AAP PRE K–12 LEARNING

A SURVEY OF THE ED TECH STANDARDS LANDSCAPE

A summary from the 2015 Ed Tech Forum hosted by the Association of American Publishers, PreK-12 Learning Group

Introduction

Every culture has its own social conventions—the written and unwritten rules by which members of that particular group interact. Learning about these conventions is paramount for anyone who plans to travel or work in a new and/or unfamiliar culture. Breaking these rules can result in miscommunication, misunderstanding, or—in the most extreme cases—excommunication. The same holds true for our digital cultures. If programs, apps, and platforms don't communicate well with others, chances are they won't be welcomed into many digital communities. This has huge implications for technology developers, whether you're developing for the global stage of the world wide web or in distinct digital cultures such as institutions, companies, schools, or private consumer networks.

And just as the increasing globalization of society underscores the importance of cross-cultural communication and understanding, the growth of movements like

cloud computing and the Internet of Things has increased the need for interoperability and cross-platform communication in digital cultures. In the preK-12 education space, this demand for interoperability is evidenced by the emergence and success of vendors that specialize in integrating disparate systems and increasingly prevalent RFPs that spell out adherence to specific interoperability standards or open APIs. However, those who work in and provide services to this market find themselves arriving more and more often at the same question—what ARE the conventions for the digital culture of prek-12 education? What standards should applications adhere to in order to be considered an accepted and contributing member of this community? On June 1, 2015, the Association of American Publishers (AAP) PreK-12 Learning Group convened a forum to ensure that all organizations involved in the creation and distribution of learning assets have the information they need to participate in this discussion.

What ARE the conventions for the digital culture of preK-12 education?

The digital culture in the preK-12 education space is complex, fragmented, and in many ways still evolving. At our June event we assembled an ed tech standards dream team and challenged each of these experts to provide an introduction to the standard they were representing, an update on the latest status, and information on how to get involved to make use of or even participate in further evolution of that standard. Each person was challenged to do so in only ten minutes. The result was a unique opportunity for participants to get a high-level overview of the preK-12 ed tech standards landscape and leave with a better understanding of how and where these different standards overlap and interact.

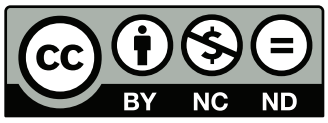
This document captures much of the information shared that day through a summary by each of the presenters. We have also linked each summary to its respective ten-minute video presentation from the forum. This is by no means intended to be a comprehensive guide to ed tech standards, nor is this meant to be an endorsement of any one standard over another. There are dozens of other important standards at play in the prek-12 digital space, but given the time constraints and context of the forum, we had to limit the scope of what we could cover in one day. The majority of those in attendance found this information useful; we hope you will, too.

If you're interested in learning more or helping move forward the conversation around ed tech standards, please do get in touch. The AAP PreK-12 Learning Group looks forward to playing an active role in this space.

Dave Gladney
Director of Digital Initiatives,
PreK-12 Learning Group
The Association of American
Publishers (AAP)

Michael Jay
President, Educational Systemics,
Inc.
Executive Council Member,
AAP PreK-12 Learning Group

Copyright



Association of American Publishers PreK-12 Learning Group

Contents

Interactive Content: EPUB, EDUPUB & Scriptable Components

Garth Conboy, Chairman of the Board, International Digital Publishing Forum (IDPF)

EPUB is the distribution and interchange format standard for digital publications and documents developed and maintained by the International Digital Publishing Forum (www.idpf.org). EPUB is based on web standards, and invents very little from whole cloth. It is built upon underlying standards: XML, HTML5, CSS, SVG, images, audio, video, etc. The EPUB markup, metadata, and packaging standards are at idpf.org/epub/301. EPUB is designed to enable consistent rendering of content across reading systems and platforms.

Watch the video presentation on EPUB

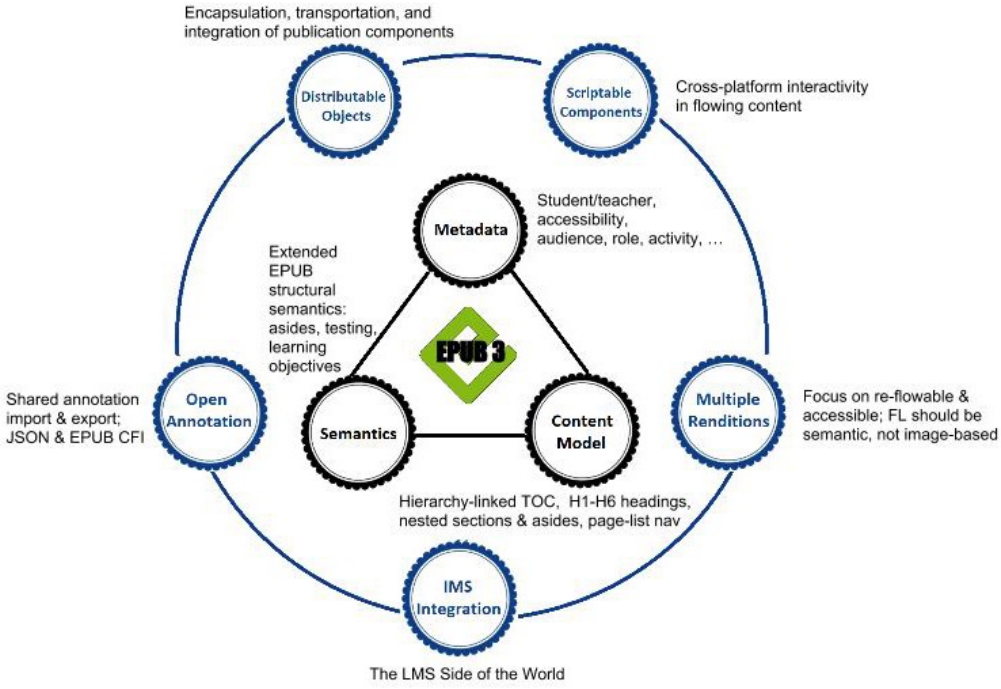
Interactive content is enabled in EPUB via JavaScript. Initial traction with such interactivity has been achieved in children's books, young adult books, and cookbooks with sci-fi/fantasy, comics/manga, and textbooks following. There are two types of scripting supported by EPUB: spine-level (an instance of <script> included in a content document directly referenced in the spine) and container constrained (an instance of <script> in a content document that is embedded in an <object>, <embed>, or <iframe>). Container-constrained scripting is likely to be consistently rendered across reading systems that support scripting (epubtest.org/compare).

EDUPUB is an emerging profile of EPUB specifically targeted at educational/textbook content. It provides a content model, structural semantics, extended metadata, LMS integration, shared annotations, distributable objects, and scriptable components. Specifications evolving toward the EDUPUB Profile include:

- idpf.org/epub/profiles/edu/spec
- idpf.org/epub/oa
- idpf.org/epub/do
- idpf.org/epub/sc/pkg, and
- idpf.org/epub/sc/api.

It is the latter two, scriptable components, that bring interactivity to EDUPUB and provide the basis for consistent rendering of interoperable components across reading systems leveraging EPUB's container-constrained scripting.

EDUPUB Universe



EPUB Scriptable Components (ESC) are defined by specification of two areas: the packaging of ESCs and the ESC components API. ESCs are packaged as EPUBs; no new XML vocabularies are required. The epubcheck validation tool can be used to ensure validity of the scriptable components and that all necessary resources are present. The EPUB Package Document can be used to store Scriptable Component metadata. EPUB fixed-layout metadata can be used to communicate the desired aspect ratio of an ESC. Standalone testing and debugging of Scriptable Components is possible, as ESCs can be ingested into any Reading System with scripting support (a component is simply a "page" with spine-level scripting). Lastly, ESCs are round-trip-able (from standalone ESC to parent document embedded, and back) via EPUB Distributed Object <collection>s.

The ESC components API provides an interoperable mechanism for component communication, interaction, and nesting. This API augments, but does not replace, EPUB 3 scripting. It is designed to work in Reading Systems that support spine level scripting with no effort, and may also be directly implemented by a Reading System that does not support spine-level scripting. The architecture

calls for all components to be in <iframe>s, and all communication done with postMessage. The messaging implementation, packaged in the ESC, enables drop-in support for Reading Systems supporting spine-level scripting.

Utilizing EPUB Scriptable Components, interactive elements may be included and nested in flowing-text EPUB content and can be expected to be rendered consistently across Reading Systems and platforms.

Common Education Data Standards (CEDS)

Jim Goodell, Senior Analyst, Quality Information Partners
Coordinator, CEDS Stakeholder Group for K-12


Watch the video presentation on CEDS

The Common Education Data Standards (CEDS) is a national collaborative effort to develop voluntary, common data standards for a key set of education data elements across all levels of education, from early learning to K-12 to postsecondary and adult education. The CEDS vocabulary includes standard definitions, option sets, and technical specifications to streamline sharing and comparing information. The initiative is sponsored by the U.S. Department of Education's Institute of Education Sciences (IES) and guided by an open process that includes representatives from across the P-20W field.

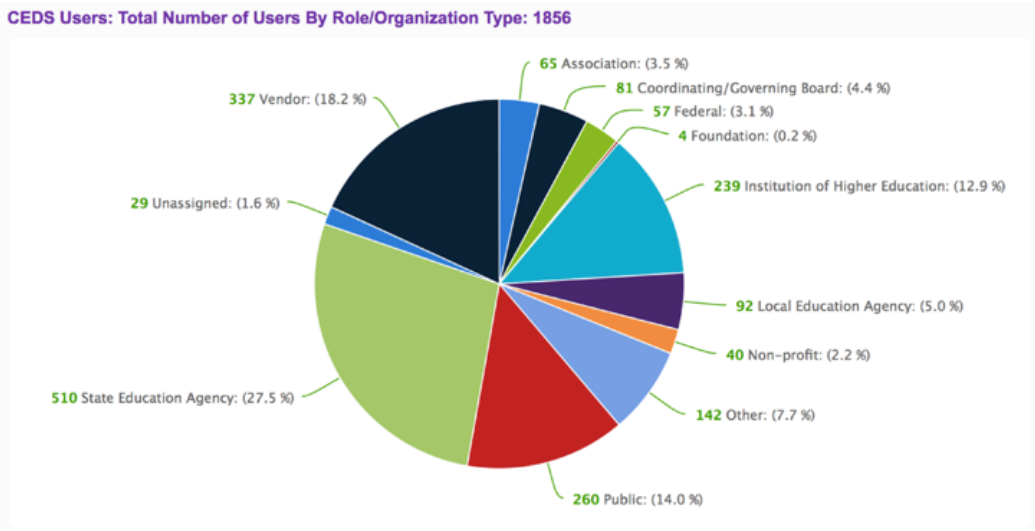
Participants in the stakeholder-driven process include:

- **State Agencies**
  - State Education Agencies
  - State Higher Education Agencies
  - Social Services Agencies
- **Local Education Agencies**
  - K12
  - Head Start
  - Social Services
- **Institutions of Higher Education**
  - Public
  - Private
  - Community Colleges

- **Early Learning Organizations**
- **U.S. Department of Education**
  NCES (SLDS, IPEDS, Forum)
  EDFacts
  Office of Educational Technology
- **U.S. Health and Human Services**
- **U.S. Department of Labor**
- **Interoperability Standard Organizations**
- **EdTech Vendors and Publishers**
- **Research Centers**
- **Education Associations**
- **Foundations**

Through CEDS policy-makers, educators, researchers, education leadership and IT staff all have a common reference for understanding the meaning of data.

The CEDS standards are available on the public web site http://ceds.ed.gov and every element definition may be referenced with a unique public URL. The site also provides tools, such as for aligning your data dictionary to CEDS elements, defining derived metrics, reference data models, and use guides. One indication of CEDS adoption is the number of users that not only access the site, but have registered to use the tools. As of May 2015 there are over 1,800 registered users.



CEDS supports both technical and non-technical audiences. Through CEDS policy-makers, educators, researchers, education leadership and IT staff all have a common reference for understanding the meaning of data.

CEDS is part of a larger ecosystem supporting data interoperability and quality. Data interoperability requires standards on multiple levels:

1. Common definitions at the data element level and for possible values
2. Data models that define context and relationships between data elements
3. Serialization – the packaging of data for transport between systems, and
4. Transport – the protocol and application programing interface by which the data is moved between systems

CEDS addresses the first layer of interoperability across the broad context of P20W education and provides reference data models addressing the second layer. Other initiatives provide the standards for serialization, transport, and real-time application integration to complete the technical stack for implementation of data interoperability within specific contexts and a narrower set of use cases.

Among other education data standards, CEDS is recognized as a kind of "Rosetta stone" that helps very different initiatives speak a common language at the data element level. CEDS works with the other organizations and associations that develop standards for data interoperability, content packaging, content discovery, micro-credentials, and application integration, to promote common vocabulary.

CEDS for Content

The content related data elements defined within CEDS were informed by other initiatives and pre-existing standards. For example, the Learning Resource domain within CEDS was developed based on the data elements defined by the Learning Resource Metadata Initiative (LRMI), influenced by the Dublin Core Metadata Initiative and others. The option sets used within those elements were developed by real-world implementations including 13 state education agencies that formed the Multi-state Tagging Initiative. CEDS brought together the LRMI elements and the Multi-state Tagging Initiative possible values. CEDS also worked with initiatives such as the Learning Registry to include element definitions supporting rating systems, and the Accessibility Metadata Project to include tags for accessible content. CEDS worked with IMS Global and the Schools Interoperability Framework to develop a comprehensive model for

assessment data and recognize the boundaries between data/metadata for content, administration, and scoring/use.

CEDS also serves as a bridge to related categories of data such as element definitions and relationships for learning standards and achievement data. CEDS defines the unit-level data definitions with consideration of the various contexts in which data (and metadata) may be used. For example, learning resource metadata may be used in a database of a stand-alone learning object repository, it may be used in tagging web pages with Schema.org/LRMI, or it may be used within a distributed architecture such as the Learning Registry.

Schools Interoperability Framework (SIF)

Alex Jackl, CEO, Bardic Systems
Technical Board Co-Chair, Schools Interoperability Framework (SIF)

The Schools Interoperability Framework is a vendor-neutral, platform-independent, completely open standard for the exchange of education data. It has 3,500 members ranging from school districts, states, the federal government, edtech vendors, publishers, and associations. It is active in the United States, Canada, the United Kingdom, and was recently selected as the national standard for education data exchange in Australia.

Watch the video presentation on SIF

It has an infrastructure component that manages the brokering of data and has direct services that allow app2app exchanges. The latest version, 3.2, utilized modern RESTful service designs to leverage the already-existent modern tools that have grown around using REST, XML, and JSON in the data industry. The data model in the SIF 3 specification is the only interoperability specification designed to specifically move the Common Education Data Standards vocabulary.

Just three months ago the SIF Association decided to expand the community to broaden its view to be more solution-oriented and to help education data users navigate through the alphabet soup of standards and edtech solutions. The new ACCESS FOR LEARNING (A4L.org) Community re-design is focused on simplifying the usage of the myriad resources currently available, moving past technical blueprint development into information access strategies. We are

starting to create deep partnerships with the other standards bodies and with new edtech providers and people concerned with privacy, data sharing, and other policy issues around data interoperability.

Data Privacy & Security—A Standards Opportunity

Bob Moore, Founder, RJM Strategies LLC
Privacy Initiatives Lead, CoSN

Data privacy and security, while often mentioned in the same breath are in fact, two different, but very closely related issues. Security refers to measures used to protect data, where privacy refers to protecting people from unwanted gathering or access to information about them. The privacy breaches we see so frequently reported in the media typically start as security breaches. And while there are some technical security standards, those are not commonly applied in the K12 market, whether by "vendors" or by school systems themselves.

As for privacy standards, they really don't exist. Laws that are intended to protect student privacy, for example, are terribly outdated, particularly at the Federal level. These laws such as COPPA (see below) and FERPA (see below) were adopted well before mobile apps and cloud services existed. Many states have been rushing to enact legislation to protect student privacy, but that has often been focused on the commercial use of data, that is the collection and use of data by websites, online service providers and mobile apps. State legislators, as well as school system administrators, fail to recognize that poor data security practices pose a much greater threat to student privacy. In addition, most schools have little or no data governance systems in place and do a generally poor job of educating students about the role they play in protecting their own privacy, their "digital footprint" as it is sometimes referred to.

Watch the video presentation on data privacy standards

There are 4 Federal privacy laws that affect education. They are:

- FERPA (Family Education Rights & Privacy Act) – 1974 – US Dept. of Education
- COPPA (Children's Online Privacy & Protection Act) – 2000 – Federal Trade Commission
- PPRA (Protection of Pupil Rights Amendment) – 1978 – US Dept. of Education
- HIPAA (Health Insurance Portability & Accountability Act) – 1996 – US Dept. of Health & Human Services

In 2014, there were 26 new student privacy laws adopted in 20 states. Even more have been considered in 2015, and with the passage of each new law grows the confusion among school leaders as to how to manage this issue.

In order to understand why privacy has become such a hot button issue in recent years, it is important to understand some basic truisms about privacy.

1. The more we rely on technology, the more we lose control of our privacy.
2. New Technology brings new privacy threats.
3. Law always lags technology.
4. Data about you is very valuable.
5. Privacy is personal.

With just a quick consideration of these statements, it's easy to understand why the concerns over privacy will only continue to grow and that this issue is not a "fad."

While there are many resources for school leaders and others interested in this topic, here are a few of the most significant:

The Protecting Privacy in Connected Learning Toolkit

The Student Data Principles by CoSN & Data Quality Campaign

The Student Privacy Pledge for Online Service Providers

A collection of privacy resources at www.FERPASHERPA.org

Experience API (xAPI)

Jonathan Poltrack, Director of Operations / Tech Team Co-Lead, Advanced Distributed Learning (ADL)

QTI specifications are now the most widely used standards for evaluating and annotating assessment questions.

The Experience API (xAPI) is a specification created by an open source community and managed by the Advanced Distributed Learning (ADL) Initiative. The xAPI specification defines Web services and data formats for tracking and accessing learning experience information. The services work by allowing statements of experience to be delivered to, and stored securely in a Learning Record Store (LRS). Additionally, the LRS provides access to previously stored data via similar xAPI services.

A core component of the xAPI is a statement. Statements are the main structure used to track data. They use a format similar to Activity Streams that are widely used in social media platforms. Simply, a statement can be thought of as a sentence containing an actor, a verb and an object like: "I did this." In this format, the actor is the performer of the action. An actor can be any relevant role in a learning enterprise including learners, mentors, teachers, tutors or groups. The verb describes the action of the statement, such as "read", "passed", or "authored". The object is the item with which the actor interacted, like a book, a test, a simulation or a class.

The xAPI also provides a way to retrieve statements previously stored in an LRS. In legacy environments, tracked data was locked in proprietary databases. This data was often presented in the form of a gradebook component that showed rolled up items like score, completion, and success (pass/fail). However, if a requirement existed to view or use more granular data, this information may not be accessible and likely not without implementing a proprietary interface. The xAPI solves this common issue by providing interoperable, secure access to data after it is initially stored.

The xAPI specification was written to be flexible enough to meet the varying use cases of the e-learning community. This flexibility can lead to a degradation of interoperability. To solve potential interoperability issues, communities of practice (CoPs) began to form to create profiles of the spec to add additional structural rules. ADL is currently developing a profile for the SCORM community that addresses topics such as launch of traditional web content, accepted verbs, and results for reporting data model elements like success and completion.

The xAPI is an ongoing, community-driven specification with contributors participating from around the world.

For more information:

General xAPI information including history, the CoP directory and FAQ:
http://xapi.adlnet.gov

xAPI specification

xAPI SCORM Profile

ADL xAPI resources and code libraries

IMS Interoperability Standards—QTI® and APIP®

Mike Powell, Founder and Chief Architect, Learning Logistics

IMS Global is a non-profit, standards organization that enhances e-learning standards ranging from metadata to transferring learner information. With over 200 participating industry members IMS develops and promotes the use of specifications that enables distributed learning and therefore benefits students with both low and high level abilities. IMS initiates efforts to standardize the packaging of test items so that they can be efficiently transported, consistently interpreted, accurately presented and made accessible to students with disabilities. These interoperability standards are known as the Question and Test Interoperability (QTI®) specification and the Accessible Portable Item Protocol (APIP®).

Watch the video presentation on QTI & APIP

The IMS Question and Test Interoperability (QTI) specifications have expanded greatly and are now the most widely used standards for evaluating and annotating assessment questions. QTI represents an Extensible Markup Language (XML) based format that allows questions and tests to be more easily exchanged between item authoring and online assessment systems. QTI standardizes how to define and mark up questions, arrange them into logical tests, and package everything into a ZIP file. An additional benefit is that QTI XML not only describes the static parts of questions and tests (text, layout, order, etc.), but also their dynamic behaviors such as how to calculate a score or how and when to provide specific feedback.

Assessment items are the primary focal points because they are the basic building blocks of QTI. An item can consist of an arbitrarily complex combination of text (with markup), multiple questions of different types, and multimedia objects. It also defines its own result and response processing to determine when an answer is considered correct and can therefore be scored and given feedback.

IMS Accessible Portable Item Protocol (APIP) Standard is another interoperability standard that enables file format interchangeability and allows all tests and test items to be easily accessible for students across all levels, including those with disabilities. It is imperative all students have access to and are able to respond to a selection of assessments in order for the assessments to be valid and reliable. Data driven instruction, one of the most dependable and popular ways teachers guide their instruction, depends on the results of informative testing.

APIP provides assessment programs and test developers with a data model for standardizing digital test items across differing delivery platforms. APIP is based on three existing interoperability standards: QTI version 2.1, Access for All (defines a common way for describing students' needs and preferences in a digital environment), and Content Packaging (used to collate all QTI information and structure it in a convenient exchange format). This powerful combination of existing standards permits APIP to be a highly efficient interoperability solution for authoring and delivering accessible tests.

The success of APIP is chiefly due to three essential areas:

- An XML-based exchange format for assessment content,
- An XML-based exchange format for online assessment tool preferences for test-takers, and
- A certification process to ensure an APIP delivery system is capable of importing and properly using information supplied by APIP accessible content and APIP PNP files.

Organizations obtaining QTI or APIP standard products are advised to require IMS conformance certification for all products to ensure the highest levels of cooperation among systems. Products that have achieved conformance certification are listed and updated at imscert.org. For more information, it is recommended that you start with the APIP Best Practices document.

Smarter Balanced Assessment Consortium Technology Requirements & Standards

Brandt Redd, Chief Technology Officer, Smarter Balanced Assessment Consortium (SBAC)

Smarter Balanced is a public agency supported by 15 states, the US Virgin Islands, and the Bureau of Indian Education. Through the work of thousands of educators, Smarter Balanced created an online assessment system aligned to the Common Core State Standards (CCSS), as well as tools for educators to improve teaching and learning. The work of Smarter Balanced is guided by the belief that a high-quality assessment system can provide information and tools for teachers

and schools to improve instruction and help students succeed—regardless of disability, language, or subgroup. Smarter Balanced involves experienced educators, researchers, state and local policymakers, and community groups working together in a transparent and consensus-driven process. To give an idea of scope and reach, 18 consortium members representing approximately 14 million students delivered tests in the Spring of 2015. Since testing is performed in seven of those grades (grades 3-8 and 11) approximately half of those students, or 7 million, were tested using Smarter Balanced assessments in the Spring of 2015.

Innovative Features

Smarter Balanced tests incorporate innovative item types that are facilitated through online delivery. There is a greater focus on Depth of Knowledge (DOK) levels 3 and 4 than previous assessments. Items addressing higher DOK levels include constructed response items and performance tasks. The result is an expectation that students are able to apply skills, not just reproduce facts or execute mathematical processes. The tests also include unprecedented levels of accessibility to students with disabilities. Publishers should consider the emphasis on higher DOK levels when they develop curricular materials and design learning activities.

Watch the video presentation on SBAC & PARCC

Technology Requirements and Device Usage

The primary technology requirements for Smarter Balanced tests that will influence district and school purchases include:

- Web connectivity
- 9.5 inch minimum screen size
- Audio (headphones)
- Mechanical keyboard (to avoid obscuring the screen)
- Pointing device
- Capable of running an approved secure browser

SETDA has posted an excellent cross reference of the hardware requirements of the various consortia here: http://gtr.setda.org. The chart on Slide 5 is a preliminary summary of device use when taking Smarter Balanced tests. Publishers of digital curricula can align their technology requirements to those expected by the assessment consortia.

Interoperability

Each member state chooses its own service provider to administer, score, and report the Smarter Balanced tests, which poses a significant interoperability challenge. To address this, Smarter Balanced chooses open standards as much as possible. Some of these standards include:

- Common Core State Standards
- SmarterApp Assessment Item Format
- Common Education Data Standards (CEDS)
- IMS Content Packaging
- SAML and OAuth (Single sign-on)
- Smarter Balanced Profile of IMS QTI/APIP*
- LRMI and Learning Registry*
- Accessible Rendered Item format (ARI)*

**Planned*

Addressing Challenges

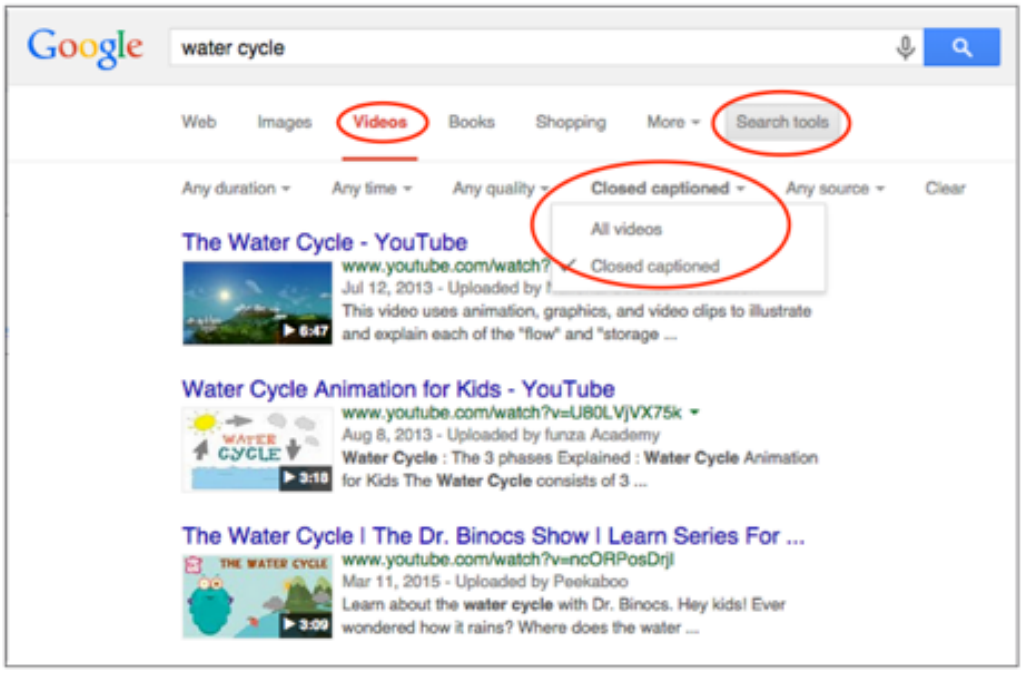
The nature of what Smarter Balanced has set out to do and the methods by which we achieve those goals present numerous challenges, including the challenge of deploying open source across vendors, packaging assessments for multiple vendors, developing an efficient assessment production system, and sustaining the pace of innovation. In order to maintain interoperability while facilitating innovation, Smarter Balanced offers its technology under open licenses – Creative Commons for Specifications and Open Source licenses for code. Smarter Balanced is actively investing in technologies like the Accessible Rendered Item (ARI) format that it will give to the greater community. The consortium's mission to serve member states places us in a unique position to invest in open-licensed technology.

Accessibility Metadata

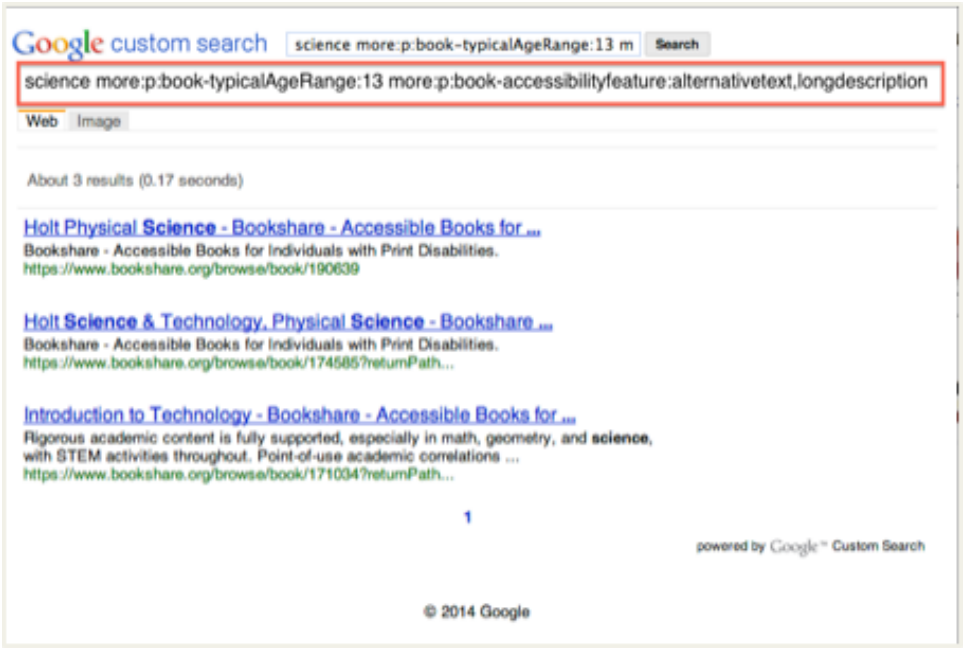
Madeleine Rothberg, Project Director, WGBH National Center for Accessible Media

Accessibility metadata offers the potential for teachers and students to rapidly identify which educational resources are most appropriate for students with disabilities. Students with different disabilities will need different accessibility features, so having detailed metadata about the efforts that have been made to make each product accessible will support publishers' efforts to increase the accessibility of their product lines and let purchasers know about that effort. It will also serve as an internal tool during product development to guide efforts to add accessibility to the product catalog.

Accessibility metadata has been defined by Schema.org for use in web-based metadata, based on IMS Global's Access for All efforts that reflect a decade of development. The same properties have also been incorporated into the Common Education Data Standards (CEDS). The properties and terms, along with examples and other documentation, are available from the Accessibility Metadata Project web site.



Currently, Google provides searching on YouTube videos that include closed captions through the Search Tools interface. The screen image above shows a general search, narrowed to videos with closed captions.



A wider range of accessibility features can be searched using Google Custom Search. Above is a sample Google custom search for science books for students age 13 that include descriptions for images (short alternative text or long description). The results are three books from the Bookshare collection.

Watch the video presentation on Accessibility Metadata

Accessibility metadata is already being published by a number of digital collections, including Khan Academy, Bookshare, Hathi Trust, the Open Library Initiative, the Learning Registry, Yahoo!, YouDescribe, and the Francophone accessible digital library, La Bibliothèque Numérique Francophone Accessible. In addition, accessibility metadata is added automatically to captioned videos embedded in WordPress blogs by the WordPress YouTube Plug-in called WP YouTube Lyte. The volume of resources with accessibility metadata on the Web is growing rapidly.

Resources for Accessibility Metadata:

The Accessibility Metadata Project
Specification, examples, crosswalk, and more:
http://www.a11ymetadata.org

Schema.org Metadata Integration Guide for EPUB 3
Advice on integrating Schema.org metadata in the EPUB® package document
By Matt Garrish, Michael Jay, and Madeleine Rothberg
http://www.idpf.org/epub/guides/schema-org-integration

Common Education Data Standards (CEDS)
https://ceds.ed.gov/elements.aspx# and filter for keyword "access"

LRMI and Learning Resource (Description) Visibility

Stuart Sutton, Managing Director, Dublin Core Metadata Initiative (DCMI)

The Learning Resource Metadata Initiative (LRMI) ontology is a small set of properties and classes primarily intended for the markup of learning resource web pages to support discovery by the major search engines. The LRMI ontology was a collaborative development of Creative Commons (CC) and the Association of Educational Publishers (AEP) with support from the Bill & Melinda Gates Foundation and the William and Flora Hewlett Foundation. The development of

the LRMI ontology went through three phases starting in June 2011: (1) expert input and specification, (2) deployment and early adoption, and (3) assessment of adoption outcomes and preparation for the transfer of the specification to an organization with the knowledge and commitment to guarantee its long-term viability.

Watch the video presentation on LRMI

In March 2012, LRMI version 1.1 was submitted to the World Wide Web Consortium (W3C) for review and discussion as a first step in its adoption in April 2014 as the learning resource extension to Schema.org—an initiative of Google, Bing, Yahoo, and Yandex to "create and support a common set of schemas for structured data markup on web pages." In October 2014, the 1.1 version of the LRMI ontology was transferred to the Dublin Core Metadata Initiative (DCMI) for long-term curation and further development. Within DCMI a permanent LRMI Task Group was created to manage the specification including strategic planning for its future development and adoption.

In order to support Schema.org-based description, the underlying data model for LRMI shares the same basic structure as W3C's Resource Description Framework (RDF) meaning that RDF-based tools and encoding formats can be used, but are not a required. Since the RDF data model is syntax-independent, LRMI structured data can be integrated across a broad array of implementation contexts and serializations including HTML5 Microdata, RDFa 1.1, JSON-LD, RDF/XML, and Turtle/N3 (to name a few current 'flavors'). While the original, and still primary, intention of LRMI was to support markup for resource discovery on the open web, the extensibility of the underlying data model supports the design of profiles that meet closed-world needs of individual and community-based applications by providing for: (1) the refinement of LRMI properties and classes through declaration of new sub-properties and sub-classes, and (2) the mixing of LRMI properties and classes with properties and classes drawn from other RDF-based ontologies to achieve richer resource descriptions and enhanced levels of interoperability.

With the transfer of stewardship of the LRMI to DCMI, the new Task Group's first task was to publish a canonical RDF schema of version 1.1 to serve as the base for both ongoing maintenance and the definition of 'next steps'. Informal discussions with personnel at Schema.org as well as anecdotal evidence indicate a clear need for development of concept schemes variously called "controlled vocabularies," "controlled property values," or "enumerations" to accompany the 1.1 properties. While the classes and properties provide the core structure and a relatively straight forward means for marking up learning resources for web discovery via Schema.org, the lack of clearly defined, machine-actionable concept schemes to constrain the somewhat infinite range of values that might be assigned to those properties can result in less than optimal metadata interoperability. To address this need, the Task Group has prepared the following draft concept schemes: Alignment Type, Educational Audience Role, Educational

Use, Interactivity Type, and Learning Resource Type. Draft concept schemes are also in preparation for Accessibility Hazard, Accessibility Feature, Accessibility API, and Accessibility Control. The draft concept schemes are serialized in RDF using the W3C's Simple Knowledge Organization System (SKOS-XL) and will go through public comment period before publication.

The design goals for the controlled vocabularies include:

1. Developing concept schemes that use existing examples as their base community-developed vocabularies with a record of application as opposed to reinventing or building from scratch—e.g., the vocabularies of the Common Education Data Standards (CEDS);

2. Developing a core, as opposed to fine-grained, concepts, and provide the technical mechanisms for their extension—e.g., regional, local, organizational additions and refinements;

3. Providing multilingual support for concept labels and descriptions to support international utility; and

4. Providing web-resolvable identifiers (URI) returning machine-actionable data to machines and narrative text to humans that includes language-tagged preferred and alternate labels and formal definitions.

Task Group work is also underway to improve implementer documentation on both the Schema.org and LRMI websites through the addition of more complete, real-world examples of Schema.org markup starting with example HTML describing educational resources without markup and including the same resources marked up in Microdata, RDFa, and JSON-LD using the LRMI ontology.

It is also the intention of the Work Group to develop usage and best practice guides and short how-to "recipes" to assist the education community in the principles and processes that lead to successful design and deployment of: (a) machine-actionable concept schemes, (b) educational frameworks, and (c) LRMI metadata profiles for community and institutional applications. The best practice guidelines will also include assistance in bridging the sometimes-difficult intersection of design and development assumptions of the closed world systems in which most implementers function and the seemingly incompatible assumptions of the open world of the web.

Other Ed Tech Standards

As noted previously, this document does not represent a comprehensive list of technical standards at work in the education space. The boundaries of this list were drawn by the PreK-12 Learning Group's Ed Tech Forum in 2015, and those confines were dictated by the amount of content that could be covered one day of programming and by the availability of standards representatives that could participate that day. Thus, some important standards were not discussed and hence were not included in this document. Following is a list of additional standards that impact the development and distribution of learning resources. The PreK-12 Learning Group intends to address these at future events or in forthcoming documentation.

Ed-Fi Data Standard

The Ed-Fi Data Standard is a CEDS-aligned open source standard that supports the integration and organization of raw education data and information from a broad range of data sources so it can be sifted and analyzed. The standard is made up of three components: a Unifying Data Model, XML Exchange Data Framework, REST API Design & Implementation Guidelines. The standard is licensed and governed by the Ed-Fi Alliance, which also licenses a collection of tools known as the Ed-Fi Implementation Suite, which includes a data store, dashboards, and validation tools. Find out more at ed-fi.org.

IMS Global Learning Consortium Standards

IMS Global is a nonprofit member organization whose main activity is to develop interoperability standards and adoption practice standards for distributed learning. Their QTI and APIP standards are covered in this document. Their portfolio of standards and specifications also includes:

- **Common Cartridge® and Thin Common Cartridge®:** Common Cartridge is a standardized format for packaging up content to make it easily transportable between learning management systems or platforms. Thin Common Cartridge is a subset of CC for use with content that is hosted securely on the web. Thin CC contains only metadata about the content and web links.
- **Learning Tools Interoperability (LTI)®:** a specification that enables interoperability between different learning applications and instructional platforms
- **Caliper Analytics Framework (under development):** a framework that aims to standardize the capture and presentation of learning activity data; define a common language for labeling learning data; and provide a standard way of measuring learning activities and effectiveness

- Learning Information Services (LIS) & OneRoster™: LIS defines how systems manage the exchange of information that describes people, groups, memberships, courses, and outcomes within the context of learning. OneRoster™ is a subset of LIS that focuses on the exchange of typical school roster information and grades.

Learning Object Metadata (LOM)

LOM is a data model created by IEEE in 2002 used to describe learning objects. A learning object was defined by the specification's working group as "any entity, digital or non-digital, that may be used for learning, education or training." LOM predates LRMI by nearly a decade. The technical working group that developed the LRMI specification did so with inspiration from—and the intention of being interoperable with—LOM. Find out more at: http://standards.ieee.org/findstds/standard/1484.12.1-2002-Cor_1-2011.html

NIMAS

The Individuals with Disabilities Education Act (IDEA) of 2004 requires states to address the difficulty of obtaining accessible textbooks for K-12 students with print disabilities by adopting a new file format, the National Instructional Materials Accessibility Standard (NIMAS). This same legislation offers a means to assist states in this responsibility by establishing a national repository to collect and store these files and make them available to states. This repository is the National Instructional Materials Access Center (NIMAC), which has been established at the American Printing House for the Blind, Inc. (APH) with support from the U.S. Department of Education. NIMAC receives source files in NIMAS format from textbook publishers, and makes these files available for download to Authorized Users in the United States and its territories through an online database. NIMAS is an XML-based source file format that is not intended to be used directly by students. Rather, the files are used as the starting point for creating braille, audio, large print, or digital text formats. In most all cases, some type of conversion is needed to convert NIMAS into a fully accessible version for a print disabled student. Find out more at: nimac.us and http://idea.ed.gov/explore/view/p/%2Croot%2Cdynamic%2CTopicalBrief%2C12%2C.

SCORM

SCORM governs how online learning content and platforms such as learning management systems communicate. While somewhat similar in scope to Common Cartridge, SCORM is particularly suited for self-paced training where the learner is usually learning independently. Common Cartridge is better suited for "blended learning" situations where there is a combination of traditional, teacher-led learning and web-based learning. Find out more at adlnet.gov/scorm.

Standards not specific to education

In addition to those listed above, there are a host of other technical standards and specifications that impact the development of educational resources and tools

but are not specific to education. These are important to note and may be examined from a preK-12 perspective in future Learning Group events or documentation: XML, HTML5, Schema.org, ONIX, MARC, JSON, and many more.

Links & Resources

EPUB/EDUPUB

- Main EPUB project website: http://idpf.org/epub
- EDUPUB profile: http://www.idpf.org/epub/profiles/edu/spec/
- Garth Conboy's Ed Tech Forum Video: https://vimeo.com/136139595
- Garth Conboy's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum-49175187

CEDS

- Main CEDS project website: https://ceds.ed.gov
- CEDS Data Model: https://ceds.ed.gov/dataModel.aspx
- Jim Goodell's Ed Tech Forum Video: https://vimeo.com/137528825
- Jim Goodell's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum-common-education-data

SIF

- Main SIF Association website: http://a4l.org
- SIF Implementation Specification (North America): https://www.sifassociation.org/Specification/Pages/North-America.aspx
- Alex Jackl's Ed Tech Forum Video: https://vimeo.com/137524046

Data Privacy

- CoSN's Protecting Privacy in Connected Learning initiative: http://www.cosn.org/focus-areas/leadership-vision/protecting-privacy
- Bob Moore's Ed Tech Forum Video: https://vimeo.com/137534147
- Bob Moore's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum-49174436

Experience API (xAPI)

- Experience API main project website: http://www.adlnet.gov/tla/experience-api
- xAPI Specification: https://github.com/adlnet/xAPI-Spec
- Jonathan Poltrack's Ed Tech Forum Video: https://vimeo.com/136144142
- Jonathan Poltrack's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-edtech-forum-at-cic-xapi

IMS Interoperability Standards—QTI and APIP

- IMS QTI®/APIP® Alliance: http://www.imsglobal.org/apip/alliance.html
- QTI Specification: http://www.imsglobal.org/question
- APIP Specification: http://www.imsglobal.org/apip
- Mike Powell's Ed Tech Forum Video: https://vimeo.com/137508610
- Mike Powell's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum-49174550

SBAC

- Smarter Balanced Assessment Consortium website: http://www.smarterbalanced.org
- SBAC Technology resources: http://www.smarterbalanced.org/smarter-balanced-assessments/technology
- Brandt Redd's Ed Tech Forum Video: https://vimeo.com/136170306
- Brandt Redd's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum-sbac

Accessibility Metadata

- Accessibility Metadata Initiative website: http://www.a11ymetadata.org
- Accessibility Metadata Specification: http://www.a11ymetadata.org/the-specification
- Madeleine Rothberg's Ed Tech Forum Video: https://vimeo.com/137535566
- Madeleine Rothberg's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum-49175467

LRMI

- Learning Resource Metadata Initiative website: http://lrmi.net
- LRMI Specification: http://www.lrmi.net/the-specification
- Stuart Sutton's Ed Tech Forum Video: https://vimeo.com/136129373
- Stuart Sutton's Ed Tech Forum Slides: http://www.slideshare.net/edpublishers/2015-cic-edtech-forum

Acknowledgements

The AAP PreK-12 Learning Group would like to thank all of those who shared their knowledge and insights as part of this event and contributed to the development of this document:

Garth Conboy
Chairman of the Board, International Digital Publishing Forum

Jim Goodell
Senior Analyst, Quality Information Partners
Coordinator, CEDS Stakeholder Group for K-12

Alex Jackl
CEO, Bardic Systems
Technical Board Co-Chair, School Interoperability Framework (SIF)

Michael Jay
President, Educational Systemics

Bob Moore
Founder, RJM Strategies LLC
Privacy Initiatives Lead, CoSN

Jonathan Poltrack
Director of Operations / Tech Team Co-Lead,
Advanced Distributed Learning (ADL)

Mike Powell
Founder and Chief Architect, Learning Logistics

Brandt Redd
Chief Technology Officer, Smarter Balanced Assessment Consortium (SBAC)

Madeleine Rothberg
Project Director, WGBH National Center for Accessible Media

Stuart Sutton
Managing Director, Dublin Core Metadata Initiative (DCMI)