Mapping the Terrain: Developing Content & Pedagogy metadata categories for learning resources

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Teachers need to search for learning objects and make use of them in their teaching

– To support inquiry learning
– Pressure to integrate technology
– Personalize learning trajectories
– Interactive e-textbooks are coming of age

The common available technology

The web is not “semantic”

– Google and its like do not support “surgical” searching --- the search results are based on popularity
– HTML does not usually include pedagogical meta-data
– No standard semantics for pedagogical meta-data for learning objects

As a result teachers compromise:

- authoring their own learning objects
- make decisions on use without any “reflecting feedback”
Our solution: Coupled pair of tools for tagging/searching learning objects on the internet
A content-list page in the future textbook
Design dilemmas

– What meta-data should be tagged?
  Research perspective
  Practical perspective
– How should tagged database be displayed (organized for navigation)?
– Scope of tagged database: Personal? Universal? Well defined communities?
The Edumap challenge: Two discourses

Descriptive –

As if it is not tied to specific context
so that tasks may be found suitable for a variety of contexts.

• Research-based frameworks
  – Balanced Assessment¹ (object × organization of curriculum)
  – Semiotics, including pedagogical nature of Interactive Diagrams²
  – Curricular specificity / mathematical expressivity³

¹ Balanced Assessment, 1995, Assessing Mathematical Understanding and Skills Effectively - AMUSE
  http://hgse.balancedassessment.org/amuse.doc
The Edumap challenge: Two discourses

Envisioned Usage (pragmatic categories)
Teachers were likely to expect this kind of tagging:
   Mathematical topic
   Pedagogical role (homework, assessment, etc)
   Class arrangement

Represented by green balloon
Edumap cycles of Design:

• A light hand with research-based categories of metadata
### Mathematical Domain

<table>
<thead>
<tr>
<th>Domain</th>
<th>Pattern / Function</th>
</tr>
</thead>
</table>

### Mathematical Actions

<table>
<thead>
<tr>
<th>Modeling / Formulating</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transforming / Manipulating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Inferring / Drawing Conclusions</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Using Technology</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

### Mathematical Topic

<table>
<thead>
<tr>
<th>Pattern / Function</th>
<th>Equations</th>
</tr>
</thead>
</table>

### Mathematical Object

<table>
<thead>
<tr>
<th>Type of Equation</th>
<th>Quadratic</th>
</tr>
</thead>
</table>
### Operations

<table>
<thead>
<tr>
<th>Represent</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modify</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Transform - build a family</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Analyze</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Operate with/on</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Compare</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Balanced Assessment:** Operations on objects

### Representation

<table>
<thead>
<tr>
<th>Verbal</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Numeric</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Symbolic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Mathematical Representation**
Edumap cycles of Design:

- A light hand with research-based categories of metadata
- A separate section for “Resource Usage”
Envisioned usage of task

Envisioned usage of technology
Edumap cycles of Design:

• A light hand with research-based categories of metadata
• A separate section for “Resource Usage”
• None of the fields are compulsory
Edumap / Keshif experiment: Method & Finding

- **Short professional development** with pre-service teacher candidates at University of Haifa
- **Structure of experiment**
  - 23 pre-service participants
  - Pre-task (submitted online): *Select three tasks from Visual Math to serve as 1. Opening the topic; 2. Practice; 3. Assessment. Explain your selections – what guided you in choosing a task for each of the teaching stages?*
  - Introduction to Edumap (version 2)
  - Experiment task: *Repeat pre-task using Keshif browser, present to peers.*
- **Research questions:**
  - How will the teachers make use of the meta-data categories in designing teaching sequences?
  - How will teachers’ curricular discourse be different compared to the pre-task?
INSTRUMENTAL GENESIS OF KESHIF
case 1 (opening task): Disappointment with “envisioned usage”

• At first we tried to actually select the tasks [that were tagged as] opening tasks, and we saw that they weren’t necessarily the opening tasks that we were looking for. So we started to think together what we want in opening tasks... graphical representation... and then we asked for a pair activity, and that the explanation should be not only technological... we were left with two tasks, and we decided to look at them.
Case 2 (practice task): First descriptive, then usage

• In practice [task], it was important for us that the representation be verbal... Then we went to tasks [that were tagged as] practice... and also that it should be individual activity.
Case 3 (assessment task): Descriptive/usage/descriptive, think!

- For assessment we first did **drawing conclusions**. Then we selected individual activity. Then graphical representation. We were left with many tasks, and then we started to think what else is important for us.
Research questions & preliminary answers

1. How will the teachers make use of the meta-data categories in designing teaching sequences?
   – A blend of descriptive and usage categories
   – When a few tasks remain – personal preference

2. How will teachers’ curricular discourse be different compared to the pre-task?
   – Enriched criteria (*I didn’t think about that at home*)
   – A priori search criteria, opposed to a posteriori justification (*we started to think what’s important*)
   – Evidence of multiple “obligations”:
     • *you know your students* (personal obligation to students)
     • *what kind of lesson you want* (institutional obligations)
Preliminary conclusion

• Challenge of resolving relevance between communities encourages each community to critically evaluate what is important
  – Researchers: Which research-based categories are crucial for curricular design?
  – Teachers:
    » Which categories of usage are searchable
    » Which social contexts share meanings for metadata
Further questions

• Could it be “universal”? Supporting communities that have common grounds for common tagging
• Should tagging be automatic?
Interacting with digital textbooks

• Who?
• How?
• What can we learn from this?
Tangible representations of digital textbook contents

• Teachers: use it creating learning sequences
• Designers: reflect the big ideas in a digital textbook
• Policy makers: choosing textbooks among many
Creating the data

• Tagged learning objects:
  – Different taggers on a large corpus
  – Many taggers on the same topic
  – [Automatic tagging]

• Result: tagged database

• Let’s represent it in a tangible, accessible way
Chosen tool: Keshif Browser

- Visual
- Dynamic
- Partial solution (not suitable for sequence representation)
- Available for use at www.keshif.me

Goal

• Can we use this visual representation to gain insight about:
  – A. The tagged data
  – B. The taggers

• Today we will demonstrate a proof of concept on A - a methodology to gain insight on the tagged data
Specifics

- 9 practitioners (teachers, graduate students, mathematics education researchers)
- 74 tasks in Analysis from 3 chapters of the Visual Math textbook of Analysis – Computer supported inquiry activities for higher school (Yerushalmy et al, 1996).
- Tagging fields were predefined by researchers (for more details you can attend Yerushalmy’s presentation later during this conf.)
- Visual representation created with Keshif
What did we try to do?

• Exploring the representations to gain insights about the textbook chapters

• Check the alignments of these insights with the designers intention to define:
  – Intentional correlation: The insights reflect the designers intension.
  – Tacit correlation: The insights exist, but the designers did not intend knowingly to incorporate them (implicit or unintentional)
  – Not relevant: The insights are not relevant to the designers intentions.
Let’s try it out

• Go to the following website:

https://goo.gl/dxjwmV

• Try to gain 3 *insights* on the given data base

• Example.

• (this was created using keshif – www.keshif.me)
Method cont’d

• Initial analysis revealed insights (17) regarding the tagged data set

• The identified insights were presented to the designer in an interview to comment on

• According to the analysis of the reply, insights were categorized into the 3 categories presented earlier
Results

• Intentional correlation: The insights reflect the designers intension.

• Insight: The tasks that were designed for opening a topic were without symbolic representation almost in all cases.

• Designers reaction:
  – “This is the definition, generally speaking, of an opening task – to reach the symbolic - from sensing, complex problems which one can think about, non-mathematical information etc.”
Results – cont’d

• Tacit correlation: The insights exist, but the designers did not intend knowingly to incorporate them

• Insight: Non-technological justifications are not so common in the “derivative” chapter.

• Designers reaction:
  – “This is a logic conclusion from two other conclusions: derivative has a lot of symbolic work, and when working symbolically you cannot rely solely on technology.”
Results – cont’d

• Not relevant: The insights are not relevant to the designers intentions.
• Insight: Symbolic representation is especially common in drawing conclusions tasks’.

• Designers reaction:
  – “I am not clear why this phenomenon is shown in the data.”
  – “Maybe this testifies on the type of conclusions they aspire to. For example – how does drawing a conclusion from a graphic representation without symbolic representation looks like? That is probably not reflected in this collection.”
Limitations and pitfalls

- Tagger and designers might not be aligned
- Tagging performed by multiple taggers
  - Contradicting tagging for the same object
  - Tagging of different objects by different taggers
- Insights are dependent on user of Keshif
Summary and Conclusion

• Visual dynamic representation could assist in revealing different characteristics of datasets of curricular materials

• “Objectively” gained insights could be presented to designers (teachers?) in order to conduct a productive discussion

• Characteristics are restricted by the tagging (what you don’t tag you can’t represent)

• Automatic tagging is key

• Accessible terminology (common discourse) is important
Thank you.

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