inBloom

Learning Map and inBloom Index System

Data Model and Server

USE CASES

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Contents

Background

The Learning Map Data Model

The Bill & Melinda Gates Foundation (the Foundation) supports the implementation of the Common Core State Standards for US K-12 education. The Foundation awarded a contract to Applied Minds, LLC (AMI) to develop a Learning Map Data Model (LMDM) with the goal of it becoming a standard for educational technology infrastructure. The Learning Map will provide the organizing framework that maps the relationship between learning objectives, including dependencies and higher level groupings. It will also allow educational media resources, such as courses, books and web content to be linked to learning objectives. Curricula aligned to the standards will exhibit great diversity in highlighting paths through the Learning Map, and a suite of tools will allow authoring and visualization of the Learning Map. We believe that this data model will eventually enable the creation of online learning tools that are more responsive to the individual needs of a student. The LMDM is inspired by and based on the philosophy of the more general Knowledge Web (See: http://edge.org/conversation/aristotle-the-knowledge-web).

inBloom Technology

The Foundation has, in collaboration with the Carnegie Corporation, initiated an ambitious effort, Shared Learning Infrastructure (SLI), now inBloom Technology, to provide a new technology infrastructure that supports the Common Core Standards and the Foundation's vision, to be implemented by inBloom. AMI has been contracted by inBloom to build an implementation of a Learning Map and inBloom Index System, suitable for third-party software developers to populate content and develop applications.

inBloom's Use Cases and AMI's Role

inBloom has developed lists of use cases that they seek to support using the various components of the inBloom Technology. As AMI will be developing some of the key technologies involved, our support for these use cases will be an important part of the proposed effort.

Task 1 of the project requires AMI to refine these lists of use cases. The goal of this task is not to reduce the functionality sought by inBloom but to clarify what capabilities are most necessary for successful implementation.

This report presents our refined list of use cases. The technologies we design and implement will support the use cases as refined through this process. However, end-user availability of use case support will require applications and content as well as technology infrastructure.

Introduction

AMI is building a flexible technology infrastructure that is intended to enable a wide-ranging set of third-party applications. In this report, we will list a set of use cases that address many different user needs and situations, and identify which elements – technology framework, applications, and content – are required to implement these for intended users. In most cases, AMI is building the technology framework required, and has built some exemplary applications and tools as well.

Between the use cases and the users are three layers, which are all currently in development. The first, most fundamental layer is that of the infrastructure or technology framework. This is like the skeleton of the system itself. The next layer is of applications which run on top of the infrastructure and provide actual services to end users. These will be built primarily by third-party developers. AMI will provide several exemplary applications and visualizations for the purpose of modeling the possibilities of the system to developers who will then create end-user services. The third layer is the educational content itself, from standards to learning resources to assessments, and eventually to student data – all of which will be provided by education experts. This content is then served to end users via the applications built by third-party developers on top of the infrastructure. Use cases described in this document are only fulfilled when all three pieces – infrastructure, applications, and content – are in place.

We begin by describing various key technology elements, and then provide a table of use cases that are mapped to original requests from Sharren Bates and Brandt Redd of the Gates Foundation and inBloom. Each of these use cases is then described in terms of which elements it requires on each level of infrastructure, applications, and content.

Technology Elements

Learning Map Server (AMI)

This is the (logically) centralized graph server that holds data records for real world entities (e.g. learning objectives, standards, learning resources, schemata for discovery) and the network of relationships between them (e.g. paths, category/provenance/version metadata, hierarchies of organization).

- Since this is a core index, all use cases require the Learning Map Server to exist and be available.

inBloom Map Maker Authoring Toolset (Third Party Developers, AMI)

This is a set of tools for creating new Learning Objectives (Competencies), tying Learning Objectives to existing Learning Resources, creating/editing Paths from sets of Learning Objectives, and placing these Paths in the context of existing Paths.

- Any capability to create or modify new standards or learning objectives.
- Any capability to create or edit paths through the Common Core Standards.

inBloom Index (AMI)

This is the index of existing Learning Resources. It includes the actual database (inside the Learning Map Server) and the APIs needed to access this database. Any user case that needs to discover or use a learning resource will need the inBloom Index.

- Any visualization that needs to know about a learning resource (e.g. its language, target audience, format) in order to offer it to students, will need to read the inBloom Index .
- Any path search/browse/discovery tool that needs to filter based on appropriate content will need to search the inBloom Index .

Visualizations (Third party developers, AMI – Exemplary Visualizations)

Visualizations will primarily be built and deployed by third-party software developers. AMI has delivered two exemplary visualizations to showcase the Learning Map data model. These are the Common Core Browser and the Treasure Map Path Visualization.

LM Discovery/ Browsing tools (Third party developers)

These are the tools to navigate the master graph in the Learning Map Server. Any application that needs to find something in the graph will need this.

- Any user who wants to create/edit paths or learning objectives will need to place these new/edited entities in the context of existing ones. Thus this user will need to find the proper location for that placement.
- Any user who needs to choose among alternative paths will need to be able to discover their choices.
- Any user who needs to search for a path or learning objective meeting filtering criteria will want a simple search tool.

Data Model/API Interoperability Standards (AMI, Other inBloom partners)

Different services that are parts of the overall inBloom Technology or inBloom Index will need to "feel" like they are part of the same system in order to make creation of applications tractable. Minimum quality standards relating to data modeling, API specifications, security, performance, and usability are necessary to insure this consistency of experience.

- Any capability/application that requires more than one service will care about standards.

Student Model (AMI – Future)

This is a preliminary version of what will over the long term become the representation of a student's knowledge of Learning Objectives and their use of Learning Resources. The data modeling part of some basic elements of the Student Model should exist early on in order to increase the chances of adequate expressiveness for expected future student-oriented applications.

- Any capability that records information from student activity will need to properly represent that data.

Refined List of Use Cases

The following list represents a complete set of use cases for the Learning Map inBloom implementation. With support for these use cases through the infrastructure or technology framework, third-party software applications, content, and users, the Learning Map implementation will successfully reflect the vision of inBloom. In this table, each refined use case is mapped to original requests from Sharren Bates (labeled SB) and Brandt Redd (labeled BR).

Elements (mainly infrastructure or technology framework) that will be built by AMI are identified. Some elements that AMI is interested in building in the future, as well as use cases 13 through 17, are not in the scope of the present contract, and are marked "Future". Third-party applications, content, and user involvement will be handled by inBloom and their other partners.

During the Learning Map and inBloom Index project, we will design and implement our technology infrastructure to support these use cases.

	Use Cases	Infrastructure or Technology Framework	Third-Party Applications	Content	Users
1	*Add LOs to the LM Server* SB 2. Common Core canonical version passed through from "the official posted version"	LM Server (AMI)	Automated process to populate LM	CCSS or Other Standards	System
2	*Associate LOs with LRs* SB 3. Nodes in paths are published as "Learning Objectives" in the inBloom Index SB 10. Clicking through to content from learning maps will announce to the learning registry BR 4. Associate a learning resource with a learning objective. This should use the LRMI metadata vocabulary. As resources and learning objectives have a many-to-many relationship this assertion could be repeated many times.	LM Server (AMI) and inBloom Index Server (AMI)	Automated process to populate inBloom Index or Tool to associate LR with LO	CCSS or Other Standards and inBloom Index Server content	System
3	*Create Visualizations* SB 11. Application developers can publish additional visualizations using the Learning Map Data Store	LM Server (AMI)	Various	CCSS or Other Standards	Any

	Use Cases	Infrastructure or Technology Framework	Third-Party Applications	Content	Users
4	*View Visualizations* SB 11a. Teachers can easily choose visualizations – both the pre-populated and the updated SB 17. Students can chose a learning map SB 18. Teachers can assign a learning map	LM Server (AMI)	Learning Map visualizations such as AMI Exemplary Visualization #1 or Other classroom tools	CCSS or Other Standards	Any or Students or Teachers
5	*Create/Edit Learning Objectives* SB 6. Teachers/Curriculum Developers can create their own standards for untested subjects and create and save their own paths BR 1. Define a learning objective and associate with its corresponding ID. An identifier is associated with a definition of a learning objective. The definition includes the relationship of the learning objective to the achievement standard to which it belongs and its position within that standard. BR 2. Associate an alternative identifier with a learning objective. Multiple identifiers may exist for the same learning objective either in different formats (e.g. URL and GUID) or assigned by different organizations for historical reasons. For example, the Common Core State Standards (CCSS) are issuing "canonical" identifiers in the spring of 2012 which will include the "textual" identifier from the original text, a "URL" formatted identifier and a GUID form. Historically, the ASN and other organizations have assigned other identifiers. BR 6. Identify a sub-part of a learning objective. Certain organizations – particularly assessment developers – are finding it necessary to identify sub-parts of learning objectives in the CCSS. However, the NGA and CCSSO are not issuing official identifiers at that level of granularity. Therefore, other organizations will do so. In this case as with many others, the provenance of the assertion will be important.	LM Server (AMI) and Namespace Management (AMI)	Standards Authoring Tool such as AMI CC Browser (AMI)	CCSS or Other Standards	Authorized Standards creators

	Use Cases	Infrastructure or Technology Framework	Third-Party Applications	Content	Users
6	*Deprecate Learning Objectives* BR 7. Deprecate existing standards. Example: "Standard XYZ has been deprecated. Please see standard PDQ." Since a material change to an existing standard necessitates a new identifier, changes should be in the form of adding a new standard and deprecating an old one.	LM Server (AMI)	Standards Authoring Tool such as AMI CC Browser (AMI) and Versioning Tools	CCSS or Other Standards	Authorized Standards creators
7	*Create Learning Resource Entries* BR 3. Describe a learning resource and associate with its corresponding ID. Learning resources may be large and may require special server-side support. Accordingly, the actual content of the learning resource won't be stored in the inBloom Index . However, the inBloom Index will associate a unique identifier with metadata about the resource.	inBloom Index Server (AMI) and Namespace Management (AMI)	inBloom Index Editor	inBloom Index Server Data	Authorized inBloom Index editors
8	*Create Paths* SB 5. Paths can include multiple hierarchies of Learning Objectives SB 1. Teachers/Curriculum Developers can save their own path through the Common Core standards SB 4. Paths are published to the inBloom Index	LM Server (AMI) and inBloom Index Server (AMI)	Path Authoring/ Editing Tool such as Path Authoring Tool (AMI)	CCSS or Other Standards	Authorized path creators
9	*View Paths* SB 8. Teachers / Curriculum can publish the user view of their path with 1-2 designed visualizations	LM Server (AMI)	Path Visualization Tool such as AMI Exemplary Visualization #2	CCSS or Other Standards	Authorized path creators or Students
10	*Browse / Find Paths* SB 7. Users can browse/search for standards/paths created by others	LM Server (AMI)	Search/ Browse tools	CCSS or Other Standards	Any

	Use Cases	Infrastructure or Technology Framework	Third-Party Applications	Content	Users
11	*Browse / Find Learning Resources* SB 9. Teachers / Curriculum leads can publish the user view of their path with pre-published visualizations and search results for available content based on nodes in the path (based on learning map UID, LRMI, inBloom Index) BR 5. The learning resource with a particular ID may be found at a particular URL. The same learning resource may be found at multiple URLs so as with most assertions, this one may be repeated for the same resource but with multiple values.	LM Server (AMI) and inBloom Index Server (AMI)	Search / Browse tools	(CCSS or Other Standards) and inBloom Index Server Data	Any
12	*Use Student Data from inBloom* SB 12. Application developers can add "student model" data to visualizations SB 13. Application developers can connect specific content to learning map visualizations	LM Server (AMI) and inBloom Index Server (AMI) and Student Data Server (inBloom)	Various	CCSS or Other Standards	Any
13	*Create/Edit Student Model (Future)* SB 14. Students can enter personal information to create a learner profile SB 15. Teachers can enter personal information to create a learner profile SB 16. Learner profiles will hold a baseline for student achievement/interest data	Student Model (AMI Future)	Student Model editor and Various Student Model tools (such as editor, assessment tools, competency certification tools)	Student Model data	Students or Teachers

	Use Cases	Infrastructure or Technology Framework	Third-Party Applications	Content	Users
14	*Automatically update Student Model (Future)* SB 20. Student learner profile will be updated with activity and results data based on content they navigated to from the learning map	Student Model (AMI Future) and LM Server (AMI) and inBloom Index Server (AMI)	Various Student Model update tools	Student Model data and Student data and Usage data (paradata) and Assessment data and inBloom Index Server data and (CCSS or Other Standards)	Students or Teachers
15	*Find Personalized Relevant Content (Future)* SB 19. Students can navigate paths to be connected to relevant content and assessment opportunities SB 19a. The system will determine relevance based on pre-determined/calculated metadata or activity data	LM Server (AMI) and inBloom Index Server (AMI) and Recommendation Engine (AMI Future) and Student Model (AMI)	Path visualizations and Relevance tools and Recommendation tools	(CCSS or Other Standards) and inBloom Index Server data and Student Model data and Usage data (paradata) and Assessment data	Students or Teachers
16	*Provide Single Sign-on Capability (Future)* SB 21. System should support SSO between learning map and applications provided in the learning map visualization	LM Server (AMI)	SSO application	User authentication data	Any

	Use Cases	Infrastructure or Technology Framework	Third-Party Applications	Content	Users
17	*Enable Data Analysis (Future)* SB 22. Application providers can use data in learning registry index, learning map data store and inBloom to figure out which paths or which content has contributed to student achievement	LM Server (AMI) and inBloom Index Server (AMI) and Student Data Server (inBloom)	Data analytics applications and Security and access applications and Privacy control applications	Student data and (CCSS or Other Standards) and inBloom Index Server data and Assessment data	Application providers