inBloom

Learning Map and inBloom Index System

Data Model and Server

inBloom Index Preliminary Student Model

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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 Index Data Model, Demonstration Server, and Developer Server

Under Task 1 of the project, AMI developed a data model and API specification for the inBloom Index. Version 0.1 of the data model was delivered to inBloom in July 2012. Based on this, the inBloom Index Demonstration Server was implemented, also in July 2012. The data model will be refined and modified throughout the remaining project effort using the Demonstration Server as we build the inBloom Index Developer Server.

Preliminary Student Model

For the implementation of the inBloom Index Server to be successful, it must ideally incorporate a well-designed Student Model. While a full Student Model may be implemented as part of a later project, Task 4 of the present effort requires AMI to design a basic, extensible Preliminary Student Model, to better build a inBloom Index Developer Server as well as to smooth the path for the future building and integration of the Student Model.

This report provides the Preliminary Student Model, a deliverable under Task 4 of the contract.

Introduction

The inBloom Index is a searchable database of metadata sourced from data published by Learning Registry nodes. The inBloom Index is intended to provide a logically central service for the search and identification of structured data entities important to the Shared Learning Infrastructure. These entities include:

- Learning Objectives/Competencies, including educational standards such as the Common Core State Standards
- Learning Resources, including instructional, assessment, and supplementary material
- Complex metadata structures to be used for educational purposes, such as Competency Paths, statistical accumulations (e.g., learning resource paradata), ratings, and systems of annotation

For the implementation of the inBloom Index Server to be successful, it must ideally incorporate a well-designed Student Model. While a full Student Model may be implemented as part of a later project, inBloom and AMI feel that an initial design effort is important now. Particularly, building the inBloom Index Server requires some fundamental understanding about the Student Model design. Thus, as we consider and design a basic, extensible Preliminary Student Model, we are able to build a better inBloom Index Developer Server as well as smooth the path for the future building and integration of the Student Model.

Preliminary Student Model Schema Description

The schema for the Learning Map Data Model (LMDM) will be implemented in the inBloom Index. While the LMDM does not include a "student model" component, a student model will interact with the LMDM and rest of the schema instantiated in the inBloom Index. In order to make sure that the ecosystem of schemata in the inBloom Index work well together, a Preliminary Student Model is described here. This Model is designed to fill the following roles:

- It indicates how a student model might integrate with the LMDM.
- It gives an estimate of some of the features that a practical student model should have in order to satisfy the required use cases for inBloom Index functionality.
- It gives an indication of some advanced student model usage that could be supported by the proposed student model.
- It provides a base for the development of a full Student Model, which inBloom may wish to initiate as a later project as part of the inBloom Technology effort.

Student Metadata

A student may have many kinds of metadata associated with him/her, including:

1. Personally Identifiable Information

2. Explicitly created metadata (e.g., stated preferences, responses to questions, volunteered information)
3. Observed interaction history and "state" with data entities, such as learning resources, standards, and learning maps

Other initiatives under the inBloom Technology are addressing the many aspects of Personally Identifiable Information. The inBloom Index has as its focus Learning Objectives and Learning Resources, and is primarily concerned with how students interact with these entities and less with other aspects of student data such as attendance records. The Preliminary Student Model described here will therefore focus on explicitly created metadata and observed interaction history (items 2 and 3 in the list above).

Student Model

For the purposes of the LMDM and inBloom Index, a student is modeled as a data entity with relationships/links to a number of other types of data entities. This model is likely to include links to the following data entity types. Below each is a non-exhaustive list of possible relationship types to each entity type:

- Competency Path
  - Assignment/Choice of this Path to/by the student
- Competency Path Step
  - Assignment/Choice of this Path Step to/by the student
- Competency
  - (Partial) Achievement of this Competency
  - Assignment/Choice of this Competency to/by the student
- Learning/Instructive Resource
  - Assignment/Choice of this Competency to/by the student
  - Instruction event (e.g., time/duration of exposure, order of interaction)
- Assessment Resource
  - Assignment/Choice of this Competency to/by the student
  - Assessment event (e.g., time to completion, score, order of elements engaged)

A Note on Assignments

It should be noted that common to all of these relationships is the notion of an `assignment` or self-assignment of the student to engage and interact with a data entity. This notion is built into the base inBloom Index Data Model and will be described in more detail in that context. Its use for the Preliminary Student Model is as follows:

An assignment can be modeled as a relationship with more than two participants, and thus an abstract data entity type in its own right. As a data entity, an assignment includes at least the following properties:

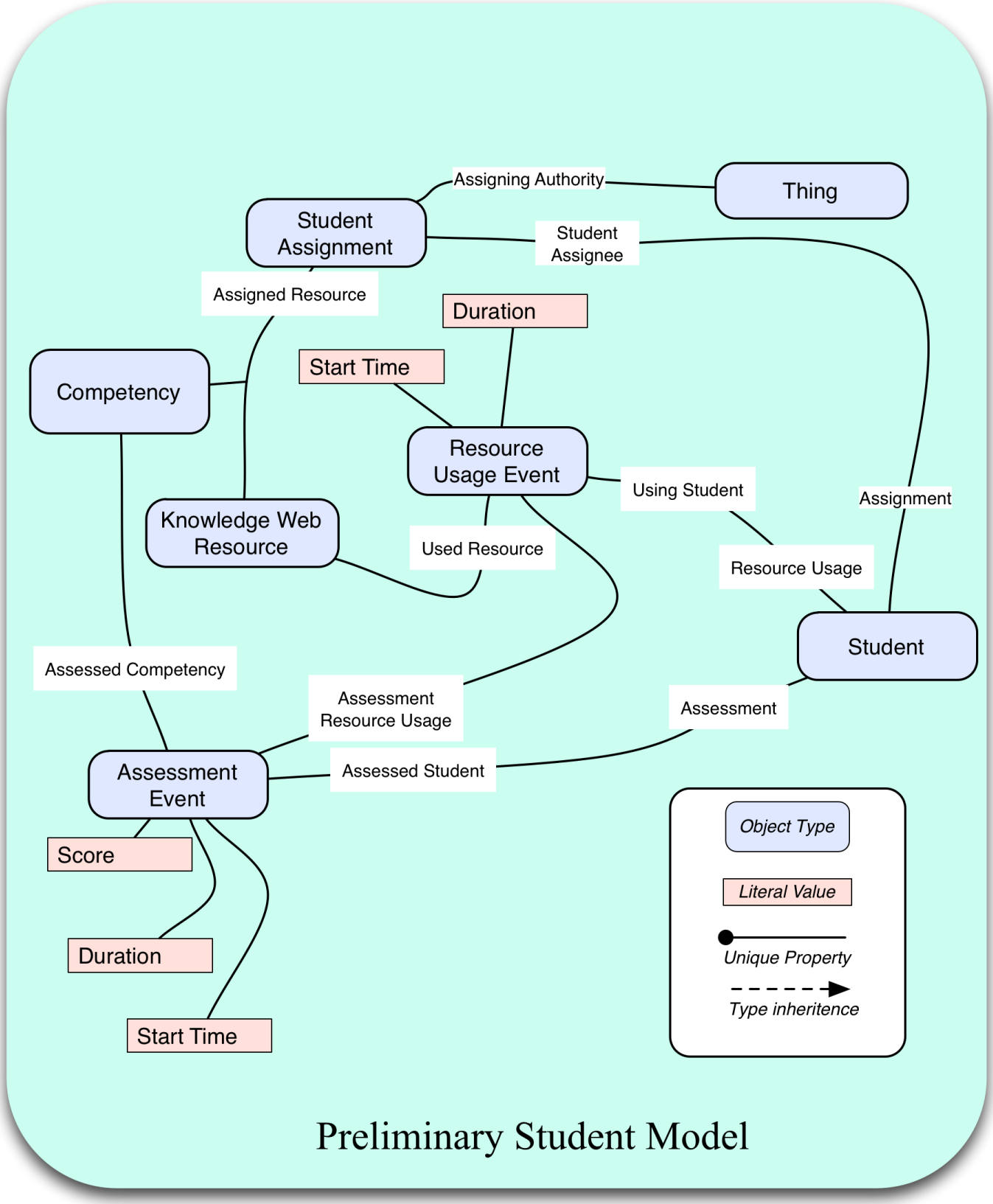
- **`Authority:`** Who made the assignment
- **`Assignee:`** Who was given the assignment
- **`Resource:`** Which data entity was assigned. This can be one of many intrinsic types (e.g., Learning Resource/Competency/Competency Path)

Additional (probably context specific) properties, such as "strength" of assignment or expiration date, may also be added to the Model as it is developed further.

Support for Advanced Usage

The Preliminary Student Model is intended to be a base on which a Full Student Model may be implemented. The Full Student Model is intended to support advanced applications of the Learning Map and the inBloom Index, such as:

- Recommendation of Competency Paths, Competencies, and Learning and Assessment Resources to a student in a particular context
- Statistical analysis of Competency Paths, Competencies, and Learning and Assessment Resources based on interaction of these data entities with many students (similar to the paradata of the Learning Registry effort)
- Development of teaching and assessment models based on knowledge of the student's past interactions
- Advanced student-facing applications that need to have access to the student's history and preferences (e.g., self guided learning systems)


Assigning Authority
Thing
Student Assignment
Student Assignee
Assigned Resource
Duration
Start Time
Competency
Resource Usage Event
Using Student
Assignment
Knowledge Web Resource
Used Resource
Resource Usage
Student
Assessed Competency
Assessment Resource Usage
Assessment
Assessment Event
Assessed Student
Score
Duration
Start Time
Object Type
Literal Value
Unique Property
Type inheritence
Preliminary Student Model

Preliminary Student Model Schema

The schema definitions for the Preliminary Student Model are based on schema.org's representations of schema, but with inBloom Index-specific additions as described in the inBloom Index Data Model specification.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