SCIS
SCHOOL OF COMPUTING & INFORMATION SYSTEMS
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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

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  - **Learning management systems**
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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

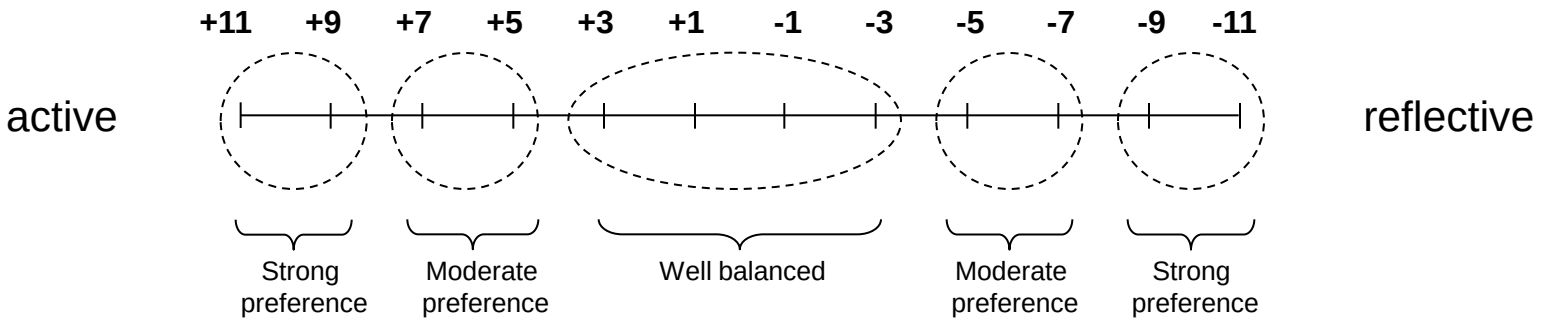
Felder-Silverman Learning Style Model

- 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?

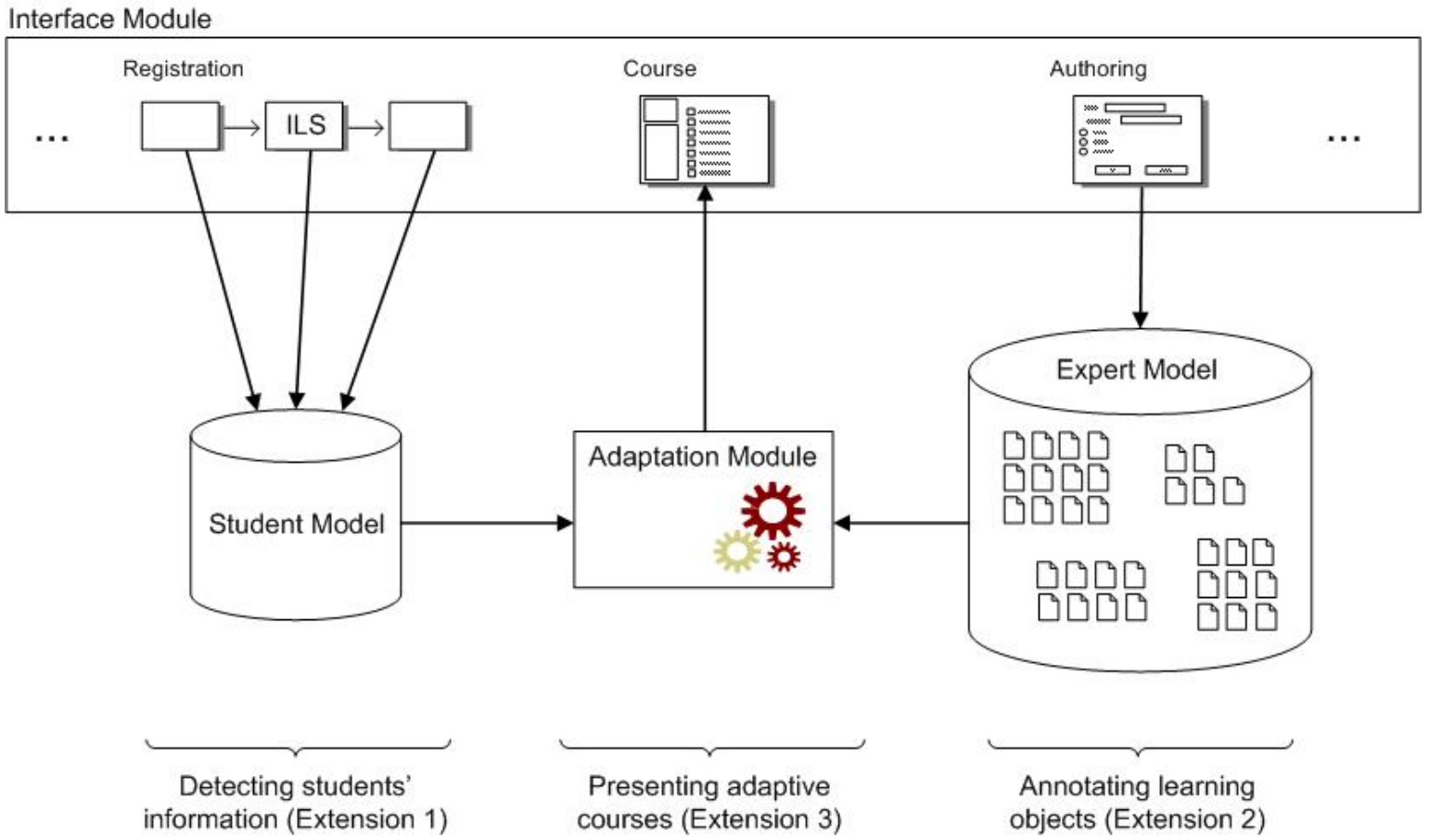
- Develop a concept which enables LMS to automatically generate adaptive courses
- Keep the concept generic so that it can be used for different LMS
- Implement and evaluate the concept in one particular LMS
- Incorporates only common kinds of learning objects
  - Content
  - Outlines
  - Conclusions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



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 has 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

		active	reflective	sensing	intuitive	sequential	global
final_exam	F	2.276	0.451	3.613	0.174	0.793	0.937
	p	0.136	0.504	0.06	0.678	0.376	0.336
time	F	**7.888 ***	3.856	1.754	0.339	**4.271 ***	0.038
	p	**0.006**	0.054	0.189	0.563	**0.043**	0.846
numlogin	F	3.937	0.11	1.28	0.012	1.356	0.014
	p	0.052	0.741	0.262	0.915	0.249	0.906
numLO	F	1.54	**4.639 ***	**4.084 ***	0.509	2.173	0.29
	p	0.219	**0.035**	**0.047**	0.479	0.145	0.592
numALO_p	F	1.486	**4.531 ***	**4.442 ***	1.668	0.867	**5.741 ***
	p	0.227	**0.037**	**0.038**	0.202	0.41	**0.019**

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

		act/ref	sen/int	seq/glo
final_exam	F	**8.862 ***	**5.127 ***	0.490
	p	**0.004**	**0.027**	0.486
time	F	**8.063 ***	0.018	0.180
	p	**0.006**	0.893	0.672
numlogin	F	**4.586 ***	3.866	2.806
	p	**0.036**	0.054	0.099
numLO	F	**6.635 ***	1.370	0.003
	p	**0.012**	0.246	0.953
numALO_p	F	2.649	0.131	0.055
	p	0.108	0.718	0.816

Means:
Act.: 166.07 points
Ref.: 184.37 points

Means:
Sen.: 169.98 points
Int.: 185.43 points

Means:
Act.: 3.81 h
Ref.: 6.68 h

Means:
Act.: 27.24
Ref.: 31.08

Means:
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 whereever 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

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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