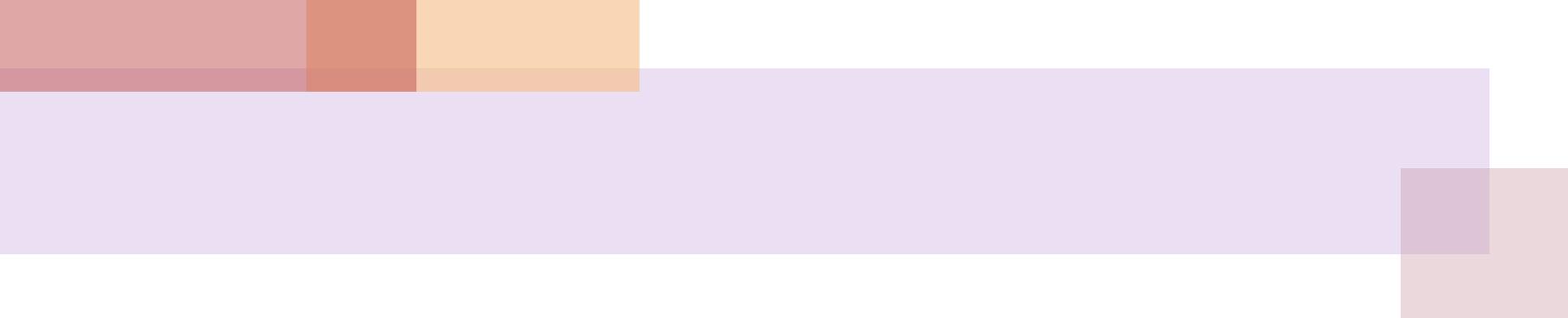




# **Reference model for linking between curriculum standards and digital resources using linked data**

**Hyunsook Chung**  
**Department of Computer Engineering**  
**Chosun University**



# **INDEX**

**Overview of Achievement Standards**

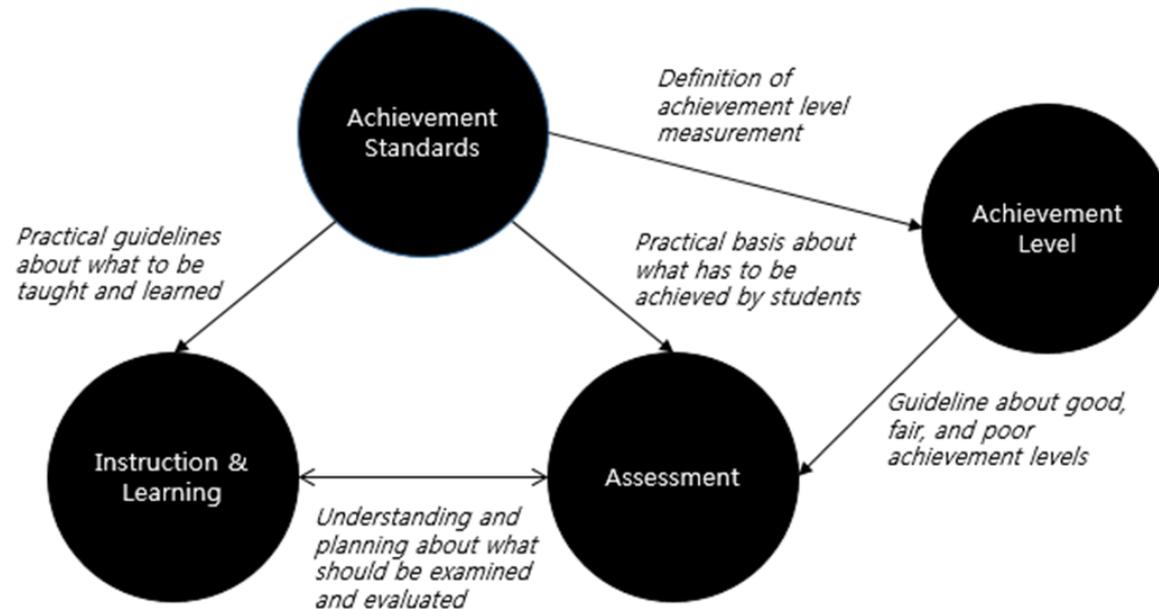
**Linked Data of Achievement Standards**

**Mapping ASN and Korean Achievement Standards**

# What is Achievement Standards?

## ▶ Achievement Standards

- ▶ Definition : a statement of the ability and characteristics of knowledge, skills, and attitude that students must achieve through learning, to be presented as a practical basis of teaching/learning and assessment.(According to the 2009 Revised National Curriculum of Korea)



# What is Achievement Standards?

## ▶ Example(Connecticut Science Grade-level Expectation)

Second criteria of science subject (second level)

Curriculum standard per school grade ← First criteria of science subject (top level) Goal of achievement

<p><u>Properties of Matter</u> — <u>How does the structure of matter affect the properties and uses of materials?</u></p> <p><u>PREKINDERGARTEN</u> ← School level</p>			
<p><u>PK.1 - Objects have properties that can be observed and used to describe similarities and differences</u></p>			
Core Science Curriculum Framework	Preschool Curriculum Framework	Grade-Level Expectations <i>Students should be able to:</i>	Preschool Assessment Framework
<p><b>PK.1.a.</b> Some properties can be observed with the senses, and others can be discovered by using simple tools or tests.</p>	<p>Cognitive Development: Logical-Mathematical/Scientific Thinking -</p> <ol style="list-style-type: none"> <li>1. Ask questions about and comment on observations and experimentation;</li> <li>2. Collect, describe and record information;</li> <li>3. Use equipment for investigation;</li> <li>4. Use common instruments to measure things;</li> <li>5. Demonstrate understanding of one-to-one correspondence while counting;</li> <li>6. Order several objects on the basis of one attribute;</li> <li>7. Sort objects by one or more attributes and regroup the objects based on a new attribute;</li> <li>8. Engage in a scientific experiment with a peer or with a small group.</li> </ol>	<ol style="list-style-type: none"> <li>1. Use senses to make observations of objects and materials within the child's immediate environment.</li> <li>2. Use simple tools (e.g., balances and magnifiers) and nonstandard measurement units to observe and compare properties of objects and materials.</li> <li>3. Make comments or express curiosity about observed phenomena (e.g., "I notice that..." or "I wonder if...").</li> <li>4. Count, order and sort objects (e.g. blocks, crayons, toys) based on one visible property (e.g., color, shape, size).</li> <li>5. Conduct simple tests to determine if objects roll, slide or bounce.</li> </ol>	<p>COG 1 Engages in scientific inquiry</p> <p>COG 3 Sorts objects</p> <p>COG 5 Compares and orders objects and events</p> <p>COG 6 Relates number to quantity</p>

Achievement statement (third level)

# What is Achievement Standards?

- ▶ An example of the achievement standards of the science subject of middle school.

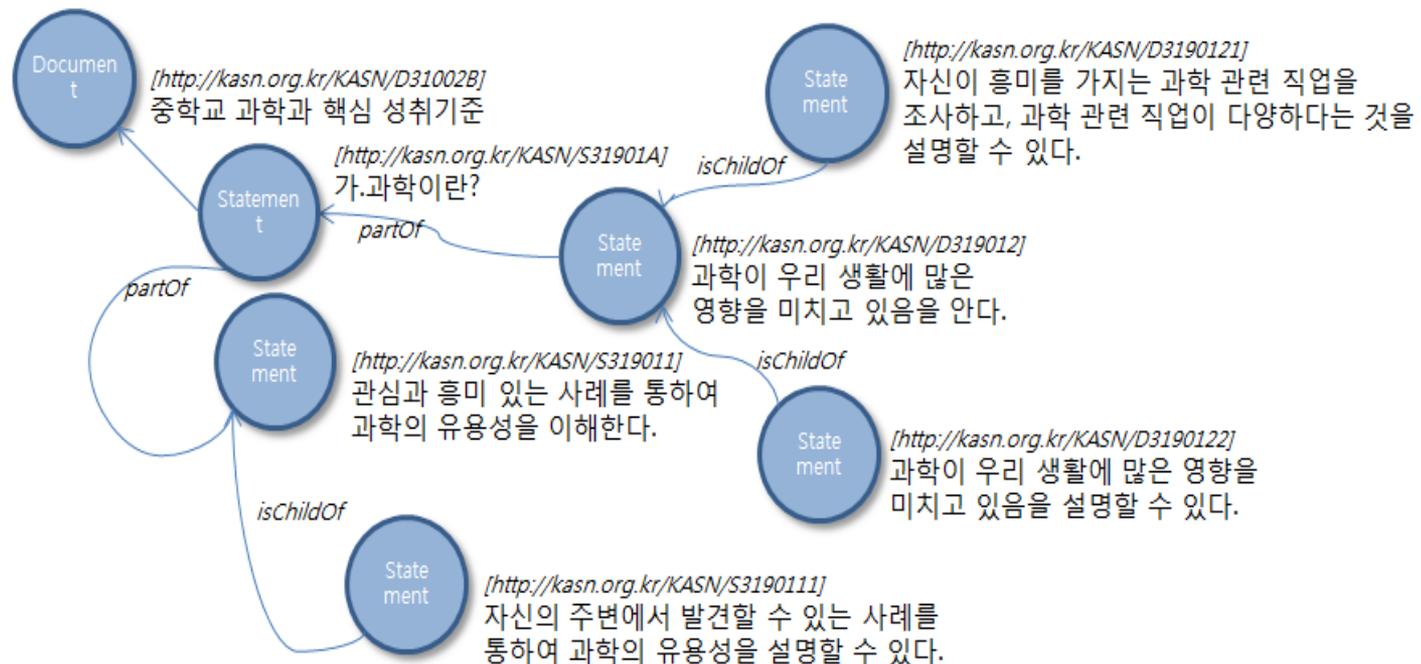
## A. What is Science?

교육과정 내용	성취기준	핵심 성취 기준	핵심 성취기준 선정 근거
과9011. 관심과 흥미 있는 사례를 통하여 과학의 유용성을 이해한다.	과9011. 자신의 주변에서 발견할 수 있는 사례를 통하여 과학의 유용성을 설명할 수 있다.	√	<p>·과학이란? 단원은 3개의 성취기준으로 구성되어 있으며, 이 중 1개를 핵심 성취기준으로 선정한다.</p> <p>·과9011은 주변의 사례를 통하여 과학의 유용성을 인식하도록 하는 것으로, 이는 과학에 대한 긍정적인 태도 함양에 중요하므로 핵심 성취기준으로 선정한다. 또한 이 성취기준은 과9012-2를 포괄할 수 있다.</p>
과9012. 과학이 우리 생활에 많은 영향을 미치고 있음을 안다.	과9012-1. 자신이 흥미를 가지는 과학 관련 직업을 조사하고, 과학 관련 직업이 다양하다는 것을 설명할 수 있다.		
<p>[탐구 활동] 과학 관련 직업 조사하기</p> <p>[탐구 활동] 과학이 우리 생활에 미치는 영향 조사하기</p>	과9012-2. 과학이 우리 생활에 많은 영향을 미치고 있음을 설명할 수 있다.		

# Achievement Statements Path

## ► Hierarchical Path

- Achievement standards are composed of many statements, which have hierarchy relationships

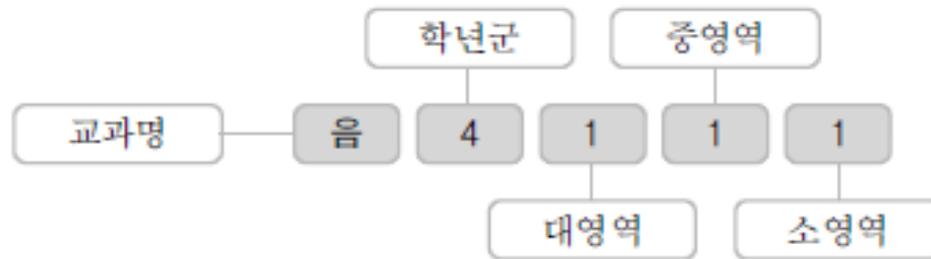


# Code Format

## ▶ Achievement Statement Code Format

School Grade	Coding
Elementary 1-2 grade	2
Elementary 3-4 grade	4
Elementary 5-6 grade	6
Middle 1-3 grade	9

Section	Subsection	Detailed statement
1. 표현	1-1. 바른 자세로 표현하기	(1) 바른 자세로 노래 부를 수 있다.
		(2) 바른 자세와 주법으로 악기를 연주할 수 있다.



# Achievement Standards Repository

## ▶ Need of the digitized achievement standards

▶ It is necessary to convert the contents of achievement standards distributed presently in a document format for each subject into a data structure that a machine can process through conversion to data and hierarchical structuralization.

## ▶ Approaches

- ▶ RDB(ER Modeling)
- ▶ Linked Data

The screenshot shows the NCIC website interface. At the top, there is a navigation bar with the NCIC logo and text: "국가교육과정정보센터 National Curriculum Information Center". To the right of the logo are links for "우리나라 교육과정", "세계 교육과정", "지역·학교 교육과정", "교육과정 자료실", "NCIC소개", and "2015 국가 교육과정 개정". Below the navigation bar is a search area with a dropdown menu labeled "전체검색" and buttons for "검색" and "상세검색".

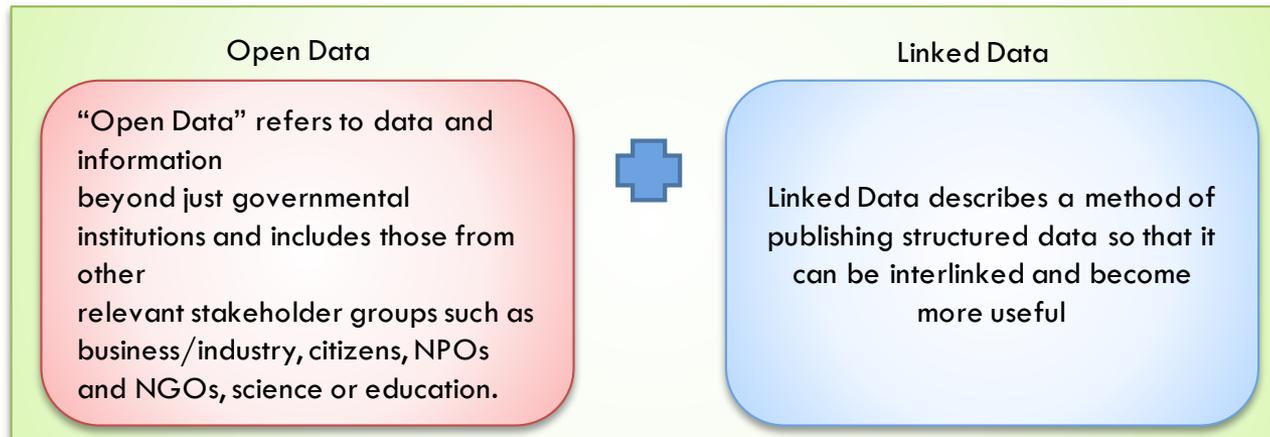
The main content area is titled "성취기준" (Achievement Standards) and displays a table of standards. The table has columns for "번호" (Number), "제목" (Title), "과목" (Subject), "작성자" (Author), "작성일" (Date), and "조회수" (View Count). The table lists 10 items, all authored by "송지운" (Song Ji-un) and dated "2014-02-07".

번호	제목	과목	작성자	작성일	조회수
1	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 영어	영어	송지운	2014-02-07	4280
2	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 수학	수학	송지운	2014-02-07	3422
3	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 사회/역사	사회/역사	송지운	2014-02-07	3917
4	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 도덕	도덕	송지운	2014-02-07	1935
5	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 기술/가정	기술/가정	송지운	2014-02-07	2280
6	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 국어	국어	송지운	2014-02-07	3785
7	2009 개정 교육과정에 따른 중학교 핵심 성취기준의 이해_ 과학	과학	송지운	2014-02-07	3375
8	2009 개정 교육과정에 따른 초등학교 핵심 성취기준의 이해_5,6학년	초등학교	송지운	2014-02-07	8928
9	2009 개정 교육과정에 따른 초등학교 핵심 성취기준의 이해_3,4학년	초등학교	송지운	2014-02-07	8146
10	2009 개정 교육과정에 따른 초등학교 핵심 성취기준의 이해_1,2학년	초등학교	송지운	2014-02-07	5687

At the bottom of the page, there is a pagination bar with a left arrow, a right arrow, and numbers 1 through 10, followed by a double right arrow and a refresh icon.

# What is Linked Open Data?

## ▶ Linked Open Data



Wikipedia

Exposing, sharing, and connecting pieces of data, information, and knowledge on the Semantic Web using URIs and RDF

Linked data describes **a method of publishing structured data** so that it can be interlinked and become more useful

# Principles of Linked Data

- ▶ 1. **Use URLs** to identify things.
- ▶ 2. **Use HTTP URLs** so that these things can be referred to and looked up ("dereferenced") by people and user agents.
- ▶ 3. **Provide useful information** about the thing when its URL is dereferenced, using standard formats such as RDF/XML.
- ▶ 4. **Include links to other**, related URLs in the exposed data to improve discovery of other related information on the Web.



# **INDEX**

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**Overview of Achievement Standards**

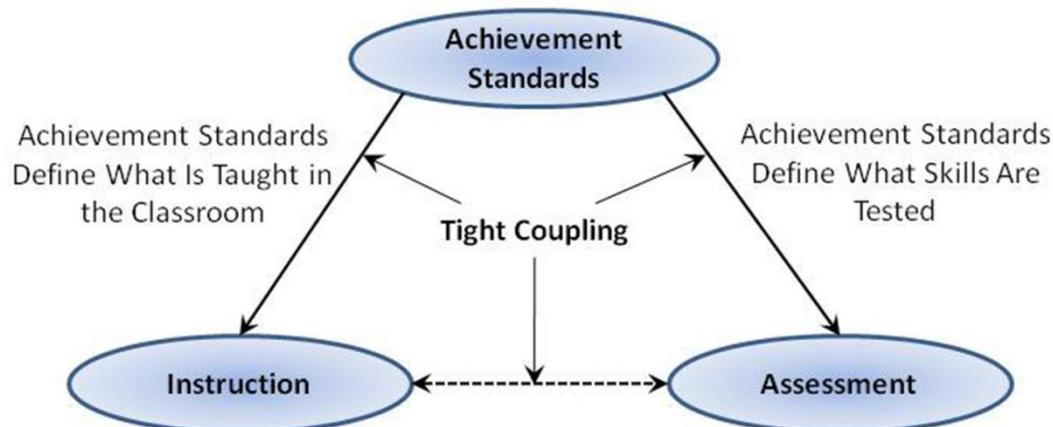
**Linked Data of Achievement Standards**

**Mapping ASN and Korean Achievement Standards**

# Overview of ASN

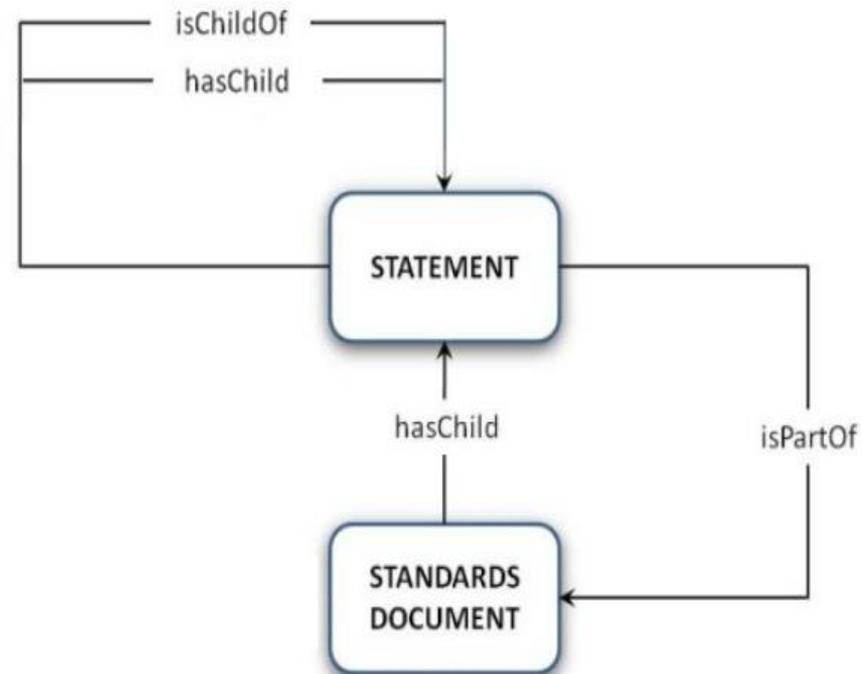
## ▶ Achievement Standards

- ▶ 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.
- ▶ **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, and learn



# Overview of ASN

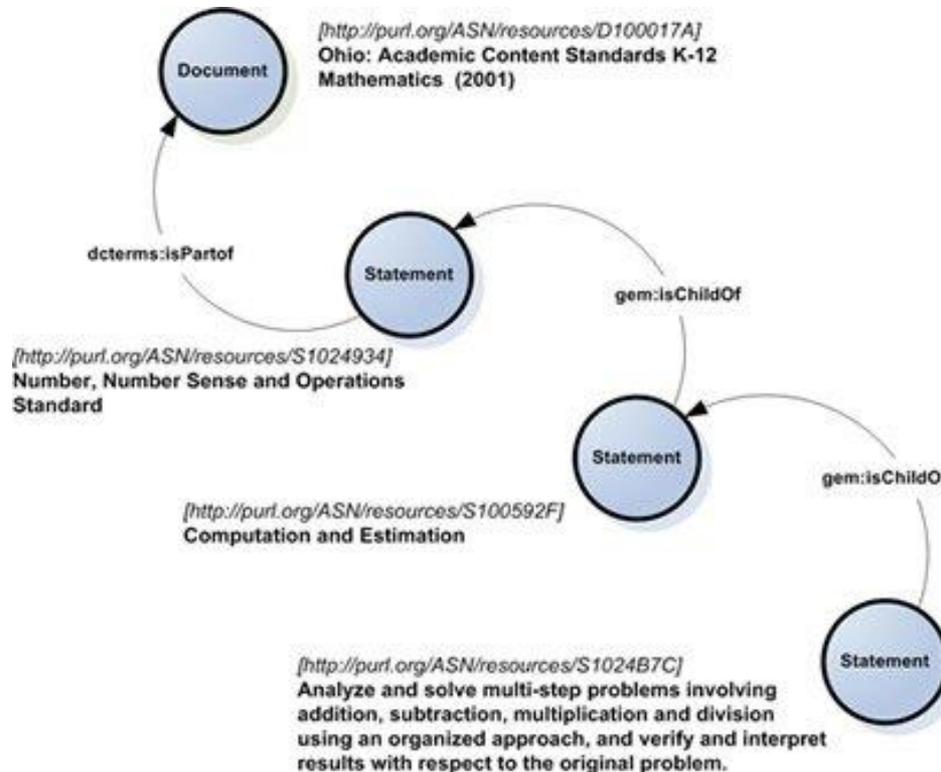
- ▶ **Achievement Standards Network**
  - ▶ The ASN is made up of two fundamental entities: **(1) standards documents**, and **(2) statements**.
  - ▶ ASN takes each standards document as it is produced by its official promulgating agency and **"atomizes" its content into atomic statements**.
  - ▶ These two entities—documents and statements—are framed in terms of an entity-relationship model (**ER**) and embodied in RDF/XML (**Resource Description Framework**).
  - ▶ Both **structural and semantic relationships** between the ASN's primary entities—the standards document entity and its atomic statement entities—have been defined.



# Overview of ASN

## ▶ ASN Taxon Paths

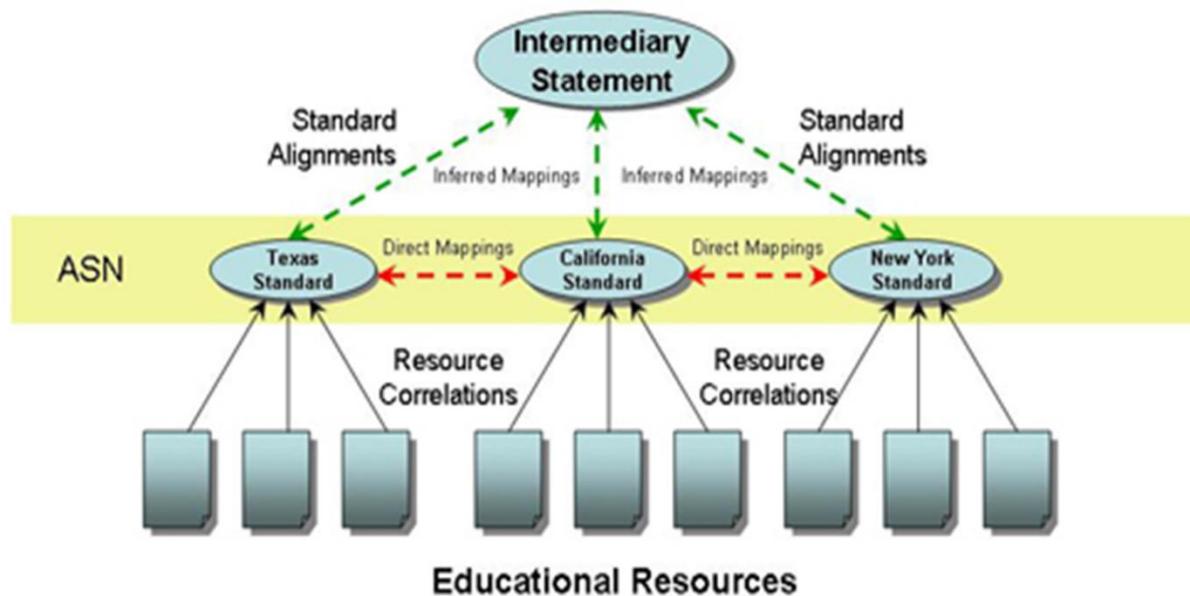
- ▶ A single traversal of a branch of a standards document--here from the root (i.e., the standards document description) to a leaf (i.e., a statement at some arbitrary level in the branch hierarchy).



# Overview of ASN

## ▶ ASN Goals

- ▶ Create an international repository of curriculum in machine addressable form that
  - Are accurate digital representations of curriculum and their component statements (semantic units);
  - Are consistent in form; and
  - Are modeled in RDF and amenable to the
  - Semantic Web



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**Overview of Achievement Standards**

**Linked Data of Achievement Standards**

**Mapping ASN and Korean Achievement Standards**

# ASN Documents and Implementation

## ▶ ASN Achievement Standards Document and Implementation

Curriculum standard per school grade      First criteria of science subject (top level)      Goal of achievement      Second criteria of science subject (second level)

<u>Properties of Matter</u> – <u>How does the structure of matter affect the properties and uses of materials?</u> <b>PREKINDERGARTEN</b> ← <b>School level</b>			
<u>PK.1 - Objects have properties that can be observed and used to describe similarities and differences</u>			
Core Science Curriculum Framework	Preschool Curriculum Framework	Grade-Level Expectations <i>Students should be able to:</i>	Preschool Assessment Framework
<b>PK.1.a.</b> Some properties can be observed with the senses, and others can be discovered by using simple tools or tests.	<b>Cognitive Development: Logical-Mathematical/Scientific Thinking -</b> 1. Ask questions about and comment on observations and experimentation; 2. Collect, describe and record information; 3. Use equipment for investigation; 4. Use common instruments to measure things; 5. Demonstrate understanding of one-to-one correspondence while counting; 6. Order several objects on the basis of one attribute; 7. Sort objects by one or more attributes and regroup the objects based on a new attribute; 8. Engage in a scientific experiment with a peer or with a small group.	1. Use senses to make observations of objects and materials within the child's immediate environment. 2. Use simple tools (e.g., balances and magnifiers) and nonstandard measurement units to observe and compare properties of objects and materials. 3. Make comments or express curiosity about observed phenomena (e.g., "I notice that..." or "I wonder if..."). 4. Count, order and sort objects (e.g. blocks, crayons, toys) based on one visible property (e.g., color, shape, size). 5. Conduct simple tests to determine if objects roll, slide or bounce.	<b>COG 1</b> Engages in scientific inquiry <b>COG 3</b> Sorts objects <b>COG 5</b> Compares and orders objects and events <b>COG 6</b> Relates number to quantity

Achievement statement (third level)

# ASN Documents and Implementation

## ▶ ASN Achievement Standards Document and Implementation

- ▶ All data of the standard are registered into ASN Framework and can be browsed each information on the web

## Connecticut Science Curriculum Grade-Level Expectations

[View](#)

[About these standards](#)

### About this resource:

**Title en-US:** Connecticut Science Curriculum Grade-Level Expectations

**Description en-US:** The Connecticut Prekindergarten-Grade 8 Science Curriculum Standards Including Grade-Level Expectations is a resource that supports the use of the 2004 Core Science Curriculum Framework to develop rigorous science curriculum, instruction and assessments. Grade-level expectations (GLEs) are instructional guidelines that describe what students should be able to do to demonstrate the science knowledge and abilities they have developed as a result of a series of learning experiences and a comprehensive curriculum.

**Publication Status:** Published

**Subject:** Science

**Education Level:** Pre-K, K, 1, 2, 3, 4, 5, 6, 7, 8

**Language:** English

**Source:** [http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/pk8\\_science\\_curriculums...](http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/pk8_science_curriculums...)

**Date Valid:** 2010

**Repository Date:** 2011-03-02

**Author en-US:** Connecticut State Department of Education

**Publisher en-US:** Connecticut State Department of Education

**Identifier:** <http://purl.org/ASN/resources/D10003B3>

**Manifest:** <http://asn.jesandco.org/resources/D10003B3/manifest.json>

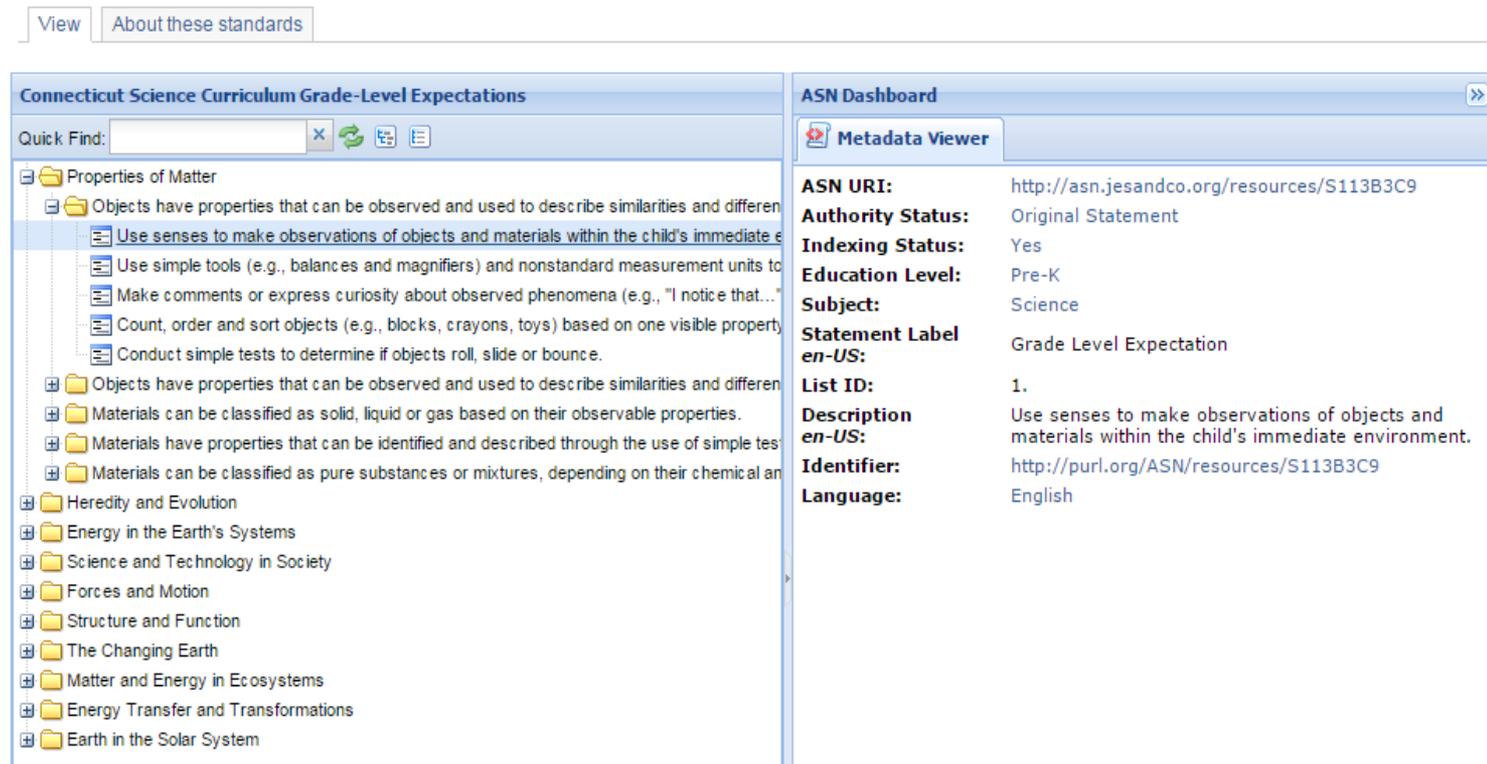
# ASN Documents and Implementation

## ▶ ASN Achievement Standards Document and Implementation

- ▶ Achievement stated in the document could be interpreted to metadata applied ASN entity and properties as follows:

### Connecticut Science Curriculum Grade-Level Expectations

View About these standards



ASN Dashboard	
<b>ASN URI:</b>	<a href="http://asn.jesandco.org/resources/S113B3C9">http://asn.jesandco.org/resources/S113B3C9</a>
<b>Authority Status:</b>	Original Statement
<b>Indexing Status:</b>	Yes
<b>Education Level:</b>	Pre-K
<b>Subject:</b>	Science
<b>Statement Label en-US:</b>	Grade Level Expectation
<b>List ID:</b>	1.
<b>Description en-US:</b>	Use senses to make observations of objects and materials within the child's immediate environment.
<b>Identifier:</b>	<a href="http://purl.org/ASN/resources/S113B3C9">http://purl.org/ASN/resources/S113B3C9</a>
<b>Language:</b>	English

# Korean Achievement Standards Document

▶ The curriculum standard area of content per education level

Grade group		Primary school 3-4 grade group	Primary school 5-6 grade group
Area of content		초등학교 3~4학년군	초등학교 5~6학년군
분야	학년군		
물질과 에너지		<ul style="list-style-type: none"> <li>· 물체의 무게</li> <li>· 물체와 물질</li> <li>· 액체와 기체</li> <li>· 소리의 성질</li> </ul>	<ul style="list-style-type: none"> <li>· 자석의 이용</li> <li>· 혼합물의 분리</li> <li>· 거울과 그림자</li> <li>· 물의 상태 변화</li> </ul>
생명과 지구		<ul style="list-style-type: none"> <li>· 지구와 달</li> <li>· 동물의 한살이</li> <li>· 동물의 생활</li> <li>· 지표의 변화</li> </ul>	<ul style="list-style-type: none"> <li>· 식물의 한살이</li> <li>· 화산과 지진</li> <li>· 식물의 생활</li> <li>· 지층과 화석</li> </ul>
		<ul style="list-style-type: none"> <li>· 온도와 일</li> <li>· 용해와 용액</li> <li>· 산과 염기</li> <li>· 물체의 빠르기</li> </ul>	<ul style="list-style-type: none"> <li>· 전기의 작용</li> <li>· 여러 가지 기체</li> <li>· 렌즈의 이용</li> <li>· 연소와 소화</li> </ul>
		<ul style="list-style-type: none"> <li>· 날씨와 우리 생활</li> <li>· 식물의 구조와 기능</li> <li>· 태양계와 별</li> <li>· 우리 몸의 구조와 기능</li> </ul>	<ul style="list-style-type: none"> <li>· 지구와 달의 운동</li> <li>· 생물과 환경</li> <li>· 생물과 우리 생활</li> <li>· 계절의 변화</li> </ul>
학년군		중학교 1~3학년군 ← Middle school 1-3 grade group	
분야	학년군		
물질과 에너지	과학이란?	<ul style="list-style-type: none"> <li>· 힘과 운동</li> <li>· 열과 우리 생활</li> <li>· 분자 운동과 상태 변화</li> </ul>	<ul style="list-style-type: none"> <li>· 물질의 구성</li> <li>· 빛과 파동</li> <li>· 물질의 특성</li> <li>· 일과 에너지 전환</li> </ul>
생명과 지구		<ul style="list-style-type: none"> <li>· 전기와 자기</li> <li>· 화학 반응에서의 규칙성</li> <li>· 여러 가지 화학 반응</li> </ul>	<ul style="list-style-type: none"> <li>· 지구계와 지권의 변화</li> <li>· 광합성</li> <li>· 수권의 구성과 순환</li> </ul>
		<ul style="list-style-type: none"> <li>· 기권과 우리 생활</li> <li>· 소화·순환·호흡·배설</li> <li>· 자극과 반응</li> </ul>	<ul style="list-style-type: none"> <li>· 태양계</li> <li>· 생식과 발생</li> <li>· 유전과 진화</li> <li>· 외권과 우주개발</li> </ul>

← Section

# Korean Achievement Standards Document

## ▶ Definition of Korean Achievement Standards Document

▶ According to ASN class/property model, Korean achievement standards documents can be defined as follows:

- **Title (en):** Science subject curriculum.
- **Description (en):** *(omission)*.
- **Publication Status:** Published.
- **Subject:** Science.
- **Education Level:** K-3, 4, 5, 6, 7, 8, and 9.
- **Language:** Korean.
- **Source:** <http://ncic.re.kr/nation.dwn.ogf.inventoryList.do>
- **Date Valid:** 2011.
- **Repository Date:** 2012-12.
- **Author (en):** Ministry of Education
- **Publisher (en):** Ministry of Education.

# Korean Achievement Standards Model

## ▶ Based on three classes of ASN profile

- ▶ CurriculumStandard(StandardDocument)
- ▶ StatementDocument(AchievementStatement)
- ▶ LearningResource

LearningResource
AssessesCompetency
BroadCorrelation
ExactCorrelation
MajorCorrelation
MinorCorrelation
NarrowCorrelation
PrerequisiteCompetency
TeachesCompetency

CurriculumStandard
AlignFrom
AlignTo
Author
CurriculumVersion
DateCopyrighted
DateValid
Description
EducationLevel
HasChild
LocalSubject
Note
PublicationStatus
Rights
RightsHolder
Subject

StatementDocument
AlignFrom
AlignTo
Author
AuthorityStatus
Comment
ComprisedOf
CoreCompetency
Creator
Created
CurriculumType
DerivedFrom
Description
EducationLevel
HasChild
Identifier
IsChildOf
IsPartOf
ListID
LocalSubject
PrerequisiteAlignment
Rights
RightsHolder
SkillEmbodied
StatementLabel
StatementNotation
Subject

# Korean Achievement Standards Model

## ▶ Additional Entities

▶ Achievement Level

▶ Teaching/Learning Plan <표 II-14> 중학교 최대공약수와 최소공배수에 대한 성취수준 진술

AchievementLevel
LevelID StatementURI LevelLabel LevelContent Comment

성취기준	성취수준	
수91013-1. 최대공약수의 성질을 이해하고, 이를 구할 수 있다.	상	소인수분해를 이용하여 세 자연수의 최대공약수를 구할 수 있다.
	중	소인수분해를 이용하여 두 자연수의 최대공약수를 구할 수 있다.
	하	두 자연수의 최대공약수를 구할 수 있다.

Syllabus
SyllabusID SchoolName CourseName SchoolGrade SchoolYear Instructor LearningObjective SyllabusURI Comment

# Korean Achievement Standards Model

## ▶ Implementation of Achievement Standards Linked Data

### ▶ Namespace definition

- ▶ `xmlns:asn="http://purl.org/ASN/schema/core/"`
- ▶ `xmlns:dc="http://purl.org/dc/elements/1.1/"`
- ▶ `xmlns:skos="http://www.w3.org/2004/02/skos/core#"`

### ▶ RDF/OWL specification

```
<asn:Statement rdf:about="http://kasn.keris.org/resources/S382119">
  <dcterms:isPartOf rdf:resource="http://kasn.keris.org/resources/D10003B3"/>
  <asn:authorityStatus rdf:resource="http://purl.org/ASN/schema/ASNAuthorityStatus/Original"/>
  <asn:indexingStatus rdf:resource="http://purl.org/ASN/schema/ASNIndexingStatus/No"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/schema/ASNEducationLevel/7"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/schema/ASNEducationLevel/8"/>
  <dcterms:educationLevel rdf:resource="http://purl.org/ASN/schema/ASNEducationLevel/9"/>
  <dcterms:subject rdf:resource="http://purl.org/ASN/schema/ASNTopic/science"/>
  <asn:statementNotation xml:lang="ko">과9011</asn:statementNotation>
  <dcterms:description xml:lang="ko">자신의 주변에서 발견할 수 있는 사례를 통해 과학의 유용성을 설명할 수 있다
</dcterms:description>
  <gemq:hasChild rdf:resource="http://kasn.keris.org/resources/S382119A"/>
  <gemq:isChildOf rdf:resource="http://kasn.keris.org/resources/D10003B3"/>
</asn:Statement>
```

# Q&A

