Mapping the e-Learning Assessment Domain: Concept Maps for Orientation and Navigation

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Abstract: Concept or Topic Maps have long been used as a method of categorizing and organizing information about a domain. Building them can help people conceptualize an area and spot trends or gaps, and as a presentation method they quickly provide an overview and general impression of a space. We are currently constructing a Reference Model of the Assessment Domain that takes the form of a highly interlinked dynamic website. This represents the assessment domain via the software, projects, standards and use cases of which it is composed. In this paper we present our efforts to create complimentary concept maps of the assessment domain, not as an overview, but for navigation and orientation within the domain. These concept maps, which model resources and activities independently, have been corroborated with practitioners in the e-learning community.

Introduction

It is possible to characterize the e-learning area in terms of a number of domains that group related activities, such as managing e-portfolios or constructing learning content. The assessment domain is one of the most mature of these in terms of software and standards. Numerous commercial and academic tools are available supporting a wide range of assessment activities, from assembling and running tests or exams to managing feedback and detecting plagiarism.

This raises problems when it comes to building new tools and creating new standards for the domain, as these must be correctly situated with existing work if they are to be successful. This problem is increasingly important in the world of Service-Oriented Architecture (SOA), as new services only become effective when they extend or support existing services.

In this paper we are specifically interested in the *e-learning assessment domain*, by which we mean the part of the broader assessment domain that can be supported in some way by e-learning tools (as opposed to e-assessment, which can be interpreted more narrowly). We describe how we have turned to concept maps to help us model the e-learning assessment domain in such a way that people building services for it can place their work in the map, and see what other work is associated with the same concepts. Such a model has its emphasis on orientation and navigation rather than a complete overview.

Motivation

In the UK the Joint Information Systems Committee (JISC)[1] is financed by all the Further and Higher education funding councils within the county and is responsible for providing advice and guidance on the use of Information and Communications Technology (ICT) for learning and teaching. Part of their strategy is the development of a SOA framework for e-learning [Wilson, *et al*, 2004, Oliver 2005]. The Framework is based on a service-oriented factoring of a set of distributed core services [Smythe, *et al*, 2004], where flexible granular functional components expose service behaviours accessible to other applications via loosely coupled standards-based interfaces. The technology used is Web Services and the intention is to extend the SOA programming model into a vast networking platform that allows the publication, deployment, and discovery service applications on Internet scale.

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[1] Joint Information Systems Committee, www.jisc.ac.uk

To tackle the problem of creating services for such an ambitious network JISC have funded several projects to create Reference Models for a number of domains. Reference Models are community resources that act as a single point of information on what resources already exist for the domain, what services have been written, what standards they use, and how they fit into use cases. The idea is that users can discover what existing activity is going on in the area that they are interested in and create new software and standards that are complimentary. Wilson *et al.* (2004b) describes the relationships between frameworks, reference models, designs, and artefacts. They describe a common situation in which '*a Framework is used to derive a Reference Model, which is used in a particular Design which then results in an Artefact, such as a piece of delivered software*'.

Conole and Warburton (2005) have recently presented a detailed review of the issues facing computer assisted assessment, and conclude by saying *"The role of technology and how it might impact on assessment is still in its infancy and we need to develop new models for exploring this"*. Reference models can be thought of as partially filling this need.

We are involved in the FREMA (Framework Reference Model for Assessment) project that aims at creating a Reference Model for the Assessment Domain and delivering it via a heavily interlinked web site. Because the resulting network of resources (standards, projects, people, organisations, software, services and use cases) is so complex we require a method of providing users with a structured navigational method that does not require them knowing up front what they want to find. This led us to look at how overviews of e-learning domains have been handled previously, and work towards our own concept maps, that plot the topology of the domain.

Background
The e-learning assessment domain has been classified in a number of ways in the past. For instance Bull and McKenna (2004) classify it into four broad categories based on purpose (summative, formative, diagnostic and self-assessment) backed up by a number of taxonomies. JISC themselves have developed a simple map of the assessment domain, using a single test as the connecting thread [Kassam Stadium, 2004].

There is a move in learning and teaching to use learning outcomes as a method to define what is to be taught and therefore what is to be assessed. The skill levels defined in the learning outcomes and assessment are often set against Blooms (1956) taxonomy of learning objectives. Chang *et al* (2004) have developed an assessment metadata model (taxonomy) to aid teachers in authoring examinations, which explicitly models the cognition aspect of assessment in addition to the types of questions.

The e-learning domain is underpinned and sometime driven by the use of technology. Sclater and Howie (2003) have defined the requirements for the 'Ultimate' assessment engine. In presenting these requirements they view the assessment domain from the perspective of the roles people have in the assessment process and how they interact with the resources.

In terms of the information structures used to model the domain it is useful to clarify our terms. Perhaps the most generic way of thinking about related information is to talk about an ontology. Ontology is the study of existence, and *an* ontology is a particular understanding of existence. In Artificial Intelligence this rather grand definition is concretized into an abstract semantic graph, where there are rules that determine what types of relationship can exist between what types of node (thus limiting how reality can be modeled, and thus understood). The semantic graph itself is analogous with a Topic Map (although topic maps lack the underlying ontological rules, and are typically displayed graphically). The overviews described above are either Concept Maps or Taxonomies, which are both particular kinds of Topic Map. Concept maps are essentially Topic Maps that are intended for human viewing, as such they often have simpler metadata, and implicit meaning in their layout. Taxonomies can be thought of as a ordered topic map based on an implicit ontology dealing with classification (with the restriction that no subclass can have more than one superclass in the same taxonomy).

These different models are suitable for different types of overview. Ontologies are good for defining explicitly what is understood to exist in a domain and how those things relate to one another. Topic maps represent the instances of a domain without losing the richness of their connectedness and are thus useful for complete overviews. Concept maps reduce the information displayed and are thus useful for simplified overviews and orientation. Finally, Taxonomies enforce a particular breakdown of a domain that is useful for clean categorization, but which cannot model ambiguity very well.

Navigating the Reference Model

For the FREMA Assessment Reference Model we wanted to use a structure for the domain that could be used by human users of the model to orientate themselves and navigate around the resources. While the underlying resource types are modeled using an ontology we didn't want to expose users to this complexity, we also wanted to avoid the rigidity of a taxonomy. So we chose to create concept maps that described the domain in familiar terms, but which were not explicitly typed or restricted. Every resource in the reference model is associated with at least one concept. Users of the reference model can explore the maps and click through the concepts to the resources that are associated below.

In several consultation activities we visited potential reference model users at community events within the UK in an effort to extract common terms and perspectives on the assessment domain. Our initial efforts at creating an overview map were a little too complex to be universally understood. We therefore broke down this map over several workshops in an effort to extract a simplified view of the domain. The result was a map of resource types that are considered important within the assessment domain, and another concept map of the common processes. We refer to the resource types version as the Noun Map, and the processes version as the Verb Map.

Noun Map

The FREMA Noun Map of the Assessment Domain shows all the resource types that seem to be relevant to e-learning assessment according to the members of the e-learning community. Figure 1 shows the Noun Concept Map.

The Noun Map draws heavily from the Ultimate Assessment Engine in that it contains stakeholders and roles [Sclater and Howie, 2003], however because it does not show workflow it does not connect these, or associate them with the types of resources they manipulate. The Noun Map is intended to allow users who deal with specific types of resources to find those resources in the map and discover what other resource types might be relevant.

Verb Map

The FREMA Verb Map of the Assessment Domain shows all the activities that seem to be important in e-learning assessment according to the members of the e-learning community. Figure 2 shows the Verb Map.

The verb map shows what people do, but it does not group these activities according to any stakeholders, or relate them to any notion of resource types. There is an implicit clockwise order that follows a common view of how assessments are constructed and executed. The Verb Map is intended to allow people who are interested in a particular activity to find that process, and thus the resources underneath, and also find what other processes are related.

Feedback and Future Work

We have received positive feedback from the community in terms of the coverage of our concept maps, however the noun and verb maps are works in progress, and it is expected that they will be extended and refined through feedback from the e-assessment community and the experience of the FREMA project. We are aware of certain areas where changes are anticipated. For example, an assessment is in respect of a certain subject matter or content area and is oriented towards certain intended learning outcomes. This pedagogic context, highlighted in the work of Chang *et al* (2004), probably requires greater recognition in the maps. Also in a number of subject areas, objective testing is highly developed, and issues of the reliability and validity of the assessment are of considerable concern. These issues probably require detailed extension of the "usage data" regions of the maps.

There are areas of extension and refinement which may be expected from feedback from communities outside higher and further education. Professional training, for example, has a greater emphasis on practical skills and hence of subject mastery. Commercial training may have a series of follow-up assessments of effectiveness and Cost-benefit analyses of training provision are particularly relevant in industries where skilled performance involves hazardous or expensive materials or processes.
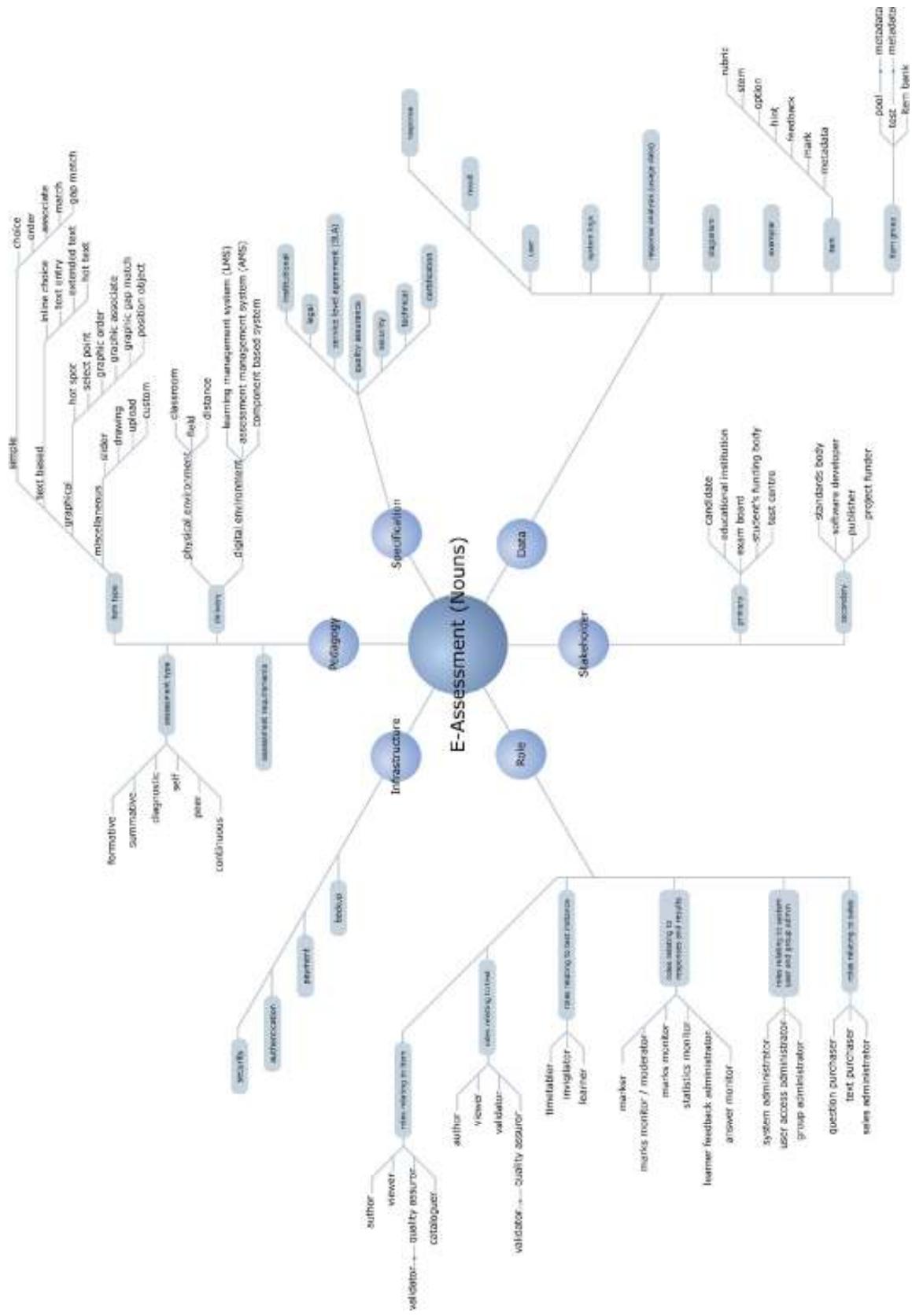
Figure 1: FREMA Noun Concept Map
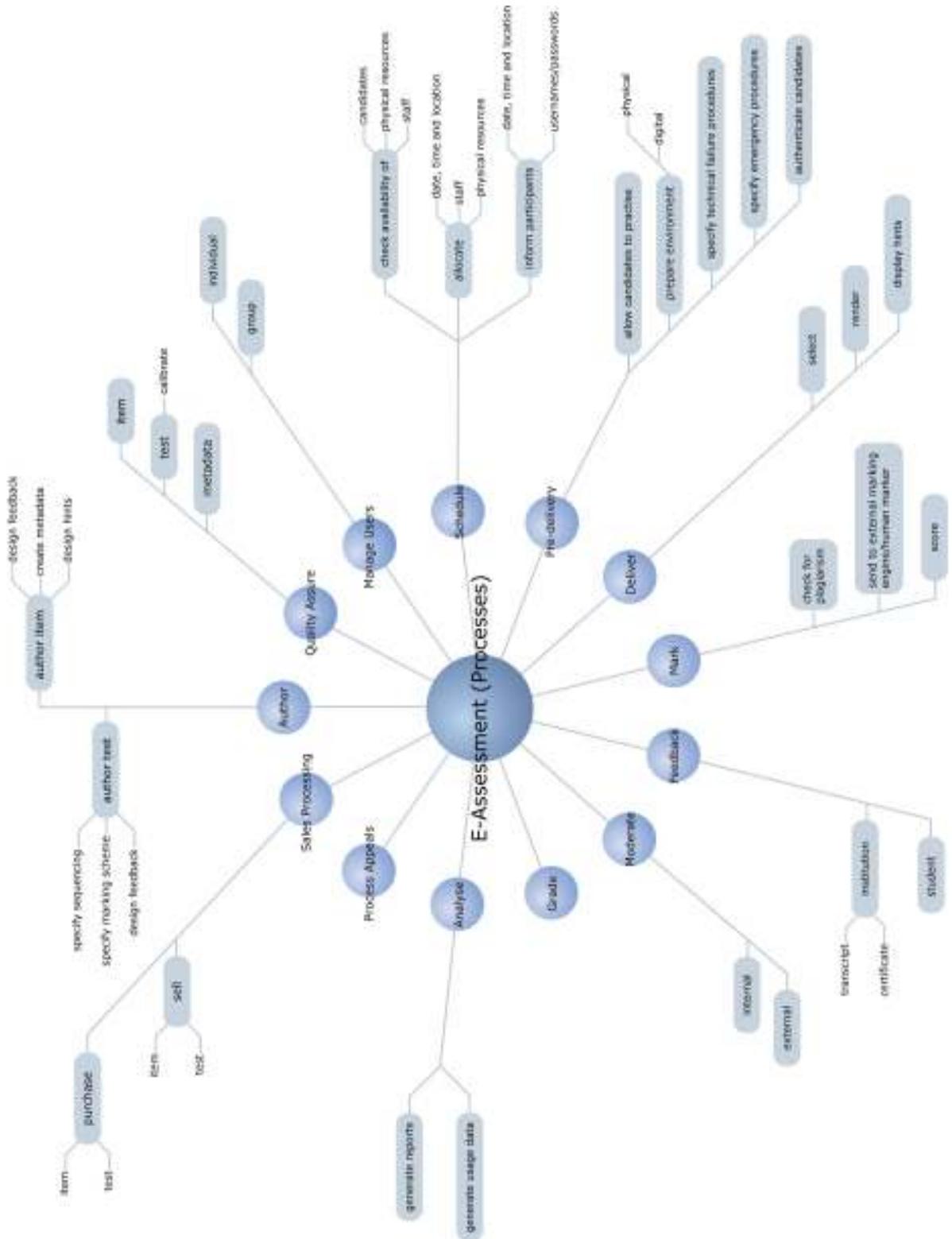
Figure 2: Verb Map

Conclusions

In this paper we have briefly described some of the methods of providing overviews of the e-learning domain, in particular in the context of support Reference Models for emerging Service-Oriented frameworks. We have described some of the affordances of the different information structures, including ontologies, taxonomies, and topic and concept maps. Finally we have presented the concept maps that we have produced as a result of consulting with the e-learning community, which model resource types and activities independently. Both maps are currently being built onto the front end of the FREMA reference model and either may be used to drill down to the items in the reference model below.

Despite some of the limitations that we have mentioned above, we believe that these maps are relatively exhaustive and that any work that might be classified as belonging to the e-learning assessment domain could be located on the maps. The limitations mostly come in terms of granularity, or the ease with which users searching for a topic will find it on the map. Once we have a prototype reference model, we will look specifically as how effectively users navigate whilst using the maps. From community reaction so far, we believe that while we have managed the scope rather well, the current division of nouns and verbs might not be particularly natural for everyone. At the same time we need to avoid the confusion of our original mixed map. One way forward may be to combine the maps in a very controlled way, for example by associating stakeholders with activities and activities with resources. Our concept maps are also very similar to taxonomies in structure, and it may be that we need to take more advantage of the flexibility offered by the concept map structure. Combining our maps may create cycles in our graph structure, but since we are not building a strict taxonomy this will only be a problem if it disorientates users.

In any complex domain where disparate people are required to work together to achieve a common aim it can be helpful to provide a mechanism for overview. Once people delve into more specific areas then this becomes a need to support navigation and orientation. We believe that while a complex domain itself may be best modeled with an ontology or a topic map, the overview is best presented as a concept map. In this paper we have presented two complimentary concept maps of the assessment domain that we intend to use with the FREMA reference model for Assessment. On the FREMA website we will use these concepts maps to help users discover resources, orientate themselves within the domain and discover new areas that might also be of interest.

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