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 under-standing of major concepts and processes

- Helping students achieve a clear under-standing 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

- Opportunities: Standards embody reform agenda, integral to perspective of curriculum reform as a 'design by assembly' problem *(AAAS, Designs for Science Literacy, 2001)*

- 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
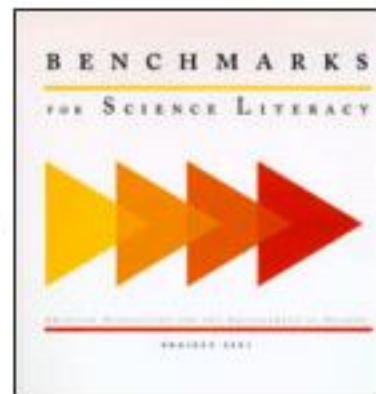
What is a Benchmark?

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

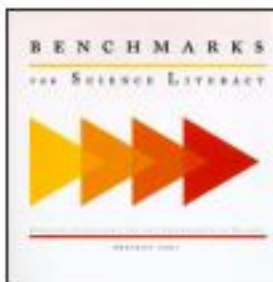Strategies to check student understanding
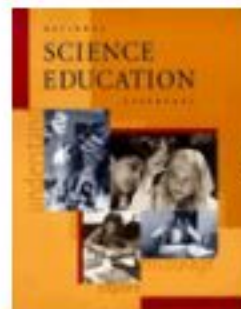
Assessment activities

Flow of Matter in Ecosystems Map

matter cycle *food web* *plants making food*
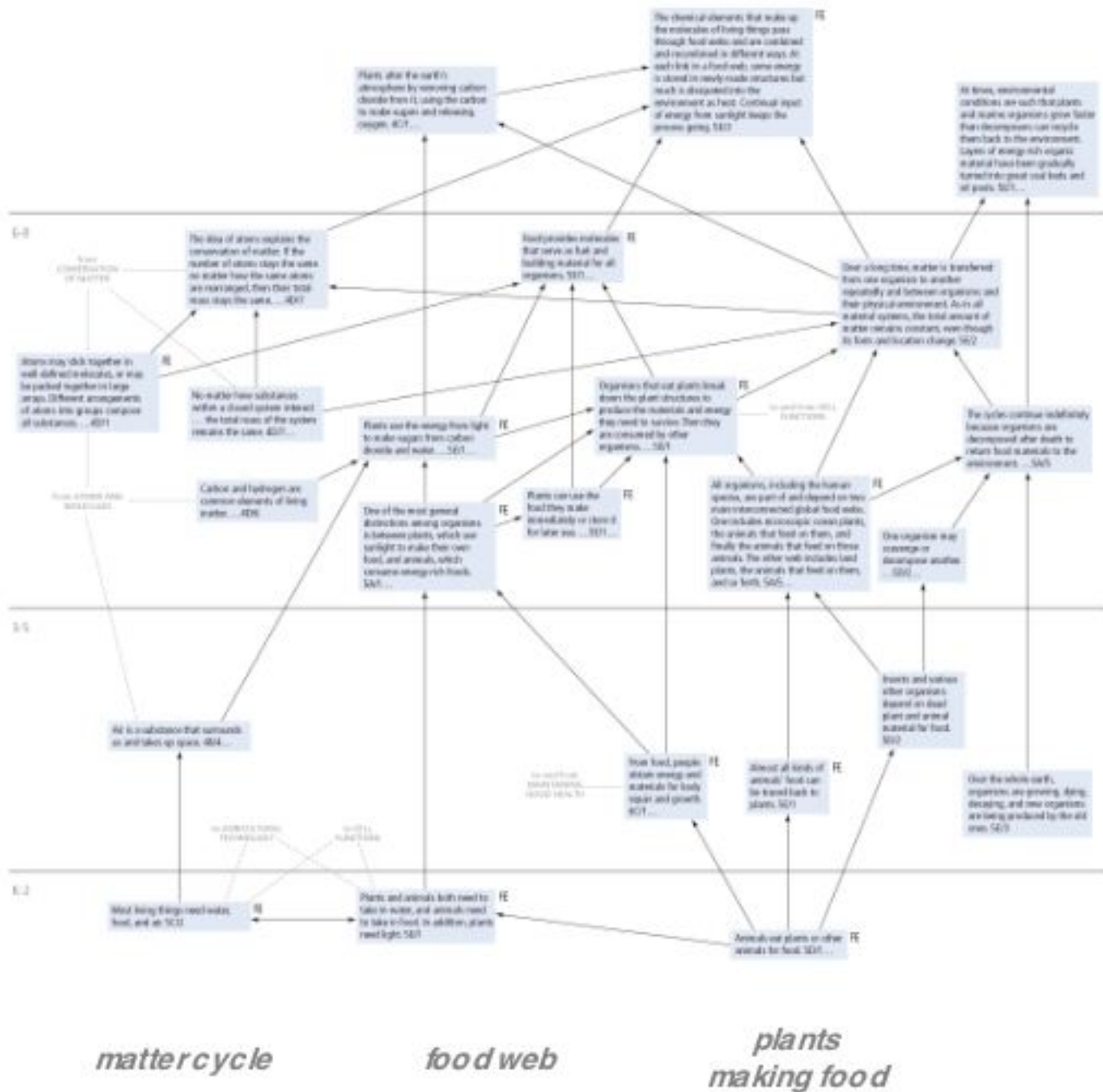
Comparing Standards

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

Literacy Goals

Learning Goals

Connections

Materials Development

Teacher Preparation

Assessment

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?
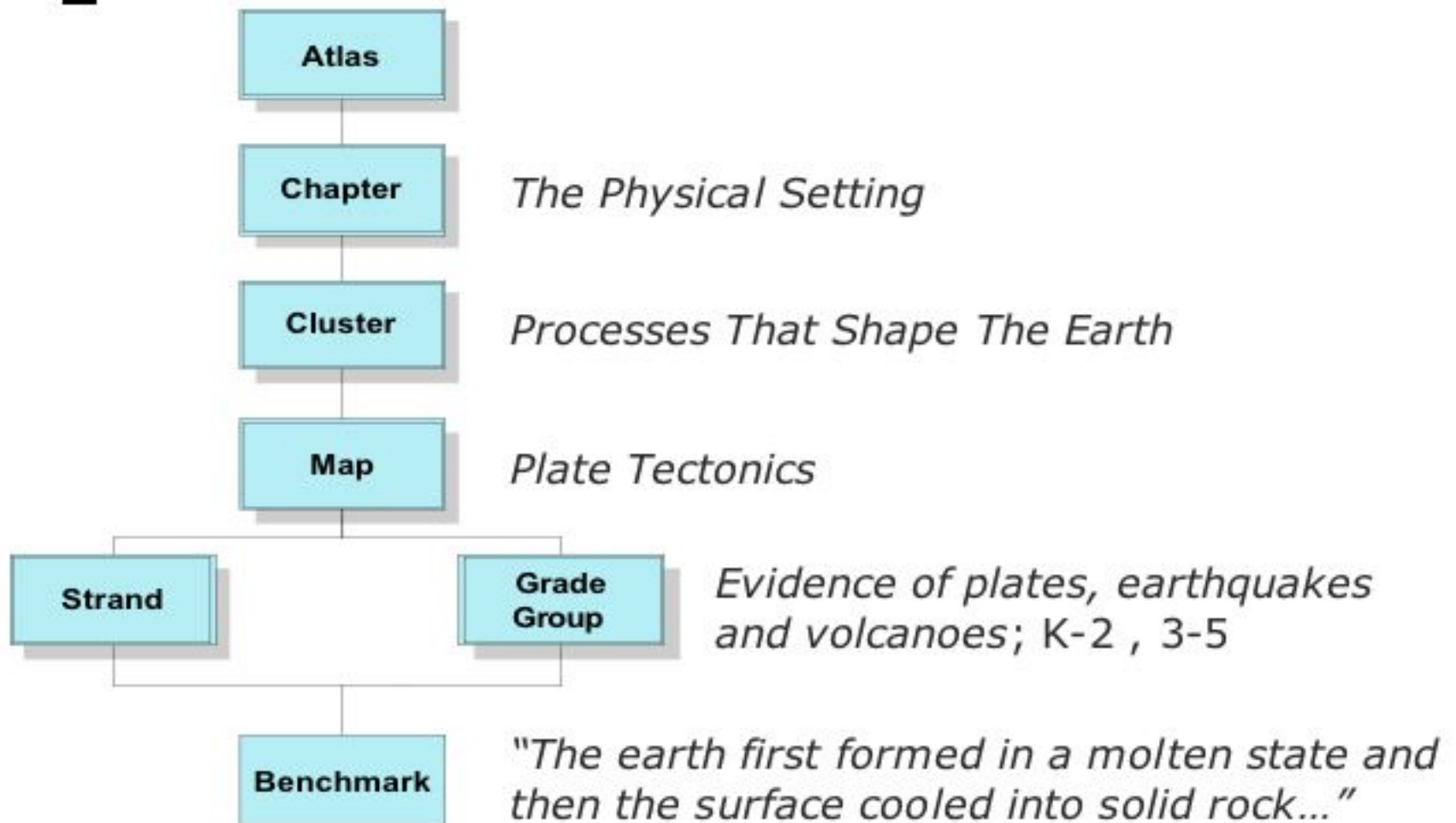
Points to Consider

- 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

Atlas

Chapter — *The Physical Setting*

Cluster — *Processes That Shape The Earth*

Map — *Plate Tectonics*

Strand | **Grade Group** — *Evidence of plates, earthquakes and volcanoes*; K-2 , 3-5

Benchmark — *"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

The Strand Map Service in the Harvard-Smithsonian Digital Video Library

Digital Libraries Clients

DLESE	Harvard Smithsonian Video Digital Library	Other NSDL Digital Libraries
CSIP	CSIP	CSIP / OAI-PMH

Strand Map Service Middleware

Concept Space Interchange Protocol (CSIP) Server

OAI-PMH Server

Visual Component Generator (VCG)

Benchmark Repository

Query Registration Service

Other Digital Libraries Query Interfaces

Strand Map Service: How it works
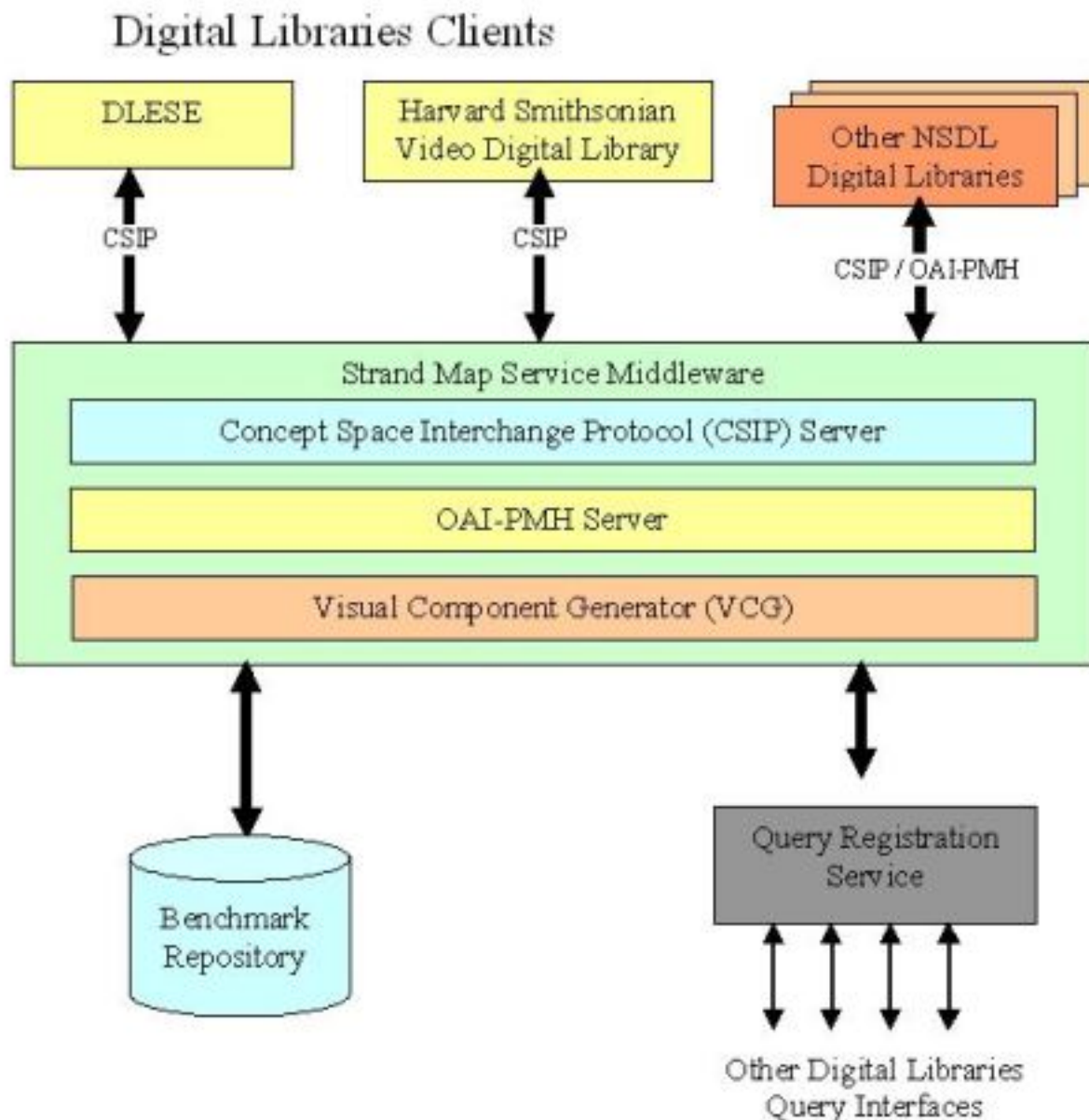
Pilot Study Results

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 (**S**calable **V**ector – 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

  - Free at **http://www.adobe.com/svg/viewer/install/**

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

Service Description (cont)

```
<SMS-CSIP xmlns="http://sms.dlese.org" …>
<ServiceDescriptionResponse>
<Version majorNo="1" minorNo="1"></Version>
<SupportedConfigurations>
    <Configuration>Skeleton</Configuration>
</SupportedConfigurations>
<SupportedQueryTypes>
    <Query>Content-based</Query>
    <Query>Navigation-based</Query>
</SupportedQueryTypes>
<SupportedReplyFormats>
    <Format>SMS</Format>
    <Format>SVG</Format>
</SupportedReplyFormats>
<SupportedLibrarySearch>
    <Library>Harvard Smithsonian</Library>
</SupportedLibrarySearch>
```

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

Content-Query Example 1

```
<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"/>
        …
        <Admin>
        <IDNumber>SMS-BMK-0141</IDNumber>
```

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>
```

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Address http://preview.dlese.org/sms/demonstrator%20front%20page.htm → Go   Links »

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Digital Library for Earth System Education   Funded by the National Science Foundation

⚙ 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; Review DLESE resources; Please give us feedback

⚙ Are you new to DLESE?

⦿ **Educational resources**

Browse Earth Concepts

Browse resources & collections

◯ **News & opportunities**

◯ **Email discussions**

◯ **Everything else**

Search   Tips

⚙ 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.
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Pick a Map

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.

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

Weather and Climate

Pick a map

Pick a strand of concepts

Pick a grade range

Solar System	Stars	Galaxies and the Universe	Atoms and Molecules
Conservation of Matter	States of Matter	Chemical Reactions	Laws of Motion
Waves	Flow of Energy in Ecosystems	Natural Selection	Scientific Investigations

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>
```
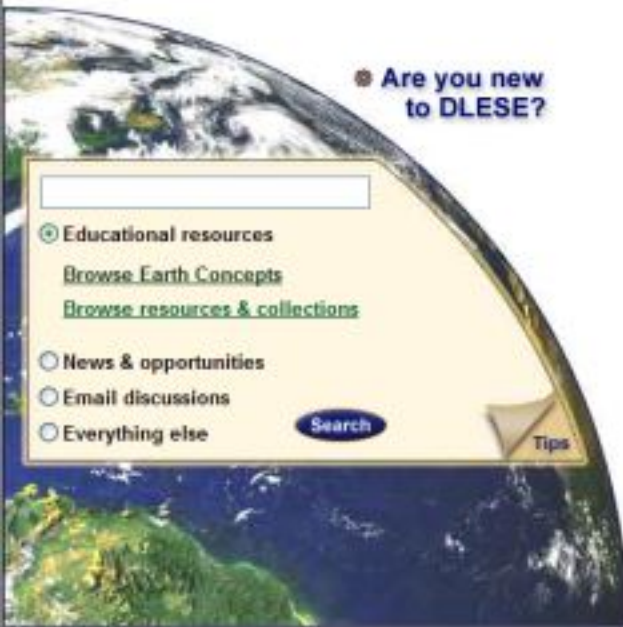
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Plate Tectonics	Flow of Matter in Ecosystems	Weather and Climate	Changes in the Earth's Surface
		Weather and Climate	
Solar System	Stars	Galaxies and the Universe	Atoms and Molecules
Conservation of Matter	States of Matter	Chemical Reactions	Laws 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.

Pick a map

Pick a strand

Pick a grade range

the earth's interior   earthquakes and volcanoes   evidence of plates

9-12

The theory of plate tectonics provides an explanation for a diverse array of seemingly...

Earthquakes often occur along the boundaries between colliding...

Ocean-floor plates may slide under continental plates, sinking deep into the...

The earth's plates ride on a denser, hot, gradually deformable layer of the earth...

The slow movement of material within the earth results from heat flowing out...

The solid crust of the earth-including both the continents and the ocean...

6-8

The interior of the earth is hot. Heat flow and movement of material within the earth cause...

Matching coastlines and similarities in rock types and life forms suggest that...

The earth first formed in a molten state and then the surface cooled into solid rock...

Some changes in the earth's surface are abrupt (such as earthquakes and volcanic...

There are a variety of different land forms on the earth's surface (such as...

Get Graphical Map

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

the earth's interior   earthquakes and volcanoes   evidence of plates
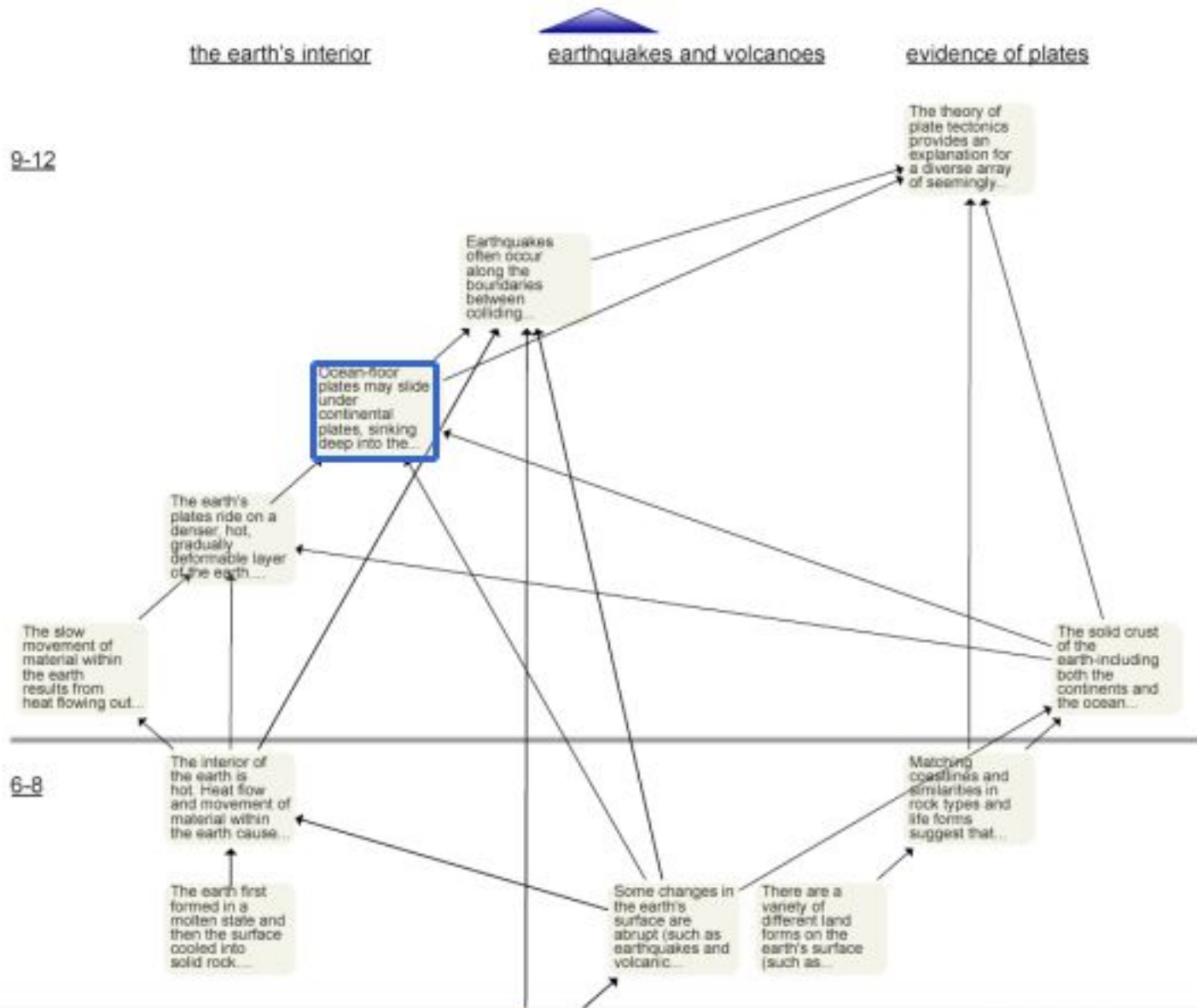
To begin, pick a map from the selections below or click a map from the grid. Then, to see details, pick a strand and/or a grade range.

9-12

The theory of plate tectonics provides an explanation for a diverse array of seemingly...

Pick a map

Pick a strand

Pick a grade range

Earthquakes often occur along the boundaries between colliding...

Ocean-floor plates may slide under continental plates, sinking deep into the...

The earth's plates ride on a denser, hot, gradually deformable layer of the earth...

The slow movement of material within the earth results from heat flowing out...

The solid crust of the earth-including both the continents and the ocean...

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Search for   Type search term(s) here   Web Search   Popups blocked

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Browse Earth Concepts

Plate Tectonics > *Ocean-floor plates may slide*

BACK

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.

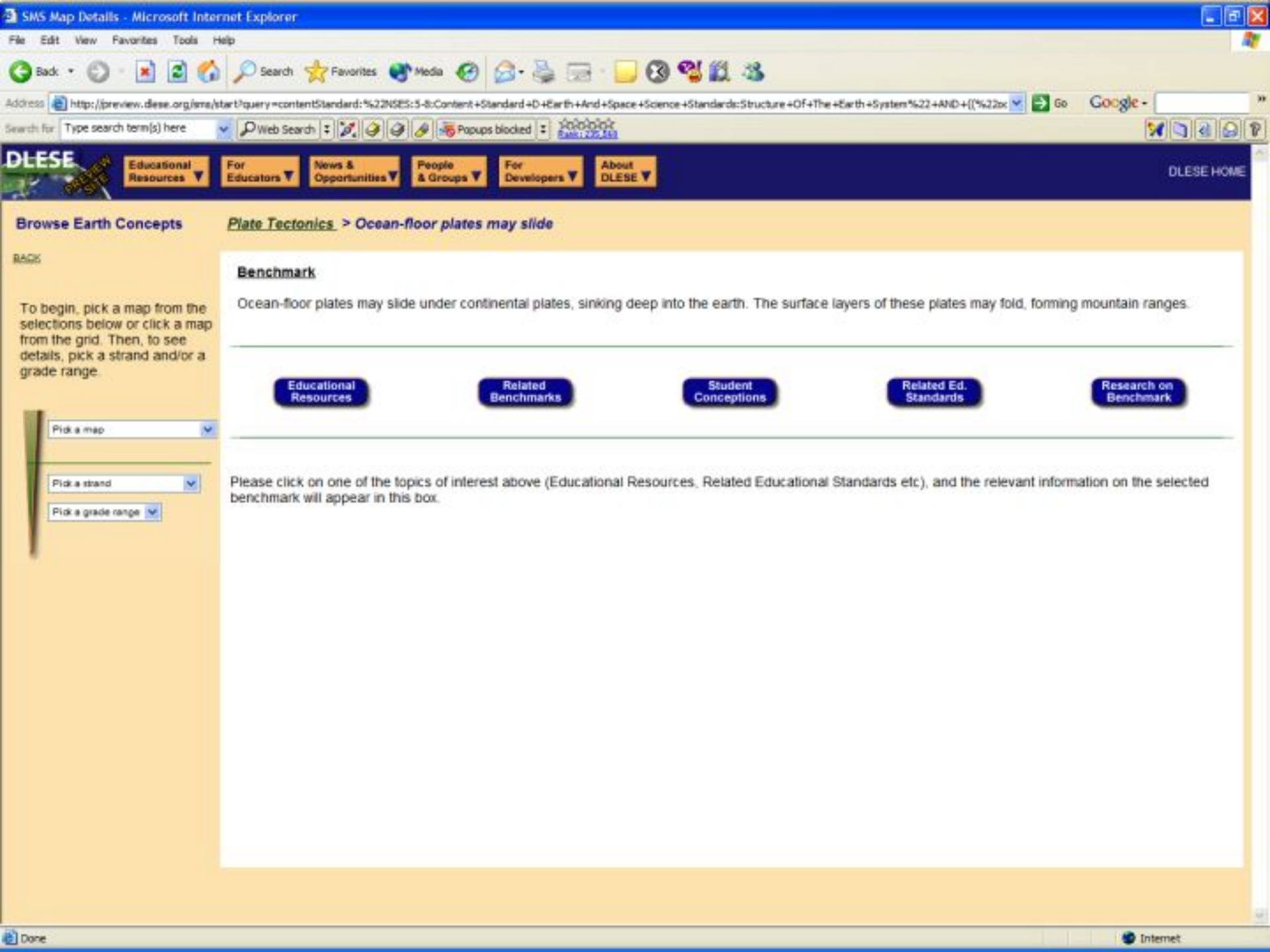Pick a map

Pick a strand

Pick a grade range

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.

Educational Resources   Related Benchmarks   Student Conceptions   Related Ed. Standards   Research on Benchmark

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.

Done   Internet

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Browse Earth Concepts

Plate Tectonics > *Evidence of plates* > *Ocean-floor plates may slide*

BACK

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.
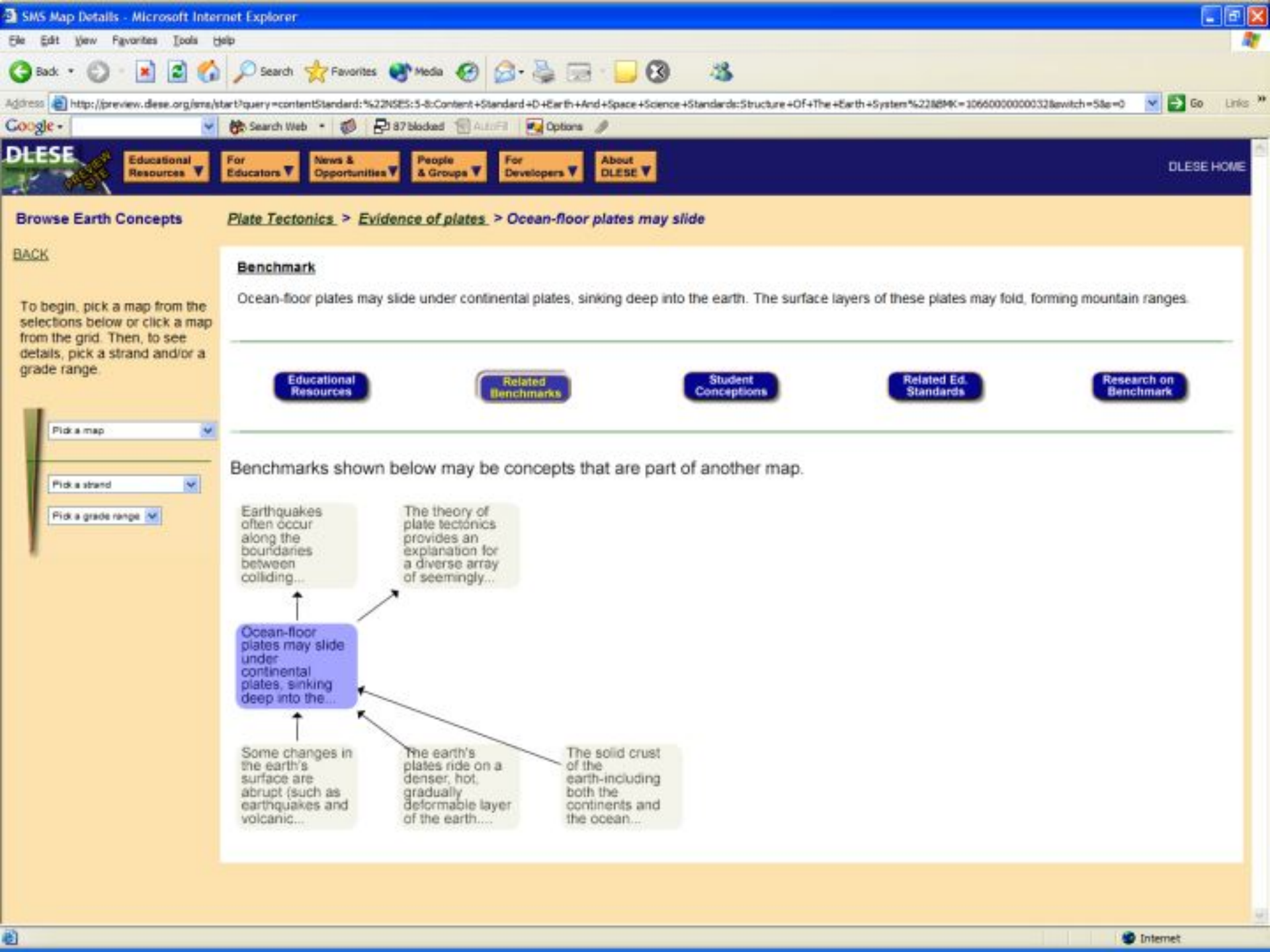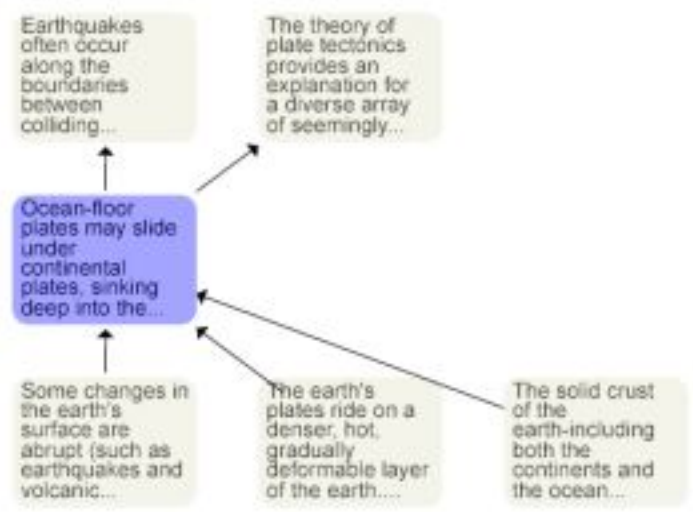
Pick a map

Pick a strand

Pick a grade range

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.

| Educational Resources | Related Benchmarks | Student Conceptions | Related Ed. Standards | Research on Benchmark |

Benchmarks shown below may be concepts that are part of another map.

Earthquakes often occur along the boundaries between colliding...

The theory of plate tectonics provides an explanation for a diverse array of seemingly...

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...

The earth's plates ride on a denser, hot, gradually deformable layer of the earth....

The solid crust of the earth-including both the continents and the ocean...

Get Benchmark Neighbors (Graphical)

```
<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:
  - Faisal Ahmad, fahmad@colorado.edu
  - Sonal Bhushan, sonal@ucar.edu

References

- Sumner, Ahmad, Bhushan, et al, "Linking Learning Goals and Educational Resources through Interactive Concept Map Visualizations", *International Journal of Digital Libraries,* To appear in: Special Issue on Information Visualization Interfaces for Retrieval and Analysis, October 2004.

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- A. M. O'Donnell, D. F. Dansereau, and R. H. Hall, "Knowledge Maps as Scaffolds for Cognitive Processing," *Educational Psychology Review*, vol. 14, pp. 71-86, 2002.