



# **Learning Standard Alignment in the SLC Technology: A Whitepaper**

**SLC Project Document**

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## Change Log

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## 1. Introduction

This document is part of a series of documents that describe aspects of the technology developed or used by the Shared Learning Collaborative (SLC). It is intended to be used by state and local education agency staffs, who are involved in implementing technology solutions and integrating with the SLC Datastore, to serve as a preview of anticipated functionality of the SLC technology and related components, and as a guide to understanding the content-oriented technological components from the SLC. This shared technology infrastructure will help educators provide personalized learning to their students. As of March 2012, some aspects of the solution are still under active research and development; implementation details are subject to change prior to release of the SLC's shared technology infrastructure.

### 1.1. Document Structure

This document is divided into five sections:

- **The Case for Standards Alignment** – Explains the benefits of alignment to educational standards, from the perspectives of different stakeholders.
- **Content-Related Data Requirements** – Contains information about metadata used to align content with Learning Standards, and data that Content Providers and Education Organizations need to make available in order to enable the identified use cases.
- **The SLC's Learning Standard Alignment Technology** – Describes the major components or processes of the SLC Solution which enable the use cases listed in the previous section.
- **Glossary of Terms** – Defines domain-specific terms as they are used throughout this document.
- **References** – Provides links to additional, supporting information for topics which require further detail. These references go to greater depth in describing or specifying various systems and components, and are generally considered to be authoritative.

## 2. The Case for Learning Standards Alignment

Alignment of educational resources and data to defined, emerging curriculum standards is the first step for delivering personalized learning. When student achievement goals are mapped against a set of standard, prescribed learning objectives which allow flexibility for applying different progressions and approaches, it becomes much easier for educators to determine student progress and identify specific areas in which students require additional support.

Learning resources are available from a large number of sources, with each item differing in applicability and quality. But when these resources are aligned with standards, teachers can more easily solve the problem of finding appropriate resources in ways that reduce administrative burden, while increasing the quality and result-oriented impact of materials provided to individual students.

### 2.1. Standards Alignment for Teachers

States and districts create and adopt learning standards to set clear goals for what their students must know and be able to do in core subject areas to fulfill locally defined expectations. The Common Core State Standards, now adopted by all but 5 states, reflect common priorities for what students should know and be able to do in Math and English Language Arts, to be college- and career-ready.

State standards, especially the Common Core, set out goals for student learning; but it is up to states, districts and educators to implement effective curriculum, instruction and assessment strategies to support students in meeting those goals. The SLC's Learning Map tools, discussed in Section 4.2, support curriculum teams and teachers in defining their approaches to standards fulfillment, by allowing them to define the sequence of instruction based on learning standards.

Once an educator, using a Learning Map, identifies one or more learning objectives for which to develop a lesson plan, he or she must assemble materials appropriate to that task, and which fulfill class and individual student needs. Learning standard alignment is one of the most important differentiators of educational content. The SLC's Learning Registry Index and associated tools discussed in Section 4.1 assist teachers in quickly locating the most appropriate learning standard-aligned materials and assessments, of the many that are available to them.

### 2.2. Standards Alignment for Students

As available student achievement data becomes increasingly standard-aligned, opportunities for students and their parents or guardians to participate in the direction of the personalized learning experience also increase. States and

school districts will be able to grant access to relevant data and tools made available through the SLC technology to students and their parents. This participatory involvement will allow analysis of objective progress, independent search for useful and engaging materials, and the ability to take an overall more active role in understanding and suggesting remediation and supplementary activities when the need arises.

### **2.3. Standards Alignment for Content Producers and Managers**

To ensure that the large quantity of educational resources available from content publishers, state and district content managers, and others charged with producing or providing resources reaches the right users, it is important that the resources are described and advertised using technologies that allow them to be targeted at the right audience, and are made accessible and easily identified as being appropriate and valuable to categories of target users. This is accomplished by content providers “tagging” the resource to create resource descriptions, and submitting these descriptions to search indexes that educators and students will use to find them.

The major benefit of properly tagging and advertising the availability and applicability of learning, teaching and assessing materials, is that it will be easier for educators to identify the best-suited materials for specific students by using targeted searches, as in the educator and student use cases above.

The process of tagging resources is made easier through the use of the SLC’s Content Tagging Utility, described in more detail in Section 4.1.2.

### 3. Content-Related Data Requirements

The applications and scenarios identified in the preceding sections can only be realized if the underlying data models support collection of the necessary data and relationships. The SLC is using and designing such models, which standardize the types of data required, how they are stored, so that they may be presented via applications in a consistent manner. It is also critical that the requisite student and resource data is made available to the SLC Datastore from state and local source systems.

In this section, we describe the specifications that provide standard-alignment of student achievement and learning resources, as well as the standard-aligned data that must be present for the previously described features and applications to function as designed.

#### 3.1. Content Metadata Standards

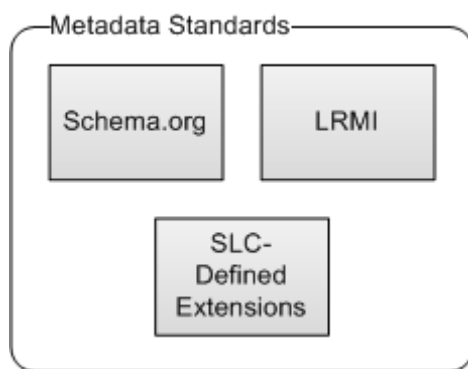


Figure 1: Metadata Standards

For learning resources to be discovered based on standards alignment, they must previously have been “tagged” with metadata, including information which indicates the learning standards and objectives to which they are aligned.

The SLC is working in parallel with other important efforts, including LRMI, to ensure metadata standards are in place that allow the vision of standard-aligned educational content to be achieved in a consistent manner across all applications and uses.

##### 3.1.1. LRMI Metadata

The Learning Resources Metadata Initiative (LRMI) is an organization chartered with defining a vocabulary used to describe the specific properties of educational resources that make them unique from other types of content. These so-called *metadata* terms are extensions to the Schema.org namespace, meaning that they are compatible with the web page markup syntax understood by search engines, but they can also be used in resource descriptions distributed through the Learning Registry.

As of March 2012, the latest draft of the LRMI specification introduces a number of important properties, or “tags”, that are used to describe aspects of education-oriented material that can be used to search for content that meets specific requirements:



- **intendedEndUserRole** – Who the content is intended to be used by (e.g. student or teacher).
- **competency** – The learning objective or standard to which the content is aligned. It contains a reference to the **standard** (as a URL), and also the **alignmentType**, or relationship between the content and the standard. Examples of alignmentType include “assesses”, “teaches”, and “requires”, used to designate that the material assesses competency in the given standard, that it consists of materials used to teach the standard, or requires competency in the standard skill in order to make use of the material, respectively.
- **educationalUse** – How the content is intended to be used.
- **timeRequired** – The amount of time a typical user would be expected to take, to complete usage of the content.
- **typicalAgeRange** – For materials intended to be used by students, the age range of anticipated users.
- **interactivityType** – The learning mode of usage intended: active, expositive or mixed.
- **learningResourceType** – A characterization of the type of resource; for example, whether it is a presentation, handout, lesson plan, assessment, etc.
- **useRightsURL** – A link to the license, or description of usage rights that apply to the material.

These properties supplement the set of more generically applicable metadata terms in common use, such as those specified by the Dublin Core Metadata Initiative (DCMI, or Dublin Core).

When scaling up teams and tools to tag or re-tag content for alignment to the Common Core, state and local education agencies should require that LRMI-compatible tagging tools and structures be used, to ensure compatibility with the data and applications made available through the SLC technology.

### 3.1.2. LRMI Paradata

Another product of the LRMI is its Paradata Specification. Paradata is a specialized type of metadata which describes how a resource has been used, when and by whom.

Paradata, as specified by LRMI, includes statements about a resource consisting of three parts: an **actor**, a **verb**, and an **object**. An actor identifies who has done something with a resource, a verb describes what the actor has done with it, and an object refers to the resource itself.

### 3.1.3. SLC-Specified Metadata/Paradata

It is important to note that while the LRMI Paradata Specification provides a framework for expressing usage information, it may not specify a standardized set of actors or verbs, or may produce a set that falls short of enabling the SLC's most compelling use cases. The SLC will produce guidelines for expression of additional properties, or tags, that fulfill its users' needs, and will specify how such metadata and paradata will conform to the LRMI standards, as well as to other relevant or necessary content description standards.

### 3.2. SLC Data Model Dependencies

In the previous sections, we've described valuable features of various SLC components that make use of learning standard alignment. However, these uses cannot be accomplished without having student performance data aligned to the same set of standards as are applied to learning resources and Learning Maps. Standard-aligned data entities in the SLC data model include (in order of

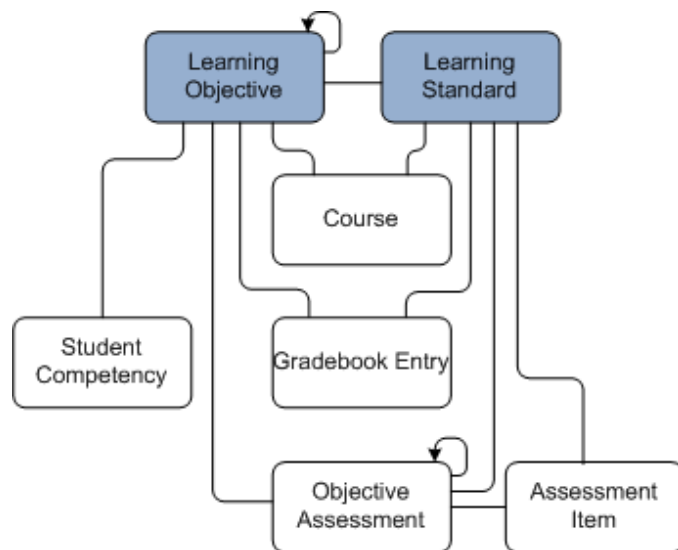


Figure 2: Learning Standard Data Model

increasing granularity)  
Courses, Grades and  
Competencies, Assessments  
and Assessment Item results.

As an example of how standard-aligned student data might be used, consider a set of formative assessments that have been labeled ("tagged") as corresponding to a certain learning objective. If a student's scores for those assessments show that the student has achieved a sufficient level of competency, then an SLC technology-compatible application would

be expected to indicate that he or she has fulfilled the associated learning objective. Complex processing rules may be needed to determine objective fulfillment for cases of conflicting results and differing levels of proficiency measured for the same learning objective.

The SLC data model includes the expression of a hierarchy of learning objectives and learning standards, which correspond to Common Core and state-specific standards. This allows the objectives and standards to be referenced by other data items, resulting in the alignment of student performance indicators to these standards and objectives, using the following relationships:

### **3.2.1. Course**

Course entities, provided to the SLC Datastore from a course catalog, may be standard-aligned. That is, each course may be associated with a set of learning objectives and/or learning standards. Student competency relative to these objectives and standards can then be determined at a very broad level, by final course grades.

### **3.2.2. Gradebook Entry**

Student grades recorded for assignments and exams provide the means for a more detailed determination of objective competency. For this to be useful, gradebook-level data must be provided to the SLC Datastore, and each gradebook entry must be standard-aligned; that is, it must be associated with a set of learning objectives and/or standards.

### **3.2.3. Student Competency**

In cases where gradebook entries are not recorded as numerical scores or letters, as is often the case at lower grade school levels, a student competency level indicator may be assigned instead. In the same way that gradebook entries can be aligned to learning objectives, so too can student competencies.

### **3.2.4. Objective Assessment and Assessment Items**

Objective assessment results provide an important measure of student fulfillment of learning objectives. Again, for SLC technology-compatible applications to analyze student objective achievement, assessment results must be provided to the SLC Datastore. But assessment metadata, indicating standard alignment, must also be included in the SLC Datastore; assessment maintainers and vendors will need to provide this alignment information.

Standard alignment can be done at the broad assessment level, in which an entire assessment is associated with the set of standards and objectives to which it applies. When coupled with student assessment results, this can be used to provide a rough view of student achievement progress.

Assessment-to-standard alignment can also be specified more granularly, at the item level, in which each assessment item is linked to the corresponding learning standard(s) that it tests. This would enable the most detailed view of a student's standard-based achievement.

## **3.3. The SLC Datastore**

It is important to note that the provision of these data entities identified in Section 3.2 from state and local data systems, as well as the alignment of that data to the learning standards, is a requirement of enabling many of the features envisioned by the SLC and its members, and the ultimate goal of making personalized

instruction a reality. Figure 3 depicts some of the systems that are potential sources of integration to be considered, when analyzing how and from where to provide standard-aligned data to the SLC Datastore.

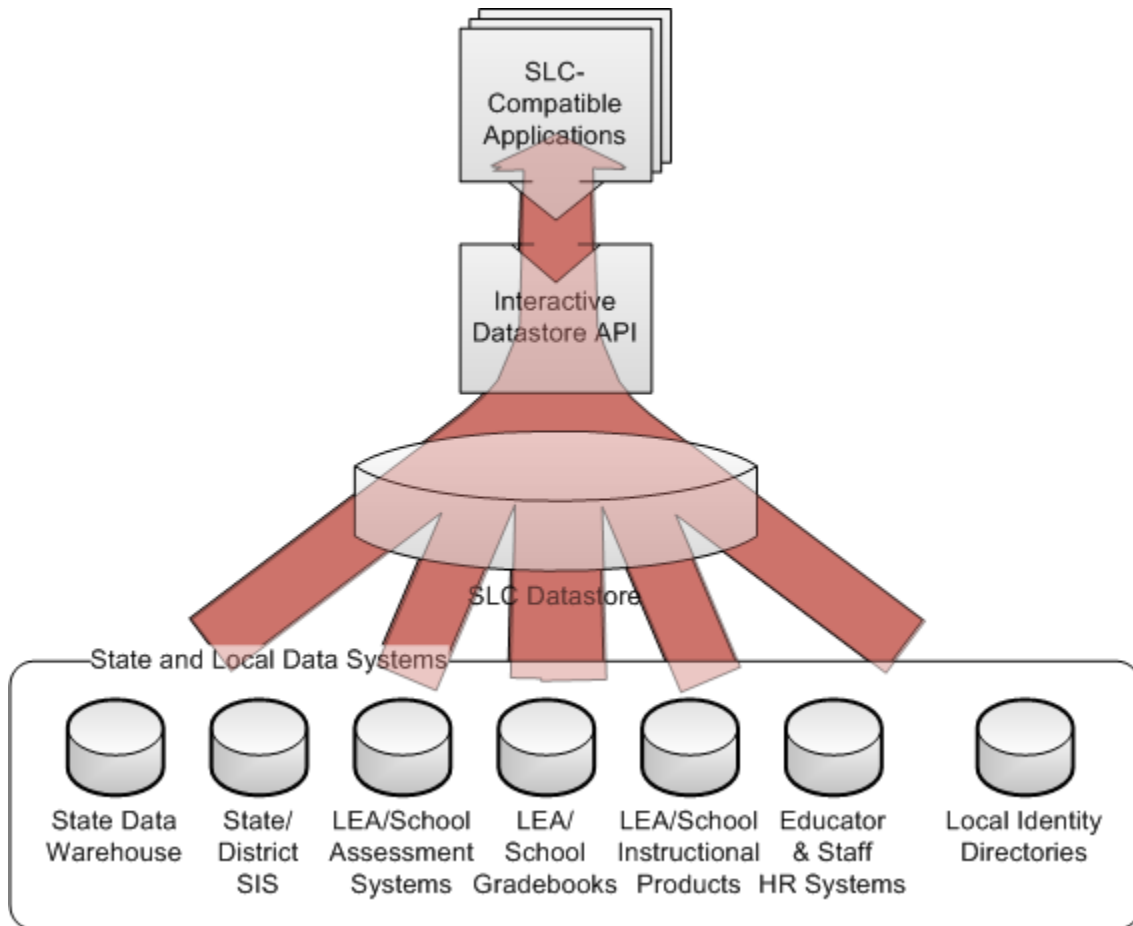


Figure 3: The SLC Datastore

## 4. SLC Learning Standard Alignment Technology

A major goal of the SLC is to provide a framework and core infrastructure that supports alignment of learning resources, assessments and student achievement data with the Common Core, as well as other SEA/LEA-defined learning standards. The following sections describe some of the functionality the SLC intends to produce, with an emphasis on how alignment to standards such as the Common Core will benefit all stakeholders in the public K-12 educational process.

The technology described will be released to the community under an open source license. This will allow states, districts and software vendors to build on the base functionality the SLC provides, potentially collaborating to produce significant enhancements to the tools and platform, as well as creating completely new applications that take advantage of the standard-aligned data made accessible via the shared technology infrastructure.

### 4.1. Learning Resource Advertisement and Discovery

Several components of the SLC technology work together to ensure that the universe of available learning resources, or content, are made readily available to search engines and other learning applications that educators and students will use. This set of tools is designed to help content consumers wade through droves of available content, to hone in on materials that are most appropriate and likely to be of value to specific individuals.

The solution assumes that learning resources exist in multiple locations, in multiple products and repositories, in all corners of the Internet. They need to be described, in terms of their purpose, standards alignment, and use, for applications to understand where the content is and for what or whom it is most useful. Search engines, recommendation engines and other applications can then easily find and classify those content objects, and help users find the right content for their needs.

The SLC will provide three major components that enable connections between users, applications, standards and content:

- The SLC Learning Registry Index: an announcement-based service that receives and indexes learning content announcements, which include resource alignment with standards, purpose and usage.
- Content Tagging Utility: a tool used to label, or tag, learning resources with the learning standards to which they apply.
- Resource Search App: a tool used to locate available learning resources which conform to certain requested parameters, including learning standard alignment.

Each of these components is described in more detail in the following sections.

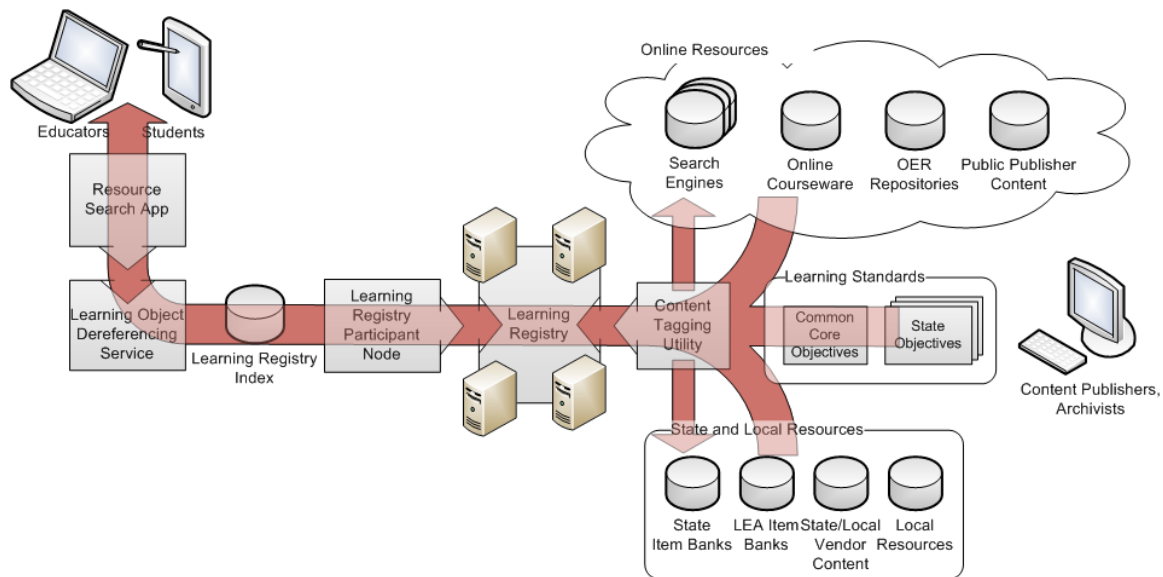


Figure 4: Learning Resource Advertisement and Discovery

#### 4.1.1. The SLC Learning Registry Index

The SLC Learning Registry Index establishes a link between applications and learning resources by storing and cataloging resource descriptions, allowing the described resources to be located quickly by the users who seek them, based in part on the resources' alignment with learning standards.

Information about learning resources is obtained from the Learning Registry network, a joint technology effort of the U.S. Departments of Education and Defense. The Learning Registry project is supported by public, private and nonprofit members who participate in various roles as educational content publishers, indexing and search providers, and content consumers. Based on an open framework, the Learning Registry allows anyone to subscribe to, and make use of, the information flowing through it.

SLC's Learning Registry participant node listens to assertions published to the Learning Registry network, consolidating them in the Learning Registry Index for easy access by applications. The usefulness of the information collected depends upon content publishers, who must populate the Learning Registry with properly formatted and accurately "tagged" descriptions of their available resources. This information enables applications to discover the content most relevant to their users.

Content descriptions are introduced into the Learning Registry via "announcement" messages sent through a publishing node. Learning Registry

nodes, including the SLC's Learning Registry participant node, may keep the published learning resource descriptions in local data stores, for later recall. The registry will include metadata such as resource locations, LRMI-specified classification tags, and activity-related tags, as described in Section 3.1.

The Learning Registry Index has an API, called the Learning Object Dereferencing Service, which is used by SLC technology-compatible applications to search for and retrieve learning object descriptions (of both objectives and resources). This interface provides a powerful vocabulary that supports expression of either precise or broad search parameters. It allows applications, and therefore users, to find resources that are most appropriate within a given context or expected usage.

SLC's Learning Registry participant node is peered with other Learning Registry nodes so that it can receive resource description publications, and filters out announcements received from the network that are not relevant.

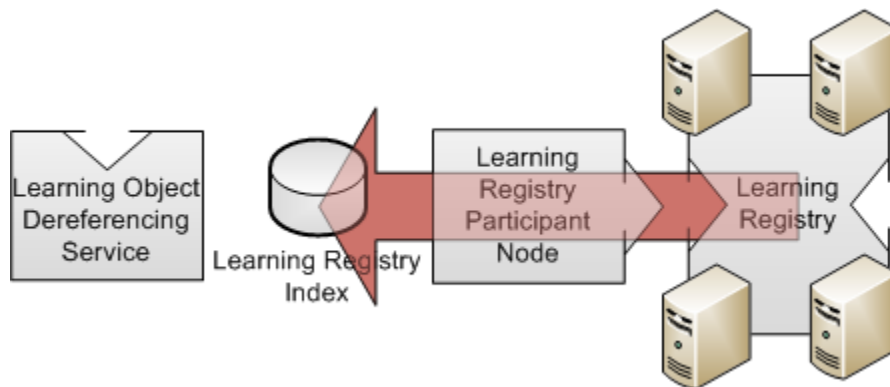


Figure 5: The Learning Registry Index

In addition, it is expected that some SLC technology-compatible applications, depending on their intended functionality, will contribute information to the Learning Registry network as a whole, and therefore indirectly feed useful data back into the Learning Registry Index. In this capacity, such applications would require the use of the Learning Registry participant node. Example feedback includes:

- Announce usage of resources by an SLC education organization.
- Announce applicability of resources for an SLC education organization.
- Announce the effectiveness of resources.
- Announce relationships between state standards and the common core.
- Announce teacher ratings for content from an SLC education organization.
- Announce updates to content.
- Announce LRMI-based tagging of content.
- Announce changes to the Common Core.



These additional use cases may require the use of paradata and other constructs, as described in Section 3.1.

In addition to learning resources, SLC technology applications require learning objectives. It is expected that the Common Core will “announce” updates to its learning objective standards to Learning Registry participants, in much the same way as learning resources are announced. Further, state organizations will “announce” their own learning standards and their standards’ relationships to the Common Core via this network. These learning objectives are related to learning resources via metadata tagging, as described in Section 3.1.1.

#### 4.1.2. Content Tagging Utility

The SLC Content Tagging Utility allows producers and maintainers of teaching and learning materials, assessments, and other types of resources to label each item as to its intended audience, applicability and alignment to learning standards.

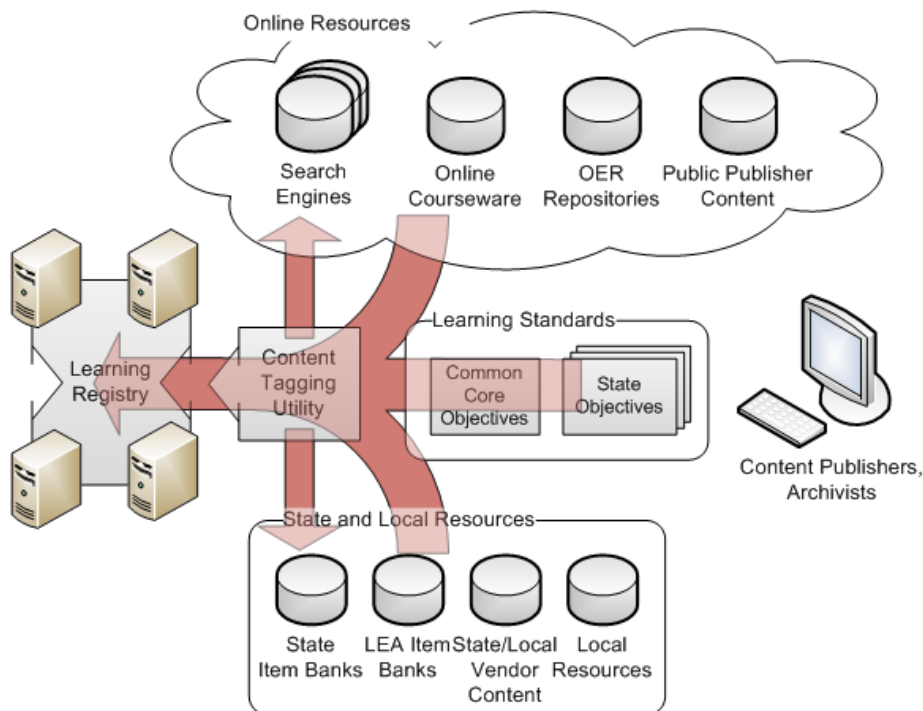


Figure 6: Content Tagging

Users can create resource descriptions for large quantities of content, aligning items with the Common Core, state standards, or locally defined standards for untested subjects, according to the LRMI and Learning Registry Index vocabularies. The utility will be available both as an “app” through the SLC portal and as a standalone website-installable version, optimized for batch-tagging of multiple resources. The content tagging utility will have the following features:



- **Tagging** – Learning resources will be tagged with LRMI vocabulary, applicable Common Core learning objectives, and Learning Registry Index-specific vocabulary.
- **Learning resource identifiers** – Learning resources will be presented to the tagger application as a URL or list of URLs that represent the authoritative identifiers for learning resources specified in the Learning Registry Index.
- **Authentication** – The SLC portal-compatible portlet will retrieve user and role information from the SLC portal. The tagging app will utilize this identity information to create digital signatures on all Learning Registry submissions on behalf of the user.
- **Learning Objectives** – Learning objectives and standards will be obtained from the Learning Registry Index through a web service. This means that Common Core State Standards, as well as state-defined standards will be available for tagging, as long as they have been published to the Learning Registry.
- **LRMI vocabulary** – LRMI vocabulary will be obtained from the current LRMI standard.
- **SLC-specific Learning Registry vocabulary** – The tagging utility will support the SLC-defined metadata referred to in Section 3.1.3.
- **Auto-populate** – Auto-populate fields based on site settings, existing metadata or previously selected values.
- **Vocabularies** – Generate a keyword-based index of various vocabularies to simplify the tagging process and eliminate the need for the user to traverse the various vocabulary trees.
- **Data persistence** – All applied tags will be posted to the Learning Registry. Optionally, this data can be written to a local database, or provided to the user to facilitate cut-and-paste to another application.
- **Versioning** – When data is persisted to a database, previous versions will be retained and the current version will be indicated.

The generated resource descriptions are published to the Learning Registry, resulting in their being persisted in the SLC Learning Registry Index, where they can be discovered by SLC technology-compatible search tools. Resource descriptions can also be stored in local content repositories for later recall and other purposes. If resource descriptions are stored in a web-accessible location, content providers may submit them to search engine indexers, for inclusion in global web search results.

#### 4.1.3. Resource Search App

The SLC-developed resource search app makes use of additional components within the SLC technology to enable discovery of learning standard-aligned

educational resources. The search app is provided via the SLC user portal, and may also be provided as a standalone website-compatible utility.

The search app queries the Learning Registry Index, as well as Internet search engines like Google, Bing and Yahoo, to locate resources that match certain characteristics, such as standard alignment, suitability for an intended audience and usage applicability.

The search app will provide an enhanced user experience for discovering, filtering, and viewing learning resources, and will have the following primary features:

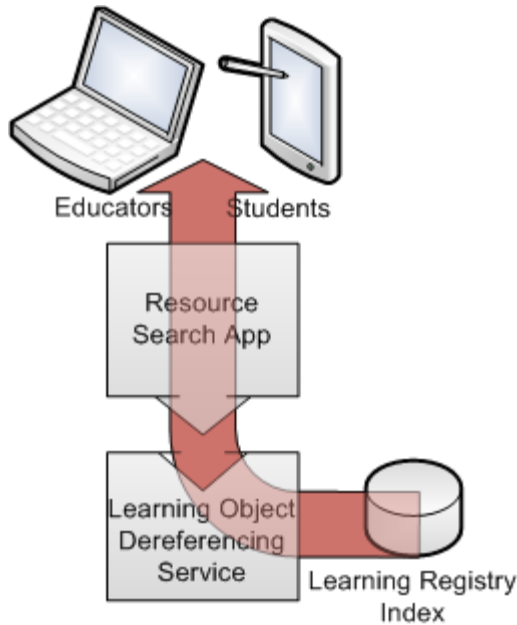


Figure 7: Resource Search

- **Search** – Capture learning resource search results the Learning Registry Index or other search engines, based on configuration.

- **Results** – Display a visual summary of results, with the ability to preview details about resources.

- **Data Persistence** – If a learning resource result is selected, post information about this selection event to the Learning Registry.

- **Authentication** – The SLC portal-compatible portlet will retrieve user and role information from the SLC portal. The search application will utilize this identity information to produce digital signatures for

all Learning Registry submissions.

- **Content Filter** – Dynamically filter results based on selection of keywords, LRMI-based predicates, and Learning Registry Index-specific predicates.
- **Identity Filter** – Dynamically filter results based user identity, role and subject, (to return only resources licensed for use by the requester, for example).

## 4.2. Learning Maps

The SLC's Learning Map tools are a suite of related components, including Learning Map authoring and visualization apps, as well as a Learning Map repository that provides a web service-based API for storing and retrieving Learning Map data.

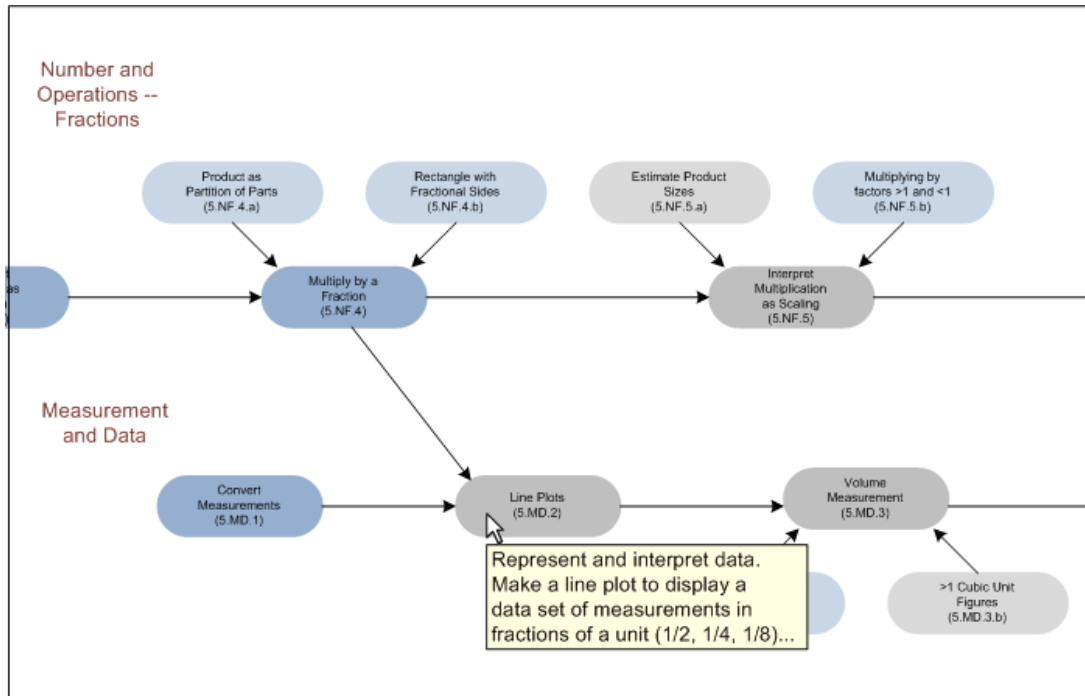


Figure 8: Possible Curriculum Leader View of Learning Map

### 4.2.1. Learning Map Authoring App

State and local curriculum planners and teachers use the Learning Map authoring app to create new Learning Maps or update existing Learning Maps. In the process, Learning Map authors either customize pathways through the Common Core or create their own standards and pathways through untested subjects.

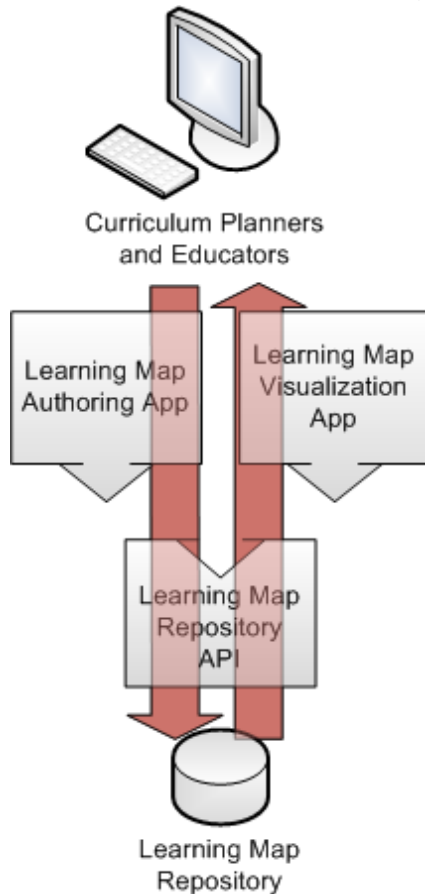
The authoring app is a graphical tool, from which a Learning Map author selects a set of learning objectives, and creates arrangements of those objectives that suggest a sensible teaching/learning order, or path, through the material. Parallel “tracks” of objectives can be specified, as well as sequential orderings, leading to complex arrangements best visualized on a two-dimensional canvas.

The Learning Map authoring app will be available through the SLC portal; portal administrators will configure which users have access to this app, and what usage rights (create, update, delete) they have.

In addition to storing Learning Maps in the Learning Map repository, the authoring app can optionally announce the availability and applicability of new or revised Learning Maps via the SLC Learning Registry Index.

#### 4.2.2. Learning Map Visualization App

Once Learning Maps have been developed by linking paths through learning objectives using the authoring app described above, these maps can be visualized by educators, using the Learning Map visualization app, via the SLC portal.



**Figure 9: Learning Maps**

The visualization app, as initially developed, is functionally a learning standard browser, in which a selected Learning Map is displayed, with each node indicating the Common Core or state-specified standard or objective to which it corresponds. An educator can view the recommended order of instruction, and can use the map for lesson planning, as well as procurement of teaching resources and assessments to support that plan. It is intended that each identified learning objective can be selected and used as the basis for content searches by activating the resource search app, so that an educator can locate educational content (assessments, teaching materials, etc.) relevant to that objective.

Because the Learning Map visualization app, as with all SLC-developed components, will be available through an open source license, others in the educational software development community will be able to use its code as the basis for different visualization modes. For example, an app could be developed that gives an indication of progress of an individual student, or an aggregation of students by section, course,

school, or other grouping, charted against a given Learning Map. From the student performance view, an educator could quickly determine objectives in which the student has attained competency, and those which are logically next in the individual's learning progression. Materials suitable for a given student or group can then be found, as described previously, by searching the Learning Registry Index for educational content aligned to the next objectives to be fulfilled. Such a student-data-driven Learning Map can also give a visual indication of whether a student is having difficulty, and requires specialized

intervention. The SLC data model supports this important use case, as discussed in Section 3.2.

The SLC technology includes the data and content services required to enable application developers to build adaptive, data-driven Learning Maps. However, the SLC's Learning Map visualization app reference implementation will only include the functionality needed to link Learning Maps with learning standard-aligned content through a Learning Registry Index search.

## 5. Next Steps

To achieve the vision of personalized learning each member of the educational community can contribute in different ways to ensure the holistic system is working collaboratively:

- Learning standard developers (Common Core and state education organizations) should publish their standards as resource descriptions in the Learning Registry, or arrange for a third party to make authoritative standard announcements on their behalves.
- Educational content providers and maintainers, including public and private resource publishers and assessment vendors, should “tag” their materials to indicate alignment with learning standards and publish the resulting resource descriptions in the Learning Registry.
- State and local education organizations should initiate or continue efforts to align student performance data with learning standards. They should also encourage content providers and other vendors to support learning standard alignment as described in this paper.

The SLC will continue to support and develop the technology necessary to enable these activities.

## 6. Glossary of Terms

The following terms are defined as they are used in the context of this document, rather than more generically.

Term	Definition
Learning object	A category of information that includes learning objectives and learning resources.
Learning objective	A collection of related learning standards, which together identify facets of the overall objective. In the Common Core State Standards, learning objectives are referred to as “clusters” of learning standards.
Learning resource	Education-oriented materials. Examples include teaching and learning materials such as items, student assessments, examples of student work, lesson plans and modules of courseware.
Learning standard	A description of a concept that a student should comprehend, demonstrate proficiency in. Learning standards include those produced by the Common Core State Standards Initiative, as well as K-12 education standards of individual states.
Metadata	Information describing a learning resource, such as its location, publication date, author and learning standard alignment.
Paradata	A category of metadata that describes how a learning resource is (or has been) used.
Resource description	A document that defines the logical relationship between a resource (in the context of this paper, a learning resource) and metadata and/or paradata related to it.
Resource tagging	The act of creating a resource description.

## 7. References

The following links provide further supporting detail about the important related initiatives mentioned in this document.

Organization or Specification	URL
Common Core State Standards (the “Common Core”)	<a href="http://www.corestandards.org/">http://www.corestandards.org/</a>
Dublin Core Metadata Initiative (Index of Terms)	<a href="http://dublincore.org/documents/dcmi-terms/">http://dublincore.org/documents/dcmi-terms/</a>
Learning Registry (Technical Guides)	<a href="http://www.learningregistry.org/documents">http://www.learningregistry.org/documents</a>
LRMI Metadata (Draft Specification v0.7)	<a href="http://wiki.creativecommons.org/LRMI/Properties/Version_0.7">http://wiki.creativecommons.org/LRMI/Properties/Version_0.7</a>
LRMI Paradata (Specification v1.0)	<a href="http://goo.gl/yCvm6">http://goo.gl/yCvm6</a>
Schema.org	<a href="http://www.schema.org/docs/gs.html">http://www.schema.org/docs/gs.html</a>
Shared Learning Collaborative (Technical Specifications)	<a href="http://www.slcedu.org/technology/technical-specifications">http://www.slcedu.org/technology/technical-specifications</a>