Model-based Scaffolding Technologies for Learning Web Resources

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Learning on the Web

- Model-based scaffolding for learning
- Learning skill development

Web resources → navigation → knowledge construction

Web: Unstructured

Knowledge: no model of how to learn
Outline

- **Web as learning resources**
  - Navigation, knowledge construction, and self-regulation
  - Problems and difficulties in learning Web resources
  - Related work on solutions

- **Model-based scaffolding with cognitive tools**
  - Model of how to learn with unstructured resource
  - Cognitive tools as scaffolds for executing the model

- **Scaffolding technologies for learning skill development**
  - Self-assessment
  - Accumulating experiences of executing the model

- **Conclusion**
Web as Learning Resources

- Vast and diverse
- **Unstructured** (not so suitable for learning)
- Unreliable to reliable (miscellaneous)
Learning Process Expected

Knowledge exploration

Navigation

Resource navigation

Page navigation

Web page

Learning resource-a

Learning resource-b

Learning resource-c

Web

Knowledge construction

Learn widely/deeply

Learner

Learning goal
Learning Process Expected (Cont.)

Self-regulation

Navigation Planning

Reflection

Plan execution

Navigation

Monitor

Control

Resource navigation

Page navigation

Web page

Learning resource-a

Learning resource-c

Knowledge construction

Learning goal

Learner
Problems

Due to unstructured resources

- **Difficulties in navigation**
  - unclear relationships among pages/resources
  - how to select pages/resources to make navigation path

- **Difficulties in self-regulation**
  - concurrent with navigation and knowledge construction
  - how to monitor/control navigation and knowledge construction processes

- **Self-assessment**
  - no correct (expected) achievement of learning goal
  - how to assess subjectively/relatively
Related Work

- **Restructuring hyperspace of Web resources**  
  (From unstructured to structured resources)
  - Resource-based restructuring 
    - Automatic indexing [Kibby and Hayes 89],[Brusilovsky, et al. 04] 
    - Manual indexing [Hasegawa and Kashihara 01],[Dieberger and Guzdial 03]
  - Model-based restructuring 
    - Domain model: KBS-Hyperbook [Henze and Nejdl 01] 
    - Collective knowledge model: CoWeb [Dieberger and Guzdial 03], Knowledge Sea II [Brusilovsky, et al. 04]

- **Enabling learning process**
  - Adaptive hypermedia approach [Brusilovsky 01], [De Bra 02] 
    - Reducing self-regulation load
  - **Scaffolding** 
    - Prompting for eliciting self-regulation process [Azevedo 04],[Narciss, et al. 07] 
    - **Cognitive tools** for reifying self-regulation process as meta-cognitive one [Kashihara et al. 02/03]
Issues Addressed

- How to develop skills in learning within unstructured hyperspace?
  - Model of how to learn
  - Scaffolding technologies
    - for executing the model
    - for self-assessing the learning process
    - for accumulating experiences of model execution
Approach

Learning skill development

Experiences of learning process

1. Cognitive tools for reifying the learning process modeled

How to self-assess
How to accumulate experiences

2. Scaffolding technologies with cognitive tools
Learning Models and Cognitive Tools

- Model of navigation planning
  - PA: Planning Assistant [Kashiwara et al. 02]
- Model of knowledge construction and reflection
  - IH: Interactive History [Kashiwara et al. 03]
- Model of navigation, knowledge construction, and self-regulation
  - iLearn: Integration of PA and IH [Kashiwara et al. 10]
Learning within Unstructured Hyperspace

Self-directed navigation
Knowledge construction

Navigational learning

Hyperspace
Page
Knowledge constructed

Navigation goal-1
Navigation goal-n

Learning goal
Model of Knowledge Construction Process

Primary navigation process

Starting page → Terminal page

Navigation goals
- Supplement
- Elaborate
- Compare
- Justify
- Rethink
- Apply

Knowledge construction
Model of Reflection as Meta-Cognitive Process

Reflection

Self-regulation

Navigational learning process

- Primary navigation process-1
- Primary navigation process-2
- Primary navigation process-3
- Primary navigation process-n

Knowledge constructed
Reflection Process Expected

- Reflection on and re-learning of contents learned at starting and terminal pages
- Reflection on and reconstruction of primary navigation processes
- Reflection on and reconstruction of relationships among primary navigation processes
<table>
<thead>
<tr>
<th>IH functions</th>
<th>Knowledge construction/reflection process reified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note-taking</td>
<td>Learning/reflection on and re-learning the contents learned at starting and terminal pages</td>
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<tr>
<td>Annotated navigation history</td>
<td>Carrying out/reflecting on and reconstructing primary navigation processes</td>
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<tr>
<td>(a) Navigation goal annotation</td>
<td></td>
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<tr>
<td>(b) Link annotation</td>
<td></td>
</tr>
<tr>
<td>Knowledge map</td>
<td>Making/reflecting on and reconstructing relationships among primary navigation processes</td>
</tr>
</tbody>
</table>
IH: Interactive History

Primary navigation processes
Knowledge Map
Learning Skill Development with IH

- Scaffolding technologies
  - for self-assessment
    - **ihComparator** for comparing knowledge maps
      [Ota, Kashihara, and Hasegawa 05]
    - **Knowledge map mining** for collective knowledge generation
      [Ota and Kashihara 10]
  - for accumulating experiences of navigational learning modeled
    - **Learner-fadable scaffolding with IH** [Kashihara et al. 08]
Scaffolding for Self-Assessment

- **Context**
  - Learning a Web resource (closed hyperspace) with the same learning goal in a learning community
  - Cognitive tool used: IH

- **Goal**
  - Awareness about insufficiency of knowledge constructed

- **Methods/Technologies**
  - ihCompapator: comparing similar knowledge maps to highlight the difference
  - Knowledge map mining: mining common structure from knowledge maps as more proper achievement of the learning goal
ihComparator

Learner’s map

Similar map

Difference highlighted

Memo info.
A Web resource with the same learning goal

Knowledge maps

Knowledge map mining ▼ Differences

Collective knowledge
Lessons Learned

- Results
  - ihComparator and collective knowledge could give learners awareness about insufficiency of knowledge constructed.

- Potential (Effects expected)
  - Widening and deepening knowledge learned
  - Promoting self-assessment of knowledge construction process
Learner-Fadable Scaffolding with IH

- **Goal**
  - Improving skills in knowledge construction and reflection as modeled
  - More skillful in IH operations
    - Deeper understanding of IH operations
    - More skillful in knowledge construction and reflection without IH

- **Method/Technologies**
  - Learner-fadable scaffolding
    - Scaffold: IH functions
    - Scaffolding levels: the number of IH functions available
    - Fading IH functions to decrease the scaffolding level
Framework for Learner-Fadable Scaffolding

IH functions

Level 4: Knowledge map
Level 3: Navigation goal annotation
Level 2: Link annotation
Level 1: Note-taking

Web browser

Scaffolding
Fading
Lessons Learned

- Results
  - Learners could adjust and decrease the scaffolding levels to learn Web resources through (11 days over three weeks).
  - Learners could improve their skills in knowledge construction and reflection after learner-fadable scaffolding.

- Potential (Effects expected)
  - Understanding the necessity of IH functions
  - Knowledge construction independent of tools
Conclusion

- Model-based scaffolding for learning Web resources
  - Models of how to learn
  - Cognitive tools for reifying learning process modeled
  - Learning skill development with cognitive tools
    - scaffolding for self-assessment
    - scaffolding for accumulating experiences of model execution

- Future work
  - Detailed evaluation with scaffolding technologies
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Related Publications


References


