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The application of Metadata for ELearning purposes

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ABSTRACT
The aim of this article is to analyze the role of metadata in the use of learning objects. Firstly, an overview of metadata is provided and the role of educational metadata for learning objects is considered. Then the purposes, the uses and the values of metadata are investigated in this regard. In the continuation, the study reviews other related issues such as metadata categories, metadata creation, and metadata attributes or characteristics. Finally a collaborative approach for metadata creation is proposed. This research concludes that metadata has an invaluable role in facilitating the widespread use of learning objects.

Introduction

The e-Learning Consortium [1] observes that the field of e-Learning is constantly growing in association with the vast sources of e-Learning information available. It is getting more and more difficult to find and use relevant information. One vital aspect of the learning object economy is the role of metadata. Currier and Barton [2] believe that metadata is the key to enable the discovery and selection of suitable digital learning objects.

Metadata is often defined as “data about data “or “information about information”. With metadata we have some structure data that explains and describes information resources. It provides some information for data items such as how large a picture is, image resolution and etc. for an image, or for a document metadata may contains length of the document, author and the time that the document was written. Metadata in the web pages used to describe the content of them and search engines do the search based on these keywords.

Metadata Definitions

The Getty Research Institute’s Anne Gilliland-Swetland [3] notes that metadata is understood in different ways by the diverse professional communities that design, create, describe, preserve and use information. Metadata is often simply defined as “data about data” [4]. The IEEE [5] refines this definition of metadata as “information about an object”. Pöyry et al [6], extend this view and define metadata as descriptive and classifying information about an object. Tony Gill (2000), of the Getty Research Institute, provides a more complete classification of metadata as the “structured descriptions, stored as computer data that attempt to describe the essential properties of other computer data objects”. Hamel and Ryan-Jones [15] (2002) classify metadata as “structured data about content” and tagging as “the creation of the metadata file that is to be placed within a repository”. Waugh [7] describes metadata as the information associated with those objects that allow access to and manipulation of the objects. Metadata describes what the object is (such as the subject, keywords), how to use the object (where to retrieve it, how to encode it), and how the object is to be managed (its relationships with other objects) [7]. Gilliland-Swetland [3] values metadata as “the sum total of what one can say about any information object at any level of aggregation”. The concept of metadata can be applied to people, places and things. For people, this could include complex characteristics such as their learning preferences, skills, and buying habits. All these are examples of metadata [1]. Information objects consist of content, context and structure, all of which can be reflected through metadata.

Information object metadata:

- certifies the authenticity and degree of completeness of the content
- establishes and documents the context of the content
- identifies and exploits the structural relationships that exist bet ween and within information objects
- provides a range of intellectual access points for an increasingly diverse range of users
- provides some of the information an information professional might have provided in a physical reference or research setting [3].

Importance of Metadata

Library classification systems make use of metadata to catalogue books and enable efficient discovery through the use ofMachine Readable Cataloguing (MARC) and Online Pulic Ac cess Catalogue (OPAC) systems [8]. A recognized classification system in use is the Dewey Decmal Classification (DDC) system. Metadata describes certain important characteristics of its target in a compact form. It plays a central role in improving, searching for and categorizing objects within a defined context of use [6].

Gilliland-Swetland provides several reasons for the importance of metadata:

- Increased accessibility - effective searches across multiple collections
- Retention of context - document context and relationships between objects
- Expanding use - disseminate digital information to users around the world

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- Multi-versioning - create multiple and variant versions of objects
- Legal issues - document and track rights and reproduction information
- Preservation - metadata exists independently to survive evolving computer systems
- Systems improvement and economics – benchmark technical data to evaluate and refine systems

Metadata and the World Wide Web (WWW)

Gill (2000) notes that the most common application for metadata on the Web is resource discovery, because the metadata is intended to assist Web users in discovering what they are looking for. Search engines can use meta tags to provide more effective retrieval and relevance rankings. The availability of consistent, accurate and well-structured descriptions of Web resources enables greater search precision and a more accurate relevance ranking of retrieved information (Gill, 2000). Online retailers, such as Amazon.com, use metadata for their products to make it possible to find these goods and services. Metadata is collected about products (inventory number, price and name), customer profiles (payment methods, contact information) and web portal use (user interface) [4] The potentially dynamic and multimedia nature of learning objects makes most of them impossible to locate using text-based search engines such as Google, which in addition, return results that are difficult to assess by educators and learners [9].Friesen, Roberts and Fisher (2002) assert that the problems that search engines present to users in general and educators in particular, are both familiar and manifold: thousands of "matching documents" are retrieved in response to almost any search string, appropriate educational resources are difficult to find and evaluate, and multimedia or interactive content is not directly searchable. A widely suggested solution to these problems is to turn attention to the actual meanings of the words in Web documents and to provide a textual meaning for non-text-based Web resources (Friesen, Roberts and Fisher, 2002). Attempts to capture these meanings have become the motivation for Web-based descriptive metadata. Gill [16], cited in Friesen, Roberts and Fisher (2002), notes that "if there is a solution to the problem of resource discovery on the Web, it must surely be based on a distributed metadata catalogue model". The semantic web is both a technical framework and a vision of making semantically aware applications for the Web. It is a set of universal, neutral standards and tools for publishing and processing metadata in applications [11]. The semantic web also establishes the technical foundation for the metadata of learning objects. Learning systems introduce additional, domain-specific semantics to the standards. The core of the semantic web is defined by a set of World Wide Web Consortium (W3C) recommendations that established the Resource Description Framework (RDF) and Web Ontology Language (OWL) [11].

Educational Metadata for Learning Objects

According to the e-Learning Consortium [1], learning content is increasingly being broken down into smaller pieces so that it can be mixed, matched, and assembled into appropriate learning objects tailored to specific needs. Hamel and Ryan-Jones [15] (2002) concur that in order to be accessible and reusable, learning objects must be tagged with metadata that provides important and descriptive information about the object. Metadata provides data about each learning object stored in a database or any information about the object [4].Without metadata, there would be chaos and inefficiency resulting from an overflow of unidentified learning objects and content [1]. Song (2002) adds that due to the large quantity of information supplied and the ill-defined structures for learning content, it is difficult for learners to find learning resources easily. Metadata is required to support the access, search, selection, use, trade and management of learning objects [12].According to Anido et al [13], educational metadata provides information about educational resources. Metadata refers to the collection of keywords, attributes and descriptive information that informs educators, learners and systems about a learning object. Educational metadata can be utilized by educational and pedagogical professionals, by the institutions offering education, and by the learners searching for education. Well-designed and sufficient metadata aid the decision making process of learners and help educational institutions to provide suitable information about their educational offerings [6]. Metadata helps educators and learners to make decisions about the utility and functionality of a learning object [4]. Harvi Singh (2000) notes that metadata provides a common set of tags that can be applied to any learning resource, regardless of who created it, what tools they used or where it is stored. Poyry et al [6] agree that educational metadata may describe any class of educational objects (or learning objects), such as study courses. The level of metadata may also vary. Collection metadata relates to collections of objects, while item metadata relates to individual objects, often contained within collections (Gilliland-Swetland, 2000). The e-Learning Consortium [1] proposes that metadata can be, and ideally needs to be, applied to all sizes and types of learning content, from the smallest piece of raw data, all the way up to a complete course or curriculum. Using metadata this way allows each level of content to be easily searchable and reusable. For example, it should be just as easy to find and reuse one piece of text, one page in a chapter, one chapter of a course, or an entire course. The vision of truly personalized learning and living can be achieved when metadata is used to filter, select and assemble just the right pieces of learning content, to be personalized and delivered on just the right device in just the right way [1]. Metadata enables a Learning Management System (LMS) to automatically compile catalogues of all the courses, lessons and other modules available [14]. High-quality metadata will be required in order to assemble the objects dynamically and adapt course materials to the learner's needs [15].The ultimate usefulness of metadata depends on having valid metadata for every object and having the search tools to use that metadata. It is possible that a LMS may automatically provide a customized learning experience based on a combination of metadata, including learner profile and learning objectives, and used to be suggest learning objects that best fit a learner's need [4]. The key to sharing and reusing learning objects is not the learning objects themselves, but the successful deployment, standardized metadata specification.

The Purpose and the Use of Metadata

The IEEE LTSC (2002) states that the purpose of metadata is to "facilitate [the] search, evaluation, acquisition and use" of resources. Barritt and Alderman [4] agree that the purpose of metadata is to make it easy for educators and learners to find the learning objects that they need. The purpose of metadata for educational resources is also to "facilitate the sharing and exchange of learning objects, by enabling the development of catalogues and inventories while taking into account the diversity of cultural and lingual contexts in which the learning

objects and their metadata will be exploited" [1]. Frosch Wilke [16] notes that metadata can be seen as a labeling system whose purpose is to describe an object's characteristics and objectives. The purpose and usefulness of metadata in e-Learning is that it provides the ability to richly describe and identify learning content so that developers can find, assemble, and deliver the right learning content to the right person at the right time. Metadata provides the means to fully describe and identify every piece of e-Learning content so that content developers can find, select, retrieve, combine, use/reuse and target it efficiently for appropriate use [1].

Horon and Horton [14] describe how metadata makes learning content more useful to buyers, learners and instructional designers. Metadata provides a way of describing courses, lessons, topics and media components that are consistent in format and in items recorded. Description can be complied into catalogues that can be electronically searched [14]. Metadata allows for the possibility of sophisticated searches. A searcher is not limited to keyword matches, but can search for objects on a topic in a specified language with a specified duration. Metadata can also help course developers to find content that they can license or use rather than developing it from "scratch" [14]. Smith [17] states that one purpose of metadata is the cataloguing and searching for learning objects. Cataloguing and searching allows users to enter search terms to find objects in collections. It is the metadata attached to the learning objects that are being searched, not the learning objects themselves. Standardized fields are used to describe the learning object and the search engine examines the data in those fields to come up with a list of objects to match the search criteria [17]. Another purpose is tracking ownership information and handling rights management. Ownership, attribution and rights management relate to who owns a resource, who should be credited when it is used and how it may be used. This kind of metadata assists in ensuring that resources are being used as intended and that credit is given where it is due [17]. Metadata is the key to the discovery of existing content in a content repository [15]. Metadata functions in a manner similar to a card or record in a library catalogue, providing controlled and structured descriptions of resources through searchable "access points" such as title, author, date, location, description and subject. However, unlike library catalogue records, a metadata record can either be located separately from the resource it describes, or be embedded or packaged with it. Also, many visualize this metadata as being distributed across the Web, rather than collected in a single catalogue [12]. If all the metadata about learning content is recorded in a common structure or taxonomy, both the metadata and the learning content can be integrated into universally searchable and virtually centralized catalogues and databases which span multiple systems, audiences and countries [1].

The Value of Metadata

The ability to identify and discover appropriate content has significant benefits for organizations, the most notable being learning object reuse. The value of a learning object increases as its associated metadata increases in richness and completeness [16]. Singh (2000) states that metadata tagging enables organizations to describe, index and search their learning resources, which is essential for reuse. Metadata tagging also benefits individual learners, who will be able to more easily locate the information they want (Singh, 2000). There are four main uses of metadata in e-learning that emphasize the inherent value of metadata to individuals and organizations.

Categorization

The e-Learning Consortium [1] declares that the most common use of metadata is to add value through organizing information into categories. Finding information faster saves time, money and frustration. This significantly improves productivity and performance.

Taxonomies

Although it is useful to organize metadata into categories, it is more powerful to structure and organize metadata categories into ordered groups of relationships known as taxonomies. The benefits of having a taxonomy for metadata are that it can organize the content and capture the relationships between categories. Metadata taxonomies allow different systems and structures to be recognized, translated and understood [1].

Reuse

The reusability of the content and the metadata begins to increase exponentially as content and metadata become more structured and their granular size decreases. This ability to create once and reuse multiple times can provide some of the highest multipliers and Return on Investment (ROI) levels for organizations [1].

Dynamic Assemblies

The e-Learning Consortium [1] notes that information can only be reused in correspondence to the degree to which it can be flexibly and dynamically assembled into the "right stuff" for just the right person, in the right format, in the right language, delivered to the right location, on the right device, at the right time. For example, a Learning Content Management System (LCMS) could select the right "bits" of data for a particular learner who is using a wireless device, and assemble all of it into one or more learning objects. As the learner uses these learning objects, metadata, in the form of learner usage data is created and sent back to the repository of the LCMS for future analysis [1].

Metadata Categories

Metadata Elements

Erik Duval [18], from the Katholieke Universiteit Leuven in Belgium, specifies that basic metadata elements include the title, author, year of publication and similar simple bibliographic data. Within any predetermined metadata schema, a limited amount of metadata or "core metadata" can capture the main idea or essence of the learning object in a coherent and unitary fashion [19]. Richer metadata structures also include technical features, copyright properties, annotations and more [18]. Metadata may also include information such as format, size, delivery requirements, authorship, ownership, version number, instructional role, instructional characteristics and type of interactivity. Additionally, metadata can be described by a set of meta-metadata. Meta-metadata is descriptive information about the metadata record itself [6]. Usually, metadata elements are sorted into several metadata categories.

Metadata Categories

Kimberly Lightle [20], Associate Director of the Eisenhower National Clearinghouse, explains that metadata can be used to describe a digital learning object so that it can be found, managed, reused and preserved Metadata can be categorized in many ways; Table 1 describes the main categories that may be used. All of the categories in Table 1, together with

other forms of description and documentation, can be part of the metadata associated with a learning object [20].

Table 1: ***Metadata Categories***

Category	Description
Administrative	Metadata used in the managing and administering of information objects (Gilliland-Swetland, 2000), or supporting resource management within a collection [20].
Descriptive	Metadata used to describe or identify information objects (Gilliland-Swetland, 2000). It facilitates resource discovery and identification [20]. Descriptive metadata can be further divided into: Contextual metadata and content-based semantic metadata. Contextual metadata refers to the conditions and the environment in which the metadata is created, such as the equipment required creating the object. Semantic metadata refers to the semantic characteristics of the object, or the semantic metadata that explains the meaning of the object [6].
Preservation	Metadata related to the preservation management of information objects [3], such as migrating and archiving the object [20].
Structural	Metadata used to describe the structural characteristics of the object, such as the form of the object, but not the content of the object [6]. Structural metadata describes how the components of complex learning objects are bound together [20].
Technical	Metadata related to how a system functions or to the behavior of metadata [3].
Use	Metadata related to the level and type of use of information objects [3].
Control	Metadata created and used for controlling the flow of content for the relevant information system [6].

Creating Metadata

According to Barritt and Alderman [4], metadata should be rich enough to meet intended needs, but not overly burdensome to input. Some metadata is created during the development process of the learning object; other metadata will be associated with the learning object after it has been used [4].The status of metadata elements may be static, dynamic or long-term. Static metadata never changes once it has been created and includes metadata elements such as title and date of creation. Dynamic metadata may change with use or the manipulation of an object, for example, changing the image resolution. Long-term metadata is necessary to ensure that the object continues to be accessible and usable and includes the technical format and rights information [3]. The more a learning object is to be used and the more granular it is, the more detailed metadata is required. Extensive metadata will add time to the development process of learning objects. Metadata guidelines, templates and an editing process will be required to facilitate the process [4]. A metadata editor is a software tool that may be used to support the process of metadata creation.

Objective and Subjective Metadata

Metadata information can simply be an author's name, or the learning object title. It can also be complex, including completion criteria, access rights and costs [4]. The eLearning Consortium [1] observes that metadata could be as objective and straightforward as the author of a book or the file size of an animation, or could be as complex and subjective as the learning preferences or styles of an individual. Horton and Horton [14] note that some metadata items are objective, such as size and location. These values can be easily verified. However, subjective metadata elements, such as descriptions and keywords, may provide inaccuracies. Developers may wish to make learning content more attractive to potential buyers, which may lead to embellishments of some of the metadata items. Horton and Horton [14] question who can be trusted to write subjective metadata items. Metadata may be generated automatically by a computer (for example, keyword indexes), created annually by humans, or created through a combination of these two approaches [3]. Learning objects can be described in considerable detail with acceptable quality through automated means [18]. This can occur through exploiting the context of use and readily available information about the users involved. Metadata can be automatically generated from the content itself, while current search engine harvesting techniques can be quite powerful. For example, the title, language, reference documents and author name can be extracted from an HTML document. The authoring context can also be exploited to harvest metadata. Metadata from a course can be used as starting values for the metadata of a learning object derived from that course. Templates of reusable metadata can be created, where many of the relevant fields are pre-filled. Authors generally produce content for one domain or for a partic ular kind of audience. Authors could create profiles that list metadata that are common to all or most of what they do. A feedback mechanism can be provided to indicate how the learning object helped the learners achieve their goals. Learning Object Repositories could include the "Amazon.com-like" social recommending techniques to suggest relevant content [18]. However, the creation of manual metadata is still required. A focus on the importance of context and community can minimize the current burden of metadata creation [18]. The community aspect can be illustrated by websites that rely on ratings of submissions to publish or reject what they receive. Most learning objects will have multiple sets of metadata associated with them [18]. The source of the metadata may be internal, and generated at the time the object is created, such as the file name and header information. Alternatively, the metadata source may be external, which relates to metadata created later, often not by the original creator, such as rights and legal information [3]. This section outlines several alternatives to how metadata may be created and by whom.

Author Only

Currier and Barton [2] suggest that the author of a learning object creates all of the metadata when uploading the resource to the Learning Object Repository (LOR). Only learning content authors may access the upload tool provided by the repository, which may be anything from highly technical, to very user friendly. The tool may incorporate some automated metadata creation, perhaps suggesting classifications based on keywords already entered and so forth. Hamel and Ryan-Jones [15] concur that metadata is usually written by instructional designers to describe the learning objects they have created. Gilliland-Swetland [3] notes that "lay" metadata is created by persons who are usually the original creators of the object.

Metadata Specialist Only

According to Currier and Barton [2], a metadata specialist may perform the task of creating metadata. Resources may be uploaded with anything from basic information recorded by machine, to a few fields or descriptive notes entered by the

depositor, which must be rewritten as conformant metadata. A trained metadata specialist assists and ensures that the remainders of the necessary fields are filled in correctly. Greenberg [8] notes that cataloguers and indexers have been recognized as expert metadata creators. Gilliland-Swetland [3] agrees that expert metadata is created by index specialists.

Collaborative Metadata Creation

Currier and Barton [2] propose that metadata may be created through a collaborative approach. The learning object author may enter data in certain fields, such as their own name, resource title, institution and digital rights information. A metadata specialist will then check these for accuracy, and add other selected fields such as subject classification, keywords and accessibility information. This process may be truly collaborative, with the parties communicating directly, or it may be that they work completely separately, perhaps with the specialist periodically checking records in batches.

Conclusion

This article analyzed the role of metadata in the learning object economy and identified that metadata adds value through describing learning objects. Metadata can be catalogued in learning object repositories to enable learning objects to be shared and reused. Metadata allows learners and learning providers to search, evaluate, acquire and use learning content [88]. Metadata has an invaluable role in facilitating the widespread use of learning objects. However, metadata standards are required to provide a uniform way to describe learning objects, so that they can be discovered and accessed [21].

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