Knowledge Representation & Authoring in Adaptive Education

Milos Kravcik
Open Universiteit Nederland
milos.kravcik@ou.nl
Overview

Ideal learning?

Ideal authoring of learning resources?

Ideal representation of learning resources?

**Issue:** specification of concrete learning resource instances is usually context dependent and does not support reusability very well

**Structure:**

- Model of Adaptive Learning System
- Representation of Learning Resources – reusability
- Summary and Conclusion
Model of Adaptive Learning System

- Run-time Layer
- Presentation Specification
  - Adaptation Model
  - Instruction Model
    - Domain Model
    - Context Model
    - User Model
- Storage Layer
- Anchoring
  - Within-Component Layer
Representations of Learning Resources

**Declarative knowledge:** domain, user, context models

**Procedural knowledge:** pedagogical, adaptation models

Existing approaches:

- Informal scripts
- System encoding
- Elicited knowledge
- Standards
- Ontologies
- Your approach?
Informal Scripts

Alfred Bork – tutorial learning paradigm – based on Socratic dialog – frequent questions, free-form answers

Adaptive learning units – designed by a team of people with different competencies, including domain experts and teachers

Overall design – a list of modules to develop
Detailed design – sensitive to individual students by generating diagnostic questions and providing suitable feedback

Designers sketch informal scripts – design logic and messages for the learner
Programmers – programming logic, screen design, suitable media

Knowledge is represented implicitly in the design scripts – not reusable

Freedom of authors, complicated authoring process
System Encoding

Example – **WINDS**:
- teachers specified pedagogical requirements
- programmers implemented them in ALE
- **procedural knowledge encoded** in the system

**Simplified authoring** – authors without programming skills can create adaptive courses

**Fixed representation** of procedural knowledge
Elicited Knowledge

Separation of learning design and adaptation strategies from concrete materials & contexts

Reusability of procedural knowledge

To achieve a critical mass of its instances a specification language has to be standardized

- **lowest level**: direct adaptation techniques/rules
  - adaptive navigation support & adaptive presentation
  - implem.: AHA!; expressed in AHAM syntax
  - techniques usually based on threshold computations of variable-value pairs.

- **medium level**: adaptation language
  - more goal / domain-oriented adaptation techniques: based on a higher level language that embraces primitive
  - lower level adaptation techniques (wrapper)
  - new techniques: adaptation language

- **high level**: adaptation strategies
  - wrapping layers above
  - goal-oriented
Standards

IMS Simple Sequencing: provides learning material tailored to the learner’s current context, but makes no distinction between users.

IMS Learning Design: explicit notation to enable interoperability on the level of systems; personalization – conditions, DIV layers, hide-visible properties.

Towle & Halm: IMS LD provides a way to implement simple adaptive learning strategies, but not complex forms of adaptive learning, like multiple rules interactions or enforced ordering.

aLFanet: learning standards are not harmonized to work with each other and available tools are too complex for non-specialized authors.

ALD: IMS LD can be used to model and annotate adaptive learning design, but designing more complex adaptivity behavior might be not too easy.

Zarraonandia: reusability of learning design – runtime adaptation to actual context.
Ontologies

Challenge: creation and use of ontologies to represent various types of knowledge relevant for personalized adaptive learning

Stojanović et al., 2001: lack of formal semantics as major obstacle to interoperability of e-learning systems –> ontologies

Henze et al., 2004: reasoning and ontology framework for personalized learning on the Semantic Web
  ontologies – domain, user, observation (interaction), presentation

Jovanović et al., 2006: dynamic assembly of personalized learning content on the Semantic Web
  ontologies – content structure, content type (pedagogical role), learning path, domain, user model
Your Approach?

Which type of knowledge you want to specify and use?

How do you want to author it?

How do you want to represent it?
Summary & Conclusion

Koper, 2005: *the notation must make it possible to identify, isolate, de-contextualize, and exchange useful parts of a learning design so as to stimulate their reuse in other contexts*

Various ways of knowledge representation for learning resources

**Issue:** reusability and adaptivity

**Challenge:** representation of various types of knowledge and their interaction when generating concrete instances dynamically

**Interoperability** demands – between systems & between models/layers

Standards are not harmonized

Semantic Web is used as mediator