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Towards a Role-Based Metadata Scheme for Educational Digital Libraries : A Case Study in Singapore

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Abstract. In this paper, we describe the development of an appropriate metadata scheme for GeogDL, a Web-based digital library application containing past-year examination resources for students taking a Singapore national examination in geography. The new metadata scheme was developed from established metadata schemes on education and e-learning. Initial evaluation showed that a role-based approach would be more viable, adapting to the different roles of teachers/educators and librarians contributing geography resources to GeogDL. The paper concludes with concrete implementation of the role-based metadata schema for GeogDL.

1 Introduction

GeogDL [12] is a Web-based digital library (DL) application containing past-year examination questions and solutions to help students prepare and revise for a Singapore national examination in geography. The geography resources in GeogDL are divided into three categories: questions; solutions and supplementary resources. In the initial version of GeogDL, these resources were described using the fifteen elements stipulated in the Dublin Core (DC) metadata element set [2] plus some user-defined ones. We made use of DC because it is more widely accepted in libraries for cataloguing online content due to its “easily understood descriptive names and single-word labels” which some librarians and para-professionals might somewhat relate to as a “simpler version of the US MARC (MACHine Readable Cataloguing) tags” [7]. However, we found that our metadata element set based on DC, extended for education with four additional elements on pedagogy, audience, duration and

standards, still too restrictive to describe adequately the examination resources in GeogDL.

This paper describes our investigation to develop an appropriate metadata scheme to describe the geography examination resources in GeogDL, adhering both to international and Singapore standards on education and e-learning. Based on an initial evaluation of the metadata scheme, we proposed a refinement to the metadata scheme that adapts to the different roles of potential contributors of geography resources. The paper concludes with concrete implementation of the role-based metadata schema for GeogDL.

2 Metadata Schemes on Education

2.1 Some Metadata Schemes for Educational Resources

Although DC has been identified as the emerging resource description standard for the Internet, its simplicity is also its bane in failing to describe the more sophisticated educational resources. Attempts are made to develop a comprehensive scheme to describe adequately educational resources, among the well-known ones are : (1) Gateway to Educational Materials (GEM) [6]; (2) Instructional Management System (IMS) [14]; and (3) Shareable Content Object Reference Model (SCORM) [11].

GEM, initiated by the US National Library of Education in 1996, is a union catalogue of lesson plans and other curriculum units on the Internet, extending the DC set to a semantically rich domain-specific content representation with an additional eight elements added [6]. GEM seems more suited for teachers than students.

IMS, on the other hand, is developed to promote open specifications for facilitating online distributed learning activities such as locating and using educational content, tracking learner progress, reporting learner performance, and exchanging student records between administrative systems. The IMS Metadata specification, slightly more technical in nature than GEM, proves to be far more methodical in describing the materials to be classified [14].

SCORM is a set of specifications for developing, packaging and delivering high-quality education and training materials whenever and wherever they are needed [11]. It is a product of the U.S. Government's initiative in Advanced Distributed Learning (ADL).

2.2 SingCORE : Singapore-defined Standard for Learning Systems

It is apparent from our investigation that metadata schemes need to be tailored to meet the requirements of the *specific educational systems and the countries in which the resources would mainly be used*. To support interoperability across all sectors of education and training in Australia, the EdNA Metadata Standard in Australia [3], for example, ensures that elements and element qualifiers are devised to meet the Australian education requirements.

Hence, for GeogDL to be used by schools in Singapore, its metadata scheme needs to subscribe not only to international standards but also to SingCORE [9], a Singapore-defined standard for metadata developed as part of the Singapore e-Learning Framework (SeLF).

The SingCORE framework provides a comprehensive approach to describe courseware for interoperability in different learning environments. SingCORE has eight categories proposed in IMS Learning Resource Metadata Specifications Version 1.2.2, adopting the IEEE Learning Object MetaData's conceptual model : (1) General; (2) Life Cycle; (3) Meta-Metadata; (4) Technical; (5) Educational; (6) Rights; (7) Relation; and (8) Classification. To distinguish this customized set of forty-three elements, the schema is named SingCORE – “Sing” as in “Singapore” and “CORE” to denote the most important parts.

Table 1 shows the elements identified for the eight categories and the associated elements in the SingCORE metadata set [9].

Table 1. SingCORE Metadata Schema

Categories as proposed in IMS	Elements (Sub-Elements)
1. General	Identifier, Title, Catalog Entry (Catalog, Entry), Language, Description, Keyword, Coverage, Structure, Aggregation Level
2. Life Cycle	Version, Status, Contribute (Role, Entity, Date)
3. Meta-Metadata	Contributor (Role, Entity, Date), Metadata Scheme
4. Technical	Format, Size, Location, Requirement (Type, Name, MinVersion, MaxVersion), Installation Remarks, Other Platform Requirements, Duration
5. Educational	Interactivity Type, Learning Resource Type, Interactivity Level, Semantic Density, Intended User Role, Context, Typical Age Range, Difficulty, Typical Learning Time, Description, Language
6. Rights	Cost, Copyright and Other Restrictions, Description and Usage Rights, Unit Pricing
7. Relation	Kind, Resource (Identifier, Description, Catalog Entry (Catalog, Entry))
8. Classification	Purpose, Taxonpath (Source, Taxon – Course (ID, Entry), Taxon – Module (ID, Entry), Taxon – Topic (ID, Entry), Taxon – Chapter/Lesson (ID, Entry)), Description, Keyword

3 Development of an Appropriate Metadata Scheme for GeogDL

Ellington et. al. [4] propose four basic factors to match the natural learning processes of humans, and thus ensure the successful learning experiences of learners by: (F1) making learners *want to learn*; (F2) incorporating sufficient activities to help learners experience *learning by doing*; (F3) providing sufficient channels of *feedback* to learners; and (F4) enabling learners to *digest and relate* what they have learned to the real world.

To situate GeogDL within the context of use, an earlier study [12] was carried out on GeogDL involving designers, secondary school students and usability-trained evaluators to identify possible goals or scenarios of use prospective users might have when using GeogDL. Scenarios are beneficial in helping designers to think about

possible uses of systems [1]. Four possible goals or scenarios of use with the inclusion of basic factors proposed by Ellington et. al. [4] were identified to engage learners in a successful learning experience when using GeogDL :

- *Goal #1: Practice/revision* on multiple-choice (MCQs), short structured and essay-type questions. Model answers and hints to tackle these questions should also be provided (applying F2). Feedback should be provided (applying F3).
- *Goal #2: Trend analysis.* The idea is to give information on when and what questions are being asked over the years. This would help students identify trends in the types of questions asked and the topics covered. This may increase their motivation to want to learn (applying F1).
- *Goal #3: Mock exam.* This would help students better manage their time in answering questions. To make it fun, a scoring system could be incorporated for MCQs (applying F4), while hints/model answers could be provided for structured and essay questions (applying F3).
- *Goal #4: Related links and resources.* This could include related topics, teachers' recommendations, etc., thus showing relationships of concepts, and linking concepts to the real world (applying F4).

Since the SingCORE key vocabularies, defined for the education environment in Singapore, have incorporated the IMS standards and the IEEE Learning Object Metadata's conceptual model, we decided to use SingCORE as a base to derive an appropriate metadata schema for GeogDL. To determine if the SingCORE schema is able to describe adequately geography resources in GeogDL, we interrogated the SingCORE metadata set using the above four goals.

In a detailed walkthrough of the SingCORE metadata set, we found it comprehensive but not adequate enough to support the types of resources for the four scenarios of use :

- To address Goals #1 and #2, we need metadata elements to describe the type of exam questions and record details on when the papers were examined. SingCORE metadata set does not provide for information on examination questions and resources. Hence, we suggest a pointer to an external metadata schema for examination resources under "Learning Resource Type" in the "Educational" Category in SingCORE (see Figure 1). The metadata schema for examination resources is described with new elements "Paper", "Question" and "Type" as shown in Figure 2.

To support feedback and comments from users, enabling true essence of learning, an additional ninth category named "Annotation" would be necessary. The category would consist of a pointer to an external Annotation Metadata Schema. Annotations could take the form of free-text contribution as in forums/chats or feedback in Likert-scale ratings. The metadata schema for "Annotation" also addresses multiple versions, where versioning history of an annotation is kept (see Figure 3). We suggest including a "Version History Location" pointer to two more elements "Version ID" and "Parent ID" under the "Life Cycle" category (see Figure 4), since the SingCORE metadata set does not capture versioning of resources.

Figure 1. Revised Metadata Schema for the “Educational” Category

Figure 2. Examination Questions, Solutions and Resources Metadata Schema

Figure 3. Annotation Metadata Schema

Lifecycle Category
 -> *Version History Location*
 -> Version
 -> Status
 -> Contribute
 -> Role
 -> Entity
 -> Date

Figure 4. Revised Metadata Schema for the “Lifecycle” Category

- To address Goal #4, we need metadata elements to describe the relationships of elements. This is addressed in SingCORE under the “Relation” category.
- Finally, we think that students’ performance (Goal #3) should not be captured in the metadata set to describe resources. Instead a separate metadata schema could be used to describe users’ behaviors and performance, which will not be addressed in this paper.

4 Initial Study and Analysis of the New Metadata Schema

Having developed the metadata scheme for GeogDL, adapted from SingCORE to support the four goals, we then conducted an initial evaluation.

4.1 Profiles of Subjects

Two third-year students and three lecturers from the Information Studies Programme at Temasek Polytechnic (Singapore) took part in the initial evaluation. They were familiar with general metadata standards, and would be helpful in providing feedback on the new metadata scheme developed for GeogDL. Because SingCORE is a relatively new standard approved for e-learning in Singapore, these five subjects were also not familiar with the SingCORE metadata set.

4.2 Protocol

A paper-based version of the SingCORE interface with the additional elements proposed for GeogDL was drawn and presented to the subjects. They were also given a sample geography examination question to be described using the metadata scheme. For each element in the metadata scheme, the subjects were asked to comment on its comprehensiveness and usefulness using a 5-point Likert-type scale. They were also asked if they needed additional help in coding the particular examination question using the metadata scheme.

4.3 Recommendations Towards a Role-Based Metadata Scheme

One problem highlighted was that some of the terms (jargon) used to describe elements were too difficult to understand, even to the subjects who were library-science-trained. We asked the subjects to identify those terms and changes were made

to speak the users' language, for example, the element "aggregation level" was changed to "size of resource".

The subjects also commented that because they were too familiar with the DC and MARC schemes, they would prefer cataloging according to material types instead of the step-by-step entry process based on the eight categories, as proposed by SingCORE. To address this problem, GeogDL will be designed to allow input of the metadata according to the type of resources as requested by different users, determined largely by their roles.

Feedback received also showed that although the GeogDL metadata scheme contained too many elements, they thought the elements were relevant. It was, however, felt that contributors such as teachers/educators or librarians might be interested only in certain elements. Hence the metadata scheme was revised to adapt to the different roles of teachers/educators and librarians contributing geography resources to GeogDL, allowing them to see only those elements relevant to them.

Table 2 shows the revised metadata set based on roles of contributors with Column 1 stating the nine categories, and Column 2 indicating the number of elements (within brackets) in the SingCORE (S) and GeogDL (G) metadata sets. Column 3 highlights new elements added to the GeogDL metadata set to produce a more comprehensive nine categories and fifty-one elements for GeogDL. It also identifies the categories within the GeogDL metadata set relevant to the roles of contributors either as a teacher/educator or a librarian or a student, indicated under "Life Cycle" and "Meta-Metadata" categories with elements capturing role, entity and date (see Column 3, Rows 2 & 3).

Table 2. Revised Role-Based GeogDL Metadata Set

Category	# of Elements SingCORE (S) GeogDL (G)	Additional Elements
1. General	S(9); G(9)	
2. Life Cycle	S(3); G(5)	Version and Parent IDs to capture versioning. Element "Contribute" describes role, entity and date.
3. Meta-Metadata	S(2); G(2)	Element "Contributor/Validator" describes role, entity and date.
4. Technical	S(7); G(7)	
5. Educational	S(11); G(11)	More detailed info on types of resources : exam questions, solutions, resources.
6. Rights	S(5); G(5)	
7. Relation	S(2); G(2)	
8. Classification	S(4); G(4)	
9. Annotation	S(0); G(6)	Annotation, parent, person IDs, types of annotations, date, description.

For example, the GeogDL metadata interface will be designed to trigger off customizations based on roles, for example, a bibliographic display for librarians to

include only categories #1-4 and # 6-7 (see Table 2, Column 1). On the other hand, teachers/educators would be interested and able to contribute to categories #1-3, 5, 8 and 9, and hence GeogDL metadata interface will permit access only to these categories. If the categories for a resource are not complete, GeogDL will notify the respective person(s) to do so.

4.4 Concrete Proposal for Implementation of the Role-Based GeogDL Metadata Schema

The role-based schema of GeogDL allows contributors such as teachers/educators, librarians and students to contribute to different categories and elements of the metadata. To implement the role-based schema, an XML (Extensible Markup Language) role file is designed to contain all the roles-related information. The information will indicate the types of users, the associated tasks performed and the aspects of metadata that require their inputs.

Figure 5 shows the architecture of a role-based metadata tool in GeogDL comprising four components : (1) input/editing interface; (2) metadata tool generator; (3) GeogDL metadata schema and (4) metadata role file. For example, if a geography resource is to be input into GeogDL, based on the contributor's role, the metadata tool generator will then dynamically generate the appropriate metadata editing interface using information from the GeogDL metadata schema (#3) and the metadata role file (#4).

Figure 5. Architecture of a Role-Based Metadata Tool in GeogDL

Figure 6 shows the role-based metadata tool in relation to the entire GeogDL architecture. Details of other components can be found in [13]. For the purpose of this paper, we will only be discussing the components relevant to metadata creation and maintenance whereby three new components are being implemented on the GeogDL interface namely : (i) Resource Input; (ii) Resource Import; and (iii) Resource Export.

For resource input, a role-editing tool allows authorized users of GeogDL to enter role-based information through a user interface with the role file automatically

generated, so that the tool provides support for metadata entry and validation based on the roles of users.

GeogDL also supports import of other metadata formats to GeogDL-compliant metadata format. For example, an IMS-compliant metadata can be incorporated into GeogDL-compliant metadata via a metadata convertor tool, based on information of the IMS and GeogDL metadata schemas stored in the convertor.

Similarly, the tool also allows for conversion and export of GeogDL metadata to other established metadata formats. Presently, we are working on the conversion of two standards, IMS- and SingCORE-compliant metadata to/from GeogDL-compliant metadata. With this architecture, it would not be difficult to include conversions of other standards if necessary.

Figure 6. Architecture of a Role-Based Metadata Tool in GeogDL

6 Related Work

Our work on deriving an appropriate metadata schema for GeogDL shares similar goals with existing DL projects with different approaches and in different domains.

While our work has similarities with these projects, a major difference is that these DLs do not provide all the necessary features offered by GeogDL to help students to revise and prepare for a national examination in Singapore. Hence, capturing details on examination questions, sources and related resources are important. Equally important are annotations on them.

For example, the Digital Library for Earth System Education (DLESE) [10] contains elements through sharing of geography resources for various educational levels in earth system science education. A novel feature of the DL is that its contents rely entirely on users' contribution of resources, which may include maps, simulations, lesson plans, data sets, etc. Other users may then incorporate these resources into their lesson plans. Because of the complexity of geospatial educational resources, NEEDS-DLESE has adopted several metadata schemes such as DC and IMS to create a new metadata framework [8]. In contrast, GeogDL resources are mainly designed by teachers/educators for students.

A scheme closer in nature to GeogDL is the Federal Geographic Data Committee (FGDC) standard used to provide a common set of terminology and definitions for the documentation of digital geospatial data. It is, however, a rather complex standard with 119 compound elements or groups of elements hierarchically arranged to describe relationships among other elements [5].

GeogDL has special requirements which are not met by established standards such as IMS and Singapore-defined standards such as SingCORE. GeogDL derives an appropriate metadata schema based on its objectives and initial study that contributors of metadata have different roles and are capable of providing information to certain sets of elements in the metadata.

The role-based metadata tool generator allows authorised users such as teachers to add and modify resources in the DL. Since each resource is associated with appropriate metadata, the tool also provides support for metadata entry and validation (see Figure 5).

7 Conclusion and On-going Work

Designing any system always faces tradeoffs. One could go for simple design but not comprehensive enough to meet all requirements. In contrast, one could go for detailed and exhaustive design, but may lack practical usage. GeogDL aims to address these two areas through providing a role-based metadata schema to deal with the extensive set of elements by assigning different people to contribute to only certain elements, thus reducing the entry set of elements for each user.

Realising that there are also other resources that may not be GeogDL-compliant, a convertor is being developed to allow for conversion of GeogDL resources to IMS and SingCORE standards and vice versa, as described in Section 4.4 (see Figure 6).

More work needs to be done to further refine, test and use the metadata scheme involving different groups of authors, teachers/educators and librarians.

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On-going work involves evaluating the new interface components in GeogDL to support multi-role inputs of the metadata of geography resources, as well as import/export of metadata from/to established formats to allow for wider use of resources. We believe our work have important implications on research involving DLs in education and learning systems.

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References

1. Carroll, J.: Making use: Scenario-based Design of Human-Computer Interactions. The MIT Press. (2000).
2. Dublin Core Metadata Initiative (DCMI). <http://www.dublincore.org> (accessed 18 Feb 2003).
3. Education Network Australia. <http://www.ischool.washington.edu/sasutton/EdNA.html> (accessed 18 Feb 2003).
4. Ellington, H., Percival, F. and Race, P.: Handbook of Educational Technology. Kogan Page. (1995).
5. Federal Geographic Data Committee. <http://www.fgdc.gov> (accessed 18 Feb 2003).
6. GEM - The Gateway to Educational Materials. <http://www.geminfo.org> (accessed 18 Feb 2003).
7. Greenberg, J. (Ed.). Metadata and organizing educational resources on the Internet. NY: The Haworth Information Press, c2000.
8. Needs-Engineering. <http://www.needs.org> (accessed 18 Feb 2003).
9. SingCORE. <http://www.ecc.org.sg>. (accessed 18 Feb 2003).
10. Sumner, T. and Dawe, M (2001), *Looking at digital library usability from a reuse perspective*. In Proceedings of the First ACM+IEEE Joint Conference on Digital Libraries 2001, pp. 416-425. ACM Press.
11. SCORM. <http://www.adlnet.org> (accessed 18 Feb 2003).
12. Theng, Y.L. Goh, H.L., Lim, E.P., Liu, Z., Pang, L.S., Wong, B.B. and Chua, L.H. Intergenerational Partnerships in the Design of a Digital Library of Geography Examination Resources, *ICADL2002*, 427-439, LNCS 2555, Springer-Verlag.
13. Lian-Heong Chua, Dion Hoe-Lian Goh, Zehua Liu, Lim Ee Peng, Rebecca Pei-Hui Ang, "A Digital Library For Geography Examination Resources," ACM/IEEE Joint Conference on Digital Libraries (JCDL2002), Portland, Oregon, July 2002.
14. Welcome to IMS Global Learning Consortium, Inc. <http://www.imsproject.org/index.html> (accessed 18 Feb 2003).