

Achievement Standards Network (ASN): An Application Profile for Mapping K-12 Educational Resources to Achievement Standards

Stuart A. Sutton
University of Washington, USA
sasutton@u.washington.edu

Diny Golder
JES & Co, USA
dinyg@jesandco.org

Abstract

This paper describes metadata development of an application profile for the National Science Digital Library (NSDL) Achievement Standards Network (ASN) in the United States. The ASN is a national repository of machine-readable achievement standards modeled in RDF that shape teaching and learning in the various states. We describe the nature of the ASN metadata and the various uses to which that metadata is applied including the alignment of the standards of one state to those of another and the correlation of those standards to educational resources in support of resource discovery and retrieval.

Keywords: Resource Description Framework (RDF); educational resources; K-12 achievement standards; Achievement Standards Network (ASN); National Science Digital Library (NSDL)

1. Introduction

The correlation or mapping of learning resources such as lesson plans, curriculum units, and learning objects to formally promulgated achievement standards is a growing imperative in the U.S. K-12 environment. We choose “achievement standards” as a generic term indicating all forms of statements formally promulgated by a jurisdiction, community or organization to help shape teaching and learning in K-12 schools.²⁰ Achievement standards are frequently called curriculum objectives in the cataloging literature and academic standards, curriculum standards, learning indicators, benchmarks and an array of other names by various education communities and promulgating agencies. The standards movement in the U.S. has been stimulated largely by the perceived need to increase quality and accountability in the nation’s K-12 schools.

Starting slowly with the clarion call of *A Nation at Risk: The Imperative for Educational Reform*, development of policies defining accountability for U.S. teachers and schools has accelerated the processes of standards-based education in the U.S. Largely unheard of in the U.S. at the beginning of the 1990s, every state in the Union except one has promulgated achievement standards defining what K-12 students will learn, when that learning will take place, and how learning will be assessed. Influences such as the federal No Child Left Behind Act of 2001, testing regimes such as the National Assessment of Educational Progress (NAEP) and state high-stakes testing are major drivers in the developing call for learning resources that assist teachers in meeting the

²⁰ There are two broad classes of resources of concern to the ASN—curriculum standards and content standards. “[A] *content* standard describes what students should know and be able to do; a *curriculum* standard describes what should take place in the classroom. Specifically, curriculum standards address instructional technique or recommended activities as opposed to knowledge and skill per se (Marzano & Kendall, 1997).” “Content standards specify ‘what students should know and be able to do.’ They indicate the knowledge and skills—the ways of thinking, working, communicating, reasoning, and investigating, and the most important and enduring ideas, concepts, issues, dilemmas, and knowledge essential to the discipline—that should be taught and learned in school (National Education Goals Panel, 1993)”

demands of demonstrable accountability lurking behind the articulated state standards (Sutton, 2008).²¹

The social and political thrust in the U.S. behind the national move toward accountability in K-12 education has roots in standards-based systems of teaching and learning. Since achievement standards reflect the knowledge, skills and habits of mind that K-12 students are expected to attain in a particular content area and at a given grade level, clear articulation of achievement standards coupled with rigorous assessment are at the heart of the systemic school initiatives in the U.S. under NCLB. NCLB invests states with the responsibility to create the standards for proficiency and then assess students against those standards in the core subjects of mathematics and language arts starting in 3rd grade. While the U.S. has what are loosely called “national standards,” they are the result of standards-making activities of non-governmental organizations and bear no resemblance in terms of political force to the official national standards found in other countries around the world.

Fundamental to this notion of standards-based education are three “guiding questions” (Gaddy, Dean & Kendall, 2002):

1. What knowledge and skills will students be learning?
2. What evidence will be gathered and used to ensure that students learn?
3. What experiences will be used to ensure that students learn?

As illustrated in Figure 1, there should be a tight coupling among the achievement standards, what is being taught and the student learning assessed. Student learning degrades to the extent there is a misalignment between what is taught and what is assessed or between the goals of what is taught and the goals the educational system expects students to achieve.

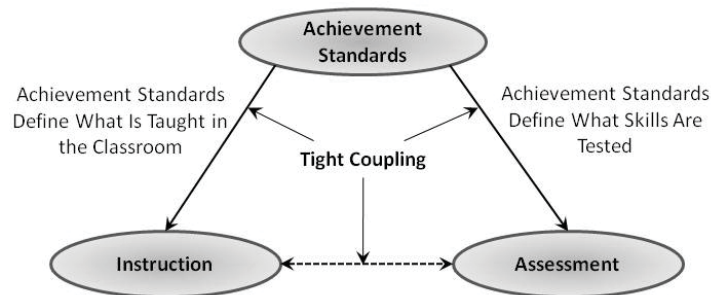


FIG. 1: Aligning goals, content and assessment

One of the major goals of the ASN is to support this tight coupling amongst achievement standards, instruction and assessment by providing a national repository of comprehensive machine-addressable achievement standards that can be used by applications serving the education community including search engines, metadata generation tools and other 3rd party services. Prior to the ASN, collection holders and publishers wishing to correlate educational resources to achievement standards were faced with either developing very expensive, project-specific collections of achievement standards (and then maintaining them when they changed) or acquiring those standards from commercial entities (at even greater expense). In either case, the systems so deployed are not interoperable outside the closed system environments in which they were deployed.

The remainder of this paper is organized as follows: Section 2 describes the general architecture of the ASN in terms of its functionality and content. Section 3 is framed in terms of

²¹ Since Sutton’s paper was written in 2007, all 50 states in the U.S. have now created achievement standards for K-12 education.

the major tasks that the ASN is intended to accomplish in satisfying the need to express necessary relationships amongst the information objects of which the ASN is composed. Section 4 briefly explores the ASN potential for defining additional semantic relationships among ASN objects. In section 5, we describe the ASN mechanism for the refinement of standards statement by 3rd parties needing more fine-grained expressions than those provided by the promulgator in the canonical standards document. Section 6 provides conclusions and future directions.

2. ASN Architecture

The metadata for the ASN application profile has been developed around two primary objects—the K-12 standards document and the standards document component statements. The metadata for these objects, including declaration of relationships among them, has been modeled using Resource Description Framework (RDF). The modeling of the ASN took place during the early stages of the emergence of the DCMI Abstract Model and predates current DCMI work on the description set profile. Work is underway to bring the ASN XML/RDF encodings of the application profile into full alignment with the recent developments around the Abstract Model.

In order to guarantee maximum endorsement of the contents of the ASN by the promulgators of the standards, the focus of processing has been document-centric and the faithful rendering of the standards document in a form amenable to the Web environment. In document processing, each standards document is analyzed and decomposed into a set of atomic semantic units we call statements with each statement being assigned its own URI using Persistent URLs.

Several properties have been declared to express the structural relationships holding between individual statements and between statements and the parent document. It is anticipated that additional structural relationships among ASN objects will evolve as the publishing environment for standards matures and greater reliance is placed on the Web for access to those standards. In general, the current structural properties make it possible to express comprehensive units of meaning in standards documents in the form of hierarchical taxon paths. Figure 2 illustrates a single hierarchical taxon path for an Ohio math standard.



FIG. 2. An Ohio math standard taxon path

The taxon path in Figure 2 is composed of metadata describing the standards document and a hierarchical structure of metadata describing three statements. Currently, two properties are used to handle these structural characteristics: (1) <dcterms:isPartOf> to describe the relationship between a statement and its standards document; and (2) <gem:isChildOf> to describe the hierarchical relationship between two statements in a taxon path. While the structure of most U.S. K-12 standards documents is hierarchical in nature, nothing in the ASN architecture precludes the definition of additional properties to manage more complex non-hierarchical structural relationships between statement objects.

Currently, access to the contents of the ASN repository of standards is accomplished either through: (1) the batch downloading of an entire standards document in RDF/XML from the ASN for use in local systems where the complete standards document is needed to meet local purposes; or, (2) through the dereferencing of an individual statement URI that has been assigned to a metadata record describing a resource. Dereferencing treats the object identified by the URI as the leaf object in a taxon path and returns all object metadata in the upward direction of the path including RDF/XML metadata describing the standards document.

2.1. Contents of the ASN

The ASN Achievement Content Standards Repository (ACSR) includes over 700 current and historical achievement standards documents for K-12 education as promulgated by departments or boards of education in each of the United States. Also included is a growing body of standards from nationally recognized content groups (e.g., the American Association for the Advancement of Science (AAAS)). Co-operative work is underway with the Australian Learning Federation to include all of the Australian national, state and territory standards. Currently, the machine-addressable standards statements in the ASN exceed 340,000 individual statements.

2.2. Functional Components of the ASN Architecture

The ASN architecture is composed of four major components and related services that make it possible for users and applications to access ACSR data stores and to author new standards documents within the ASN environment.

2.2.1. Standards Development Application (SDA)

The SDA assists standards bodies in developing well structured standards by providing a Web-based standards authoring environment. Created originally by ASN for the U.S. State Educational Technology Directors Association (SETDA), the development application is available to ASN member organizations maintaining standards within the ASN. Promulgators of achievement standards can register with the ASN and, through the authoring environment both author and publish their standards. The goal of the project with SETDA is for all 50 states in the U.S. to either author directly into the ASN or to republish in the ASN from their paper systems thus assigning globally unique ASN URI.

2.2.2. Standards Repository Application (SRA)

The SRA manages the ACSR data store of state, national, and international standards as well as the interface to the standards development application. The SRA also handles the processes associated with batch download of RDF/XML standards documents by third-party publishers, intermediaries and other service providers.

2.2.3. Metadata Generation Interface (MGI)

The MGI provides the means through Web Services for third-party metadata generation tools to interact with the ACSR and supports searching, browsing and the assignment of ASN URI to metadata records.

2.2.4. URI Resolver Application (URA)

The URA dereferences a state or national ASN standard URI embedded in a metadata record providing the full-text of each of the statement objects in the URI's associated taxon path.

3. Core ASN Tasks

As originally conceived, the ASN was intended to support two core tasks: (1) *correlation* of educational resources to achievement standards to support resource discovery and retrieval by K-12 teachers; and (2) *alignment* (mapping) of a standard statement in one standards document to a statement in a different standards document. Figure 3 illustrates these two core relationships.

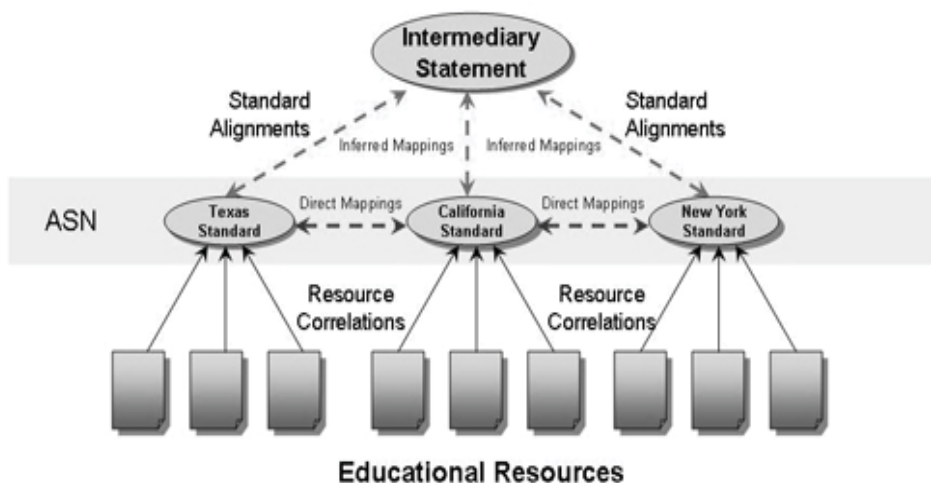


FIG. 3: Alignment and correlation processes

3.1. Correlation

A *correlation* is the assertion of a relationship between some educational resource and a standards statement as illustrated at the bottom of the Figure 3. In general, a correlation states that the resource being described is useful in achieving the goal(s) of the standards statement. In its simplest form, the <dcterms:conformsTo> property can be used in a Dublin Core description of an educational resource to assert this relationship. However, where the strength of fit between the resource being described and the standards statement is less than perfect, use of a separate description of the correlation including information regarding the strength of fit is more appropriate than the use of <dcterms:conformsTo>. We are in the process of defining a schema and accompanying constraints for describing such complex correlations in an educational resource description set where the educational resource being described is less than optimally useful in meeting the goal(s) of the standards statement.

3.2. Alignment

An *alignment* is the assertion of a relationship between a statement object in one standards document and a statement object in a different standards document—for example, the assertion that a statement in a Texas standard is similar to, or the same as, a statement in a New York standard. Thus, alignments are the means by which we make claims that one statement is more-or-less equivalent to another statement. Such alignments can be: (1) *direct* (see the red arrows in Figure 3), where the mappings are many-to-many; or (2) *inferred* where the mapping is to some form of intermediary statement and used in the manner of a switching language (i.e., many-to-

one). The assumption behind the indirect alignments in Figure 3, is that we can state that there is a high likelihood that the substance of the Texas standard illustrated is similar to that of the New York standard because both are aligned to the same intermediary statement.

In the U.S., several NSF-funded research projects are developing intermediary applications that use ASN as their core data infrastructure. The Standards Alignment Tool (SAT) under development as part of the Computer-Assisted Content Standard Assignment & Alignment (CASAA) project at the Center for Natural Language Processing at Syracuse University uses natural language processing to suggest possible alignments between ASN standards statements (<http://www.cnlp.org/research/project.asp?recid=48>). WGBH uses ASN standards data in their Teachers Domain intermediary application that generates its alignment mappings dynamically through use of a controlled vocabulary performing the switching functioning (<http://www.teachersdomain.org/>). Through a member's Teachers Domain profile, the system maps all retrieved educational resources to the controlling standards in the member's state.

4. Semantic Relationships

While the current relationships defined in the ASN are structural in nature (e.g., defining the hierarchical structure of a taxon path as well as the structural relationship between a statement and its parent document), nothing in the ASN architecture precludes the definition of other semantic relationships between statement objects in one or more standards document objects. For example, strand maps, such as those developed by American Association for the Advancement of Science (AAAS) that incorporates the learning goals articulated in the *Benchmarks for Science Literacy* (Project 2061, 1993) and the Strand Map visualizations published in the *Atlas of Science Literacy* (Project 2061, 2001; Project 2061, 2007), help participants see how other standards statements relate and contribute meaning to the statement being studied. Thus, strand maps illustrate the relationships between individual learning goals and show the growth-of-understanding of ideas.

Edges connecting statements in the AAAS strand maps indicate that achieving the goal embodied in one statement contributes to achieving another. While the exact meaning of connecting lines in AAAS strand maps must be inferred from the context of the map, we envision making the meaning of various strand relationships explicit through definition of new ASN properties.

5. Refinement Semantics

Since ASN statements are faithful to the standards document, there are occasions when the granularity of a leaf in a taxon path could be effectively subdivided into more granular statements. For example, the leaf statement in the Ohio math standard from Figure 2 states:

Analyze and solve multi-step problems involving addition, subtraction, multiplication and division using an organized approach, and verify and interpret results with respect to the original problem.

A publisher of testing instruments might well want to break this Ohio statement down into its sixteen constituent aspects (as illustrated in Table 1) in order to test separately one or more of those aspects.

TABLE 1: Statements derived from the canonical Ohio statement.

	involving addition	involving subtraction	involving multiplication	involving division
Analyze multistep problems ...	analyze addition	analyze subtraction	analyze multiplication	analyze division
Solve multistep problems ...	solve addition	solve subtraction	solve multiplication	solve division
Verify multistep problems ...	verify addition	verify subtraction	verify multiplication	verify division
Interpret multistep problems ...	interpret addition	interpret subtraction	interpret multiplication	interpret division

To accommodate the need to further refine what we call *original* statements (i.e., the canonical statement from the standard’s promulgator), we define a class of *derived* statements. This process of refinement is illustrated in Figure 4.

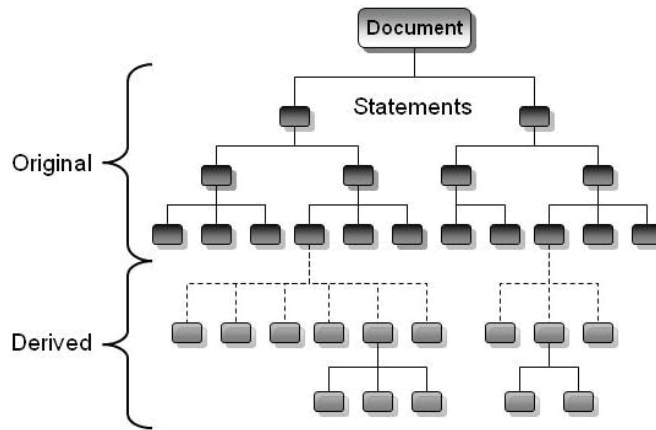


FIG. 4: Refining taxon paths through creation of derived statement objects by 3rd parties

In general, derived statement objects will be created either directly in the ASN by 3rd parties with the need for such refinements or in a namespace maintained by those parties. However, nothing precludes the ASN from creating such refinements where it deems it necessary to do so. In either case using the example in Figure 4, the derived statements are declared as children of the original statement created by the promulgating agency.

6. Conclusion & Future Work

The ASN is intended to provide critical system and data infrastructure to support K-12 teaching and learning in the U.S. It provides a common reference for any information system needing to utilize achievement standards in delivering interoperable standards-based services to the educational community. However, the ASN provides more than authoritative achievement standards texts in digital form by articulating a principled framework for future development of standards-based services that are amenable to the Semantic Web.

While any promulgating standards body can use the ASN to author and expose their standards, we are aware that other standards repositories will likely be developed—perhaps by the individual promulgators of some standards. What the work with the ASN provides is a means by which such systems can be designed to interoperate intelligently. System criteria for such interoperability include:

- Standards documents and their distinct semantic units (i.e., analogs of ASN statements) are treated as related objects within the system;
- Standards documents and each semantic unit are described (including the source text of each semantic unit);
- Each object in the system is assigned a URI that is dereferenceable by humans and Web-based applications; and
- The value returned through dereferencing is the set of URIs of the objects that compose the complete taxon path—thus providing everything necessary to reconstruct the structural and semantic context of the identified standard object.

Future work, in addition to the development of the separate correlation resource discussed briefly in Section 3.1, includes the exploration of versioning demands and mechanisms for standards statement objects. The document-centric nature of the ASN reflects the reality of the current publishing environment for U.S. K-12 standards. Promulgators of these standards periodically publish new versions with each version superseding the previous one. However, we think that as the publishing environment shifts to the Web through applications such as the ASN, fewer promulgators of standards will follow this publication cycle and will instead engage in ongoing versioning at the level of what the ASN defines as the statement or the taxon path.

In anticipation of such a shift, we are currently exploring mechanisms of statement versioning that track the changes to statement objects over time. This will allow us to aggregate ‘families’ of statement objects while maintaining metadata about each object—e.g., when a particular version of a statement object was created, under what circumstances, and how that object relates to other versions of the same statement.

The ASN work described here is somewhat related to the work of the IEEE LTSC 1484.20 Reuseable Competency Definitions (RCD) standard.²² However, it differs in substantial ways including reliance on a different underlying abstract model and the RCD’s focus on unstructured text intended for human interpretation. As work on the ASN goes forward and the Joint DCMI/IEEE LTSC Taskforce’s work on expressing IEEE LOM metadata using the Dublin Core Abstract Model moves to completion, we anticipate that aspects of the RCD may be deployed in the ASN framework.²³

Acknowledgements

The authors acknowledge the support of the entire ASN community including Bruce Walker and our colleagues at the Syracuse University Center for Natural Language Processing (CNLP), WGBH: Teachers Domain, DLESE and Digital Learning Sciences, the American Association for the Advancement of Science (AAAS), and the State Educational Technology Directors Association (SETDA). This work is partially funded by the National Science Foundation under grant number DUE: 0121717.

²² IEEE LTSC 1484.20 Working Group, <http://ltsc.ieee.org/wg20/>.

²³ Joint DCMI/IEEE LTSC Taskforce, <http://dublincore.org/educationwiki/DCMIIEEEELTSCTaskforce>.

References

- Commission on Excellence in Education (NCEE). (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Government Printing Office.
- Gaddy, Barbara B., Ceri B. Dean, and John S. Kendall. (2002). *Noteworthy perspectives: Keeping the focus on learning*. Aurora, CO: Mid-continent Research for Education and Learning. Retrieved March 21, 2007, from http://www.mcrel.org/PDF/Noteworthy/5022IR_NW_Focus.pdf.
- Marzano, Robert J., and John S. Kendall. (1997). *The fall and rise of standards-based education: A National Association of School Boards of Education (NASBE) issues in brief*. Aurora, CO: Mid-continent Research for Education and Learning. Retrieved March 23, 2008, from http://www.mcrel.org/PDF/Standards/5962IR_FallAndRise.pdf.
- National Education Goals Panel. (1993). *Promises to keep: Creating high standards for American students*. Washington, DC: National Education Goals Panel.
- No Child Left Behind Act of 2001* (§§ 6301-7941). 20 U.S.C.
- Project 2061, American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.
- Project 2061, American Association for the Advancement of Science. (2001). *Atlas of Science Literacy*. Washington, D.C.: American Association for the Advancement of Science and the National Science Teachers Association.
- Project 2061, American Association for the Advancement of Science. (2007). *Atlas of Science Literacy*. Washington, D.C.: American Association for the Advancement of Science and the National Science Teachers Association.
- Sutton, Stuart A. (2003). Principled design of metadata-generation tools for educational resources. In Marcia A. Mardis, *Developing digital libraries for K-12 education*, (pp. 45-63). Syracuse, NY: ERIC Clearinghouse on Information and Technology.
- Sutton, Stuart A. (2008). Metadata quality, utility and the semantic web: The case of learning resources and achievement standards. *Cataloging & Classification*, 46(1).

Appendix A. ASN Taxon Path RDF/XML Encoding

```
<rdf:RDF
  xmlns:dcterms="http://purl.org/dc/terms/"
  xmlns:gemq="http://purl.org/gem/qualifiers/"
  xmlns:asn="http://purl.org/ASN/schema/core/"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">

  <!--STATEMENT DESCRIPTION -->
  <rdf:Description rdf:about="http://purl.org/ASN/resources/S1024934">
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/4"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/10"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/K"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/6"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/8"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/12"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/2"/>
    <dcterms:isPartOf rdf:resource="http://purl.org/ASN/resources/D100017A"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/9"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/11"/>
    <dcterms:description>Number, Number Sense and Operations Standard</dcterms:description>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/7"/>
    <rdf:type rdf:resource="http://purl.org/ASN/schema/core/Statement"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/1"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/3"/>
    <dcterms:subject rdf:resource="http://purl.org/ASN/scheme/ASNTopic/math"/>
    <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/5"/>
  </rdf:Description>
```

```

<!--STATEMENT DESCRIPTION -->
<rdf:Description rdf:about="http://purl.org/ASN/resources/S100592F">
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/6"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/10"/>
  <dcterms:subject rdf:resource="http://purl.org/ASN/scheme/ASNTopic/math"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/1"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/12"/>
  <rdf:type rdf:resource="http://purl.org/ASN/schema/core/Statement"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/3"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/9"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/7"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/5"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/11"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/2"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/8"/>
  <dcterms:description>Computation and Estimation</dcterms:description>
  <gemq:isChildOf rdf:resource="http://purl.org/ASN/resources/S1024934"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/K"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/4"/>
</rdf:Description>

<!--DOCUMENT DESCRIPTION -->
<rdf:Description rdf:about="http://purl.org/ASN/resources/D100017A">
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/6"/>
  <dcterms:created>2001</dcterms:created>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/10"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/8"/>
  <rdf:type rdf:resource="http://purl.org/ASN/schema/core/StandardDocument"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/12"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/7"/>
  <dc:title>Academic Content Standards K-12 Mathematics</dc:title>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/5"/>
  <dcterms:description xml:lang="en-US">The mathematics academic content standards prepare all students for
success in the workplace and post-secondary education. Competency in mathematics includes understanding of
mathematical concepts, facility with mathematical skills, and application of concepts and skills to problem-solving
situations. Students are able to communicate mathematical reasoning using mathematical
and everyday language.</dcterms:description>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/9"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/K"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/1"/>
  <asn:jurisdiction rdf:resource="http://purl.org/ASN/scheme/ASNJurisdiction/OH"/>
  <dcterms:subject rdf:resource="http://purl.org/ASN/scheme/ASNTopic/math"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/2"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/11"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/3"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/4"/>
</rdf:Description>

<!--STATEMENT DESCRIPTION -->
<rdf:Description rdf:about="http://purl.org/ASN/resources/S1024B7C">
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/scheme/ASNEducationLevel/4"/>
  <rdf:type rdf:resource="http://purl.org/ASN/schema/core/Statement"/>
  <dcterms:description>12. Analyze and solve multi-step problems involving addition, subtraction, multiplication
and division using an organized approach, and verify and interpret results with respect to the original
problem.</dcterms:description>
  <dcterms:subject rdf:resource="http://purl.org/ASN/scheme/ASNTopic/math"/>
  <gemq:isChildOf rdf:resource="http://purl.org/ASN/resources/S100592F"/>
</rdf:Description>
</rdf:RDF>

```

APPENDIX B.

ASN Document Properties

Property Label	Context-Specific Definition
Adoption Date	The date the standards document was adopted by the jurisdiction in which it was intended to apply.
Creator	The person or organization chiefly responsible for the intellectual content of the standards document.
Change Note	A change note is intended for documenting fine-grained changes to a standards document for the purposes of administration and management.
Date Copyrighted	Date of the copyright of the standards document.
Date Valid	Date (often a range) of validity of a standards document.
Description	An account of the content of the standards document.
Editorial Note	Information regarding the analysis of the standards document in preparation for its representation within the ASN.
Education Level	The grade or grade bands covered by the standards document being described.
Has Child	Identifies child statements of the standards document being described. I.e., identifies the top-level statements of the standards document.
History Note	A piece of information intended for users of the scheme, documenting significant changes to the meaning/form/state of the standards document since any previous version.
Identifier	An unambiguous reference to the resource within a given context. For the ASN standards documents, the value of the «identifier» is always a network-resolvable URI.
Jurisdiction	A legal, quasi-legal, organizational or institutional domain of the entity mandating the use of the achievement standard--e.g., California.
License	A legal document giving official permission to do something with the standards document.
Local Subject	The text string denoting the subject of the document as designated by the promulgating agency.
Publisher	An entity responsible for making the resource available. In the ASN, the promulgating agency of the standards document.
Repository Date	The date the standards document was added to the ASN repository.
Rights	Information about rights held in and over the standards document.
Status	The publication status of the standards document--e.g., "Draft," "Published," "Superseded."
Subject	The ASN topic of the content of the document being described.
Title	A name given to the standards document by the promulgating agency.

ASN Statement Properties

Property Label	Context-Specific Definition
Creator*	A person or organization chiefly responsible for the intellectual content of the statement being described when different from the creator of the standards document (e.g., 3 rd party derived statement).
Comment	Supplemental text provided by the promulgating body that clarifies the nature, scope or use of the statement being described.
Concept Term	A word or phrase used by the promulgating agency to refine and differentiate the statement being described contextually (e.g., a McREL concept term).
Created*	Date of creation of the statement.
Description	The text of the statement being described.
Education Level	The grade or grade bands covered by the standards statement being described.
Identifier	An unambiguous reference to the resource within a given context. For the ASN standards statement, the value of the «identifier» is always a network-resolvable URI.
Is Child Of	The statement being described is lower in some arbitrary hierarchy than the statement identified in the «isChildOf» property. The statement identified is a parent of the statement being described.
Is Part Of	The described statement is a physical or logical part of the referenced standards document.
Jurisdiction*	A legal, quasi-legal, organizational or institutional domain of the entity mandating the use of the statement--e.g., California.
Local Subject*	The text string denoting the subject of the statement as designated by the promulgating agency.
Relation*	A related resource.
Statement Label	The textual label identifying the class of the statement as designated by the promulgating body--e.g., "Standard," "Benchmark," "Strand," or "Topic."
Statement Notation	An alphanumeric notation or ID code as defined by the promulgating body to identify the statement.
Status	The publication status of the statement taken from the ASN Status controlled vocabulary.
Subject	An ASN topic of the content of the statement being described.

*Properties that are generally optional with ASN statements but mandatory when the statement is "derived" (i.e., created a 3rd party).