# When MARC consumed ScOT: a tale of linked educational metadata

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***Abstract***
*Australian school libraries have an expressed need to organise resources according to Australian Curriculum outcomes. Education Services Australia (ESA) has aligned digital resources to the Australian Curriculum since 2011, publishing them on platforms including Scootle. The Schools Catalogue Information Service (SCIS) at ESA creates and distributes MARC records to 93% of Australian school libraries, but has not traditionally provided curriculum-alignment data. This paper describes a trial in which headings from a linked data subject vocabulary (the Schools Online Thesaurus) in MARC records are supplemented with URIs for the purpose of consuming Australian Curriculum alignment data. A widget is presented to demonstrate possible downstream applications.*

# Introduction

Teacher librarians (TLs) are ideally placed to meet resource needs for Australian teachers and students (Australian Library and Information Association [ALIA] 2014a), but these professionals have an expressed need for greater support in matching (or 'aligning') local and online resources to educational objectives such as those specified in the Australian Curriculum (Softlink 2014; Kennedy 2013). Education Services Australia (ESA), a not-for-profit ministerial company owned by all Australian education ministers, has done significant work since 2011 aligning digital resources to the Australian Curriculum as part of its work towards the National Digital Learning Resource Network (NDLRN). The Schools Catalogue Information Service (SCIS), a unit of ESA, provides Machine Readable Catalogue (MARC) records to 93% of Australian Schools. SCIS has not traditionally aligned resources to curriculum, but is currently exploring methods for doing so. This paper describes one method used in the NDLRN that holds promise for the school libraries context. *Metadata-driven alignment* leverages SCIS's significant investment in subject cataloguing using the Schools Online Thesaurus (ScOT), and exploits linked data capabilities in both ScOT and the Australian Curriculum to infer alignment between resources and curriculum outcomes.

The paper begins by examining resource alignment generally and in the context of the Australian Curriculum. The NDLRN is described as a key precedent for this kind of work. Considerations around alignment for Australian school libraries are explored, including methods of establishing alignment between curriculum and resources. Metadata-driven alignment using MARC records is considered, including the opportunities present by linked data, and encoding of Resource Identifiers (URIs) in MARC records.

Finally, a SCIS trial project is described as a proof-of-concept. In this trial, a widget on the SCIS online public access catalogue (OPAC) makes use of a SCIS web service to display suggested Australian Curriculum alignments. The web service suggests resource alignments by linking URIs from MARC records to ScOT and the Australian Curriculum.

# Curriculum Alignment

In educational contexts, alignment can be broadly considered as the multiple linkages amongst formal curriculum outcomes, instructional resources, the content and process of teaching, and assessment (Carr & Harris 2001). Close alignment amongst these facets has been identified as being a crucial ingredient for improved student outcomes (Squires 2012). In this paper, the term 'alignment' is used to refer to the specific aspect of matching instructional resources to curriculum outcomes.

The INFOhio Alignment Standard notes that use of resources aligned to an objective "should result in a measurable increase in students' understanding of concepts or ability to perform skills" specified in the objective (Adamich 2009).

At the operational level, curriculum alignment has been defined in a range of metadata standards, including MARC, the Learning Resource Metadata Initiative (LRMI), and the ANZ-LOM metadata profile.

The MARC field “658 - Index Term-Curriculum Objective” was introduced in 1993 as a result of work by the Northwest Ohio Educational Technology Foundation, in response to a lack of MARC elements relevant to cataloguing for children and educational contexts (Adamich 2006). The element is intended to denote “curriculum or course-of-study objectives applicable to the content of the described materials”[i].

According to the LRMI extension to schema.org, a *CreativeWork* can be linked via the *educationalAlignment* property (“an alignment to an established educational framework”) to an *AlignmentObject* (described as a ‘node in an Educational Framework’).

In ANZ-LOM (Education Services Australia 2015), an education objective may be given within the *Purpose* element for a given resource. The intention of the educational objective is to “classify resources with the systematic instruction, schooling or training given to the young in preparation for the work of life” (p21).

The terms ‘applicable’, ‘purpose’, and ‘use’ in these operational definitions highlight that alignment relates to the purpose of a resource, as opposed to its ‘aboutness’ described by subject description.

## Resourcing the Australian Curriculum

The national Australian Curriculum published by the Australian Curriculum and Reporting Authority (ACARA) provides a common set of learning outcomes for participating jurisdictions and educational bodies.

Version 8.1 of the Australian Curriculum’s F-10 Curriculum represents:

> …a progression of learning from Foundation - Year 10 that makes clear to teachers, parents, students and others in the wider community what is to be taught, and the quality of learning expected of young people as they progress through school. (Australian Curriculum and Reporting Authority [ACARA], 2015a)

Discipline-specific subject matter is presented in eight learning areas: English, Mathematics, Science, Health and Physical Education, Humanities and Social Sciences, The Arts, Technologies and Languages. In some cases, learning areas consist of a set of subjects, such as The Arts, which is comprised of Dance, Drama, Media Arts, Music, and Visual Arts.

The ‘building blocks’ of the Australian Curriculum learning areas are the Content Descriptions, which describe what is to be learnt within each learning-area/subject at a given grade or band of grades. As demonstrated in Figure 1, each Content Description is labelled with a unique code (eg. “ACTDIP012”) and given a description that includes several elaborations. Content Descriptions are designated a year level or band of year levels, and a broad learning area. Importantly, the ‘aboutness’ of Content Descriptions is described via one or more concepts from the ScOT thesaurus (see below).

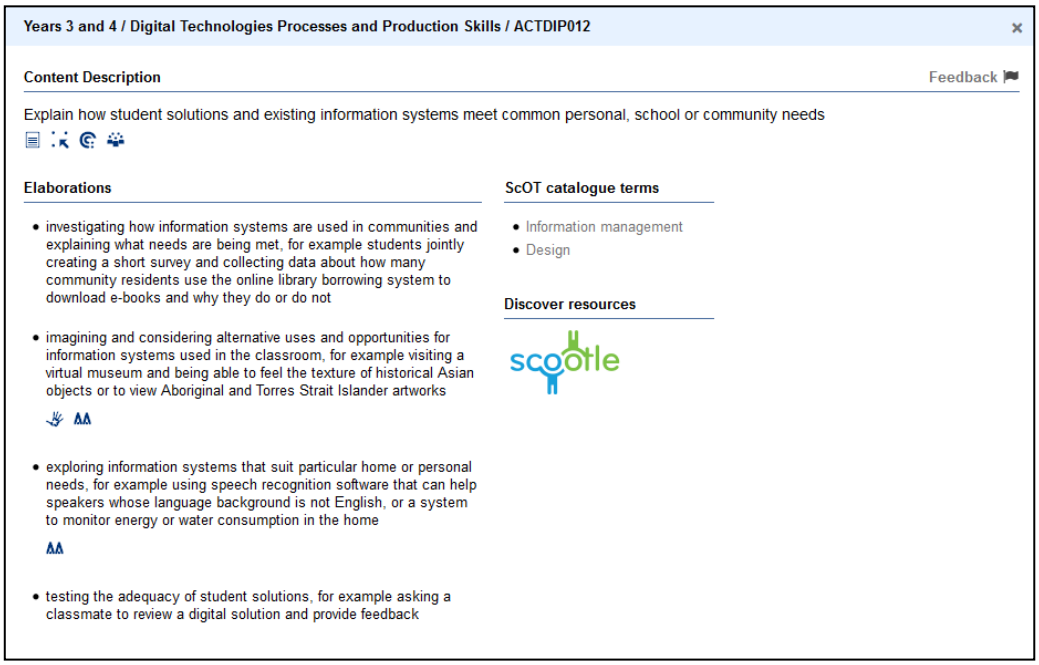


Figure 1. Human-readable representation of Australian Curriculum Content Description ACTDIP012

There are generally two structural levels in the Australian Curriculum that sit between the upper-level learning-areas/subjects and the lower-level Content Descriptions. Strands provide the structure of learning themes or domains within learning-areas/subjects. For example, English is composed of three strands: Language, Literature and Literacy. Strands are further composed of sub-strands, in which the specific Content Descriptions are situated.

Work on the Australian Curriculum is accompanied by work to create and curate curriculum-aligned instructional resources. ACARA seeks to support Australian educators by "developing materials to support teachers as the curriculum is being implemented" (ACARA, 2015b). ESA works with ACARA to create, publish, and disseminate curriculum materials. The 2014 Review of the Australian Curriculum (Australian Government 2014) reiterated an ongoing need for "content designed to be pedagogy-enhancing", and noted the role of ESA in supporting this. More recently, the Education Council's 2015 National STEM School Education Strategy (Education Council 2015) reinforced the importance of "uptake of online learning materials, linked to classroom practice", and emphasised that "effort under the national strategy will build on, and link to, the Australian curriculum".

## The NDLRN, Scootle, and Australian Curriculum Connect

The NDLRN has been a core initiative to deliver curriculum-aligned resources to Australian educators. The NDLRN was developed and is jointly owned by the Australian federal government and all Australian school education jurisdictions. It comprises a collection of digital learning objects as well as a set of technical and metadata standards and the technical infrastructure for storing, publishing, and sharing resources and metadata[ii]. Resource metadata is encoded in ANZ-LOM and delivered via jurisdictional portals and Scootle, the national portal developed by ESA. Within ANZ-LOM records, the topic of resources is described using the ScOT

vocabulary. The majority of resources have been aligned to Australian Curriculum outcomes.

Scootle provides access to over 20,000 digital learning objects, including interactives, images, audio files and video clips. Educators can find curriculum-aligned resources via Scootle's *Find by Australian Curriculum* feature. This tool was developed from the Australian Curriculum Connect initiative, which sought to make curriculum-aligned NDLRN resources findable in Scootle and jurisdictional portals. Using *Find by Australian Curriculum*, users can browse from learning areas, through strands and sub-strands to find learning objects associated with particular Content Descriptions.

In Scootle, the ScOT vocabulary serves to organize searching, browsing and faceting by subject.

## The Schools Online Thesaurus (ScOT)

ScOT is a topical subject vocabulary owned by ESA and made available under the ScOT license for non-commercial use in education systems. It is one of the Australian Education Vocabularies (AEV) managed by ESA. ScOT was first published in 2004 to provide coverage for subjects relevant to the education sector, including both curriculum content and pedagogy.

ScOT is registered with the Library of Congress Subject Heading and Term Source Codes.

ScOT developed from each of the three sources of warrant identified in the ANSI/NISO Z39.19 Guidelines: *literary* warrant from language in the educational and school-library literatures, *user* warrant from the language of students and teachers (such as in search behavior), and *organizational* warrant from the language of the Australian Curriculum and other curriculums and syllabi. As such, ScOT plays a harmonizing role, using equivalence relationships to relate and consolidate concepts where terminologies differ between jurisdictions, between curriculum and resources, and also where user's search language differs.

As well as managing equivalence, ScOT is arranged into a strict hierarchy, with ten top concepts and broader and/or narrower relationships defined for all concepts down to a maximum depth of 14 hierarchical levels.

These relationships can be seen in an example ScOT concept displayed in Figure 2.

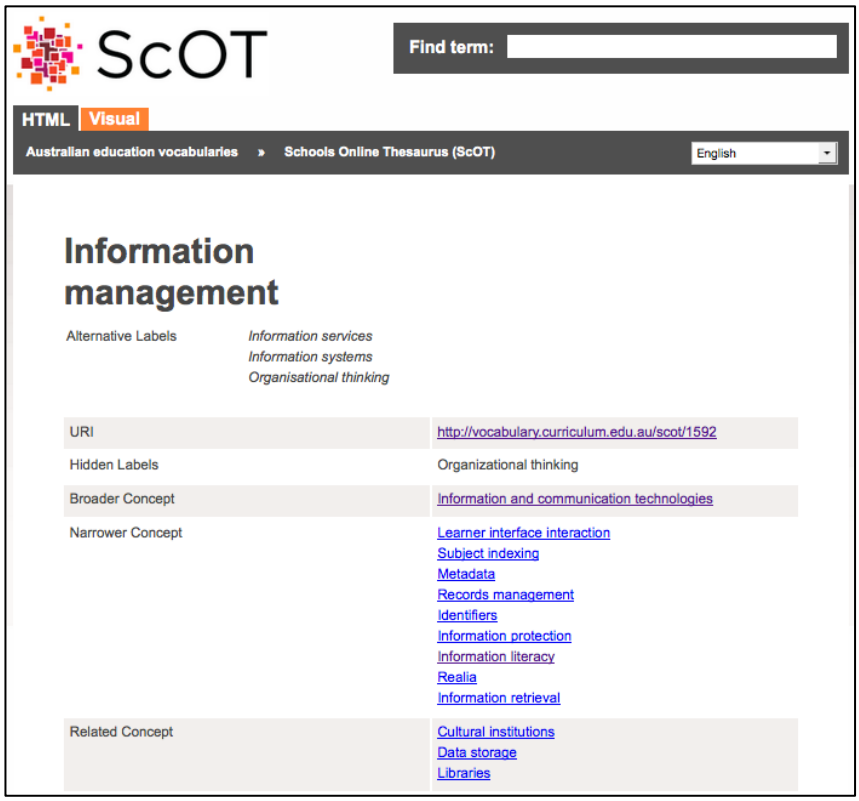


Figure 2. A human-readable representation of a ScOT concept

ScOT is managed using the PoolParty software, and encoded in the W3C's Simple Knowledge Organization System (SKOS) standard. It is a linked data vocabulary, published in RDF and stored in a Sesame triplestore database. It is made available as RDF/XML, JSON, or MARC-21 downloads, and can be queried dynamically via the AEV SPARQL endpoint. Figure 3 demonstrates the RDF representation of the same ScOT concept displayed in Figure 2.

```
– <rdf:RDF>
  – <rdf:Description rdf:about="http://vocabulary.curriculum.edu.au/scot/1592">
      <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
      <skos:prefLabel xml:lang="en">Information management</skos:prefLabel>
      <skos:altLabel xml:lang="en">Information services</skos:altLabel>
      <skos:altLabel xml:lang="en">Organisational thinking</skos:altLabel>
    – <skos:changeNote xml:lang="en">
        6.5 - BT Business and enterprise removed, BT Information and communication technologies added.
      </skos:changeNote>
      <dcterms:created rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2005-02-01T00:00:00</dcterms:created>
      <dcterms:modified rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2013-12-23T22:34:51Z</dcterms:modified>
      <skos:broader rdf:resource="http://vocabulary.curriculum.edu.au/scot/4229"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/10478"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/13506"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/1595"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/7088"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/7111"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/8120"/>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/9261"/>
      <skos:related rdf:resource="http://vocabulary.curriculum.edu.au/scot/11448"/>
      <skos:related rdf:resource="http://vocabulary.curriculum.edu.au/scot/1593"/>
      <skos:inScheme rdf:resource="http://vocabulary.curriculum.edu.au/scot/6f1bbd29-fccf-4b0a-91d5-9089f768e88c"/>
      <skos:hiddenLabel xml:lang="en">Organizational thinking</skos:hiddenLabel>
      <skos:prefLabel xml:lang="ja">情報管理</skos:prefLabel>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/15411"/>
      <skos:narrowerTransitive rdf:resource="http://vocabulary.curriculum.edu.au/scot/15411"/>
      <skos:related rdf:resource="http://vocabulary.curriculum.edu.au/scot/1594"/>
      <skos:prefLabel xml:lang="zh">信息管理</skos:prefLabel>
      <dcterms:contributor>Education Services Australia Ltd</dcterms:contributor>
      <skos:prefLabel xml:lang="id">Pengelolaan informasi</skos:prefLabel>
      <skos:altLabel xml:lang="id">Manajemen penerangan</skos:altLabel>
      <skos:altLabel xml:lang="id">Manajemen informasi</skos:altLabel>
      <skos:narrower rdf:resource="http://vocabulary.curriculum.edu.au/scot/16495"/>
      <skos:altLabel xml:lang="en">Information systems</skos:altLabel>
    </rdf:Description>
  </rdf:RDF>
```

Figure 3. RDF representation of a ScOT concept

## Australian Curriculum Resourcing and Australian School Libraries

Whilst ESA has work extensively on Australian Curriculum alignment, this work has traditionally been out of scope within the SCIS business unit.

SCIS supports Australian, New Zealand and international school libraries, offering access to the largest database of school-related catalogue records in the Southern Hemisphere. Approximately 93% of Australian schools import MARC-21 records into their local systems via SCIS's online download service or a Z39.50 connection to SCIS's Voyager library system.

Given that MARC records are distributed to schools from SCIS's central database, SCIS is well placed to offer resource alignment solutions. This is in keeping with SCIS's foundational purpose of mitigating the cataloguing burden on school libraries by cataloguing 'once for everybody'.

As early as 2003, the Ministerial Council on Education, Employment, Training and Youth Affairs' ICT in Schools Taskforce (Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA] 2003) acknowledged the role of libraries and library systems in delivering curriculum aligned resources:

> It is highly desirable that the system that enables teachers to plan lessons or units of work online also enables them to seamlessly discover resources from a local educational repository or from school library collections. (p20-21)

The Australian Library and Information Association (ALIA 2014a), identifies provision of resources and curriculum support as being a core function of TLs, and notes their specialist skills in "ensuring the school library collection supports the school curriculum and community". This capability for organising and providing resources to support curriculum is emphasised in ALIA's Teacher Librarian Practice for the Australian Professional Standards (ALIA 2014b).

However, a SCIS survey of 300 school library staff (Kennedy 2013) revealed a sense that teachers are not aware of library resources, collections were not adequately supporting the curriculum, and appropriate materials for the curriculum were difficult to find. Respondents expressed a need for training in resourcing the curriculum. As a result, they listed "Resources linked to the Australian Curriculum" as the most desirable of a range of possible services, with 78% rating it as of "High value" and a further 15.7% declaring that they would be prepared to pay extra for such a service. Similarly, in a more recent Softlink *Survey of school libraries*, "Aligning Australian Curriculum (ACARA) with existing resources/practices" was reported as respondents' highest priority objective (Softlink 2014).

There are a number of key considerations in establishing and delivering alignment for the broad array of resources described in school libraries' MARC records. These include where to store alignments and how to distribute them to end-users, but a more fundamental issue is how best to establish alignments in the first place.

### Alignment storage and distribution

Established alignments can be stored in databases and made findable in an online interface. However, this solution does not deliver that alignment data directly to local school catalogues. To do so, alignment data must be located in MARC records.

Adamich (2006) described a number of MARC fields of potential utility for curriculum alignment, including subject headings and notes fields. However, the 658 field is dedicated for describing curriculum outcomes, allowing systems to index them and make them independently searchable and displayable.

To date, the MARC 658 field has not been widely adopted. In a survey of WorldCat records, Feighan and Mitchell (2013) found that as of 1 July 2013, only 4679 records contained a 658 field (less than 0.0016%).

Adamich (2009) notes that one of the key barriers to widespread adoption of MARC-based resource alignment practices has been the lack of "standards information… which has been codified and made available in electronic form for easy access" (p21). The 658 contains two subfields that require registered codes. The $c subfield contains a curriculum code. This is not a barrier for the Australian Curriculum, which offers unique alphanumeric codes for all Content Descriptions. The $2 subfield contains a Library of Congress registered code[iii] designating the source of the specified curriculum terms or code. This subfield was a barrier to cataloguing Australian Curriculum outcomes until five Australian Curriculum and AEV codes were registered by the Library of Congress as MARC 658 source codes on 12 November 2015[iv].

## Alignment Creation

SCIS has considered three broad strategies for creating resource alignments, defined by the entity proposing the alignment: resource-driven, evaluator-driven, and metadata-driven.

Certain resources are created to address a curriculum-outcome or set of curriculum outcomes, via the efforts of the authors and/or publisher. For example, textbooks are relevant to curriculum at global levels and may constitute a course-of-study in themselves (Squires 2012). In these cases, the alignment is *resource-driven* – it can be derived from the resource itself (Adamich 2009). These resources might be referred to as being "born-aligned".

In Australia, born-aligned resources are produced by publishers including Pearson, Oxford University Press, and RIC Publications[v]. They will often include rubrics or other documentation specifying the curriculum outcomes they are designed to address, or such information may be available as an online supplement to the resource.

If alignment information is included on the resource, the alignment is easily accessible to traditional descriptive cataloguing, working from "the resources' representation of itself"[vi]. Such alignments can readily be encoded in a resource's MARC record, in either a note field or, preferably, the designated 658 field.

Resources that are not born-aligned may be serendipitously relevant to curriculum elements or element subsets, by virtue of their subject matter (Adamich 2009). Any fiction or non-fiction resource found in a school library may have broad relevance to a learning area and/or specific relevance to a subset of its granular curriculum elements, though its coverage is unlikely to be as systematic or comprehensive as a born-aligned resource. In these cases, it is not the resource itself that proposes the alignment. Rather, the alignment may be identified via the judgement of an expert or semi-expert evaluator or set of evaluators.

The nature of the evaluator/s may suggest sub-categories of *evaluator-driven alignment*, such as crowd-sourced alignment, subject-matter expert (SME) alignment, or cataloguer alignment.

Crowd-sourced alignment can be established when groups of end-users – most likely teachers or TLs – contribute alignment propositions regarding a resource which are collected and aggregated in a system according to defined business rules.

Cataloguer alignment faces barriers including constraints arising from the practices of descriptive cataloguing itself. Cataloguing practice takes descriptive information from a source other than the cataloguer (usually the resource itself), avoiding cataloguer judgements that prescribe how, who, and in what contexts a resource should be used. For example, RDA 7.7.1 stipulates that the educational level of a resource's intended audience may be recorded "if the information is stated on the resource or is readily available from another source".

Alignments generated by SMEs are likely to be robust and fit-for-purpose, but this work is intensive and potentially costly, and not necessarily viable in smaller educational settings. It is also an inefficient method for providing significant breadth of coverage of resources or curriculum outcomes. Nevertheless, it is a potentially valuable exercise in settings where there is sufficient expertise and/or specific alignment needs. For example, the Kerferd Library at Mentone Girl's Grammar School in Melbourne has been working with teachers and heads of department to establish a set of high-quality resources robustly aligned to Australian Curriculum outcomes (Feighan 2015). These alignments have been stored in the library catalogue course reserve module, although now the Library of Congress has registered the AEV codes as MARC 658 authorities, the Kerferd Library is working towards encoding alignments in the MARC 658 field.

For the NDLRN, ESA conducted SME alignment as resources were procured. The alignment metadata created by SMEs was encoded in the resource's ANZ-LOM record. This work was time-intensive and not always practical, such as when large batches of new resources were ingested. In addition, a large backlog of unaligned or poorly aligned resources severely limited the viability of retrospective alignment.

Adamich (2009) describes an evaluator-drive alignment project undertaken as part of the Ohio Department of Education's INFOhio project. In this model, "education teams" of SMEs and TLs identified candidate resources, which SMEs aligned to relevant outcomes in the Ohio Academic Content Standards. Alignments and auto-generated MARC fields (including the 658) were sent via an automatic email to teacher librarians, who modified their local library record. The TL then submitted that record to a central database, the INFOhio Curriculum Resource Catalogue, making it available to other schools. The project involved state-wide training sessions for education teams.

## Metadata-Driven Alignment

Alignment can be inferred via resource metadata, especially when this metadata is standards-based or in other ways related to curriculum objectives or curriculum objective metadata (Adamich 2009). As opposed to the more definitive evaluator-driven alignment, metadata-driven inferences can be considered as an alignment 'suggestion' along the lines of "This resource is related to the same topics as this objective". Metadata-driven alignment can be derived by systems automatically and

'on the fly', so there is no requirement to store the alignments *per se*, such as in MARC records or a dedicated database.

Like evaluator-driven alignment, metadata-driven alignment can be applied to any resource even if it is born-aligned. However, unlike evaluator-driven alignment, metadata-driven alignment can be applied in an automated fashion to backlogs of resources and new resources into perpetuity, as long as the required metadata elements are applied to the resource. Likewise, if curriculum is altered or new curriculum outcomes appear, they can be aligned to as long as the required metadata elements are applied to them.

Classroomclicks.com (Adamich 2009) was an online database of resources aligned to the California Academic Content Standards (CACS), developed by the Education Resource Services (ERS) program of the Tulare County Instructional Services Division. A team of cataloguers assigned Library of Congress Subject Headings (LCSH) to each CACS outcome. The website presents CACS in a browsable format, along with resources from the ERS catalogue that correspond to the LCSHs of the selected outcome. Adamich (2009) did not provide details of how resource headings were matched to curriculum headings, although he states that, to some extent, subject catalogue practices were geared toward ensuring sound alignment matches were produced in the system.

In NDLRN, metadata-driven alignment was considered a flexible and extensible approach, suited to accommodating a backlog of resources, active resource procurement, and an evolving curriculum. Furthermore, because ScOT concepts could be assigned to Content Descriptions in any learning area, aligned resources could be discovered in cross-curricular contexts. For example, 'Climate change' in a History curriculum objective could match with resources developed for the Science curriculum.

Resources potentially related to a given curriculum element were identified by matching on education level, learning area, and topical subjects, providing a robust tripartite model of metadata-driven alignment. Whilst exact matches could be sought on education level and learning area, matching on topical subjects involved more complex considerations.

The hierarchical relationships within the ScOT thesaurus meant that to establish an alignment it was not necessary to have direct matches between ScOT concepts in resources and curriculum outcomes: a curriculum concept may be a broader concept of a resource concept. A system could impose business rules limiting or weighting the hierarchical distance between curriculum and resource concepts. For example, parent concepts could be matched but grand-parent concepts could be rejected. This will be elaborated below, when Figure 7 is described.

## Metadata-driven Australian Curriculum Alignment for Australian School Libraries

SCIS has used ScOT for subject cataloguing since July 2006 (Salmond 2006), so it is well placed to trial metadata-driven alignment with a similar implementation to that used in NDLRN.

Whilst the various alignment approaches are not mutually exclusive, metadata-driven alignment is particularly appealing for SCIS because of the extensibility and efficiencies it offers. Processes can be automated without requiring additional manual input, and will be applied equally to existing resources and newly catalogued resources.

A metadata-driven alignment implementation in SCIS would necessarily differ from the NDLRN scenario in that year-level and learning-area metadata are not available in SCIS MARC records – only topical subjects via the ScOT vocabulary. This means that whilst the 'aboutness' of a resource and a curriculum objective may be aligned, the broad learning area and the year-level appropriateness remains dependant on user judgement.

The subject headings that enable metadata-driven alignment are encoded in and travel with the MARC record, making it available to downstream users. However, because metadata-driven alignment enables alignments to be established 'on-the-fly' it does not require that an alignment itself 'lives' in the MARC record, such as in the 658 field. This is advantageous for two reasons. Firstly, whilst school libraries may wish to encode alignments in their local MARC records, SCIS is ambivalent about prescribing educational objectives about a resource on behalf of all of its subscriber libraries, except perhaps in the case where a resource is born-aligned. Secondly, metadata-driven alignment is a fluid solution, enabling it to adapt to potential changes in curriculum, and even addition to entirely different curriculum frameworks. Alignments that are hard-coded do not possess such flexibility, are at risk of redundancy, and therefore pose a maintenance overhead.

## ScOT and the Australian Curriculum as Linked Data

Both ScOT and the Australian Curriculum are expressed as linked data, and this provides significant opportunities for SCIS and Australian school libraries.

Linked data, as envisioned by Tim Berners-Lee (2006), identifies 'things' by URIs, and these things are linked via URIs to other, related things. URIs should be resolvable HTTP URLs that are openly available and provide information about the thing. That information should be stored in and made available through standards-based formats such as RDF and SPARQL.

All structural components of the Australian Curriculum and the data relating to them are identified by URIs and published in RDF as machine-readable linked data, incorporating links to a range of Australian Education Vocabularies (AEV) (ACARA, 2015c). In the case of Content Descriptions, RDF descriptions include the identifying code and textual description and elaborations, as well as links to the ScOT vocabulary to describe topical content. Figure 4 displays the RDF representation for the same Content Description demonstrated in Figure 1, including the ScOT concepts highlighted in yellow[vii].

Australian Curriculum data is made available as RDF/XML and JSON downloads, or it can be queried dynamically through its SPARQL endpoint.

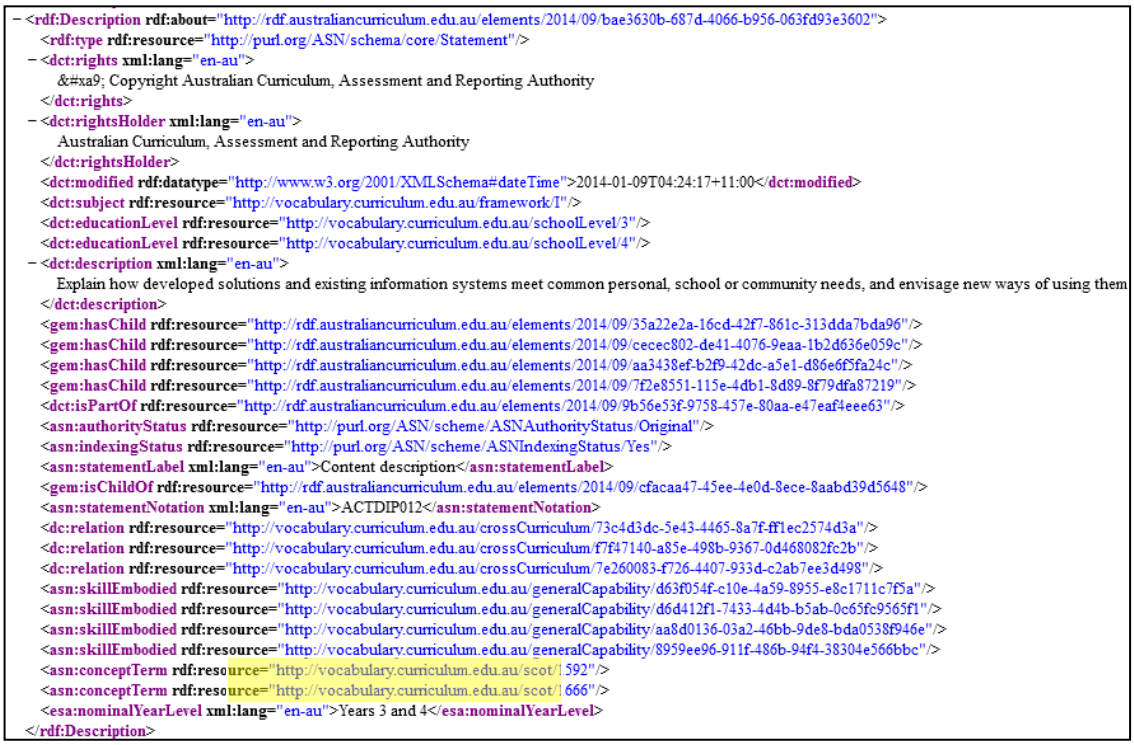


Figure 4. Machine-readable representation of Australian Curriculum Content Description ACTDIP012

Consuming linked data allows a system to integrate complex networks of links between datasets in multiple remote systems (Summers 2008), in this case a subject vocabulary (ScOT) and a curriculum framework. This has the maintenance benefit that the required data is not stored and maintained locally, but in the systems that host the authoritative version (Seeman 2015). Because of this, a SCIS metadata-driven alignment system is able to 'outsource' the process of performing matching inferences to those external systems. This can be done 'on request', so there is no need to maintain alignment data through periodic local processing. Finally, because the data and inferencing capabilities are openly available and exist outside the SCIS system, downstream users can implement this functionality in their own systems as long as they have MARC records containing URIs to enable linking.

## Identifiers in MARC records

In order to consume linked data from MARC records, URIs for linked data elements must be inserted into the MARC (Bowen 2010). MARC Discussion paper No. 2010-DP02 (Library of Congress 2009) is concerned with recording URIs for controlled values in the subfield appropriate for the value itself. The paper does not finalise the issue but accepts the need for further experimentation.

Rather than replacing textual values with URIs, some MARC fields – including the 650 Subject Added Entry-Topical Term – make provision for identifiers such as URIs to be stored in the $0 subfield[viii]. These URIs are to be accompanied by a registered parenthesised Standard Identifier source code[ix]. In the case of a URI, the source code is 'uri'. Examples of this pattern can be found in MARC Discussion Paper No. 2016-DP04.

## Matching SCIS Resources to Curriculum – A proof of concept

An implementation was devised to perform metadata-driven alignment by making use of ScOT URIs in SCIS MARC-21 records. The implementation was devised to address the following use case: A TL has a known item – either one that is already in their collection or one that they are considering acquiring – and they want to know how it can be used by teaching staff towards Australian Curriculum outcomes.

For the purpose of this project, ScOT URIs were inserted into a small set of test records. An example can be seen in Figure 5.

| | Tag | I1 | I2 | Subfield Data |
|---|---|---|---|---|
| ➔ | 028 | 4 | 2 | ‡a CLI14002000 ‡b VEA |
| | 028 | 4 | 2 | ‡a 13ICT01B |
| | 040 | | | ‡a N.S.W. ‡e rda |
| | 082 | 1 | 4 | ‡a 025.04 ‡b ONL ‡2 a15 |
| | 082 | 0 | 4 | ‡a 025.04 ‡b ONL ‡2 23 |
| | 245 | 0 | 0 | ‡a Online research skills ‡h [videorecording]. |
| | 260 | | | ‡a [Pyrmont NSW] : ‡b ClickView Pty Limited, ‡c 2014. |
| | 300 | | | ‡a 1 DVD (18 min.) : ‡b sound, colour. |
| | 336 | | | ‡a two-dimensional moving image ‡2 rdacontent |
| | 337 | | | ‡a video ‡2 rdamedia |
| | 338 | | | ‡a videodisc ‡2 rdacarrier |
| | 505 | 8 | | ‡a Contents: Tips for online research -- Assessing website credibility. |
| | 511 | 0 | | ‡a Presenter: Monica Kabissios. |
| | 520 | 8 | | ‡a Summary: Search engines are a useful tool, but how can students get the best results from them? Join the fictional Professor Doogle as she looks at skills including: selecting and searching search engines and data bases; using precise keywords; predicting expected results to assess credibility of the information, and assessing website credibility. This program helps students develop a critical approach to conducting online research. |
| | 650 | | 7 | ‡a Internet ‡x Research. ‡2 scisshl |
| | 650 | | 7 | ‡a Information skills. ‡2 scisshl |
| | 650 | | 7 | ‡a Websites ‡x Reviews. ‡2 scisshl |
| | 650 | | 7 | ‡a Internet. ‡0 (uri)http://vocabulary.curriculum.edu.au/scot/4222 ‡2 scot |
| | 650 | | 7 | ‡a Information literacy. ‡0 (uri)http://vocabulary.curriculum.edu.au/scot/7111 ‡2 scot |
| | 650 | | 7 | ‡a Information management. ‡0 (uri)http://vocabulary.curriculum.edu.au/scot/1592 ‡2 scot |
| | 650 | | 7 | ‡a Websites. ‡0 (uri)http://vocabulary.curriculum.edu.au/scot/5994 ‡2 scot |
| | 650 | | 7 | ‡a Design. ‡0 (uri)http://vocabulary.curriculum.edu.au/scot/1666 ‡2 scot |
| | 650 | | 7 | ‡a Reviews (Literary texts) ‡0 (uri)http://vocabulary.curriculum.edu.au/scot/742 ‡2 scot |
| | 700 | 1 | | ‡a Kabissios, Monica. |

Figure 5. MARC record with ScOT URIs in the 650 $0 subfield

### Webservice

A web service was developed to enable a client-side script from an external site to submit a SCIS Bibliographic ID and receive HTML content to display related Australian Curriculum outcomes. It was written in PHP and installed on the SCIS server. The web service implemented the following processing steps, as illustrated in Figure 6:

Step 1: The web service accepts a SCIS bibliographic ID (corresponding to the MARC 001 Control Number field in the SCIS Voyager system) as a URL parameter.

Steps 2 - 3: The ID is sent to SCIS's Voyager Oracle database and the corresponding MARC-21 record is returned to the SCIS server. Each ScOT URI in a MARC 6XX $0 subfield is identified and extracted.

Step 4: ScOT URIs are incorporated in a SPARQL query, which is sent to the ScOT SPARQL endpoint. The query extracts the parent concepts. See Appendix A for an example of this query.

Steps 5 - 6: The ScOT SPARQL endpoint delivers identifiers for the ScOT concepts and their parent concepts (the "full set") to the Australian Curriculum SPARQL

endpoint. The Australian Curriculum SPARQL endpoint identifies Content Descriptions that are tagged with any ScOT concepts in the full set, and returns their details to the ScOT SPARQL endpoint.

Step 7: The ScOT SPARQL endpoint packages query results in the SPARQL Results format and returns them to the SCIS server as application/XML. Results include the codes, description, and year-level of matched Content Descriptions, and the ScOT concepts and hierarchical level at which they were matched. See Appendix A for an example of these results.

Step 8: Results are parsed on the SCIS server. Content Descriptions are selected if their ScOT concepts match to more than one distinct ScOT concept in the resource. These are rendered as HTML in a JavaScript package and sent in a HTTP response to the client. This JavaScript package generates the HTML to display Australian Curriculum alignment suggestions on the client side. Because the SCIS MARC records do not include specific year-level data, the HTML includes a menu for selecting the year-level of suggested curriculum outcomes, allowing users to judge the year-level appropriateness of the curriculum objective for the resource.

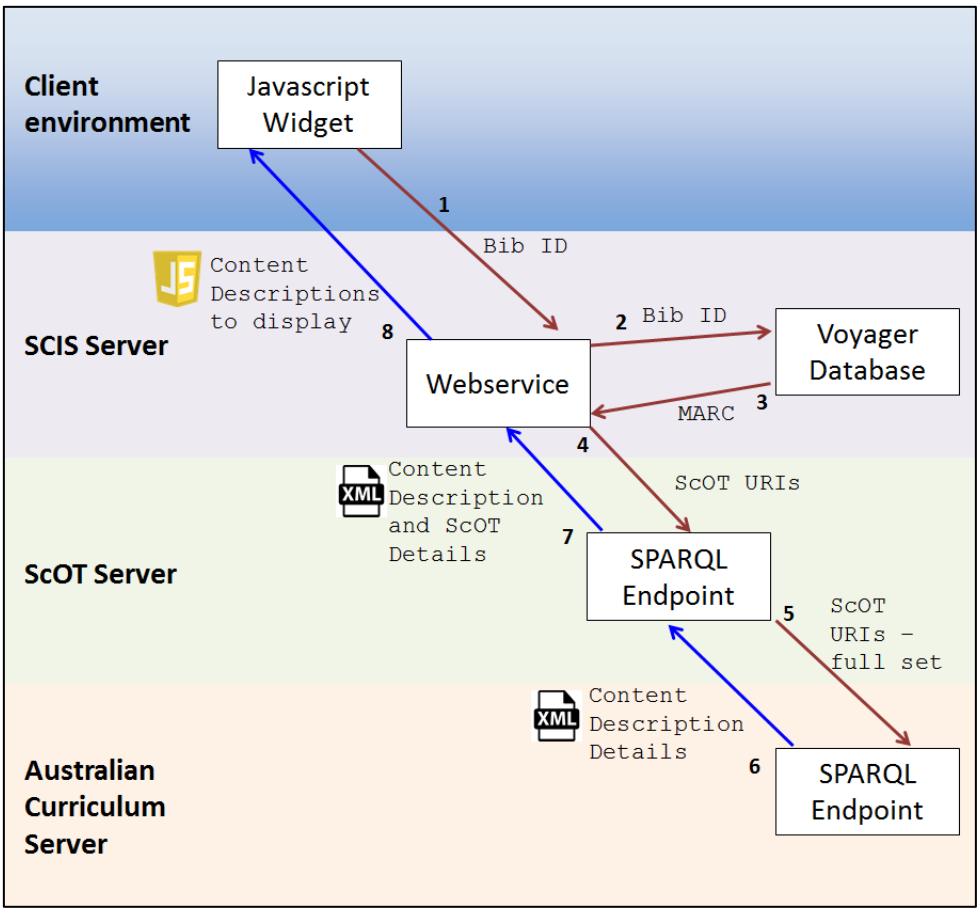


Figure 6. SCIS metadata-driven alignment Web Service implementation

The operational mechanism whereby Australian Curriculum outcomes and SCIS resources are aligned via metadata-driven alignment is illustrated in Figure 7. In summary, an alignment is suggested when at-least two of the ScOT concepts of an Australian Curriculum outcome, or the children of those concepts, match two independent ScOT concepts in the resource. In this example, the hierarchically

structured ScOT concepts are in green boxes. An Australian Curriculum outcome (red box) is tagged with the ScOT concepts labelled “Design” and “Information Management”. One resource (dark blue box) is suggested as an alignment because it is tagged with the same ScOT concepts. Another resource (light blue box) is also suggested because it is tagged with one matching concept (“Design”), and the child concept of another (“Information literacy”). This mechanism is implemented in Step 4 (extracting a resource’s parent ScOT concepts) and Step 8 (selection of Content Descriptions based on number of unique matches) above.

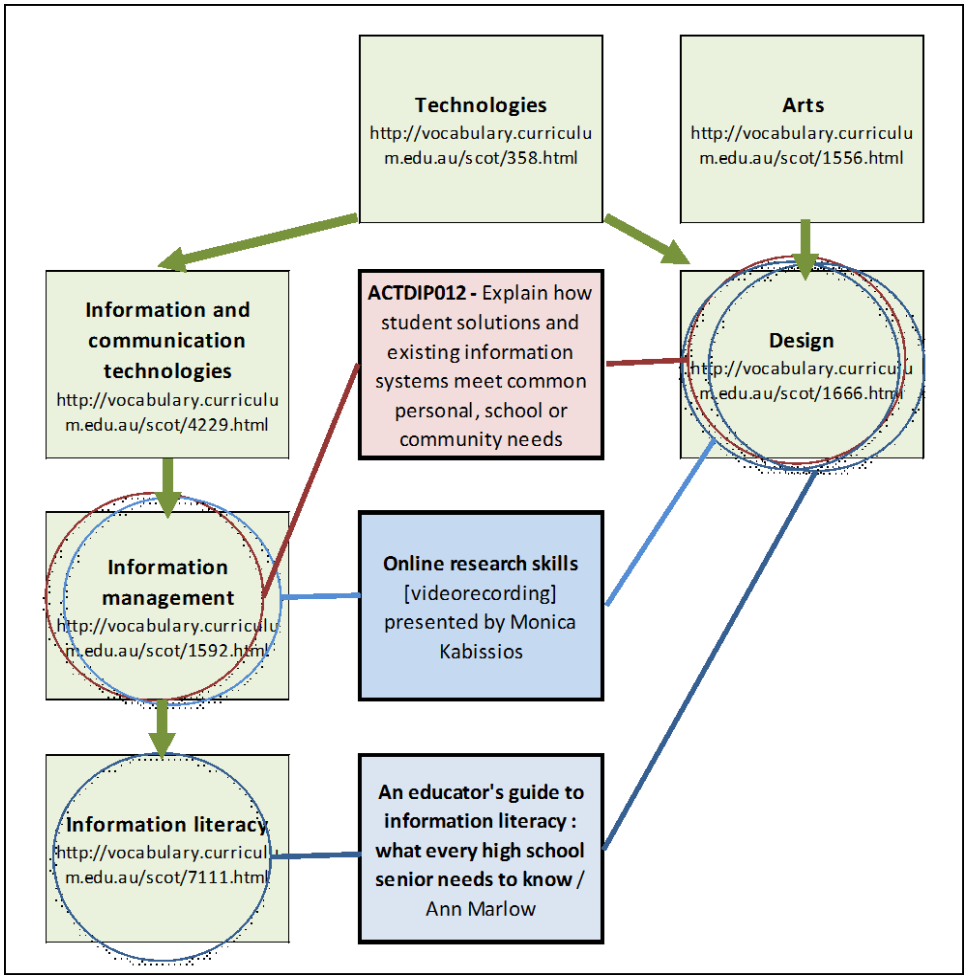


Figure 7. Aligning Resources to Curriculum using Hierarchically Structured Subject Concepts

## Widget

Two lines of JavaScript were written, enabling a “widget” to be installed on any client system. The client system is required to extract and insert the SCIS bibliographic ID as a parameter. For demonstration purposes, the widget was inserted on the SCIS OPAC (see Figure 8). The code includes a <script> element that points to the SCIS web service described earlier, and a  element to be populated by HTML to display query results.


Figure 8. Metadata-driven alignment widget on the SCIS OPAC

# Conclusions

This paper explored an avenue for enabling Australian school libraries to add value for their school communities by linking library resources to relevant outcomes from the Australian Curriculum. The solution described – metadata driven alignment – exploits linked data from the Australian Curriculum and the ScOT vocabulary to enable alignment inferences to be drawn from SCIS MARC records held in local school library catalogues. It is a demonstration of the value of including URIs for linked data vocabularies in MARC records.

In a trial implementation, ScOT URIs were inserted into a small set of resources. This enabled a widget on the ScOT OPAC to display suggestions for Australian Curriculum outcomes from a range of year levels for which the resource may be educationally relevant. The widget operated by communicating from the client environment with a SCIS web service, which in turn communicates via linked data with ScOT and, through ScOT, with the Australian Curriculum.

Further work is needed before SCIS considers inserting ScOT URIs in all records. This includes establishing the extent of alignment that might be achieved through the metadata-driven alignment methods described here, both in terms of coverage of the curriculum and resources. Secondly, some evaluation of the face-value validity and instructional value of the metadata-driven alignment results should be established.

Other possible implementations should be explored, including addressing a use-case in which a teacher or TL has an instructional need for resources aligned to a particular curriculum outcome. How might metadata-driven alignment be used to dynamically construct a list of suggested resources from the collection?

If these trials were to be implemented, a batch process of retrospectively inserting ScOT URIs into MARC records would need to be undertaken. Moving forward, this would have to be implemented as a regular, automated process.

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# Appendix A

## Sample SPARQL Query and SPARQL Results

The following query is used in the SCIS metadata-driven alignment web service described in this paper. It can be run from ScOT's AEV SPARQL endpoint (http://vocabulary.curriculum.edu.au/PoolParty/sparql/scot).

```
PREFIX asn:<http://purl.org/ASN/schema/core/>
PREFIX skos:<http://www.w3.org/2004/02/skos/core#>
PREFIX xsd:<http://www.w3.org/2001/XMLSchema#>
SELECT distinct(str(?c) as ?rootScOT) (str(?hierarchyLevel) as ?depth)
?notate ?desc (str(?year) as ?yr)
WHERE{
?c a skos:Concept .
FILTER (?c IN
(<http://vocabulary.curriculum.edu.au/scot/1666>,<http://vocabulary.curricu
lum.edu.au/scot/1592>))
{{?c skos:broader{0} ?n1 .
BIND((0) AS ?level)}
UNION{?c skos:broader{1} ?n1 .
BIND((1) AS ?level)}
BIND (xsd:integer(?level) AS ?hierarchyLevel)}
OPTIONAL {
SERVICE <http://rdf.australiancurriculum.edu.au/sparql>
 {  ?curr asn:statementLabel 'Content description'@en-AU.
?curr asn:conceptTerm ?n1.
?curr <http://purl.org/ASN/schema/core/statementNotation> ?notate.
?curr <http://purl.org/dc/terms/educationLevel> ?year.
?curr <http://purl.org/dc/terms/description> ?desc
}}
FILTER (bound(?curr))
} ORDER BY ?curr
```

The query can also be run directly via the following URL:

```
http://vocabulary.curriculum.edu.au/PoolParty/sparql/scot?query=PREFIX%20as
n%3A%3Chttp%3A%2F%2Fpurl.org%2FASN%2Fschema%2Fcore%2F%3E%20%0APREFIX%20skos
%3A%3Chttp%3A%2F%2Fwww.w3.org%2F2004%2F02%2Fskos%2Fcore%23%3E%20%0APREFIX%2
0xsd%3A%3Chttp%3A%2F%2Fwww.w3.org%2F2001%2FXMLSchema%23%3E%20%0ASELECT%20di
stinct(str(%3Fc)%20as%20%3FrootScOT)%20(str(%3FhierarchyLevel)%20as%20%3Fde
pth)%20%3Fnotate%20%3Fdesc%20(str(%3Fyear)%20as%20%3Fyr)%0AWHERE%7B%20%0A%3
Fc%20a%20skos%3AConcept%20.%20%0AFILTER%20(%3Fc%20IN%20(<http://vocabulary.
curriculum.edu.au/scot/1666>,<http://vocabulary.curriculum.edu.au/scot/1592
>))%20%0A%7B%7B%3Fc%20skos%3Abroader%7B0%7D%20%3Fn1%20.%20%0ABIND((0)%20AS%
20%3Flevel)%7D%20%0AUNION%7B%3Fc%20skos%3Abroader%7B1%7D%20%3Fn1%20.%20%0AB
IND((1)%20AS%20%3Flevel)%7D%20%0ABIND%20(xsd%3Ainteger(%3Flevel)%20AS%20%3F
hierarchyLevel)%7D%20%0AOPTIONAL%20%7B%20%0ASERVICE%20%3Chttp%3A%2F%2Frdf.a
ustraliancurriculum.edu.au%2Fsparql%3E%20%0A%20%7B%20%20%3Fcurr%20asn%3Asta
tementLabel%20%27Content%20description%27%40en-
AU.%20%0A%3Fcurr%20asn%3AconceptTerm%20%3Fn1.%0A%3Fcurr%20%3Chttp%3A%2F%2Fp
url.org%2FASN%2Fschema%2Fcore%2FstatementNotation%3E%20%3Fnotate.%0A%3Fcurr
%20%3Chttp%3A%2F%2Fpurl.org%2Fdc%2Fterms%2FeducationLevel%3E%20%3Fyear.%0A%
3Fcurr%20%3Chttp%3A%2F%2Fpurl.org%2Fdc%2Fterms%2Fdescription%3E%20%3Fdesc%0
A%7D%7D%20%0AFILTER%20(bound(%3Fcurr))%20%0A%7DORDER%20BY%20%3Fcurr&format=
application/xml
```

The following is an extract from the SPARQL results delivered by ScOT's AEV SPARQL endpoint using the above query:

```
<?xml version='1.0' encoding='UTF-8'?>

<sparql xmlns='http://www.w3.org/2005/sparql-results#'>
      <head>
            <variable name='rootScOT'/>
            <variable name='depth'/>
            <variable name='notate'/>
            <variable name='desc'/>
            <variable name='yr'/>
      </head>
      <results>
            <result>
                  <binding name='desc'>
                        <literal xml:lang='en-au'>Explain how developed
solutions and existing information systems meet common personal, school or
community needs, and envisage new ways of using them</literal>
                  </binding>
                  <binding name='notate'>
                        <literal xml:lang='en-au'>ACTDIP012</literal>
                  </binding>
                  <binding name='yr'>
      <literal>http://vocabulary.curriculum.edu.au/schoolLevel/3</literal>
                  </binding>
                  <binding name='depth'>
                        <literal>0</literal>
                  </binding>
                  <binding name='rootScOT'>
      <literal>http://vocabulary.curriculum.edu.au/scot/1666</literal>
                  </binding>
            </result>
      </results>
</sparql>
```

## Endnotes

[i] http://www.loc.gov/marc/bibliographic/bd658.html

[ii] http://www.ndlrn.edu.au/about/about_landing_page.html

[iii] http://www.loc.gov/standards/sourcelist/curriculum-objective.html

[iv] https://www.loc.gov/marc/relators/tn151112src.html

[v] For example, see http://www.ricgroup.com.au/bookshtml2/6357RH/index.htm#1; ISBN 9781921750830

[vi] http://access.rdatoolkit.org/rdachp0_rda0-324.html

[vii] This can be viewed online at http://rdf.australiancurriculum.edu.au/elements/2014/09/bae3630b-687d-4066-b956-063fd93e3602.rdf

[viii] https://www.loc.gov/marc/bibliographic/bd650.html

[ix] https://www.loc.gov/standards/sourcelist/standard-identifier.html