Personalized Course Delivery in Learning Management Systems

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Adaptivity and Personalization in Learning Systems

How can we make learning systems more adaptive, intelligent and personalized

- Based on a comprehensive student model that combines learner information and context information
- In different settings such as desktop-based, mobile and ubiquitous settings
- In different situations such as for formal, informal and non-formal learning
- Supporting learners as well as teachers
- Develop approaches, add-ons and mechanisms that extend existing learning systems
Adaptivity and Personalization in Learning Systems

- **Students’ characteristics**
  - Learning styles
  - Cognitive traits
  - Context information (environmental context & device functionalities)
  - Motivational aspects
  - Affective states

- **Different settings**
  - Learning management systems
  - Mobile / Ubiquitous learning
Adaptivity and Personalization in Learning Systems

- Students’ characteristics
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- Different settings
  - Learning management systems
  - Mobile / Ubiquitous learning
Why aiming at enabling learning management systems to adapt to students’ learning styles?
Why Learning Management Systems?

- are used by most educational institutions
- Examples: Moodle, Blackboard, Sakai, ATutor
- are developed to support teachers to create, administer and teach online courses
- provide a lot of different features
- domain-independent
- provide only little or in most cases no adaptivity
Why Learning Styles?

- Complex and partially inconsistent research area
- Learners have different ways in which they prefer to learn
- If these preferences are not supported, learners can have difficulties in learning
- Previous studies showed that providing learners with courses that fit their learning styles has potential to help learners in learning
Felder-Silverman Learning Style Model

- Each learner has a preference on each of the dimensions

**Dimensions:**

- **Active – Reflective**
  - learning by doing – learning by thinking things through
  - group work – work alone

- **Sensing – Intuitive**
  - concrete material – abstract material
  - more practical – more innovative and creative
  - patient / not patient with details
  - standard procedures – challenges

- **Visual – Verbal**
  - learning from pictures – learning from words

- **Sequential – Global**
  - learn in linear steps – learn in large leaps
  - good in using partial knowledge – need „big picture“
Felder-Silverman Learning Style Model

- Scales of the dimensions:

  - Strong preference but no support → problems
Felder-Silverman Learning Style Model

- Differences to other learning style models:
  - Combines major learning style models (Kolb, Pask, Myers-Briggs Type Indicator)
  - New way of combining and describing learning styles
  - Describes learning style in more detail (Types <-> Scale)
  - Represents also balanced preferences
  - Describes tendencies
  - Domain-independent
  - Are “flexible-stable” over time
How to provide adaptive courses in learning management systems?
Research Question

How to extend typical LMS with adaptivity?

- Develop a concept which enables LMS to automatically generate adaptive courses
- Keep the concept generic so that it can be used for different LMS
- Implement and evaluate the concept in one particular LMS
- Incorporates only common kinds of learning objects
  - Content
  - Outlines
  - Conclusions
  - Examples
  - Self-assessment tests
  - Exercises
Aims and Benefits

- Teachers can continue using their courses in LMS
- Students get personalized support with respect to their learning styles
- Requirements for teachers
  - Teachers shall have as little as possible additional effort
  - Provide learning objects → Excluded the visual/verbal dimension
  - Annotate learning objects (distinguish between the objects)
General Concept for Providing Adaptivity in LMS

Detecting students’ information (Extension 1)
Presenting adaptive courses (Extension 3)
Annotating learning objects (Extension 2)
Structure of a course

Chapter 1:

Examples
Self-assessment
Exercises
Outline
Content with/without outlines between subchapters
Conclusion
Examples
Self-assessment
Exercises
Conclusion

Chapter 2:

...
Adaptation features

- Sequence of examples (before or after content)
- Sequence of exercises (before or after content)
- Sequence of self-assessments (before or after content)
- Sequence of outlines (only once before content or between content)
- Sequence of conclusion (after content or at the end of the chapter)
- Number of examples
- Number of exercises
Adaptations for active/reflective learners

- **Active learners**
  - Self-assessments before and after content
  - High number of exercises
  - Low number of examples
  - Outline only at the begin of content
  - Conclusions at the end of the chapter

- **Reflective learners**
  - Outlines between content
  - Conclusion after content
  - Avoid self-assessments before content
  - Examples after content
  - Exercises after content
  - Low number of exercises
Adaptations for sensing/intuitive learners

- Sensing learners
  - High number of examples
  - Examples before content
  - Self-assessment after content
  - High number of exercises
  - Exercises after content

- Intuitive learners
  - Self-assessment before content
  - Exercises before content
  - Low number of exercises
  - Low number of examples
  - Examples after content
  - Outlines only at the begin of content
Adaptations for sequential/global learners

- **Sequential learners**
  - Outlines only at the begin of content
  - Examples after content
  - Self-assessment after content
  - Exercises after content

- **Global learners**
  - Outlines between content
  - Conclusion after content
  - High number of examples
  - Avoid self-assessment before content
  - Avoid examples before content
  - Avoid exercises before content
Ambiguous Learning Preferences

- Active/Reflective = +11 → strong active style
- Sensing/Intuitive = -11 → strong intuitive style
- Sequential/Global = -11 → strong global style

Number of Exercises
- Active → high number
- Intuitive → low number
- Global → no preference
  → Moderate number of exercises
Evaluation of the Concept

- Implemented add-on for Moodle (Version 1.6.3)
- Evaluated with more than 400 students participating in a course about object-oriented modelling

Course consisted of

- Lecture (optional)
- Practical part - 5 Assignments (compulsory)
- Online Course in Moodle (optional)
- Final Exam (compulsory)

The aim of using a LMS was to provide students with additional learning material and learning opportunities
Evaluation of the Concept

- Randomly assigned to 3 groups:
  - Courses that fit to the students’ learning styles (matched group)
  - Courses that do not fit to the students’ learning styles (mismatched group)
  - Standard course which includes all learning objects (standard group)

- Procedure
  - Students filled out a learning style questionnaire
  - Adaptive course is automatically generated and presented
  - Students were nevertheless able to access all learning objects and take a different learning path
Evaluation of the Concept

Results:

- Average score on assignments & score on final exam
  - no significant difference

- Time spent on learning activities
  - Standard (5h 34 min) > Matched (3h 47min)
  - Mismatched (5h 33min) > Matched (3h 47min)

- Number of logins
  - Standard (32 logins) > Matched (28 logins)

- Number of visited learning activities
  - no significant difference

- Number of requests for additional LOs
  - Mismatched (8.30%) > Matched (6.59%)

→ Students from the matched group spent significant less time in the course but achieved in average equal grades
→ Demonstrates positive effect of adaptivity
What benefits does adaptivity have for learners with different learning styles?
Aim of this research

- Investigating the effects and effectiveness of adaptivity for students with different learning styles
  - Does students with different learning styles benefit from adaptivity in different ways?
    - Effects of adaptivity for students with different learning styles
  - Which students can be supported more effectively by using adaptivity comparing their learning styles?
    - Effectiveness of adaptivity comparing different learning styles

- Same data as for the previous study has been used
Effects of Adaptivity

- Comparing data from matched and mismatched course with respect to learning styles and behaviour/performance variables (using ANOVA)
- Learning Styles:
  - Two groups for each dimension (e.g., active and reflective)
- Performance
  - Scores of final exam
- Behaviour
  - Time spent on learning activities
  - Number of logins
  - Number of visited learning activities
  - Number of requests for additional LOs
## Effects of Adaptivity - Results

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<th>intuitive</th>
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Effectiveness of Adaptivity

- Which students can be supported more effectively by using adaptivity comparing their learning styles?

- Looking only at data from matched course and comparing the students’ performance and behaviour with respect to their learning styles.
Effectiveness of Adaptivity

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</table>

Means:
- Act.: 166.07 points
- Ref.: 184.37 points
- Sen.: 169.98 points
- Int.: 185.43 points
- Act.: 3.81 h
- Ref.: 6.68 h
- Act.: 27.24
- Ref.: 31.08
- Act.: 415.21
- Ref.: 624.73
Summary of Findings

- Adaptivity based on learning styles can help students in learning
- Adaptivity has different effects for learners with different learning styles
- Findings give a deeper insight in the effects and effectiveness of adaptivity
- Findings show that for some learning styles adaptivity works better than for others, in terms of encouraging them to use the course more intensively and/or letting them achieve better scores.
How to make the adaptive mechanism more flexible for teachers?
Aim of Research

- Use the adaptive mechanism for extending LMSs to automatically generate courses that fit students’ learning styles
- Make our approach applicable for different courses (e.g., with theoretical and practical focus)
- Make it easier for teachers to use our adaptive mechanism
How to make the mechanism more flexible?

- **Requirements**
  - Generic and work for different LMSs
  - Require from teachers as little as possible additional work
  - Restrict teachers as little as possible in their course design

- **Solutions**
  - Use only types of LOs that are available in most LMSs
  - Only ask teachers to annotate LO with the type once they create them
  - Use a course structure that allows many different types of LOs but does not require each type of LO to be available in each chapter/section
Considered types of learning objects

- Commentaries
- Content Objects
- Reflection Quizzes
- Self-Assessment Tests
- Discussion Forum Activities
- Additional Reading Material
- Animations
- Exercises
- Examples
- Real-Life Applications
- Conclusions
- Assignments

- Teachers can add many different types of LOs in their courses
- Teachers can add types of LOs wherever they feel they fit (as they usually do in LMSs)
- Teachers does not have to add types of LOs
- However, the more LOs are available in the course, the more adaptivity can be provided
How to provide adaptivity?

- Adaptive Annotation
  - Distinguishing between recommended and standard learning objects

- Adaptive Sequencing
  - Changing the sequence in which types of learning objects are presented
Structure of a course

Chapter 1:

Commentary

Few LOs that raise a student’s interest [0..2 types of LO]*
Self-assessment tests, animations, exercises, examples, or real-life applications

Content

Conclusion [0..1]

Remaining LOs*
Self-assessment tests, animations, exercises, examples, real-life applications, additional reading material, reflection quizzes, and forum activities

Conclusion [0..1]

Assignments

Chapter 2:

...

*Sequence of LOs is based on how well the types of LO fit to the student’s learning styles
Demo

...
Current research & development

- Moving the adaptive mechanism to Moodle 2.0
- New features
  - Developed as installable package
  - Usable for different courses within Moodle (with an interface to define which courses should use the adaptive mechanism)
- Future features:
  - Using dynamic and automatic student modelling instead of a questionnaire
  - Adding further characteristics of students to be considered by the mechanism
Questions

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