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Digital Libraries in Support of Web-based Training in Calculus

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Abstract: The focus of this paper is on state-of-the-art digital libraries and the possibilities they could offer for students studying Calculus. Standards, principles and advanced technologies underlying proper functioning of digital libraries are given a special regard. Special consideration is given to overall development of digital libraries and their impact on tertiary education. Libraries specialized in the area of mathematics are analyzed with regard to the relationship between individual information background of each student and their prospective successful performance.

Keywords: digital library, higher education, mathematics, metadata, web-based education.

I. Introduction

Reforms in mathematical education confront students with new targets and challenges which are characterized by mobility and information based society.

Advanced IT, communication and multimedia technologies now allow new ways of storing, sustaining and distribution of large arrays of information in all fields of science and education. One of the most efficient solutions is found via access to information archives stored in digital libraries. Web portals allow access to hosts of such libraries whereby a great variety of multilingual and multi topical information is at the disposal of inquirers. In general, digitalization and digital libraries are in themselves a new area within the explosively expanding scientific content and the concurrent dynamic settlement of traditions in the field of education.

All conditions and requirements which a digital library is to meet in the settings of continually changing academic environment are determined by its function of a mediator between society and knowledge. Experience shows that the underlying elements of this key role are the availability of advanced technologies; their proper use and the ability to cull specific information in conformity with user requirements. In this respect digital libraries serve as bridges between stored information and users; hence their importance as educative link in the process of training prospective specialists.

II. Digital libraries: major terms and state

The definition of a present day digital library should include the following components [1]:

- It should contain a bulk of digitalized scientific and popular literature as well as other educational items which are accessed by means of IT.
- It is supposed to function within the structure of at least one institution/affiliation; and the condition that all items are systematized in topical hierarchies, classifications and ontological schemes.
- All items are to be designated and described by appropriately selected format of metadata which correspond to the basic standards concerning digital libraries of IMS and support OAI-MPH standards.

Content could be stored locally or be made accessible through Internet digital libraries store "physical" materials which later underwent digitalization such as books, audio-visual and multimedia materials, photographs, archived documents and/or materials which have been originally produced in digital format. The major function of such libraries is sharing knowledge [2].

Some of the advantages of digital libraries over conventional ones are [3, 4]:

- Possibility to share information whereas in conventional libraries single copies of materials would pose a limit for them to be used by a larger number of users. Being digitalized such documents will be possible to be shared by a great many users simultaneously.
- New electronic forms and formats. In conventional libraries is contained on paper which is not always the most appropriate option to be used. For example, mathematical libraries could contain entire

formulae in the form of computer characters that can be used directly by programs such as Matlab, Maple, Mathematica.

- Digital libraries could offer materials in a variety of formats – sound, animation, video with or without subtitles custom made for use by people with disabilities or for special types of training.
- Fast and easy upgrading of information. Upgrading of digital copies is much cheaper and faster as compared to paper documents. Additionally, digital copies allow to indicate used version and the date of upgrading.
- Accessibility from any point in place and time whilst conventional libraries require that users visit its building which is operable only during a set period of time. Digital libraries are accessible via internet at any time and through any PC which is hooked up to the global net.
- Superior search power as compared to conventional browsing of paper documents. Computer search methods are much faster and accurate as compared to manual search. These are more useful especially in cases with multiple reference making from numerous information sources.

Metadata appear to be of key importance to all these functions assuring necessary information on the meaning of the original resources. In fact, they are additional data describing specific details of original data. Metadata can involve various features, peculiarities, connections and properties belonging to original data. In the past metadata were used mainly for the purpose of cataloguing of books in conventional libraries. Today metadata are the key to successful searching finding and use of correct data.

By using metadata it is possible to move from digital libraries to specialized storages for storing arrays of metadata coupled with additional semantic information(mostly in the form of ontologies and taxonomies; digital storages of metadata which attempt at categorizing and connecting all possible information resources in the respective area.

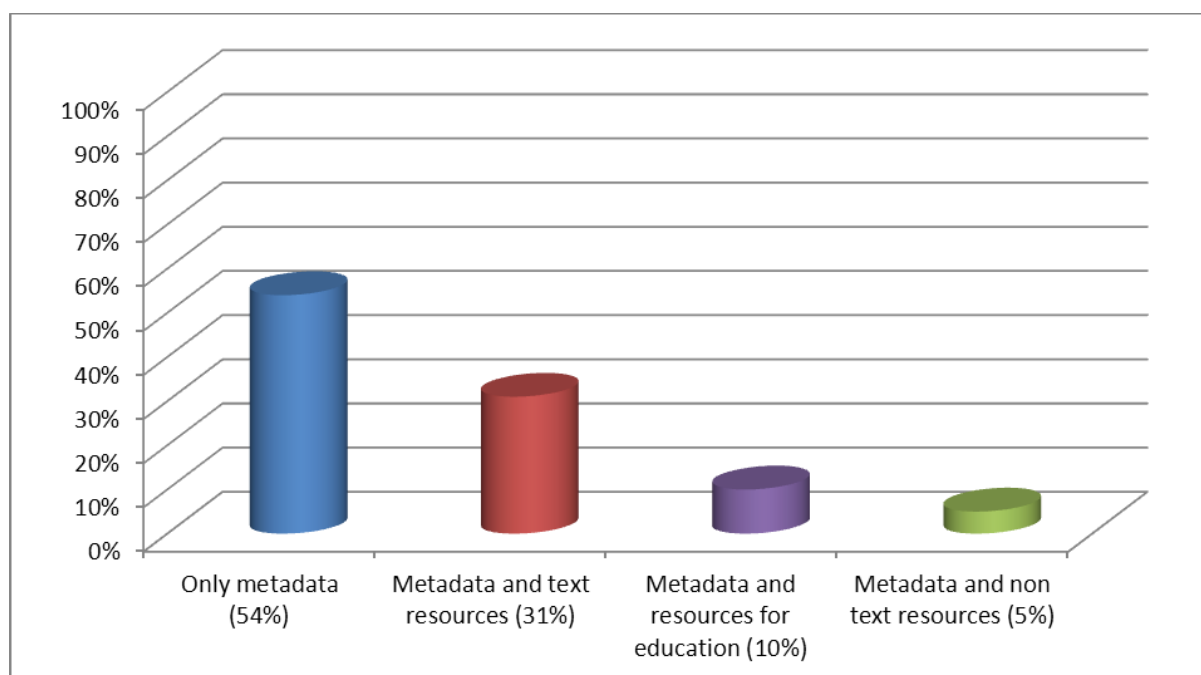
III. Development of digital libraries and their impact on higher education

The last couple of years saw the intensive growth of digital libraries.

Digital libraries have evolved to the status of indispensable element of the research infrastructure of every academic institution [5].

Two levels of development and expansion of digital libraries are observed. The first is connected with the development of digital libraries in virtually every institution that has not availed of this invention. The second level is related to the enlargement of the scope of resources in the available digital libraries and further development of the range of services offered to end users [7].

Figure 1 Resource allocation in digital libraries



An average number of records in a digital library amount to 9000. A large percentage of them (90%) concern resources in text format. These in turn can be divided into records containing only metadata about resources, but not the very resources (54 %); records containing metadata and text resources (31%) ;records of metadata and non-text resources such as graphics, video, audio and other formats of data (5%),plus records presenting metadata and resources for education (10%). More than half of the resources are articles from journals (48%) whereas the second largest part of textual resources includes mostly books or parts of books (23%). The remainder part includes theses, accounts, conference papers and working articles (29%).

Figure 2 Types of text resources in digital libraries

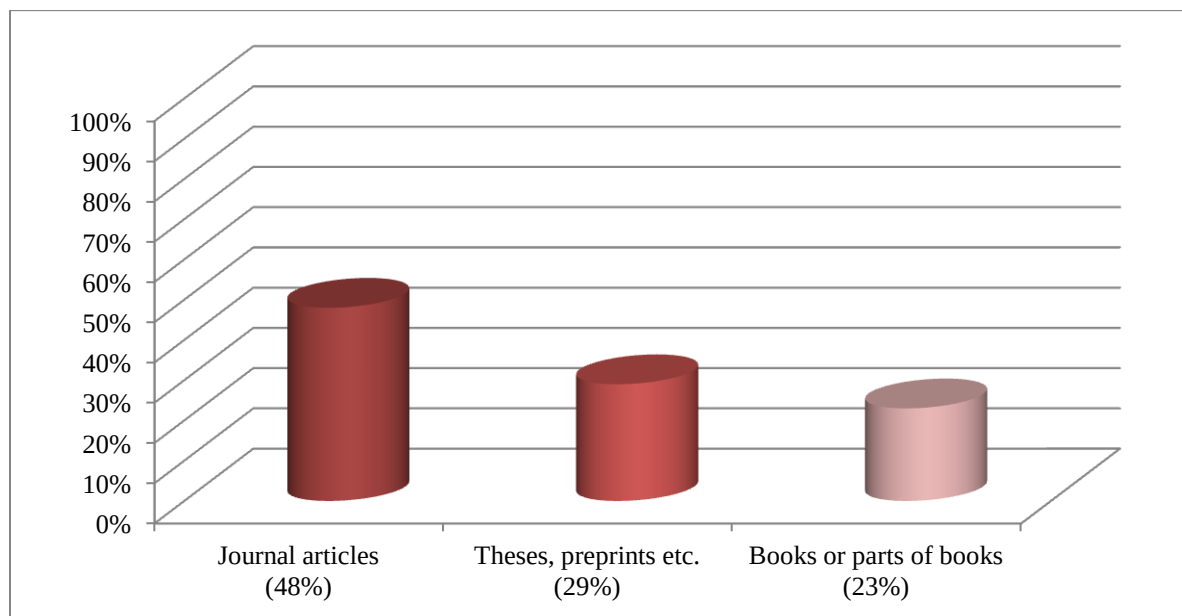
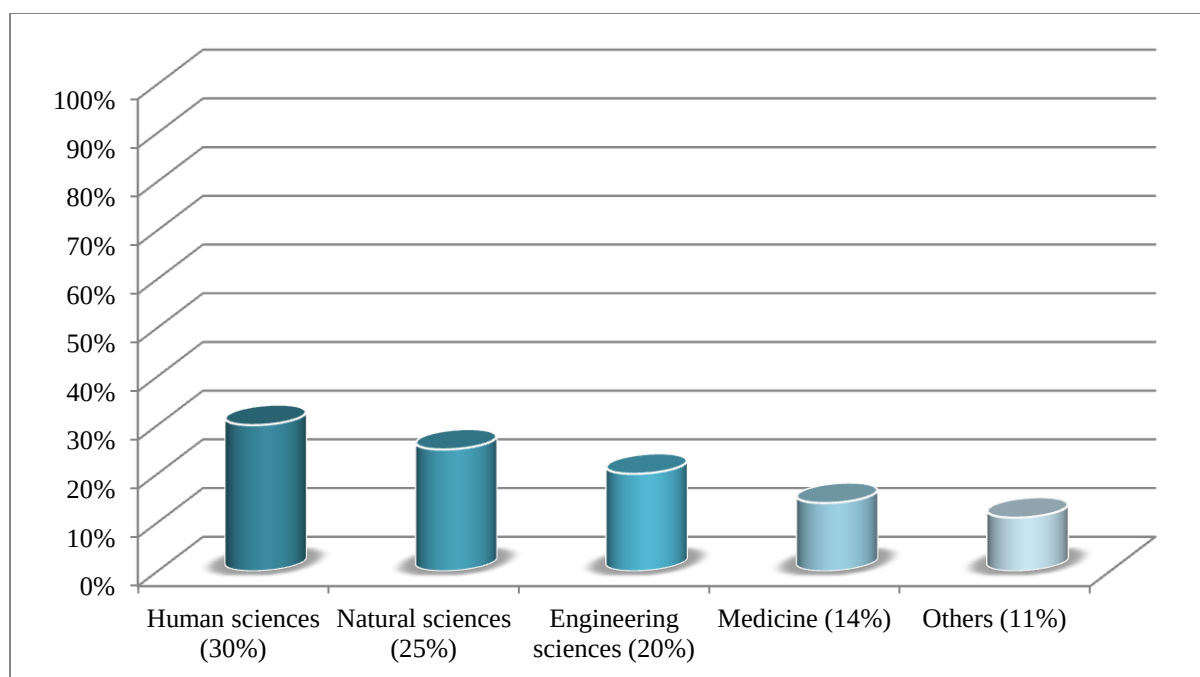


Figure 3 Resource allocations in digital libraries



Information literacy and competence are prerequisites of advanced education. They are defined in various ways, however, it appears that the most accurate formulation of information literacy is the one given by American Library Association (ALA) [6]: information literate person is defined as one capable of being aware of when you need information meanwhile possessing the skill to locate, evaluate and effectively use the information you need. Since information can be presented in many formats literacy is not confined to printed word (basic literacy) but with other types of non-evident literacy.

In studying the problem a couple of formulations come to the front:

Information literacy is a process and information skills are to be developed within the context of the entire educational process; the final goal being the acquisition of information competence. Both information literacy and competence are dynamic values open to future development. Likewise both values determine one of the major demands on the contemporary labor market.

IV. Advanced digital libraries in the realm of mathematics

National Science Digital Library (NSDL) (<http://nsdl.org>) [8] is a digital library allowing access to a large amount of resources, collections and pools for the purpose of familiarizing with various fields of science, scientific disciplines, technologies and engineering. The main idea is to provide students with assistance in their studies of science and technology and to facilitate faculty in their search of adequate and relevant references.

CITIDEL (Computing and Information Technology Interactive Digital Educational Library) [9] is an integral part of National Science Digital Library (NSDL) which serves the community of computing educators.

Mathematical Sciences Digital Library (<http://www.mathdl.org/>) [10] has been developed by the (Mathematical Association of America (MAA)) and is one of the first collections of National Science Digital Library. Its constituent components are:

- Journal of Online Mathematics and its Applications (JOMA);
- Resources for teaching in digital classroom; a collection of interactive teaching materials;
- „Convergence” – on-line journal dedicated to the history of mathematics
- Course Communities in Undergraduate Mathematics is a new collection focused on resources for particular courses. So far materials have been recommended for one-variable calculus, multivariable calculus, and an introductory course in differential equations.

iLumina (<http://www.ilumina-dlib.org/>) [11] is a digital library of teaching materials on natural sciences and mathematics. It is developed for fast and precise links to the educational resources. These are of various types ranging from individual images and video clips to full study courses. Resources in iLumina are catalogued in MARC and NSDL metadata formats which describe both technical and specific learning information connected with each resource. This library contains thousands of educational resources and several virtual collections.

V. Conclusion

A digital library is of key importance to providing a comprehensive learning and research process for users who are extremely dependent on available resources for their further improvement and development. Its primary goals are to support learning in processing digital information; to encourage and motivate its use and, finally, to convince undergraduates in the usefulness of digital resources without ignoring conventional ones (during learning the emphasis is on various electronic databases containing a large variety of information).

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