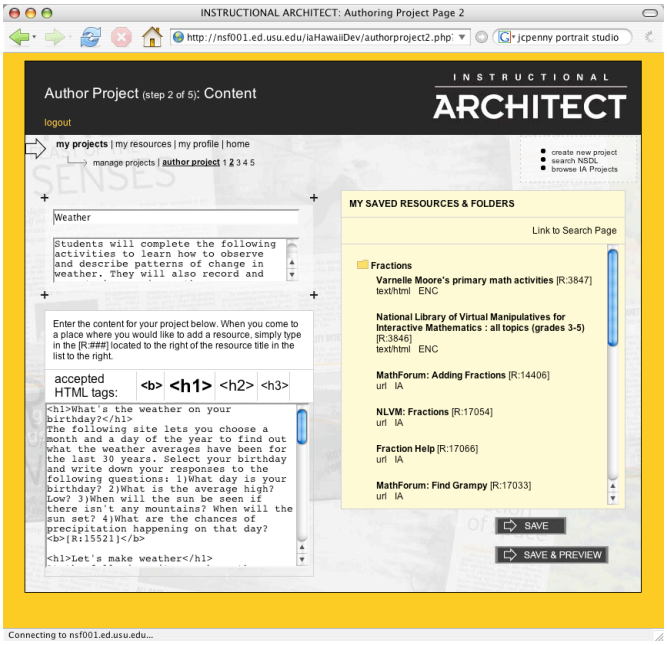

Figure 2. 'My projects' area

An example user project can be seen in Figure 3. The figure shows the instructional annotations added by a teacher, with an NSDL online learning resource (a weather simulator) in the foreground. We note that the IA is available as an Internet portal, and thus is available for anyone to use.

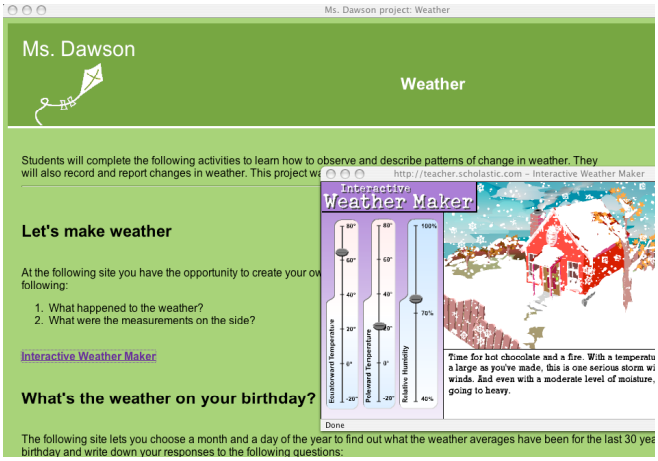

Figure 3. Example IA user project

Methods

Instructional Architect Users

The instructional projects created by IA users offer a unique window into understanding the kinds of projects users create and the resources used. Since 2003, over 1000 users have created accounts on the IA portal, with 60% of the users registering in the past year. Approximately 40% of the registered users were teachers who participated in DLConnect workshop activities; the remaining users simply come from the wider Internet, and not much is know about their background or motivations.

Workshop participants

The two DLConnect professional development workshops that formed a focus of this paper involved 52 in-service mathematics and science teachers. Each six-hour workshop was conducted in a computer lab where participants sat at an Internet-connected computer. The instructor had a projector to demonstrate the software to participants. The workshop curriculum, designed to help participants integrate digital libraries resources in teaching, introduced participants to the NSDL and the IA. Then, through hands-on activities, participants designed (individually or collaboratively) simple IA projects for their classroom.

Participants completed a pre-survey at the beginning of the workshop, and a post-survey at its conclusion. The survey items included a number of Likert-scaled and open-ended items intended to collect demographic information and to measure teachers' prior knowledge and experience regarding digital libraries and learning resources, their attitudes towards their utility, the technology infrastructure in their schools, and their opinions on the usefulness of the workshop.

Table 1 shows participant demographics from the two workshop implementations. Table 1 also reports the mean for each group's self-reported experience with using online resources, and the level of technology use in their schools (with Workshop A participants generally reporting lower levels of technology use).

Table 1: Participant demographics

Workshop	N	% female	Workshop time (hrs)	Tech use in school (0=very low; 4=very high)	Experience teaching with learning resources (0=very low; 4=very high)
A. Secondary science	33	47	6	1.7	2.2
B. Elementary science & math	19	83	6	3.4	2.8

Findings

The data reported include a) quantitative analyses of IA users' usage and design activities with online resources using the Instructional Architect, and b) qualitative analyses of workshop participants' pre and post workshop comments on electronic surveys.

Designing with Online Resources: Usage and Design

Usage analyses reveal that many visitors to the IA are one-time users. As such, we defined an 'active' user as having logged in within the past 6 months and designed at least three IA projects (which contain added content). Active users comprised 10% of the accounts (or 97 accounts), perhaps representing the 'early adopters' (Moore, 1991).

Active vs. less-active users. Table 2 shows differences between the activities of active and less-active users. To identify significant differences, all data were log transformed to normalize skew (as is common with these kinds of data (Recker & Pitkow, 1996)). Results from one-sample t-tests show that:

- Active users published significantly more of their projects ($t(91) = 19.81$; $p < .0001$);
- Active users included significantly more resources per published project ($t(90) = 15.15$; $p < .0001$);
- Active users saved significantly more resources ($t(96) = 20.80$; $p < .0001$);
- Active users added significantly more words per published project ($t(91) = 15.51$; $p < .0001$).

Table 2: Usage data (totals and untransformed means)

	# accounts	**Total # projects**	**# saved resources**	**Mean # published projects**	**Mean # resources in published project**	**Mean # saved resources**	**Mean # words in published project**
Less-active users	916	1188	3625	.38	1.27	3.96	55.64
Active users	97	511	2133	4.06	14.07	21.99	646.35

Resource origin. Table 3 shows the number of resources saved directly from an NSDL search, comprising 37% of the total number of saved resources. However, in our observations, we noted that often workshop participants located a resource within an NSDL digital library (at a smaller level of granularity than cataloged), and then saved its URL. Although this resource was discovered within a digital library, it simply appears as a user-added Web resource.

Table 3: Resource usage: totals (percent)

	Saved from NSDL	User added Web resources	
		Domain Name in NSDL	Domain Name not in NSDL
# saved resources (%)	2122 (36.7)	2257 (39.1)	1400 (24.3)
# used resources (%)	1185 (30.8)	1664 (43.2)	1000 (25.9)

Further examination of the origin of resources revealed that the domain name of almost 40% of the user-added resources (and 43% of those used in projects) exist in the NSDL. From this we infer that NSDL resources appear to be of high value to users: they preferred resources from domains that are in the NSDL, but apparently at a smaller granularity than cataloged.

Resource granularity. We estimated the granularity of participants' resources by examining a random subset of saved resources. These were manually categorized into one of three categories: small (simple resource), medium (a set of web pages on one topic, with multiple format types), or large granularity (large website, typically consisting of several topics). Results show that the plurality (38%) of these resources had small granularity, whereas 21% were medium and 24% were large (with the remainder unavailable).

Design using Learning Resources: Participant Views

Participants' comments on the pre and post-surveys were analyzed by first identifying recurring topics regarding the design of learning activities using learning resources. These topics were then categorized into major themes. Participants' comments were then coded following those themes, as described below. The letters 'A' or 'B' are used to indicate participants' groups, respectively.

Convenience or currency of online resources

Participants offered many comments about the benefits resulting from the ease with which online resources can be accessed. Thus, the possibility of saving time (and money) acted as a motivator. The literature has documented that teachers' are frequently pressed for time (Swain & Swain, 1999), and it is noteworthy that participants seem to appreciate the way online resources might save them time. Participants also appeared to value the currency of resources, particularly in comparison to textbooks. The value that teachers place on accuracy and currency of online resources has been identified in other research (Sumner, Khoo, Recker, & Marlino, 2003).

Representative quotes are as follows:

"Gives you quick access to useful tools." (A)

"… helpful to be able to access huge amounts of information compiled for learning." (A)

"It saves time and is easier than other types of research." (A)

"… lots of information quickly." (A)

"It is readily available at no cost." (A)

"Newer info than the 1985 text book we use." (A)

"They are more up to date than any textbook." (B)

Online resources as enrichment

Many participants commented on the value of online resources for enriching classroom activities. In this view, online resources were mostly used to enhance an existing activity, or to provide supplemental information for students.
Representative quotes include:

"They offer a far greater selection than available in any junior high library, and kids enjoy learning more when it is connected to a computer." (A)
"Quick, easy reference. Good places to send students for remedial or additional information geared towards their interests."(A)
"Resources that can be used for enhancing education for students." (A)
"Available sites that are readily accessible for teachers to use to enhance classroom instruction." (B)
"These are resources that allow a teacher to find useful information for use in the classroom or to enhance a classroom project." (B)
"Some of the resources are used to provide enrichment to the established curriculum." (B)
"… sites for students to access to receive up-to-date, accurate information to assist in effective learning" (B)
"… sites I can go to access information or programs for my students. They are also sites with lesson plans I can use or adapt to my needs." (B)

Online resources as reference and research

Participants commented on the value of online resources for supporting research. They mentioned that online resources could help increase their own content and teaching knowledge. Participants also seemed aware that many lessons plans were available on the Web for their use.
Representative quotes include:

"… the choices of extensions that are available on the web. They provide lessons that have been tried and tested." (A)
"…stay current in my subject area. Also, sometimes, the explanation in the book is not sufficient so I research better ways to teach the topic." (A)
"They offer new ideas, and more resources than available locally." (A)
"It keeps us current in the changing scientific world." (A)
"It provides you a quick and easy way to find out information." (A)
"Labs and activities are already worked out. Material can be researched right in the classroom." (A)
"The online resources that I use are mostly to facilitate research." (B)
"… sites to help with lessons, lesson planning, research, encyclopedias, locate pertinent information for particular lessons." (B)
"Online resources might include websites that have information for teacher's knowledge or lesson ideas and plans--information that a student might not use but would be useful to a teacher." (B)
"I know there are thousands of online resource websites that provide lesson plans for teachers." (B)

Teacher networking

A few teachers mentioned the importance of finding out what other teachers are doing. In this way, they supported the idea of using the network to form teacher contacts. Representative quotes include:

"It is better to be able to go beyond what is local and see how other teachers in other geographical areas are teaching in the same subject areas." (A)

"They can show examples of what other teachers are doing to teach key concepts."

Difficulties in using online resources

Many teachers commented on difficulties associated with using online resources. Many of these barriers were associated with technical problems. Others also focused on managing and sifting the large amount of content available on the Internet. Interestingly, all the quotes in this category came from teachers in Group A, the group with less access to technology in their schools.

Representative quotes include:

"If technologically inept this may create a problem." (A)

"…computers not always available, district servers sometimes block needed sites." (A)

" … difficulties with servers, and a limited number of computers available in schools" (A)

"… sifting through the false and/or opinionated sites. Also, most science sites are designed for high school level or above." (A)

"..too much fluffy stuff." (A)

"There can be a lot of garbage out there." (A)

"Often it takes too long to find things that will work for my classroom. There is so much stuff, it is difficult to find just what I am looking for. Taking the class to the writing lab or media center is a hassle." (A)

"It is at times hard to sift through all the information to find good reliable stuff." (A)

Designing learning activities: Post workshop comments

After the workshop, when asked how they might use the Instructional Architect and the NSDL to help design learning activities, teachers noted how these resources could be used to create new and unique opportunities for students:

"Many things can be brought into the classroom that would otherwise be unavailable." (A)

"… Articles, labs, assignments, activities for teachers and students, (for example, the Virtual Frog dissection)" (A)

"It is essential to stay current and to provide a variety of opportunities for students to learn and review." (A)

"… teachers [can] choose reputable links and combine them with simple instructions to create a student learning experience on the web." (B)

" …you can organize these online resources and include information and instructions about how to use each of the resources in a meaningful way." (B)

"… we can create projects for students using online resources." (B)

"I used the idea that it would be beneficial and a learning experience for my students in regards to magnets and electricity. Did it encourage learning and exploration?" (B)

Many teachers, however, only foresaw simple uses of the tools and resources. Thus, after the workshop, teachers appeared to note few ways the tools and resources could significantly influence their teaching practice.

Representative quotes include:

"[The IA is] an online lesson planner or student guide of appropriate sites to visit for a specific subject." (A)

"A way to make web pages of links" (A)

"A way for the teacher to post information and links to resources for students to use." (B)

"A teacher can make a collection of online resources that students can access to use for practice or research." (B)

"Online resources I would use with Instructional Architect are mainly websites with information or activities that students could use to learn information or practice skills." (B)

Finally, one teacher acknowledged the limitations of the workshop format, with this quote: "I don't think the quality of the project I created was exceptional. I need more time to create the purpose and objective of the activity." (B).

Conclusion

This paper presented an image of teaching as design. In particular, we sought to understand the extent to which teachers view their practice and their use of online resources as an opportunity to design learning activities for their students. However, limitations (including lack of knowledge about the demographics for many IA users, workshop participant self-selection, the use of self-report survey data, and the lack of follow-up) preclude generalizing to the larger teacher population.

Quantitative analyses of IA user activities suggest that active use is relegated to 'early adopters'. These users design significantly more instructional projects with more content and more online resources than less-active users. Users in general appeared to value NSDL resources, and preferred those of smaller granularity. However, without additional observations, it is hard to know what kind of role online resources and projects play in learning contexts.

Qualitative analyses of workshop participants' comments identified many potential benefits of using online resources in support of their teaching. These include their convenience and currency, and their use to enrich classroom activities. Participants also identified several barriers in using online resources.

The frequency with which participants mentioned accessing online resources for research purposes was an interesting finding. Participants described the important role of online resources in furthering their scientific knowledge as well as their teaching knowledge. This untapped potential has been advocated by other researchers (Davis & Krajcik, 2005).

In future work, we plan to analyze project content to better characterize what users are designing. We also plan to examine the impact of our teacher professional

development programs by comparing the content and quality of participants' projects with those coming from the wider Internet.

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