E-Learning: State of the Art sowie neue Entwicklungen mit adaptiven Lernplattformen

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Outline

- What is e-learning?
- New generations and forms of learning
  - Mobile learning
  - Informal learning
  - Game-based learning
  - Adaptive/Personalized Learning
- Adaptivity in Learning Management Systems focussing on Learning Styles
  - How can learning styles be identified in learning management systems
  - How can cognitive abilities help in this detection process?
  - How can adaptivity with respect to learning styles be presented in LMS?
- Future Research Directions
What is e-Learning?

Electronic learning (CDs, tapes, ...)

Computer-based learning (computers)

Web-based learning (internet)
What is e-Learning?

- e-learning + e-teaching = e-education
- technology enhanced learning
- blended learning
Web-based Learning

Learning Management Systems
- Created for supporting teachers/course developers
- Provide a great variety of features
  - Content
  - Multimedia files
  - Quizzes
  - Forums
  - Chat
  - Wiki
  - Blogs
  - ...
- Support of
  - Administration of courses
  - Marking
  - Tracking mechanism
  - ...
New Generations and Forms of Learning

■ Mobile learning
  ● Using mobile devices (PDAs, mobile phones, ...) for learning at different places
  ● Taking advantages of learning opportunities offered by mobile devices
  ● For example,
    ○ Learning about plants in the nature
    ○ Learning a foreign language by walking around in the respective country
    ○ Learning in a museum
New Generations and Forms of Learning

- Informal learning
  - Learning without the intention of learning
  - Occurs in everyday life and may not even be recognized as learning
  - For example,
    - Learning to speak
    - Unplanned discussions
    - Arising interest for something
New Generations and Forms of Learning

- Game-base learning
  - Learning while playing → informal learning
  - Basic idea: combine learning and playing games
  - For example,
    - Games including some questions
    - Games which play in a specific environment (e.g., 1000 years ago)
    - Role-playing games
    - Management games
    - Strategical games
New Generations and Forms of Learning

- Adaptive/Personalized learning
  - Learning is adapted to each individual person
  - Basic idea: learning systems provide learners with courses that fits to their individual needs
  - For example,
    - Systems which adapt to the learners’
      - Prior knowledge
      - Goals
      - Motivation
      - Cognitive abilities
      - Learning styles
Adaptive Systems

- Adaptive systems aim at providing adaptivity
  - AHA!
  - TANGOW
  - INSPIRE
  - MASPLANG
  - ...

- Limitations
  - are either developed for specific content (e.g. accounting) or for specific features (e.g. adaptive quizzes)
  - content cannot be reused
  - are not often used
Learning Management Systems (LMS)

- Learning Management Systems (e.g., Moodle, Blackboard, WebCT, ...) are developed to support authors/teachers to create courses
  - provide a lot of different features
  - domain-independent
  - content can be reused in other LMS
  - are often used in e-learning
  - provide only little or in most cases no adaptivity
Adaptivity in LMS

■ Aim of my research
  ● Combining the advantages of LMSs with those of adaptive systems
  ● Extend LMSs with adaptivity
  ● Incorporate learning styles in LMSs

■ General aims
  ● Developing concepts for LMSs in general
  ● Implementing and evaluating these concepts by the use of a prototype (Moodle)
  ● Teachers should have as little as possible additional effort
Research Directions

- How to identify learning styles?
- How to improve the detection process of learning styles by the use of additional sources?
- How to provide adaptivity based on learning styles in LMS?
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“
Scales of the dimensions:

- Active: -11 to -1, +1 to +11
  - Strong preference
  - Moderate preference
  - Well balanced
- Reflective: -11 to -1, +1 to +11
  - Strong preference
  - Moderate preference

Strong preference but no support → problems

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
How to identify learning styles?
How to identify learning styles?

- Collaborative student modelling
  - “Index of Learning Styles” (ILS) questionnaire
    - 44 questions (11 for each dimension)
    - Online available
  - Problems with questionnaires
    - Reliability & validity of the instrument
    - Motivate students to fill it out
    - Non-intentional influences
    - Can be done only once
How to identify learning styles?

- **Automatic student modelling**
  - What are students really doing in an online course?
  - Infer their learning styles from their behaviour
  - Advantages:
    - Students have no additional effort
    - Can be updated frequently → higher tolerance
  - Problem/Challenge:
    - Get enough reliable information to build a robust student model
Determining Relevant Behaviour

- Felder and Silverman describe how learners with specific preferences act in learning situations.
- Mapped the behaviour to online-learning.
- Only commonly used features are considered:
  - Content objects
  - Outlines
  - Examples
  - Self-assessment tests
  - Exercises
  - Discussion Forum
## Determining Relevant Behaviour

<table>
<thead>
<tr>
<th>Active/Reflective</th>
<th>Sensing/Intuitive</th>
<th>Visual/Verbal</th>
<th>Sequential/Global</th>
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<td>content_stay (-)</td>
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Building an model for inferring learning styles

- **Data-driven approach**
  - Using Bayesian Networks in order to build a model to identify learning styles
  - Train the model with data about behaviour and learning styles
    - can represents dependencies in the model more accurate
    - very much dependent on data
Building an model for inferring learning styles

- Literature-based approach
  - Building a model based on literature
  - Based on the idea that behaviour of learners provide hints on their learning styles.
  - Using indications from data and a simple rule-based approach to identify learning styles
  - is very general since it is based on literature
  - dependencies in the model might be less accurate
Evaluation

- Study with 75 students
  - Let them fill out the ILS questionnaire
  - Tracked their behaviour in an online course
- Aim was to identify learning styles on a 3-item scale (e.g., active, balanced, reflective)
- Investigated the efficiency of the data-driven approach and the literature-based approach
- Using a measure of precision

\[
\text{Precision} = \frac{\sum_{i=1}^{n} \text{Sim}(LS_{\text{predicted}}, LS_{\text{ILS}})}{n}
\]
## Results

Correctly detected learning styles:

<table>
<thead>
<tr>
<th></th>
<th>act/ref</th>
<th>sen/int</th>
<th>vis/ver</th>
<th>seq/glo</th>
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DeLeS – A tool to identify learning style in LMS

DeLeS = Detecting Learning Styles

Basic concept
- Define relevant patterns of behaviour
- Extract data about patterns from the LMS database
- Use literature-based approach to calculate learning styles based on the gathered data

Requirements
- Applicable for LMS in general
  -> Usable for different database schemata
  -> Deal with missing data since maybe not all information can be tracked by each LMS
Tool Architecture

1. Features
2. Patterns
3. Data Extraction Component
4. LMS Database
5. Raw data
6. Calculation Component
7. Learning Style
Improving the detection of learning styles by using information from cognitive traits
Relationship between LS and CT

- The aim is to use additional source in order to get more information to identify learning style more accurately
- Examplarily, we investigated the relationship between learning styles and working memory capacity
Relationship between FSLSM and WMC

Felder-Silverman Learning Style Model

- Sensing
- Intuitive
- Active
- Reflective
- Visual
- Verbal
- Sequential
- Global

Working Memory Capacity

- High
- Low
## Literature Research

<table>
<thead>
<tr>
<th>Fielder-Silverman Learning Style Dimensions</th>
<th>High WMC</th>
<th>Low WMC</th>
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<tr>
<td>Reflective</td>
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### Cognitve Styles

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Relationship between FSLSM and WMC

Felder-Silverman Learning Style Model

- Sensing
- Intuitive
- Active
- Reflective
- Visual
- Verbal
- Sequential
- Global

Working Memory Capacity

- High
- Low
Verifying the relationship

- Participants
  - 225 students from Austria
- Detecting learning styles
  - ILS questionnaire
- Detecting working memory capacity
  - WebOSpan Task
Results

- **Active/reflective:**
  - Low WMC $\leftrightarrow$ strong active preference
  - Low WMC $\leftrightarrow$ strong reflective preference
  - High WMC $\leftrightarrow$ balanced learning preference

- **Sensing/intuitive:**
  - Low WMC $\leftrightarrow$ sensing learning preference
  - High WMC $\leftrightarrow$ balanced learning preference

- **Visual/verbal:**
  - Low WMC $\rightarrow$ visual learning preference
  - Verbal learning preference $\rightarrow$ high WMC

- **Sequential/Global:**
  - No relationship found

→ Identified relationships can be included in the detection process of learning styles and cognitive traits
Using the information in DeLeS

1. Features → Patterns
2. Data Extraction Component
3. Raw data → Calculation Component
4. Data about cognitive traits → Learning Style
5. LMS Database
How to provide adaptivity?
How to provide adaptivity?

- Develop a concept which enables LMS to automatically generate adaptive courses
- Incorporates only common kinds of learning objects
  - Content
  - Outlines
  - Conclusions
  - Examples
  - Self-assessment tests
  - Exercises
- Requirements for teachers
  - Provide learning objects
  - Annotate learning objects (distinguish between the objects)
Adaptation features

- Number of examples
- Number of exercises
- 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)
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 437 students participating in a course about object-oriented modelling
- 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)
Evaluation of the Concept

- **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
Future Research Directions

- Generalising the adaptive mechanism
- Combine Automatic Student Modelling with Providing Adaptivity
- Dynamic Automatic Student Modelling
- Supporting students in learning with their weak learning style preferences
Questions

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