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Developing a Schema for Describing the Contents of the Office for Learning and Teaching's Resource Library

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The Australian Federal Government's Office for Learning and Teaching (OLT) has built an important collection of learning and teaching resources for the higher education (HE) sector, a product of the many projects OLT and its precursors, including the Australian Learning and Teaching Council and the Carrick Institute, have funded over the past two decades. Although these resources are freely available on its website, the OLT considers them underutilised. Hence it has commissioned a project to reorganise the collection using more accurate and consistent metadata. This paper presents the results of the initial phase of the project, in which a new metadata schema for the OLT's repository was developed through a systematic analysis of the collection, users' and prospective users' search needs, and the domain of HE learning and teaching. While the methods used to develop controlled vocabularies, such as subject thesauri, are well established, there has been far less discussion about how schemas for describing particular kinds of information resource should be constructed. This article contributes to this discussion by showing how methods used to build controlled vocabularies can be applied, and combined, to the development of a schema used to support effective access to a scholarly repository of national importance.

Keywords: scholarly repositories; metadata; methodology; Office for Learning and Teaching; MODS

Introduction

The Office for Learning and Teaching (OLT) (www.olt.gov.au/about-olt) was established by the Australian Federal Government in 2011, following the termination of the Australian Learning and Teaching Council (ALTC). Essentially, its function is to support and enhance learning and teaching practices across the Australian higher education (HE) sector, primarily through the provision of grants and awards to academics with particular expertise and interest in learning and teaching. Its predecessor, the ALTC, and before that, the Carrick Institute, performed similar roles (Gannaway, Hinton, Berry, & Moore, 2013).

Over the past two decades, the Australian government has funded, through the OLT and its predecessors, around 600 projects, which have addressed a wide range of issues related to HE learning and teaching, sometimes in the context of particular disciplines, in other cases more broadly. With many millions of grant dollars spent on these projects,

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there is clearly an expectation that they are leading to significant outcomes, including resources that are of value to the academic community at large. It is thus important for the OLT to ensure that the resources emanating from the projects are not only collected, but are also promoted and made accessible as effectively as possible. Hence, at the end of 2013 it commissioned the project, 'National Learning and Teaching Audit and Classification', to reconstruct the database that houses the OLT's resource collection, so that end-users can more easily find what they are looking for: anecdotal evidence had suggested low levels of recall and precision. The commission was awarded to a team of academics and librarians from Charles Sturt University, the University of Wollongong and the Australian Council for Educational Research (ACER). The grant received totalled $149,000; the project began in early 2014 and is due to be completed in mid-2015.

The OLT's resource collection that is the subject of the commission is known as its 'Resource Library' and can be accessed at www.olt.gov.au/resource-library. It contains the resources deposited upon completion of those projects funded by the OLT, ALTC, the Carrick Institute and certain other national bodies since 1994. In most cases, these resources include a final project report, which typically includes recommendations for best practice. In some cases, other resources emanating from the project are also deposited, such as checklists, handbooks and other material that may be of utility, or at least interest, to educators outside of the project. Thus a project may be represented by just one resource in the Resource Library, or it may be represented by several resources. Resources are mostly indexed at the project level, but sometimes at the resource level. The bibliographic content of the physical resources is also somewhat inconsistent. For example, some files consist of final reports together with their appendices, whereas for other projects the report and appendices are presented in separate files. Furthermore, the sorts of material presented in appendices to some reports are, for other projects, deposited as bibliographically independent resources. Most of the files are in PDF format.

Figure 1 shows the basic search interface of the Resource Library, which operates on a subset (i.e. the project resource subset) of a broader content management system (CMS) used by the OLT. The CMS currently employs a standard version of Drupal, along with an Apace Solr search platform. As well as the basic 'keyword' search, two other search interfaces (or 'views' in Drupal parlance) are also available: an A–Z listing of 'keywords', and an advanced search with the following options: resource title, author, project title, year, project ID, lead institution, discipline and resource type. The screen capture in Figure 1 includes the top record from a listing of 625 'resources' (625 was, in fact, the total number of *records* in the system at the time, with some records linking to multiple files). While result sets can be sorted and filtered in various ways, each record can only be displayed in one format, which, as Figure 1 suggests, is quite succinct, comprising just a few bibliographic elements, such as title, author(s) and year of publication. It should be noted, however, that all of the resources cited are immediately downloadable and examinable via the links displayed; their files are stored in the system.

At first glance, the database may appear to be organised effectively, but of course a retrieval system is only as good as its indexes, and two major problem areas readily emerge when one starts searching. First, there is a lack of clarity around the *kind* of metadata one is searching on. What, for example, does 'keyword' cover: various elements such as title and author, or just subject? When one 'filters' by keyword (on the left-hand side of the screen), the list of (top) terms seem to mostly represent subjects, but initial searches appear to retrieve on, for example, titles and author names as well. Have the search fields been optimally configured, and are they the right ones?

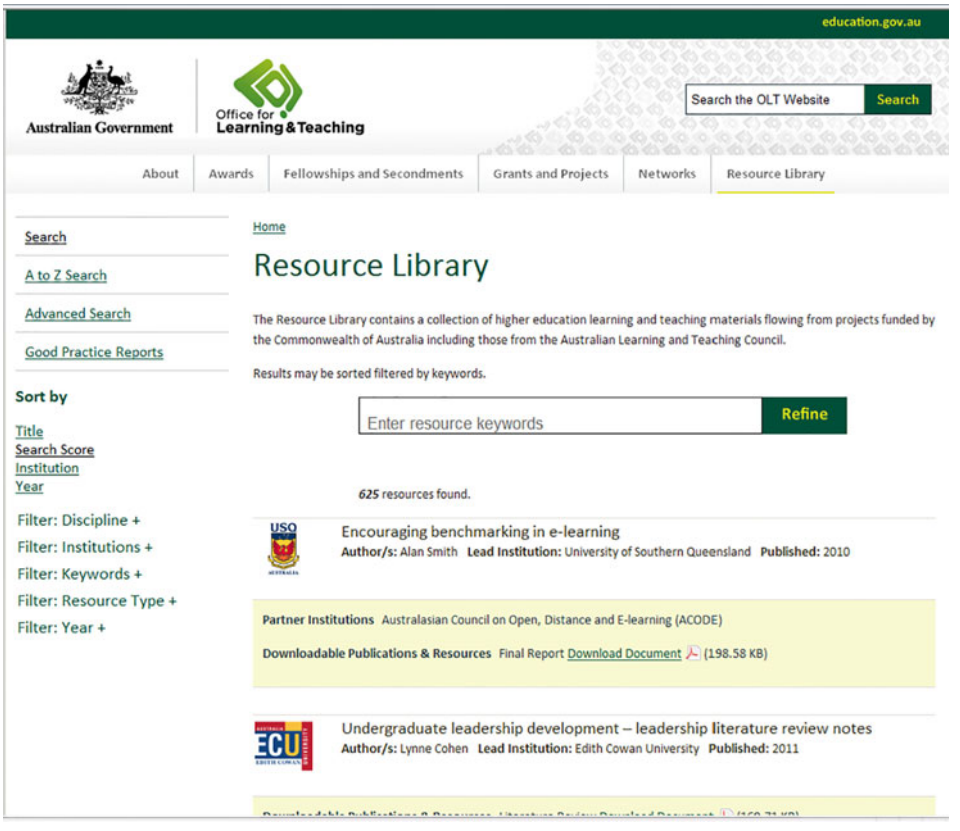

Figure 1. OLT resource library search interface.

The second problem area pertains to the actual terms one searches on. For example, the terms 'bachelor', 'bachelors' and 'undergraduate' lead to quite different result sets; these differences cannot be readily explained away by non-subject elements, and examination of the resources would suggest that unless a user searchers on all three terms, they are likely to miss resources of interest. In other words, for subject searching in particular, there appears to be a need for vocabulary control. Limited results on fairly common educational terms also raise the question of whether there is sufficient subject indexing, as well as whether it is accurate and consistent.

The aim of the National Learning and Teaching Audit and Classification project is to answer the above questions by reviewing the ways in which the resources in the OLT's collection have been described, both in terms of the kinds, i.e. *elements,* of metadata recorded and in terms of the *values* used to record these elements. To this end, the project consists of seven phases. First, a new *schema,* or element set, is to be constructed based on analysis of the resources to be described and the prospective users' information needs. (The extent to which the resulting schema will be implemented in the project is dependent on the parameters of the current CMS.) The existing set of elements is based on neither a particular standard nor any systematic research, and has been applied inconsistently, with some of the fields, such as description, being entered only when staff resources and expertise were permitted, and other fields, such as commentary, only being entered in a small minority of 'experimental' cases.

In the second phase, the performance of the existing retrieval system is assessed, in order to determine the need, or otherwise, for revision to the current set of 'keywords' and to establish a baseline for the later evaluation of the redeveloped system (assuming there is a need for it). Third, for those elements of the new schema for which it is determined that vocabulary control is desirable, relevant, existing vocabularies are evaluated for their applicability. In the fourth phase, the necessary vocabularies will be constructed, or adapted from those extant, with the aid of some free-listing and card-sorting exercises; they will also be tested by mapping them against the existing keywords and by means of think-aloud protocol analysis. In the fifth phase, new indexing guidelines will be written up. Sixth, all of the resources currently in the Resource Library will be re-indexed, using the new schema, vocabularies and guidelines. Finally, an audit of the existing collection will be conducted, based on the re-indexing, to identify possible gaps, as well as strengths, in the collection's coverage of HE learning and teaching topics.

This paper describes the conduct and results of the critical first phase of the project, which was completed in June 2014. While standards exist for the design and construction of the kinds of controlled vocabularies that are likely to be implemented in the latter part of the project, there has been comparatively little discussion around the methodology for the development of bibliographic schemas for particular collections and resource types, as the following section will indicate.

Literature review

The project team needed to consult the Library and Information Science (LIS) and Education literature for two principal reasons. First, it needed to identify any existing solutions that might be applied to the system redesign, and second it needed to consider approaches to the redesign that have been reported as successful in the past. The main category of 'solutions', in this case, is metadata standards. With respect to the vocabularies that might be applicable, there are several well-established candidates (e.g. the *Australian Thesaurus of Education Descriptors* (ATED) and the *ERIC Thesaurus*), and a small amount of literature discussing their respective merits has also been published. Relevant *schemas,* on the other hand, were much harder to identify. No standard element set appears to have been published specifically for scholarly repositories, although many hosted by universities apply either the metadata object description schema (MODS) or Dublin Core (DC) or extensions thereof (Park & Tosaka, 2010).

MODS (www.loc.gov/standards/mods) is managed by the Library of Congress and based on the MARC21 record format standard. The Australian METS profile (http://www.nla.gov.au/standards/australian-mets-profile), which has been designed 'to support the collection and preservation of and access to content in Australian digital repositories', applies MODS, but it is unclear if the profile is being routinely followed (the University of Sydney, for instance, has being applying DC, according to Brownlee [2009]). DC (dublincore.org) is a schema with a more general application and is typically extended to cover particular applications; there are DC 'application profiles' for learning objects, but none that has been published specifically for scholarly repositories, to the authors' knowledge. DC is very well established and has its own ISO standard (15836:2003). Other schemas applied in the field of education were also reviewed, but they are primarily for *learning objects* (e.g. IEEE LOM; see, e.g. Agostinho, Bennett, Lockyer, & Harper, 2004), whereas the vast majority of the resources in the OLT collection are of a 'secondary' nature, i.e. they are aimed at the educators rather than the students.

The authors could not find any published discussion of the elements required to describe resources specifically for HE learning and teaching, of this secondary kind (though there are collections similar to that of the OLT Resource Library in other countries, such as that of the Higher Education Academy Resource Centre in the UK, at http://www.heacademy.ac.uk/resources). It was thus up to the project team to investigate what these elements might be; this investigation required an appropriate methodology. As Hider (2014) has recently pointed out, while there are well-established, though less well-documented, approaches to the construction of controlled vocabularies for document retrieval systems, there is a noticeable lack of guidance, or even discussion, on how *schemas* should be developed. This may be because they are developed (and redeveloped) less frequently, or because they are generally much smaller than controlled vocabularies and so there is less development required, or because at this level 'development by committee' may be a more realistic approach. Likely, a combination of these reasons is involved.

Where there is commentary, if not discussion, on a schema's development, the approach taken varies considerably. In many cases, it appears to be based primarily on what Bliss (1939) called 'scientific and educational consensus', typically arrived at through committees and expert input. However, other forms of 'warrant' are sometimes indicated, including 'resource warrant', whereby a schema is developed through the study of the information resources that it is intended to cover, and 'user warrant', whereby the search needs and behaviour of the relevant end-users, and prospective end-users, are analysed, either directly or indirectly (Hider, 2014). Often, of course, it is a matter of emphasis, with all three basic approaches taken to a certain degree. Riley and Dalmau (2007) present a typical case study, in which the schema for a digital collection of sheet music is developed using a combination of expert input and user studies.

In the case of the project in hand, there was no obvious reason to favour one particular kind of warrant, and thus all three kinds identified above were utilised with similar emphasis. It was also assumed that the specific methods used in the LIS field for developing controlled vocabularies could be effectively applied to the development of a bibliographic schema, on the grounds that these methods have already produced successful standards such as ATED and ERIC, which could, potentially, be applied to the Resource Library materials. A brief review of the approaches and methods for vocabulary construction developed in the LIS field follows.

The construction of controlled vocabularies has, in fact, been a topic of discussion amongst librarians for a very long time – indeed, for as long as vocabulary control has been attempted. Debate around whether bibliographic classification schemes (a form of controlled vocabulary based on notation rather than natural language) should be constructed *a priori* or *a posteriori* has ensued since the early twentieth century, when Hulme (1911–1912) argued for the latter approach, based on 'literary warrant'. Developing both classification schemes and 'alphabetic' indexing languages, such as subject heading lists, according to the content of the resources in a given collection, or according to the 'literature' to be found in libraries collectively, became a widely followed principle, exemplified, in particular, by the *Library of Congress Classification* and the *Library of Congress Subject Headings* (Rodriguez, 1984). The approach comprised the derivation of concepts and terms through a systematic reading of the 'item in hand' (criticised latterly for its essentialism). It can be extended to non-textual information resources, and in this paper the term 'resource warrant' is used, to represent this extension.

The earliest approaches to bibliographic classification, however, were based on an assumption that library collections represented, at least approximately, a philosophical

ontology. For example, the *Dewey Decimal Classification* was based on (and inverted) Francis Bacon's knowledge classification. *A priori* approaches continued to attract library classificationists through the twentieth century. Some were likewise based on 'philosophical warrant', others on scientific taxonomy, or on a belief that all domains of knowledge can be classified according to an established, collective view of them. Beghtol (1986) characterises these approaches as based either on 'scientific/philosophical warrant' or on 'educational warrant'. Bliss's *Bibliographic Classification* scheme was purportedly based on both types of warrant. All these approaches, however, appeal to some form of *authority,* whether philosophical, scientific or academic. In this paper, the term 'scientific-educational warrant' will be used to refer to the broader methodology. It focuses on the identification and utilisation of 'authoritative' sources, such as reference works and domain experts. It has been applied to a wide range of controlled vocabularies used in LIS, not just classification schemes. Indeed, it represents an approach especially emphasised in the analytic-synthetic method of classification construction, which typically produces a scheme that doubles as an alphabetic thesaurus.

Beghtol's typology of warrant (or more precisely, semantic warrant; 1986) includes a fourth kind, which she names 'cultural warrant'. This represents an approach to vocabulary development that might be characterised as bottom-up, in contrast to the top-down approach based on scientific-educational warrant. Thus part of this type of warrant pertains to end-users and their ontologies (Howarth & Jansen, 2014). Interest in the 'user perspective' increased during the second half of the twentieth century, when more options became available for librarians to investigate this perspective. Earlier methods include surveying end-users directly, or analysing reference queries; later methods include transaction log analysis and those most commonly employed by information architects, such as card sorting and free listing. Although Beghtol's 'cultural warrant' may not exactly equate to 'user warrant', the latter is identified in this paper as the third main kind of warrant on which controlled vocabularies are based, in LIS.

All three approaches to vocabulary construction, represented by resource, scientific-educational and user warrant, are now well established in LIS practice, as can be seen in standard guides such *Thesaurus Construction and Use* by Aitchison, Gilchrist, and Bawden (2000), where it recommends collecting concepts and terms from reference works and experts' experience and knowledge, the literature and search logs and users' experience and knowledge. Theoretically, one can see how each of the three approaches has a role to play: retrieval systems need to answer users' queries, but they also need to communicate *what* is available to the users, and to help users (particularly inexpert ones) work out what it is they need (which may or may not be in the collection). It is often recommended that a combination of two or three of the approaches be taken. For instance, in ISO 25964-1, *Thesauri for Information Retrieval* (2011), it is advised that consideration is given both to the materials to be indexed and to what 'the users want to search for'.

The various methods suggested by Aitchison, Gilchrist, and Bawden (2000) were considered in this project, for the development of both schema and vocabularies. The methods selected were as follows:

(1) examination ('bibliographic analysis') of a sample of resources from the OLT collection;
(2) analysis of prospective searches in the Resource Library as described by surveyed users and prospective users and
(3) consultation with experts in the HE learning and teaching field.

Bibliographic analysis

The resources from a random sample of 60 projects (about 10%) represented in the Resource Library were systematically examined by two members of the project team, independently. For each resource, those attributes that were considered potentially useful for finding, identifying and/or selecting it, following the FRBR model of 'user tasks' (IFLA Study Group on the Functional Requirements for Bibliographic Records, 2009), were identified and recorded in the analyst's own words. Most attributes were text based (e.g. title), but did not have to be. Each analyst's list of attributes was controlled for synonyms and near-synonyms; the lists were then mapped against each other. Where there was uncertainty as to the conceptual relationship (or otherwise) between terms, they were discussed by the analysts. The total number of occurrences of each attribute was noted.

For practical purposes, the resulting 'long list' was then shortened by collapsing attributes into conceptually broader attributes where the former occurred infrequently and/or were considered to be less important (for searching). For example, 'photos', 'tables' and 'figures' were collapsed into 'illustrative matter'. The resulting 'short list' was as follows:

Commissioning body (name)
Consultant (name)
Document number
Editor (name)
Executive summary
File type
Financial information
Funding body (name)
Glossary (presence/absence)
Grant number
Grant type
Illustrative matter
Index (presence/absence)
Institution (of grant recipients)
Institution's department (name)
ISBN
Keywords (assigned by author)
Last revised date
Lead institution (name)
Licence conditions
Literature review (presence/absence)
Number of pages
Other project team member (name)
Partner institution (name)
Project acronym
Project evaluation (presence/absence)
Project leader (name)
Project reference group member (name)
Project steering group member (name)
Project summary
Project team member (name)
Project terms of reference (presence/absence)

Project title
Project URL
Publication list (presence/absence)
References/bibliography (presence/absence)
Related project
Related URL
Research data (presence/absence)
Researcher (name)
Resource author (name)
Resource title/subtitle
Resource type
Running title
Series title
Short title
Sub-project (name)
Survey instruments (presence/absence)
Table of contents
Teaching materials
Version number
Year

User survey

An online questionnaire survey was designed to investigate the use, and prospective use, of the Resource Library. Invitations to respond to the survey were sent to electronic lists in the Australian HE field and to individual academics identified as having a particular interest in HE learning and teaching and thus, at least potentially, a strong interest in using the Resource Library. The survey was opened in April 2014 and closed the following month. This paper reports specifically on the responses to questions 10 and 11 of the survey, i.e. 'Please describe, as concretely as possible, a future search query (including particular search terms) you might wish to conduct in the database' and 'Which of … fields would be useful in your searching of the database?' Other results from the survey have been detailed in a paper presented at the ASCILITE 2014 conference (http://ascilite2014.otago.ac.nz).

One hundred and seventeen responses were received from respondents at 32 universities and 6 other employers. The sample would appear to be broadly representative of those most likely to benefit from the Resource Library: most had considerable experience in the HE sector, had received an OLT award or grant in the past and had previously used (or at least tried to use) the Library. The vast majority were interested in using the database in the future; of those, 88 responded to question 10 of the survey. The bibliographic attributes of these responses were identified and are listed in Table 1.

Responses to question 11 are shown in Table 2; 106 respondents answered the question.

Expert consultation

As the metadata for the Resource Library is produced and maintained by OLT staff without LIS qualifications, and as the end-users of the database are similarly non-expert

Table 1. Attributes in described searches.

Attribute	*n*
Subject	77
Discipline	8
Author	3
Grant type	3
Institution	3
Researcher	3
Year	3
Teaching materials	2
Resource type	2
Abstract	1
Funding amount	1
Methodology	1
Project aims	1
Title	1

searchers, a basic or 'core' set of elements was sought for implementation. To this end, the HE learning and teaching experts from both the project team and the project's reference group were asked to consider the importance (from a searching perspective) of each attribute in the lists resulting from the bibliographic analysis and user survey. It was agreed that a number of the attributes were of relatively minor use for searching, particularly as end-users have immediate access to all the resources once they had been found (so that selection and identification did not need to be extensively supported); these less important attributes were duly eliminated. Furthermore, the attributes 'Methodology' and 'Project aims' were considered to be adequately covered by 'Project summary', 'Date entered on database' to be adequately covered by 'Year', and 'Teaching materials' to be adequately covered by 'Resource type'. The distinction between 'Executive summary' (of the final

Table 2. Useful fields for searching.

Useful fields	*n*	%
Keywords	103	97.2
Author(s)	79	74.5
Project title	75	70.8
Discipline	74	69.8
Resource title	68	64.2
Year published	60	56.6
Resource type	58	54.7
Lead institution	39	36.8
Other (specified)	12	11.3
Abstract	3	2.8
Grant type	2	1.9
Date entered (on database)	1	0.9
Executive summary	1	0.9
Funding amount	1	0.9
Lead institution	1	0.9
Project leader	1	0.9
Partner institution	1	0.9
Website link	1	0.9

report) and 'Project summary' was considered to be too slight for practical purposes, and that the former should be treated as a proxy for the latter.

The remaining attributes in the two lists were combined to produce the following schema of elements, divided into those pertaining to *Project* and *Resource*. In doing so, it was decided that the usefulness of describing the 'Topic' of both the resource and the project was negligible (they would mostly be the same), and so it, and its sub-attribute, 'Discipline', and the related attribute, 'Keywords (assigned by author)', were assigned exclusively to the *Project* entity, this being deemed the more efficient option. Conversely, the 'Year' attribute was qualified into that pertaining to project ('Year of completion') and that pertaining to resource ('Year of publication'). The experts also identified an important attribute that was missing from the list, namely, Digital Object Identifier (DOI), which was duly added. The final list is given below. The provision of ratings, comments and tags from end-users was also discussed, but such elements were not included in the core schema as they were deemed outside the scope of the project as commissioned by OLT.

PROJECT
Project ID
Project title
Project acronym
Project summary
Topic
Discipline
Author keyword
Year of completion
Lead researcher
Co-researcher
Lead institution
Partner institution
Funding body
Grant type
Project website URL
Related project
RESOURCE
ISBN
DOI
Resource title
Resource type
Year of publication
Resource author

Mapping to MODS

It was noted earlier that the most relevant standard schema for the project's application is MODS. Although there was no specific need to apply MODS, and the special nature of the project-resource data model that emerged indicated that it would not be entirely appropriate to do so, it was considered desirable for the new, in-house schema to map to MODS *reasonably* well for possible future applications. It is quite possible that in time the OLT will be in a position to provide its repository's metadata as 'linked data', perhaps based on MODS. The opportunity to use the metadata in conjunction with other types

Table 3. OLT schema-MODS mapping.

OLT element	MODS element/attribute
Project ID	< identifier type = 'project id' >
Project title	< title > [subtitle can be included]
Project acronym	< title > (type = 'abbreviated')
Project summary	< abstract type = 'project summary' >
Topic	< topic > (authority = 'ated')
Discipline	< topic > (authority = 'asced')
Author keyword	< topic >
Year of completion	< dateOther type = 'project completed' >
Lead researcher	< namePart > (type = 'personal')/ < roleTerm type = 'text' > lead researcher
Co-researcher	< namePart > (type = 'personal')/ < roleTerm type = 'text' > co-researcher
Lead institution	< namePart > (type = 'corporate')/ < roleTerm type = 'text' > lead institution
Partner institution	< namePart > (type = 'corporate')/ < roleTerm type = 'text' > partner institution
Funding body	< namePart > (type = 'corporate')/ < roleTerm type = 'text' > funding body
Grant type	< note type = 'grant type' >
Project website URL	< relatedItem type = 'related' > / < url displayLabel = 'Project website' >
Related project	< relatedItem type = 'related' > / < title > etc.
ISBN	< identifier type = 'isbn' >
DOI	< identifier type = 'doi' >
Resource title	< title >
Resource type	< genre > (authority = 'olt')
Year of publication	< dateIssued >
Resource author	< namePart > (type = 'personal')/ < roleTerm type = 'text' > author

of educational data, as well as with metadata from other scholarly repositories, could be of significant benefit to the higher education sector, as indicated by recent linked data projects within and between universities (Guillermo, Tiropanis, and Millard, 2016; Zablith, Fernandez, and Rowe, 2015).

The mapping is shown in Table 3; it demonstrates a close alignment, with all elements of the new schema mappable to MODS. The alignment likewise provides further evidence for the robustness of the MODS standard in digital repository contexts.

Discussion and conclusions

The final list of elements, as set out above, constitutes the recommended schema for the new OLT Resource Library. The preferred sources of data for each element, its repeatability (or otherwise), and its optimal indexing and display settings have also been considered and specified in the recommendations provided to the OLT, with whom the initial implantation plan is now being discussed, in the context of the current system's functionality. It is possible that certain recommendations will be deferred to the next system upgrade. For example, it has been recommended that two levels of record are implemented, one for each project and one for each (deposited) resource emanating from the project; however, the version of Drupal being used by OLT does not readily accommodate multi-level records, so this may have to be postponed.

Methods commonly employed to construct controlled vocabularies in LIS proved effective in developing the schema for the OLT repository. The three methods, representing the three main approaches based on the concepts of resource warrant, scientific-educational warrant and user warrant, pointed to many of the same key attributes of the resources in question, while complementing each other by also identifying certain important attributes that were not established by the other two methods. More research needs to be conducted, however, to ascertain whether such methods, in combination, would be equally effective in developing schemas for the description of other types of information resource, in other retrieval contexts, and, if so, *how* the methods should be optimally combined.

This initial phase of the commissioned project has also highlighted the importance of assembling digital repository teams that are able to draw on a wide range of skills and expertise. The development of the schema clearly required the skills and knowledge of indexers and metadata specialists, but it also required input from domain experts (particularly to establish educational warrant) and from researchers with the relevant methodological expertise. The combined efforts of librarians, LIS academics and HE learning and teaching experts have set this project on the right track.

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