NSDL Strand Map Service

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Objectives of Workshop

- How educational standards can be used in curriculum design and assessment
- How the NSDL Strand Map Service generates concept-browsing interfaces based on educational standards
- How to create these concept-browsing interfaces using the NSDL Strand Map Service
Workshop Outline

- Introduction to Educational Standards
  - Benchmarks for Science Literacy
  - AAAS Strand Maps
- Overview of NSDL Strand Map Service
- Developing Concept-Browsing Interfaces with the Service
  - Concept Space Interchange Protocol
Part 1: Intro to Educational Standards
The Need for Reform

- Curricula often focus on quickly forgotten details and terms rather than the understanding of major concepts and processes.
- Helping students achieve a clear understanding of ideas is extremely difficult.
- Students (even the best and the brightest) understand less than we think they do.
About Educational Standards

- Content standards define what students should know or be able to do at various stages in their education.


- Harsh Realities: No Child Left Behind Legislation – 2014, Standards as ‘checklists’ to be covered (Atlas for Science Literacy, AAAS, 2001), Connections between ideas are lost (How People Learn, NRC, 2000).
AAAS Benchmarks and Strand Maps

- **Benchmarks**: Provides a set of learning goals for the ends of grades 2, 5, 8, and 12

- **Strand maps**: Node-link diagrams illustrating the relationships between individual learning goals and how student understanding of core ideas should change over time
What is a Benchmark?

3-5
When warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all the same temperature.

K-2
The sun warms the air, land, and water.

Research on the cognitive and scientific basis
Research on student conceptions
Strategies to check student understanding
Assessment activities
Comparing Standards

Benchmarks for Science Literacy
Chapter 4
The Physical Setting
Section D
Structure of Matter
Grades 6-8

National Science Education Standards
Content Standard B
Science
Properties and changes of properties in matter
Grades 5-8

- No matter how substances within a closed system interact with one another, or how they combine or break apart, the total mass of the system remains the same. The idea of atoms explains the conservation of matter: If the number of atoms stays the same no matter how they are rearranged, then their total mass stays the same.

- Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group.
Uses of Benchmarks and Maps

Curriculum

Instruction

Assessment

Materials Development

Teacher Preparation

Literacy Goals

Learning Goals

Connections
For Example…

Consider a Seed and a Log

- Under the right conditions, a maple seed can grow into a maple tree.

- But a maple tree is much bigger and more massive than a maple seed.

- How would students explain where all of the extra material a maple tree has comes from?
A Private Universe

- Look at the benchmarks on the strand map
- Decide which ones are of particular importance in answering the question
- While watching the film, think about what level of understanding did the students’ responses demonstrate
Probing for Understanding

- How do the responses of the Harvard & MIT graduates’ differ from those expected of 4th graders?
- What ideas have the Harvard & MIT graduates missed?
Points to Consider

Science education is not working for most students, even in the best schools.

A thorough understanding of science literacy and learning goals is essential for developing a coherent flow of ideas over time.

Digital libraries can help educators to understand learning goals and to develop curriculum based on these goals.
Part 2: Overview of NSDL Strand Map Service
NSDL Strand Map Service

- Modeling ‘rich representations’ of AAAS Benchmarks and Strand Maps
  - Maps
  - Strands
  - Benchmarks and Benchmark Neighbors
  - Information Associated with Benchmarks
- Visualizing relationships between benchmarks → dynamically generated concept map interfaces
- Providing a protocol that allows developers to easily embed these visualizations into their library interfaces
Modeling the AAAS Info Space

The Physical Setting

Processes That Shape The Earth

Plate Tectonics

Evidence of plates, earthquakes and volcanoes; K-2, 3-5

“The earth first formed in a molten state and then the surface cooled into solid rock...”
Concept Map Interfaces

- Provide navigational and orientational cues that are typically lacking from traditional search interfaces.
- Are useful cognitive scaffolds, helping users lacking domain expertise to understand the macro-level structure of an information space. (Hall et al. 1999, O'Donnell 2002)
Strand Map Service in DLESE

**Benchmark**

Climates have sometimes changed abruptly in the past as a result of changes in the Earth's crust, such as volcanic eruptions or impacts of huge rocks from space. Even relatively small changes in atmospheric or ocean content can have widespread effects on climate if the change lasts long enough.

**Hurricane Backgrounder**

http://www.fema.gov/hazards/hurricanes/hurfacts.shtm

This is the Hurricane site of the Federal Emergency Management Agency and one of its seventeen hazards pages. It contains the definition of a hurricane, its stages of development, and areas where they develop. Specific threats generated by hurricanes include hurricane force winds, rainfall and flooding, storm surge, and tornadoes generated by the hurricane. There is detailed information for each threat and a list of facts about tropical cyclone spawned tornadoes.

**Natural Disasters: The Terror of Our Lives**

http://library.thinkquest.org/000341/naturaldisaster/index.htm

This website teaches students about natural disasters, including blizzards, earthquakes, hurricanes, tornadoes, volcanoes, fires, and avalanches. There are photographs of each disaster and safety tips as well as definitions of the disasters and information about where they are found.
The Strand Map Service in the Harvard-Smithsonian Digital Video Library

Flow of Matter in Ecosystems

9-12

Plants alter the earth's atmosphere by removing carbon dioxide from it using the carbon.

Food web

The chemical elements that make up the molecules of living things pass through:

Plants make the food they make immediately for fuel or materials or store it for:

One of the most general destinations among organisms is between plants, which:

All is a substance that surrounds us, takes up space.

5-8

Plants use the energy in light to make sugars out of carbon dioxide and water.

Carbon and hydrogen are essential elements of living matter.

Food provides molecules that serve as fuel and building materials for all organisms.

The idea of atoms explains the conservation of matter if the number of atoms stays the same.

Digital Video Library

Search for videos:

By AAAS Benchmarks
Using Strand Map
By Other Standards
Relating To Instruction
Using Any Criterion
View All

HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS
Strand Map Service: How it works
Pilot Study Results

SMS users appear to be more focused on the scientific content of their task as opposed to the mechanics of searching

- 12 participants – undergraduate psychology students
- Two treatments: 6 with Strand Maps, 6 with DLESE
- 4 Tasks – teachers using DLESE to find educational resources in order to teach a topic in class
- Self-explanation with tasks

“...I’m reading the different little boxes to find out which one sounds more related to why earthquakes occur...this one talks about.. how the core of the earth is hot and that’s what makes earthquakes and volcanic eruptions but.. this one says that they also occur along boundaries with colliding plates, so I’m going to try this one first...”

“.. I guess the first thing I do is probably the most basic thing, just type in rock cycle into the search engine...And it yielded no results so I’ll go back.. right now I’m just clicking on the options I have here, seeing if I can narrow down the search..”
Part 3: Developing Concept-Browsing Interfaces with the Service

- Introduction to web services
- Concept Space Interchange Protocol (CSIP)
- Query portion of the protocol
- Example: Creating the DLESE demonstrator
- SMS Test Harness: Creating your own queries

Access to Service is free and unrestricted!
Web Services

- Web services are building blocks for creating open distributed systems, and allow organizations and individuals to quickly and cheaply make their digital assets available worldwide.

- A web service is identified by a URI and supports direct interactions with other software applications using XML based messages exchanged via Internet-based protocols.

Source: Search and retrieval web services workshop, John Weatherly, NSDL annual meeting 2004
Concept Space Interchange Protocol

- A REST style web service
  - Representational State Transfer
  - All state is encapsulated in the http parameters sent

- Search over and retrieval of Strand Map components such as:
  - Maps
  - Strands
  - Benchmarks and Benchmark Neighbors
  - Information Associated with Benchmarks

- Educational resources, Related Benchmarks, Student Conceptions, Related Educational Standards, Research on Benchmark, Subject, etc.
CSIP

- Four sub-services accessed with http
  - Service Description
  - Query
  - Submit Resource
  - Query Registration

- Response formats
  - XML
  - SVG (Scalable Vector Graphics)
    - An XML-based language for web graphics
    - A World Wide Web Consortium (W3C) Recommendation
About SVG

- Resolution independent (Scalable Vector – zooming in or zooming out does not effect quality)
- Displays 3 types of graphics
  - Vector Graphic Shapes (lines, polygons, circles, ...)
  - Text
  - Raster (Bitmap) Images
- Rendered on Client side
- Requires SVG Viewer plug-in
Service Description

- Used by the client to determine the capabilities of the SMS server
- Request URL: `<host>/SMS/ServiceDescription`
- Host: everglades.cs.colorado.edu:8080/sms DevelopmentV1.0
Submit Resource

- Used when the CSIP client wants to contribute some resource to the SMS repository
- Allows for the client to send a request for resource addition for a given object
- Request URL:
  - `<host>/SMS/SubmitRequest?ObjectId=ID &Resource=URL&email=senderEmail`
Query

- The primary mechanism for search and retrieval

- Two kinds of queries
  - Content – searching over text content
  - Navigational – searching over relationships
Content-Query

- Content-Query does textual searches over the strand maps metadata repository
- Request URL:
  - `<host>/SMS/Query`
  - Can use GET or POST
<Query>
  <Content-Query>
    <Name MatchType="Contains-any-word">Water Open</Name>
  </Content-Query>
</Query>

<QueryResponse>
  <SMS Number="7">
    <Record>
      <itemRecord ...
      <Data>
        <Name>Water left in an open container disappears</Name>
        <ObjectType>Benchmark</ObjectType>
        <AAASCode>4B/P3</AAASCode>
        <InternalRelationship>
          <CatalogID CatalogNumber="SMS-STD-9032" RelationType="is part of"/>
        </InternalRelationship>
      </Data>
    </Record>
    <Admin>
      <IDNumber>SMS-BMK-0141</IDNumber>
    </Admin>
  </Record>
</QueryResponse>
Content-Query Example 2

```
<Query DetailLevel="Detailed">
  <Content-Query>
    <Subjects MatchType="Contains-all-words">Biology</Subjects>
  </Content-Query>
</Query>

<Query DetailLevel="Skeleton" Format="SMS">
  <Content-Query>
    <Term>hydrosphere</Term>
  </Content-Query>
</Query>
```
Navigational-Query

- The navigational query starts from one benchmark and finds all the benchmarks that have a specified relationship to the object of interest.

Request URL:
- `<host>/SMS/Query`
- Can use GET or POST
Navigational-Query Example

<Query DetailLevel="Detailed" Format="SVG">
  <Navigational-Query>
    <ObjectID>SMS-BMK-9023</ObjectID>
    <Relation>
      <Contains/>
    </Relation>
  </Navigational-Query>
</Query>
Are you new to DLESE?

- Educational resources
  - Browse Earth Concepts
  - Browse resources & collections
- News & opportunities
- Email discussions
- Everything else

What's new at DLESE
- DLESE 2004 Annual Meeting - watch for registration information in April 2004
- DLESE Diversity portal
- New resources & reviews
- Resources about Mars: DLESE/MarsQuest Online

Welcome to Version 2 of DLESE!
- Search by National Science and Geography Standards
- Search multiple collections of resources; Renew DLESE resources; Please give us feedback

Resource of interest
The Understanding Evolution website offers teachers valuable support for teaching and learning about evolution. The heart of the site is Evolution 101, which can serve as a primer to evolutionary theory or an intensive course in the nitty gritty details of speciation, micro- and macroevolution, and ongoing research into how evolution happens. Strategies for teaching and responding to student misconceptions and roadblocks are offered. There are numerous practical examples of how evolution impacts our daily lives, including over 50 lesson plans and activities. The Understanding Evolution website (evolution.berkeley.edu) is funded by the National Science Foundation and the Howard Hughes Medical Institute (HHMI) and created jointly by UC Berkeley's Museum of Paleontology and the National Center for Science Education.

View previously featured resources of interest. Catalog or suggest an interesting Earth system site.
To begin, pick a map from the selections below or click a map from the grid. Then, to see details, pick a strand and/or a grade range.
Get List of Maps

<SMS-CSIP xmlns="http://sms.dlese.org">
  <Query DetailLevel="Skeleton" Format="SMS" Scope="Map">
    <Content-Query>
      </Content-Query>
  </Query>
</SMS-CSIP>
To begin, pick a map from the selections below or click a map from the grid. Then, to see details, pick a strand and/or a grade range.

Pick a Map

Plate Tectonics
Flow of Matter in Ecosystems
Weather and Climate
Changes in the Earth's Surface

Solar System
Stars
Galaxies and the Universe
Atoms and Molecules

Conservation of Matter
States of Matter
Chemical Reactions
Law of Motion

Waves
Flow of Energy in Ecosystems
Natural Selection
Scientific Investigations
To begin, pick a map from the selections below or click a map from the grid. Then, to see details, pick a strand and/or a grade range.

**The Earth's Interior**
- The earth's plates ride on a denser, hot, gradually deformable layer of the earth...
- The interior of the earth is hot. Heat flow and movement of material within the earth cause...
- The earth first formed in a molten state and then the surface cooled into solid rock...

**Earthquakes and Volcanoes**
- Earthquakes often occur along the boundaries between colliding...
- Ocean-floor plates may slide under continental plates, sinking deep into the...
- Some changes in the earth's surface are abrupt (such as earthquakes and volcanic...)

**Evidence of Plates**
- The theory of plate tectonics provides an explanation for a diverse array of seemingly...
- The solid crust of the earth-including both the continents and the ocean...
- Matching coastlines and similarities in rock types and life forms suggest that...

**Grades**
- 6-8
- 9-12
Get Graphical Map

```xml
<SMS-CSIP xmlns="http://sms.dlese.org">
  <Query Scope="ALL" Format="SVG">
    <Content-Query>
      <ObjectId>SMS-MAP-9030</ObjectId>
    </Content-Query>
  </Query>
</SMS-CSIP>
```
Benchmark

Ocean-floor plates may slide under continental plates, sinking deep into the earth. The surface layers of these plates may fold, forming mountain ranges.

Please click on one of the topics of interest above (Educational Resources, Related Educational Standards etc), and the relevant information on the selected benchmark will appear in this box.
Benchmarks shown below may be concepts that are part of another map.

Ocean-floor plates may slide under continental plates, sinking deep into the earth. The surface layers of these plates may fold, forming mountain ranges.
Get Benchmark Neighbors (Graphical)

```xml
<SMS-CSIP xmlns="http://sms.dlese.org">
  <Query DetailLevel="Detailed" Format="SVG">
    <Navigational-Query>
      <ObjectID>SMS-BMK-9023</ObjectID>
      <Relation>
        <Neighbor/>
      </Relation>
    </Navigational-Query>
  </Query>
</SMS-CSIP>
```
SMS Test Harness

- Available at http://swiki.cs.colorado.edu/strandmaps/uploads/6/Drivers.1.zip
- Give a Query XML file as input
- Receive the SMS/SVG response back as output
Information for SMS Developers

- **CSIP Schema:**
  http://www.dlese.org/Metadata/strandmaps/web-protocol/1.1/CSIP.xsd

- **Documentation:**
  http://swiki.cs.colorado.edu/strandmaps

- **Test Driver:**
  http://swiki.cs.colorado.edu/strandmaps/uploads/6/Drivers.1.zip

- **DLESE demo:** http://preview.dlese.org/sms

- **Contact:**
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  - Sonal Bhushan, sonal@ucar.edu
References


