

Report: Establishing an open catalogue for geospatial educational resources

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1. Abstract

Internationally there is a growing need for the development and cataloguing of educational resources. At present, a large number of geospatial educational resources are available through various platforms, such as Wikis, GitHub and Moodle. However, these resources are not always easy to find and to integrate into an academic module, amongst others, because the required metadata is not available. The aim of this project is to develop a catalogue for geospatial educational resources and a catalogue of existing resources that can be used by communities, such as ISPRS or GeoForAll, universities and other educational institutions. The catalogue will host educational resources (e.g. learning objectives, data, quizzes, references and terms and conditions for use) so that the resources can be searched and discovered. Based on the metadata, instructors can select appropriate educational resources for integration into an educational event, such as an online course or a module at university level. Similarly, the catalogue will provide a searchable list of existing geospatial educational resources sourced from the ISPRS and GeoForAll communities that will be categorized and describe. An open catalogue of searchable geospatial educational resources would be valuable for educators worldwide and would provide students with the opportunity to learn using local and international examples to widen their knowledge. In addition, such a catalogue would broaden access to geospatial education and empower communities for the benefit of society.

2. Aims and objectives

The aim of this project was to develop an open catalogue for geospatial educational resources that can be used by communities, such as ISPRS or GeoForAll, universities and other educational institutions. The objectives were to:

1. Identify the metadata that is needed to be able to search and discover appropriate educational resources;
2. Design a catalogue of geospatial educational resources; and
 - a) identify the requirements for such a catalogue;
 - b) Identify and evaluate applications for hosting of the catalogue against the requirements; and
 - c) develop and describe three sample resources (e.g. on urban data visualization, internet of things and spatial data infrastructures) using the metadata identified in (1) and add them to repositories in the identified platforms
3. Implement a catalogue of geospatial educational resources
 - a) identify geospatial educational resources to be added to the catalogue; and
 - b) implement a catalogue for indexing the resources and describe each using the metadata identified in (1).

3. Associated activities and outcomes

The activities and outcomes achieved over the last 12 months will be discussed according to the objectives (refer to Section 2).

Objective 1: Identify the metadata that is needed to be able to search and discover appropriate educational resources

The reuse of educational resources is only possible when accurate and descriptive metadata is available (Roy et al 2010). The process of creating metadata can be very tedious and time consuming but is essential for sharing and reuse of educational resources. The metadata allows instructors and students to search or discover the most appropriate and well-suited educational resources possible.

For this project, we investigated the suitability of two well-known metadata schemas, namely Dublin Core (ISO 2009) and IEEE Standard for Learning Object Metadata (IEEE 2002), for describing the geospatial educational resources. The Dublin Core Metadata Element Set (DCMES) contains 15 well defined elements for describing the “core” properties of digital and physical objects. However, the DCMES does not contain any elements that can be used for describing the pedagogical information of educational resources (Roy et al 2010). The IEEE Learning Object Model (LOM) consists of 60 optional elements that can be used to describe learning objects. The elements can be combined in various manners to beset describe the pedagogical intent of an educational resource. This flexibility is important as the IEEE LOM can be too complex for novice catalogues. Mechanisms for converting between Dublin Core and IEEE LOM does exist, but the aggregation and disaggregation of the metadata fields can affect the usefulness of the resulting metadata.

After the review of Dublin Core and IEEE LOM, we decided to not use either standard as is, but to develop our own profile of IEEE LOM. This was done by annotating various educational resources and reviewing how the elements selected would contribute to the searchability of the educational resources in a catalogue.

We decided to use the following IEEE LOM elements in our catalogue:

- | | |
|------------------|--|
| 1. General | 3.1. Interactivity type |
| 1.1. Identifier | 3.2. Learning resource type |
| 1.2. Catalog | 3.3. Interactivity level |
| 1.3. Entry | 3.4. Semantic density |
| 1.4. Title | 3.5. Intended end user role |
| 1.5. Language | 3.6. Context |
| 1.6. Description | 3.7. Difficulty |
| 1.7. Keywords | 3.8. Typical learning time |
| 1.8. Coverage | 3.9. Rights |
| 2. Life Cycle | 3.10. Cost |
| 2.1. Version | 3.11. Copyright and other restrictions |
| 2.2. Status | 3.12. Description |
| 2.3. Contribute | 4. Technical |
| 2.4. Role | 4.1. Location |
| 2.5. Entry | |
| 2.6. Date | |
| 3. Educational | |

The profile consists of only 27 metadata elements from the 60 elements that are available within the IEEE LOM standard. As the implementation progresses, we might add or remove some elements to ensure that it is easy and fast for contributors to add their material to the repository. Below is an example of how a educational resource can be described using the profile (refer to Table 1).

Table 1: Example metadata for an educational resource

Metadata element	Value
1. General	
1.1. Identifier	101
1.2. Catalog	URI
1.3. Entry	Not available
1.4. Title	Multiple Criteria Evaluation in Allocating Land for Waste Incineration
1.5. Language	English
1.6. Description	This tutorial instructs a user in basic multi-objective decision making using a variety of Open Source software: GRASS GIS, Quantum GIS and OpenOffice Calc. With it they will be able to import vector and raster data, convert vectors to raster and use map algebra to produce a land allocation map according to the factors and constraints set up by the project
1.7. Keywords	GRASS GIS; QGIS; OpenOffice Calc; Multiple Criteria Evaluation; Suitable site analysis; Land use
1.8. Coverage	Multiple Criteria Evaluation
2. Life Cycle	
2.1. Version	1
2.2. Status	Final
2.3. Contribute	
2.4. Role	Author
2.5. Entry	Ja'far Rogers
2.6. Date	2010
3. Educational	
3.1. Interactivity type	Mixed document
3.2. Learning resource type	Tutorials

3.3.	Interactivity level	Medium
3.4.	Semantic density	Medium
3.5.	Intended end user role	Learner
3.6.	Context	Higher education
3.7.	Difficulty	Easy
3.8.	Typical learning time	120 minutes
3.9.	Rights	
3.10.	Cost	
3.11.	Copyright and other restrictions	Public domain
3.12.	Description	The tutorial is available on a wiki and can be used and improve by anyone.
4. Technical		
4.1.	Location	https://gracilis.carleton.ca/CUOSGwiki/index.php/Multiple_Criteria_Evaluation_in_Allocating_Land_for_Waste_Incineration

Objective 2: Develop a catalogue for geospatial educational resources

2.1. Identify the requirements for such a repository

The successful creation or selection of a catalogue depend on the requirements of the educators, designers and learners. Requirements were specified based on our needs as educators to find educational material.

The requirements for the catalogue are as follows:

1. The application used for the catalogue:
 - 1.1. Open source is preferred as long-term funding is not available
 - 1.2. Should be accessible on all platforms
 - 1.3. Should allow the administrator to specify a metadata schema profile
 - 1.4. The application can be self-hosted or cloud based
2. The user should be able to:
 - 2.1. Add resource with descriptive metadata into the catalogue
 - 2.2. Request resource to be deleted (would depend on reason and administrative approval)
 - 2.3. Update the metadata available in the catalogue for a specific resource
 - 2.4. List all resources under a specific theme
 - 2.5. Search resources based on metadata elements
3. The administrator should be able to:
 - 3.1. Perform all functionality allowed by the user
 - 3.2. Manage registered users
 - 3.3. Approve the metadata for a resource once the metadata is added by a user
 - 3.4. Delete the metadata for a resource if requested by a user

2.2. Identify and evaluate applications for hosting of the catalogue against the requirements

An extensive search for possible application that can be used for the catalogue was done. Numerous applications were identified during the initial search. However, on closer inspection only six application were selected to be evaluated against the requirements identified. The following applications were evaluated:

- Islandora (<https://islandora.ca>)
Islandora is an open source repository that allows institutions to collaboratively manage, discover digital objects. Islandora is based on Drupal, Fedora and Solr. Example video from our

implementation is available here, https://youtu.be/QEYPnEZp_TQ From the video you can see that when the user browse resources they cannot see the detailed metadata for a specific resource. This is a limitation of Islandora.

- EPrints (<https://www.eprints.org>)
EPrints is a generic institutional repository building software that is intended to create highly configurable web-based repositories. EPrints is able to build repositories that can be configured to meet the particular requirements of a project.
- AtoM (<https://www.accesstomemory.org/en/>)
AtoM is an open source archival description application. AtoM allows users to tag files and describe the objects using metadata standards built-in to the repository.
- Zenodo (<https://zenodo.org>)
Zenodo is an open access repository popular with researchers for achieving and preserving their datasets, software, reports and other digital artifacts. An attractive feature is that each submission is assigned a DOI.
- DSpace (<http://dspace.org/introducing>)
DSpace is an open source “out of the box” repository that allows institutions to preserve all types of digital content, including text, moving images, mpegs and datasets. The files or object and metadata is stored in a relational database and supports the use of PostgreSQL and ORACLE databases.
- GeoNetwork (<https://geonetwork-opensource.org>)
GeoNetwork is specifically for geospatial data but was also evaluated as it has functionalities for storing metadata for documents in Dublin Core. Additionally, the added functionality would also allow educators to share datasets linked to an educational resource.

Although all of the evaluated applications had useful characteristics, two requirements were not fulfilled in any of these: the implementation of a profile of IEEE LOM; and creating a metadata record without the need to upload a file. Strictly speaking, the majority of these applications are implementations for a repository (a place where things are deposited or stored) and not of a catalogue (a list of descriptions of things).

The evaluation revealed that implementing the catalogue using new web application technologies, such as Google Firebase and React, would be easier than adapting existing applications to suit our requirements. See Section 4 for more detail.

2.3. Develop and describe three sample resources (e.g. on urban data visualization, internet of things and spatial data infrastructures) using the metadata identified in (1) and add them to repositories in the identified platforms

The majority of the first 12 month of the project was spent on the first two tasks under this objective. The development of sample resources has started and should be complete within the first part of 2019. However, various other resources that are available online (150+ to date) have been captured and annotated according to the metadata elements identified in Objective 1. Once the catalogue is implemented these records will be catalogued.

Objective 3: Implement a catalogue of geospatial educational resources

3.1. Identify geospatial educational resources to be added to the catalogue

Over the past 12 months, we searched the internet for geospatial educational resource and found over 150 resources that will be added to the catalogue once ready.

3.2. Implement a catalogue for indexing the resources and describe each using the metadata identified in Objective 1

As discussed in Objective 2, we found that most open source application available are actually for repositories and do not fulfil the requirements for the catalogue. In the next section, we will discuss our plan to implement a custom catalogue.

4. Implementation of a catalogue

The pilot catalogue is available at <https://isprs.education/> and the code can be accessed at https://github.com/vrautenbach/isprs_catalogue

For the backend of the catalogue, we decided to use Google Firebase. Firebase is a cloud-based NoSQL database that allows developers to quickly setup a backend for any web application. Additionally, Firebase provides other advantages, such as real-time database, a machine learning kit and performance monitoring. Each resource is stored in Firebase as a JSON objects with its various fields or attributes (Rautenbach et al 2019).

The front end or user interface of the catalogue was developed using JavaScript and specifically the React library. React is a very popular JavaScript library for creating user interfaces at the moment and allows the developer to break the interface up into components that can be updated without updating the entire page. Additionally, React JS also allows us to create responsive interfaces that automatically adjust to the resolution of device it is viewed on.

We have not yet worked on the usability and design of the interface of the catalogue, this would be in the final stages of the development process. Currently the landing page of the catalogue is a list of all the resources with an option to add a new resource or do a quick search based on the keywords. Refer to Figure 2. To list all the resources, the title, description, date, authors and keywords for all the resources are pulled from the Firebase database. The JSON objects returned is then used for the quick search using basic JavaScript functionalities. For the more advance search, the user would be able to search on all field using a Google like search or specifying specific fields. For example, retrieving all exercises (i.e. learning resource type) aimed at higher education (i.e. context).

To add a new resource, the user would need to complete a form with various field linked to the metadata elements in Table 1. Where the list of options was predefined by the standard, the user can make use of the dropdown boxes to select the most appropriate option. Refer to Figure 3. However, some of the predefined options in the standard is not that self-explanatory and the user would need assistance to complete these. To address this, we are planning to add tooltips for the fields that provide the user with a short explanation of what information is required. Once the resource is added, it can be viewed, updated and deleted. At the moment, we have not yet implemented the user restrictions, but this is the next phase and will be implemented shortly.

5. Next steps:

A workshop at the ISPRS Congress in 202 will be arranged. During this workshop, the metadata elements selected will be discussed with the community to improve the overall usability of the catalogue. At the moment, some of the elements might not be very self-explanatory and would be a barrier for use. Additionally, the workshop will be used to plan the future and next phase of the catalogue.

5. Project expenses:

The total grant received from the ISPRS for this project was CHF 8 000.00. As mentioned, some of the activities will continue in 2019, and the remaining budget will be used for these.

The following is a breakdown of the project expenses in 2018:

ISPRS WG IV Midterm Symposia	CHF 700
Research assistant	CHF 2 000

The planned expenses for 2019 is as follows:

ISPRS GeoSpatial week	CHF 700
Research assistant	CHF 4 600

References:

IEEE 1484.12.1-2002 (2002) IEEE Standard for Learning Object Metadata, available online at https://standards.ieee.org/standard/1484_12_1-2002.html

ISO 15836-1:2009 (2009) Information and documentation -- The Dublin Core metadata element set -- Part 1: Core elements, International Organization for Standardisation (ISO), Geneva, Switzerland.

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