

Enhancing distance learning using quality digital libraries and CITIDEL

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Abstract: The past ten years have demonstrated an insurgence and explosive growth of digital libraries. This paper shows how the National Science Foundation STEM (Science, Technology, Engineering, and Mathematics) Education Digital Library (NSDL) initiative can be useful to teachers and students engaged in distance learning and education. It will also explore how the computing component of NSDL can be a vital tool for the study of computing.

Key words: digital libraries, computing education, distance education

1. INTRODUCTION

The National Science Foundation (NSF) in the United States has launched an aggressive initiative to develop a national [and international] digital library for the preservation and dissemination of educational materials in the fields of science, technology, engineering, and mathematics (STEM). The initiative, coined NSDL for National STEM Digital Library, promises to deliver online educational resources in a variety of interactive formats allowing students, teachers, and the public to participate in online learning. NSDL is not only a provider of information. NSDL also accommodates the reception of information by allowing contributors (educators, learners, and the public) to submit qualified materials that the public can use or share.

One major component of NSDL is in the area of computing. Here, the word 'computing' means all areas involving the study of computers and their

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applications such as information technology, computer engineering, computer science, information systems, informatics, and software engineering. The Computing and Information Technology Interactive Digital Educational Library (CITIDEL) project is responsible for the computing content collection of the overall NSDL initiative. CITIDEL is a consortium of five institutions with Virginia Tech being the lead institution. The additional four institutions are Hofstra University, The College of New Jersey, The Pennsylvania State University, and Villanova University. CITIDEL is responsible for the collection of available computing educational resources useful for the educational environment.

A question often asked is: Why do we need CITIDEL or NSDL when we have so many resources available to us through the internet? The question is a valid one. It is true that many resources already exist via the world wide web and the internet. However, which of those resources are peer reviewed or refereed? Which are valid for educational use? How do you know that the information you receive is accurate, valid, and educationally sound? Simply speaking: You cannot! Anyone can place any digitized material on a web site and the public has very limited means to determine whether the material is accurate or correct. That is why we need a service to monitor the collection of bona-fide educational resources so that the user will know the status of the material received. Not all worthy material undergoes peer review and not all worthy material comes from journals and carefully controlled sources. However, it is important for a user to understand the credentials of the provider of information to know how best to use it.

The rapid growth of digital libraries worldwide, coupled with the NSDL initiative and the CITIDEL project, make digital libraries ideal resources for distance education and learning. Distance education programs can now tap into authenticated resources via the internet with full understanding of the source of the materials. Further, searching within a digital library restricts access to materials judged 'relevant' in some specific context. In the case of CITIDEL, resources found will be computing related. This makes the search more efficient and the user's time spent more productively. It is only natural to explore the content of digital libraries and find out how they can enhance formal learning from a distance.

2. THE NSDL INITIATIVE

The National Science Foundation in the United States has embarked on a dynamic initiative to create an online portal to serve the educational communities of science, technology, engineering, and mathematics. A visit

to the NSDL website at <www.nsdsl.org> provides details of the initiative and the manner in which the public can access its resources. The NSDL is an information system built as a distributed network. Its purpose is to 'develop and make accessible collections of high-quality resources for instruction at all levels and in all educational settings. It will also establish and maintain communication networks to facilitate interactions and collaborations among all SMET educators and learners, and will foster development of new communities of learners in SMET education.' (Manduca et al 2001). Some of the challenges of NSDL cited in this work include developing a shared vision for the form and function of the library, meeting the needs of diverse learners from different disciplines and acquiring input from a community of users. Citing from the NSF document (NSF 2000), the purpose of the NSDL initiative is to:

'To catalyze and support continual improvements in the quality of science, mathematics, engineering, and technology (SMET) education, the National Science Foundation has established the National Science, Mathematics, Engineering and Technology Education Digital Library (NSDL). The resulting digital library, a network of learning environments and resources for SMET education, will ultimately meet the needs of students and teachers at all levels—K-12, undergraduate, graduate, and lifelong learning—in both individual and collaborative settings.'

NSDL establishes a gateway to diverse digital collections of quality educational content and services whose content is a result of contributors from diverse educational communities. The library is a digital learning place for students, teachers, and other members from technical and educational communities. Not only does CITIDEL provide access to a diversity of sources, but also to a diversity of objects, not being restricted to simply textual publications and some multi-media images. In general, CITIDEL will provide access to a broad variety 'learning objects' from papers and reports, to lesson plans and emulations.

Included among the goals of the NSF initiative are the following activities (Manduca et al 2001):

- Provide quality assurance of resources in the collections,
- Enable contextual learning, empower critical literacy skills,
- Support new pedagogical approaches,
- Advance scientific knowledge and understanding,
- Enable inter- and multi-disciplinary educational opportunities,
- Support independent learning,
- Support learning that is active and that involves inquiry and discovery,
- Foster a sense of excitement about life-long learning,

Provide access for all empower users, and
Support communities of scholars.

The NSDL initiative recognizes that the effort will stimulate new ideas from the communities of users, which in turn, will promote greater excellence in science, technology, engineering, and mathematics education. You may wish to explore a more thorough overview of the NSDL initiative by visiting the website (Manduca 2001) and viewing the Digital Tour.

3. THE CITIDEL PROJECT

The CITIDEL consortium has built the 'collections track' component for educational computing resources in NSDL. In particular, it has established, begun to operate, and will maintain the part of the NSDL initiative that will serve the computing education community in all its diversity and at all levels. This will include computer science, information systems, information science, software engineering, computer engineering, informatics, information technology, and all other variations of title and substance in these and related fields. Working with professional associations such as ACM and the IEEE Computer Society and other publishers, the project has engaged in a broad range of community development activities. Through a series of presentations, workshops, tutorials, and other related activities, CITIDEL is committed to the expansion of knowledge and skills regarding the creation and use of innovative online courseware for computing and information technology education. In addition, CITIDEL is focusing on the needs of minority communities, especially faculty of Hispanic serving institutions through a series of outreach activities. It also has leveraged its ongoing collection work related to the history of computing (at Hofstra and Virginia Tech), as well as the Computer Science Teaching Center (CSTC) and the Journal of Educational Resources in Computing (JERIC). The project team draws upon an extensive set of experiences related to the goals of this project. The team represents long service to the computing education community, experience in gathering resources for wider use, and technical expertise in the development and support of digital libraries. All of these are critical to the combination of goals associated with CITIDEL.

A number of important resources currently exist. They range from the extensive collections of computing literature in the digital libraries of ACM and IEEE-CS to lists of interesting web pages gathered and maintained by individuals. Existing accessible collections such as the Networked Computer Science Technical Reference Library (NSTRLD) and the NEC

Research Index are also part of the CITIDEL collection and their expansion will take place through the association with CITIDEL. The Electronic Theses and Dissertations project (ETD) initiated some years ago by Virginia Tech, and which now involves 132 universities around the world, will provide rapid broad access to current research for post-graduate students and their supervisors. NSF and other funding organizations have supported the creation of a wide array of resources, many of which would be of great value to teachers and learners if they were more widely known. Thus, CITIDEL operates as a front-end portal to all educational resources related to computing and information technology. Building upon work in the Open Archives Initiative (OAI) and standards work related to OpenURLs, the CITIDEL project harvests metadata from all applicable repositories and provides integrated access and linking across all related collections. The project uses special metadata and niche search technologies to develop tailored services for the various parts of the broad user community. Many have already agreed to support the effort, so it is clear that CITIDEL will involve diverse groups so that digital library services and content can be most beneficial to aid the education efforts of the computing and information technology field.

4. USING CITIDEL RESOURCES IN LEARNING ENVIRONMENTS

So, how can someone access the CITIDEL library? How can one use its resources? How can someone contribute to the library? The answer to the first question is easy. Access the website at <www.citidel.org>. After a brief login procedure, the site allows access to hundreds of thousands available to teachers and students at anytime.

In the past few years, we have seen the continued promulgation of curriculum for a number of different aspects of the IT field. This is partially in response to the specialization of tasks and job descriptions, and to the many new applications that emerge each year. As each new curriculum recommendation comes forth, not only do people expand the contents of an existing subject, but also, they frequently add new subjects. On the one hand, this means that the teachers of a particular subject must update themselves; however, they may also have to teach topics for which they have no preparation! A case in point is the introduction of 'professionalism' into the computer science curriculum. While it is correct to note that recent computing accreditation requirements have included computer ethics since 1985, it is rare to find a faculty member who either had completed such a

course or had maintained sufficient interest in the subject to teach it! A digital library that can provide teaching resources to such faculty will be extremely beneficial.

4.1 Quality Assurance and CITIDEL Resources

We can consider CITIDEL resources as those derived from two types of resources – those assets that have received peer review and refereed, and those products that educators and researchers contributed directly. While the digital libraries of ACM and IEEE-CS provide access to the very best articles and publications in the field, they also provide access to newsletters and reports that, for the purposes of rapid dissemination, have not received a rigorous review and critique. Some learning objects are not eligible for publication in 'archival journals' in their initial form, where the editors of these journals may be much more interested in the publication of the analysis of the application of them in certain environments. How many times have you been frustrated to read of the educational power of a product as reported in a professional journal, only to find that the actual learning object is not readily available, or that you have build a new instance of it yourself?

JERIC and CSTC attempt to close this gap by providing a vehicle for the sharing of learning objects. CITIDEL intends to extend this notion both through using JERIC and through CSTC as resources and by accepting contributions of other resources from the general education population. It is our belief that an enormous accumulation of resources exists in the private collections of university, college, and school faculty that could have uses beyond the individual course. However, they have no other vehicle for sharing and dissemination. While not every contributed object will have direct application in every possible situation, it is possible that through CITIDEL other professionals can upgrade and improve these versions and resubmit them for other's use.

A primary characteristic of a successful educational digital library must be the two-way communication activity that results from its use. It is important to establish the notion that users of CITIDEL (and hopefully by implication the whole NSDL) contribute something to the collection in return for their initial resources. Communities develop through the continual development of resources and services. Like the internet, NSDL must continue to develop not only through the continued support from the original sponsors, but also through the contributions of its users and their institutions. Important among those contributions must be feedback. The quality of professional publications is maintained through the initial

feedback of the reviewers and referees, and eventually through the feedback of citations. Like Amazon.com, CITIDEL has built into it a feedback mechanism so that users can comment on the work both for the gratification of the originator and for the edification of other potential users. Through these mechanisms, CITIDEL can be both a resource and a development environment.

4.2 Quality Resource Location for Teachers

Resources for teaching include both information from which to derive the content of a class and also tools and techniques for making that information meaningful and interesting to learners. CITIDEL addresses each of these needs. With searches covering the entire ACM Digital Library, the IEEE Computer Society Digital Library, as well as NCSTRDL, NDLTD (2003), CSTC, and other collections of resources, CITIDEL provides access to a large collection of materials that relate to computing. Tools such as Instructional Architect and VIADUCT support gathering search results and presenting them in a coherent collection that for student use. In addition, these tools support the publication of collections for sharing with others who have similar needs. This allows faculty to work together, regardless of the distance that separates them, to produce collections and activities. Plans for CITIDEL include mechanisms to allow faculty to join groups for the purpose of sharing their expertise and supporting each other. Such groups could allow a faculty member who is teaching outside his or her specialty area to consult with others that have more expertise, sharing what they have to offer, and asking for help where needed. In distance learning, faculty members do not need to be in a regular faculty office or department. In cases where the instructor does not have access of a support unit with colleagues as information sources, such online collaboration may be critical.

4.3 Quality Resource Location for Students

Students learn by taking an active role in their education. The digital library can serve as a learning environment for these students, just as a campus library often serves this role. CITIDEL is not just a place to go to get some resources, though it is that. It is also a place to gather resources and keep them together in personalized collections. It may be possible to place a 'standing order' for notification of new resources in a particular topic area. Through its use of Instructional Architect and VIADUCT (see below), CITIDEL provides an environment for assembling a collection of materials

on a topic and a place in which to store and even publish that collection. The student is thus able to create a resource that may be of value to others. Other resources are planned that will enhance the sense that the digital library is a learning environment, a real part of the distance student's home campus.

4.4 Quality Collections in CSTC and JERIC

CITIDEL builds on existing work that allows it to provide a useful collection of materials in a very short time. Among the prior projects that led to CITIDEL, CSTC and JERIC are especially significant in the context of distance learning for computing education. The Computer Science Teaching Center (CSTC) is a product of earlier NSF grants to provide wide access to materials developed in support of teaching and learning in computing. This online publishing mechanism allows people to share presentations, simulators, examples of exercises, and applications. We can find the work of faculty and students there, including winning student poster presentations, and programs that assist in presenting various topics. Most of the materials found in CSTC go through a review process and all have descriptions in terms of their topic area and the nature of the resource.

JERIC, the ACM Journal on Educational Resources in Computing, takes CSTC to another level. JERIC is a refereed publication. Every item published in JERIC subscribes to ACM's formal refereeing policies and the item receives an evaluation for its archival quality. JERIC is entirely electronic and as such, it is able to publish program modules and interactive materials as well as papers.

All materials in JERIC and CSTC are available free of charge to the users of CITIDEL. These two publication venues provide a set of education related materials for CITIDEL.

4.5 VIADUCT as a Quality Resource

The Virginia Instructional Architect for Undergraduate Computing Teaching (VIADUCT) is a resource intended for use by developmental teachers who desire to create teaching/learning plans and/or projects that incorporate the objects identified through a CITIDEL search. Based on the Instructional Architect that was prototyped by the Department of Instructional Technology at Utah State University, VIADUCT builds upon CITIDEL to utilize its searching and browsing capabilities as an assistant to the teacher who is developing a plan for a teaching or learning activity. Working through pre-defined templates, such as the lesson plan template

shown in Figure 1, the developer can draw items from the binder that have been created because of the CITIDEL search to populate the lesson plan.

Title
Topic area
Target audience
Activity type
Time required
Attachments
Additional materials
Background needed to complete the assignment
References
Last modified
Abstract
Goals for the activity
Knowledge/ skills/attitudes to be developed (behavioral objectives)
Procedure
Assessing outcomes
Additional remarks
Author contact information

Figure 1: Headings for Lesson Plan template

Typically, the user would place these items in the areas identified as 'attachments' and 'references', but could also be part of the 'procedure' if that were to include pre- and post-class readings. However, active learning objects such as Java Applets could also be part of the plan to create a new learning object. Similarly, we can add images and videos to the template. Once complete, we can save the plan for further work, as a draft for use with a limited audience, or finally published for inclusion in CITIDEL. We can also edit VIADUCT lesson plans previously published by others in VIADUCT to accommodate the desires of the individual instructor.

4.6 How Communities Can Share Resources

CITIDEL is very much a community resource, a place for people to come together in support of each other, to find what they need and to publish what

they have. VIADUCT allows a faculty member to construct a learning module with a wealth of materials linked directly to the course syllabus. Through CITIDEL, VIADUCT provides a mechanism for organizing what the user finds and keeping it together for further development and use in future offerings of the same or similar courses. CITIDEL includes a simple interface for uploading and sharing resources created by an individual. CITIDEL also provides a mechanism for publishing the collections put together by an individual for sharing with others.

In addition to providing means for an individual to share a resource, CITIDEL provides a mechanism for collections of resources gathered by an individual or group to become searchable and accessible to a wider audience. CITIDEL is a participant in the Open Archives Initiative and uses the OAI protocol to harvest metadata from other sites. In this way, the owner of a collection remains in control of its content, but the collection becomes visible to searchers using CITIDEL.

Many groups form around a common interest in a specific topic area and have both the interest and the expertise to assemble a fine collection of resources in support of teachers and learners of that topic. Unfortunately, the task of creating and maintaining a proper digital library is beyond the capabilities of many such groups. To address this need, the Digital Library Research Laboratory at Virginia Tech is developing a 'Digital Library in a Box.' This is a collection of modules that the user can assemble with little knowledge of digital libraries. It provides users with a functioning digital library in which to load their resources. The Digital Library in a Box will offer this open source software gratis to its users.

4.7 Support Infrastructure

CITIDEL is a distributed digital library. While a resource creator can upload to CITIDEL directly, third parties own and maintain many of the resources in CITIDEL. By using OAI, CITIDEL harvests metadata and stores that locally. Searches use the metadata to match the user need to the resources available. The response returned to the user includes a link to the actual source as well as a description of the content found.

Not all materials discovered through CITIDEL or other NSDL collections will be free to all. For example, access to the text of most materials in the ACM Digital Library requires a subscription. In general, the use of 'micro-payments' will provide a mechanism to allow a user to obtain a specific item that requires a payment. Plans also include ways to recognize when a CITIDEL user does have the necessary subscription and so provide the ability to get full access to the requested material. In any event, the site will

identify materials that require payment so users can decide whether they needed such material or whether the free materials found are sufficient. Knowing about resources, whether free or not, will empower users to make the most informed choices about the resources they choose to use.

5. SUMMARY AND CONCLUSION

CITIDEL, a part of NSDL, is a resource of significance in distance learning. Just as the campus library is an important resource in traditional university learning environments, the digital library provides a corresponding resource for students in distance learning activities. An immediate consequence of the digital library is that it is fully accessible to students wherever they reside. Beyond simple access to materials, a digital library must be seen as a learning environment, where students search for resources, meet with peers with similar goals, gather and store materials for future use, publish their work, communicate with their teachers and work groups, and grow in their understanding of the nature of their discipline.

For faculty members also, the digital library is an important resource. Certainly, it is a source of information from which to create a class presentation; but it is more. This is a place to gather and store materials; it is a place to create (and perhaps to publish) well-researched syllabi that they can enhance with links to related materials. It is also a place to meet with other faculty members who are teaching related topics and to share resources and ask questions. It is also a place to publish the creative work involved in good course development.

For students and faculty, the digital library can be the meeting ground of the virtual classroom, a supportive environment rich in resources and in an atmosphere of enrichment for the learning experience.

6. REFERENCES

- Manduca, Cathryn A., McMartin, Flora P., Mogk, David W., (2001) Eds., *Pathways to Progress: Vision and Plans for Developing the NSDL*, Internal Report, National Science Foundation, March 20, 2001.
- Manduca, Cathryn A (2001) <<http://doelib.comm.nsdlib.org/PathwaysToProgress.pdf>>.
- NSF (2000) National Science Foundation document NSF00-44.
<<http://www.nsf.gov/pubs/2000/nsf0044/nsf0044.htm>>.
- NDLTD (2003) Networked Digital Library of Theses and Dissertations.
<<http://www.ndltd.org/members/index>>.