

GENDER & SCIENCE DIGITAL LIBRARY

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Abstract - *The Gender & Science Digital Library (GSDL) is a cutting-edge, collaborative project between the Gender & Diversities Institute at Education Development Center, Inc (EDC) and the Eisenhower National Clearinghouse (ENC) at Ohio State University. It is funded by the National Science Foundation (NSF). The NSF has established the National Science, Technology, Engineering, and Mathematics Digital Library program (NSDL) – a massive, international initiative which will result in a network of learning environments and resources for science, technology, engineering, and mathematics education (STEM). The program is aimed at meeting the needs of students and teachers at all levels, in individual and collaborative, formal and informal settings. As a global and cross-disciplinary resource, the GSDL is a leader in the unique and ground-breaking NSDL initiative. The primary objective of the GSDL is to create a high-quality, interactive library of gender and STEM resources for K-12, higher education, women's studies, teacher preparation programs, and informal learning environments.*

Index Terms - Gender, Diversities, Science, Technology, Engineering, Mathematics, Educational Equity

INTRODUCTION

As a global and cross-disciplinary resource, the GSDL is a leader in the unique and ground-breaking National STEM Digital Library initiative (NSDL). The primary objective of the GSDL is to create a high-quality, interactive library of gender and STEM resources for K-12, higher education, women's studies, teacher preparation programs, and informal learning environments.

The GSDL will assist educators and researchers in promoting and implementing gender-equitable STEM education in both formal and informal settings, to both male and female students, and will also assist in increasing female involvement in the sciences. In addition, it will provide resources to researchers and others working to understand the link between gender and other diversities, and the STEM disciplines.

The need for this digital resource is pressing and immediate. Today's technology-based, global economy places an increasingly high premium on STEM education. Yet, the majority of the current U.S. STEM workforce (white, non-Hispanic men) is dwindling in numbers. In

1995 the projected percentage of white men in the overall U.S. workforce was 36%. By 2005 white males are expected to be 26% of the overall workforce. Further, while women constitute 46% of the overall workforce, they hold just 12% of the STEM jobs. The clear lack of diversity at all levels in STEM education and professional placement is of great concern. Valuable perspectives and experiences that could be brought to scientific endeavors are missing. These perspectives could lead to varied interpretations of how STEM is created, taught and applied [1].

Academically, international studies show that male and female students in the U.S., routinely rank below global standards in math and science achievement. In addition, engineering continues to be one of the least popular fields for women. In 1994, women earned only 16% of all baccalaureates in engineering. Within this statistic, the disproportion amongst ethnicities is also evident - the proportion of undergraduate degrees awarded to white women was 11.1%; Latinas accounted for 0.7%, and African American women for 1.4% [2].

Educators and researchers committed to increasing STEM interest and achievement in students struggle in their efforts to find materials that will enable them to understand issues surrounding male-female dynamics and roles in relation to STEM education and practice, increase male acceptance and support of women as scientists, and engage male and female students in the study of STEM. The GSDL project will seek to address these needs. The GSDL web site will launch in the fall of 2002.

NEED AND SIGNIFICANCE OF PROJECT

To implement national and global STEM education standards for all students, create better outcomes for females, and increase the general perception that females play an important role within STEM, educators need resources to help them integrate gender-equitable instruction into their classrooms. Excellent education requires equitable instruction, and educators therefore require training in this regard. But often, teachers feel they receive little equity training from their schools of education and other teacher preparation programs.

A 1998 AAUW report found several issues of concern that perpetuate gender gaps: demographic changes leading to more pronounced gaps among girls based on racial, ethnic, economic, and regional differences; the emergence of new

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economy industries such as bio-technology and environmental science, for which girls are particularly unprepared; and teacher preparation programs giving insufficient focus to gender-equity issues [3].

Educators are constantly looking for resources that they can use in their classrooms. These resources include books, curricula, experts in the field, web sites, and other educational media. Embarking on a search on the web can sometimes be a frustrating and time-consuming activity. For example, using the different search engines such as Yahoo, Google and Excite, or directories such as Alta Vista does not always yield the required information. In addition, the time spent filtering the results obtained and determining which ones a teacher can use can take a very long time.

A digital library can make valuable tools broadly available to teachers and students, and its construction can be used to encourage sharing and community-building. A digital library has the potential to increase the use of the best teaching practices by providing the tools, training, and data needed to build equitable instruction, inquiry, and discovery into all courses. The new technologies provide a way to effectively collect, organize and disseminate the existing and ongoing resources and information about gender and science through a variety of interfaces to datasets, search and delivery agents, and links to other related information sources.

Over the years, educators and researchers have developed a significant body of research, curriculum, resources, and other products to address the specific issues of women and girls in STEM. These materials are scattered, housed in different organizations, located on shelves or within journals. Those that are online can only be located by hunting through numerous web sites, an often laborious and uncomfortable process for those who are not yet comfortable with web-based resource systems or have slow connection or access to the web.

In addition, there is a great need to provide a comprehensive resource of materials that addresses the issues surrounding STEM instruction for diverse learners within various demographics such as race, ethnicity, disability, and language. Our research has shown few resources that effectively address the needs of a diverse, global, multi-cultural audience of learners. Few, if any, on-line resources, account for the complex set of issues faced by educators across the globe in addressing the same STEM educational and professional needs faced by their U.S. counterparts. Understanding the differences not only between boys and girls, but also amongst students by race, ethnicity, or class, is a critical component in the true reflection and understanding of equity in the classroom [3].

The GSDL is currently collecting both STEM materials developed globally and international research that has been conducted on STEM issues. The ultimate aims of the GSDL are to be not only accessible but also responsive to the global audience, and address the reality of the struggle faced by on-line collections in this regard. As such, the need to adequately represent all racial and cultural groups within the GSDL is of great relevance. In turn, these materials will provide U.S.-based audiences with an important global perspective and expose them to the work of international educators, researchers, and collaborators.

The GSDL project seeks to address these collective needs and to create a resource and opportunity for K-16 educators and students around the world to expand their own knowledge base, while building new technology skills. Due to the active involvement of the intended audience, linked with critical research and technology design experts, this project promises to provide a much-needed "self-guided professional development system" and online community focused on improving outcomes for all students in STEM.

GOALS AND OBJECTIVES

The primary goal of the GSDL is to create a high-quality, interactive digital library of K-16 gender and STEM resources that will engage and assist educators in promoting and implementing gender-equitable education. The collection will focus primarily on the K-16 classroom climate, curriculum, and practice in both formal and informal settings, original source and classroom materials, links, abstracts, opportunities community creation and mentoring, videos, and other interactive materials.

The specific objectives of the GSDL are to:

- Design a user-library interface to reflect users' multiple approaches to determining their needs and accessing specific information.
- Develop a collection with a focus on materials that evidence strong STEM content and support the engagement and achievement of females, and increase male awareness of and support for females in STEM.
- Create a user-friendly protocol and support system that assists users in effectively retrieving information, engaging with other practitioners and experts, and disseminating the materials they develop. Examples, include such supports as a help line with e-mail and phone access, and forums for authors and readers to discuss work (asynchronous or synchronous).
- Ensure sustainability of the library and its fit within the federated NSDL system.
- Evaluate the effectiveness of the collection through a series of evaluation protocols.

PROJECT DESIGN AND ACTIVITIES

Developing the Collection – Criteria for Inclusion

To address the issues of ease of use and appropriateness of information, the GSDL began its collections development work by conducting focus groups with K-16 educators and students. Through focused discussions, information was gathered on how different individuals and/or groups determine what resources and information they wanted, how they would define a search question, access information sources, and gather information.

This information was compiled and analyzed as the first step in designing a set of criteria for selection and review of items for the collection and for the development of the introductory protocol.

In addition, a scan of research on intuitive search processes, on brain research, and on new developments in digital libraries has been conducted, along with outreach to experts and colleagues in the various disciplines.

The criteria developed from this information reflect the defined needs of the target audience, articulates clear gender guidelines that are inclusive and respectful of diversity, and align with national science standards and other frameworks as appropriate.

For example, instruction design criteria include interactivity, conceptual and developmental changes, content, and instructional use/adaptability. Equity criteria include fair representation of females and of gender issues, fair representation of people of color and people with disabilities and of related race, language, and disability issues, gender-fair representations, activities, and information, and gender-fair assessments and evaluations. Media design criteria include engagement, learning interface, navigation, and technical requirements. Science criteria focus on accuracy of content, organization, alignment with standards, and instructional strategies.

Developing the Collection – Materials Acquisition

The GSDL is developing a collection structure that can be expanded over time. Focusing on STEM as the core the collection will also house categories such as: gender fair curriculum, teacher guides for integrating gender equitable instruction into existing curricula, strategies to bridge gender, racial and disability divides in STEM, resources on women in STEM, scientific research about women and girls, original source materials that give first person accounts of gendered experiences, professional development and pre-service resources, evaluation and assessment resources, and reviews of research and other research information.

Sources of materials acquisition are wide ranging, beginning with the mining of internal EDC and ENC collections. In addition, the GSDL is working to forge collaborations and partnerships with organizations such as

Women in Engineering Programs & Advocates Network (WEPAN), the Society for Women Engineers (SWE), the National Council for Teachers in Mathematics (NCTM), American Association for the Advancement of Science (AAAS), Library of Congress, and the National Science Teachers Association (NSTA), to assist not only in the identification of materials sources, but also to select and evaluate, as well as to provide opportunities for joint-marketing efforts and cross-promotional efforts that will highlight the GSDL's efforts.

Services are also being planned for integration into the GSDL that will help users find and select high quality resources that match their needs, including user or third-party reviews/awards linked to items in the collection, and user registration for additional services such as email notification of new resources and discussion tools.

The goals for these services will be to promote collaboration and sharing among STEM educators and equity specialists in their many roles as learners, researchers, and information providers; to instruct and assist users and creators in finding information and tools they need; and to assist all users with any special requirements.

Using the Collection

The GSDL site design incorporates an intuitive inquiry-based protocol that will guide users through a process of refining their search questions. The web interface that is currently under development adopts and adapts existing technology and metadata structures, in order to work toward a seamless interface with other digital library collections within the NSDL.

There will be rich multidimensional strategies for searching the GSDL collection. Some of these strategies include those found in traditional libraries such as cataloging and the use of metadata. Other strategies include intelligent agents and searches based in part on individual user profiles and on feedback by similar users.

Pilot Testing and Refinement

Working with internal EDC colleagues and external collaborators, the GSDL will be pilot tested amongst a diverse audience of formal and informal educators, gender equity specialists, students, and teachers. The information gathered from the pilot test will be used to refine the selection, cataloging, and infrastructure of the library.

Evaluation

The GSDL is focused on an outcomes-based evaluation mechanism – on determining what effect our work has had on the audiences whose needs we are attempting to meet. As a keystone of our project design activities, ongoing, outcomes-based, evaluation enables us to determine the impact of our project and also functions as a project management tool allowing the project to realign staff and allocate funding resources appropriately.

Mechanisms for formative evaluation through user feedback are an integral part of the design of the GSDL. In addition to site usage and user satisfaction surveys, a transaction-based web usage system allows us to better understand users' search patterns. Indicators will be developed based on national needs assessments, tracking of web use statistics, and review by users.

In addition, EDC and ENC staff continually engage in action-reflection evaluation sessions to help better understand the process of collaboration, the integration of gender and STEM into one collection, and the process for designing such a unique collection.

CHALLENGES & OPPORTUNITIES

Sustainability

All digital libraries must have a preservation component that addresses the continued management and accessibility of its holdings. Creating and providing resources in digital form is not a trivial process, and the cost of implementation alone justifies planning for the preservation of these resources into the future. To this end, we are exploring several models sustainability, including:

- Charging of subscription fees – For enhanced web services such as professional development tracks that provide K-to-gray guidance for the learner interested in a specific STEM profession. For example, one professional development track might compile information on the specific degree/profession, such as necessary high school courses to pursue, degree requirements, recommended regional colleges and universities, available scholarships, appropriate vocational programs, and mentoring opportunities within the local/regional professional community.
- On-line, fee-based courses – Distance learning is rapidly gaining momentum as the knowledge transfer mechanism of choice for the digital age. A recent report by the American Association of University Women Educational Foundation states that online learning is on the rise and that 60% of the learners are females over the age of 25. The high enrollment of females is primarily due to the benefits of schedule flexibility, low enrollment costs, and lower levels of discomfort or alienation than in traditional classrooms [4]. These

factors combine to make digital libraries an ideal environment for such dynamic, online learning. To this end, the Gender & Diversities Institute currently offers several on-line courses that could be hosted by the GSDL site. These include *Engaging Middle School Girls in Math and Science* and *Raising and Educating Boys: Developing Connections in a Changing World*. As these courses are offered and others are added, visitors to the GSDL site would be able to get information about the course offerings and enroll directly at the site.

- Investor's Forum – Corporate sponsorships or advertising revenue are a means of promoting the sponsoring organizations' commitment to increasing educational equity at all levels and across STEM disciplines, as well as a means of increasing their future workforce pipeline. Private endowments may also be identified to target similar, discipline- or profession-specific opportunities.
- Fuller integration of the GSDL into the ongoing work of organizations and projects whose mandate is to provide updated resources and services to targeted audiences.

While we continue to explore alternative models for support and sustainability, we are very aware that, in order to reach our intended audience--teachers and other educators with limited resources--the costs of maintaining such a library cannot be passed on to individuals.

Individuals and families in poor communities around the world often may not have the financial resources to own and access computers and the new digital universe. The global reality is that most K-12 teachers and schools continue to have limited funds, access to technology, and resources to commit to such services. As such, we believe it is essential to keep in mind the twin goals of access and sustainability as we explore models that ensure continuity, growth, and broad utilization of the project's powerful and critical collection of tools.

Fit within the Federated System

The NSDL is envisioned as an online network of learning environments for STEM education, that will meet the needs of students and educators at all levels. It is meant serve as the "premier portal to a rich array of current and future high-quality educational content and services, and also serve as a forum where resource users can become resource providers." [5].

As the NSDL and other digital libraries develop, the GSDL continually engages with these organizations to align the GSDL with the meta-structure of the overall system and to ensure that our library is fully integrated with it. In partnership with NSDL working groups and the individual collections, the GSDL is working to establish standards and guidelines for interoperability and integration of collections. The GSDL is also an active participant in planning and collaboration meetings, conferences, and presentations, regularly sharing information on the development of the core and extended collection, on our learnings regarding solicitation, review, and cataloging of items, as well as on the development of the library infrastructure and our gender and diversities metadata.

Evaluation

Outcomes-based evaluation in the digital world is not without its challenges. There is a certain measure of difficulty in attempting to gauge the long-term benefits of a digital collection using evidence collected in the near term. The Institute of Museum and Library Services (IMLS) in a recent publication, posed the question, “How can systematic evaluation be applied to achievements that are best communicated through individual narratives?” [6].

This is the ongoing struggle of all digital libraries as we attempt to measure our on-going progress, and the ultimate impact of our collective work. It is critically important that individual collections and the digital library initiative at large develop an appropriate set of indicators, rather than allowing a standard set of measures to be imposed on this unique area of work.

A focus on measuring outcomes rather than output is critical. It is the outcomes of the project that are the truest reflection of an institutions missions, goals and resources, and that enable such projects to be most effective.

Evaluation is also a critical component in determining and enabling sustainability. As stated in the recent IMLS report, “well-designed evaluation helps institutions identify their successes and communicate their value to a wide range of stake holders. (It) also enables advocacy and partnerships. Good stories become more convincing in the context of systematic information, and forge the basis for ongoing funding, support and collaboration.” [6]

Collaborations and Outreach

The GSDL collaborates with a wide range of institutions and organizations to achieve its goals. Collaborators include school systems, Federal agencies that support science education and gender equity, standards setting bodies, professional networks and development organizations. The GSDL is committed to building partnerships with international collaborators, organizations or individuals who are similarly engaged in the work of understanding the role

of gender and various diversities in the creation, instruction and application of STEM.

The GSDL is also actively involved in dissemination activities that serve two primary purposes: 1) to raise awareness of the existence of the GSDL collection and the NSDL initiative and 2) to continually attract more high-quality submissions to the collection. Some such activities include attending and presenting at local, national and international conferences and symposiums, promotion of the library through professional publications, and working with organizations that regularly package materials for pre-service programs. The GSDL continues to seek opportunities to collaborate on an international level, to disseminate information about our collection, and to work with like-minded organizations in conducting professional and academic outreach relating to gender and diversity issues surrounding STEM.

CONCLUSION

As scientific and technological advances continue to impact the world at an alarming rate, there is danger in the continuing under-representation of women in the critical STEM fields. Instead of trying to retrofit students into the existing STEM cultures, these fields must become more inviting for these students. Teacher education is also a critical component in addressing this challenge. Training for teachers should emphasize not only sound pedagogical STEM models but also educational applications and innovative uses of STEM. True equity in education involves not only using technology proactively, but also equipping students with the tools and skills necessary to interpret and analyze available information, understand design concepts, and imagine innovative applications of STEM disciplines. Ultimately, progress in these areas will enable students to become lifelong learners in these fields.

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