Identifying Learning Styles in Learning Management Systems by Using Indications from Students’ Behaviour

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Why shall we use learning styles?

• Learners have different learning styles
• Considering learning styles has potential to make learning easier for learners
  – By making students aware of their learning styles as well as the related strengths and weaknesses
  – By providing students with learning material that fits their learning styles
How to identify learning styles?

- Advantages of Automatic Student Modelling
  - no additional work for students
  - direct and free from the problem of inaccurate self-conceptions of students
  - analyses data from a specific time span → more accurate & allows tracking changes in learning styles
Research Question

How to automatically identify learning styles in learning management systems (LMS)?

• General aims
  - Selected LMSs because they are commonly used in technology enhanced learning
  - Developing an approach for LMSs in general
  - Implementing and evaluating this approach in Moodle
Felder-Silverman Learning Style Model

- Each learner has a preference on each of the four 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:

  - **active**
    - +11
    - +9
    - +7
    - +5
    - +3
    - +1
    - 0
    - -1
    - -3
    - -5
    - -7
    - -9
    - -11
  
  - **reflective**
    - Well balanced
    - Moderate preference
    - Strong preference
    - Moderate preference
    - Strong preference

- Differences to other learning style models:
  - describes learning style in more detail
  - represents also balanced preferences
  - describes tendencies
Index of Learning Styles (ILS)

- Developed by Felder and Soloman to identify learning styles
- 44 questions
- 11 questions for each dimension
- Each question allows two possible answers indicating a preference for either the one or the other pole of the learning style dimension; e.g. active (+1) or reflective (-1)
- Result: a value between +11 and -11 for each dimension
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

- **Content objects**
  - Visits, time
- **Outlines**
  - Visits, time
- **Examples**
  - Visits, time
- **Self-assessment tests**
  - Visits, time on test, time on results
  - Revisions, answering a question twice wrong
  - Performance on questions about facts or concepts, details or overview, graphics or text, interpreting or developing solutions
- **Exercises**
  - Visits, time on exercises, time on results
  - Revisions
  - Performance on questions about interpreting and developing solutions
- **Discussion Forum**
  - Visits, time, postings
- **Navigation**
  - Skipping learning objects
  - Visits and time on course overview page
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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<tbody>
<tr>
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<td>ques_detail (+)</td>
<td>forum_visit (-)</td>
<td>ques_detail (+)</td>
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<tr>
<td>exercise_visit (+)</td>
<td>ques_facts (+)</td>
<td>forum_stay (-)</td>
<td>ques_overview (-)</td>
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<td>ques_concepts (-)</td>
<td>forum_post (-)</td>
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</tr>
</tbody>
</table>
From Behaviour to Learning Styles

- Raw Data
- Ordered Data (0, 1, 2, 3)
- Indications (0, 1, 2, 3)
- Measure (0 to 1)
From Behaviour to Learning Styles

- Based on the previously introduced patterns
- Data are extracted from the LMS database

1. Raw Data
2. Ordered Data (0, 1, 2, 3)
3. Indications (0, 1, 2, 3)
4. Measure (0 to 1)
From Behaviour to Learning Styles

- Four values are possible:
  3 ... the respective behaviour occurs often
  2 ... the respective behaviour is average
  1 ... the respective behaviour occurs only few times
  0 ... no information about the respective behaviour is available

- Values are calculated based on thresholds, which are derived from literature and can be adapted to the characteristics of the respective course
From Behaviour to Learning Styles

- Patterns provide indications about learning styles
- Four values are possible:
  3 ... the student's behaviour gives a strong indication for the respective learning style
  2 ... the student's behaviour is average and therefore does not provide a specific hint
  1 ... the student's behaviour is in disagreement with the respective learning style
  0 ... no information about student's behaviour is available

Raw Data

Ordered Data (0, 1, 2, 3)

Indications (0, 1, 2, 3)

Measure (0 to 1)
From Behaviour to Learning Styles

- All indication values are summed up and divided by the number of patterns where information was available
- The results were normalised on a range from 0 to 1
  0 … the student has a strong negative preference for this learning style
  1 … the student has a strong positive preference for this learning style
- If no indications are available, no conclusions about the student’s learning style can be drawn
Evaluation

- University course about object oriented modelling
- 127 students participated
- All types of learning objects described before were included
- Moodle was used and extended by few tracking functions
Evaluation

- Students filled out the ILS questionnaire and learned in the online course

- Results of ILS were compared with the results of our approach based on a 3-item scale (distinguishing e.g. between an active, balanced, and reflective learning style)
  - Automatic Approach:
    - Calculated measures based on indications \( \rightarrow \) values between 0 and 1
    - Divided results in three groups (using thresholds of 0.25 and 0.75)
  - ILS:
    - Results of ILS were normalised \( \rightarrow \) values between 0 and 1
    - Values between 0 and 1 were grouped into three groups (using thresholds of 0.25 and 0.75)
Evaluation

\[ \text{Sim} \left( \text{LS}_{\text{predicted}}, \text{LS}_{\text{ILS}} \right) = \begin{cases} 1 & \text{if both are equal} \\ 0.5 & \text{if one is balanced} \\ 0 & \text{if both are opposite} \end{cases} \]

Precision = \[ \frac{\sum_{i=1}^{n} \text{Sim}(\text{LS}_{\text{predicted}}, \text{LS}_{\text{ILS}})}{n} \cdot 100 \]
## Results

<table>
<thead>
<tr>
<th>act/ref</th>
<th>sen/int</th>
<th>vis/ver</th>
<th>seq/glo</th>
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<tbody>
<tr>
<td>79%</td>
<td>77%</td>
<td>77%</td>
<td>73%</td>
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→ showing that our approach is a suitable instrument for automatically identifying learning styles
Conclusions and Future Work

• Developed an approach for automatically identifying learning styles
• Approach is developed for LMSs in general

Future Work
• Dynamic Automatic Student Modelling
  Allowing modifying and updating the student model on the fly and therefore to respond immediately
• Tool
  Continuing to develop a tool that allows teachers to easily integrate our approach in their courses