Correlations between Students’ Behaviour in Learning Management Systems and their Learning Style Preferences

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Motivation

- Many research works have been conducted with respect to learning styles in technology enhanced learning, e.g.,
  - Recommending how systems can adapt to learning styles
  - Building adaptive systems
  - Automatic student modelling
- Most of these research works are based on the learning style model's description about how students with specific learning styles typically behave
- But most learning style models are developed for traditional learning rather than online learning
Aim of Research

How does students behave in an online course considering their learning styles?

→ Correlations between behaviour and learning style preferences

• Learning Management Systems:
  - Support teachers in creating, administrating, and managing online courses
  - Consider a broad range of features of technology enhanced learning (TEL)
  - Are commonly used in TEL
  → By incorporating only behaviour which is common in TEL, we aim at making our results applicable for TEL in general
Benefits from more detailed information

- **Student Modelling**
  - Automatic approach has several advantages over using learning style questionnaires
    - free of problems regarding inaccurate self-conception
    - Considering data from a time span → more accurate
    - Consideration of changes of learning styles
  - More detailed information about how students really behave in an online environment can make the automatic student modelling approach more accurate

- **Adaptive Course Generation**
  - More detailed information about how students really prefer to behave can help in developing more precise adaptation features

- **Potential of adaptivity regarding learning styles**
  - The existence of correlations between behaviour and learning styles gives another indication for the potential of adaptive learning with respect to learning styles
Learning Style Preferences

- **Felder-Silverman Learning Style Model (FSLSM)**
- **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
    - interested in details – interested in the overview
    - good in using partial knowledge – good in connecting areas
Learning Style Preferences

• **Index of Learning Styles (ILS) Questionnaire:**
  - Developed by Felder and Soloman
  - 44 questions
  - Result: a value between +11 and -11 for each dimension

• **Differences to other learning style models:**
  - combine major learning style models
  - describes learning style in more detail
  - represents also balanced preferences
  - describes tendencies
### Learning Style Preferences

- **Characteristic Preferences within Felder-Silverman Learning Style dimensions (Graf, Viola, Kinshuk, and Leo, 2007)**

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Reflective</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student 1</strong></td>
<td>Trying things out</td>
<td>Collaborate with others</td>
<td>Reflect about the material</td>
</tr>
<tr>
<td><strong>Student 2</strong></td>
<td>Trying things out</td>
<td>Collaborate with others</td>
<td>Reflect about the material</td>
</tr>
<tr>
<td><strong>Student 3</strong></td>
<td>Trying things out</td>
<td>Collaborate with others</td>
<td>Reflect about the material</td>
</tr>
</tbody>
</table>
Learning Style Preferences

- Derived Semantic Groups from the learning style model (Graf, Viola, Kinshuk, Leo, 2007)
- Verifying Semantic Groups by Fisher Linear Discriminant Analysis and empirical frequencies analysis

<table>
<thead>
<tr>
<th>Style</th>
<th>Semantic group</th>
<th>ILS questions (answer a)</th>
<th>Style</th>
<th>Semantic group</th>
<th>ILS questions (answer b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>trying something out</td>
<td>1, 17, 25, 29</td>
<td>Reflective</td>
<td>think about material</td>
<td>1, 5, 17, 25, 29</td>
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<tr>
<td></td>
<td>social oriented</td>
<td>5, 9, 13, 21, 33, 37, 41</td>
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<td>impersonal oriented</td>
<td>9, 13, 21, 33, 41, 37</td>
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<tr>
<td>Sensing</td>
<td>existing ways</td>
<td>2, 30, 34</td>
<td>Intuitive</td>
<td>new ways</td>
<td>2, 14, 22, 26, 30, 34</td>
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<tr>
<td></td>
<td>concrete material</td>
<td>6, 10, 14, 18, 26, 38</td>
<td></td>
<td>abstract material</td>
<td>6, 10, 18, 38</td>
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<tr>
<td></td>
<td>careful with details</td>
<td>22, 42</td>
<td></td>
<td>not careful with details</td>
<td>42</td>
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<tr>
<td>Visual</td>
<td>pictures</td>
<td>3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43</td>
<td>Verbal</td>
<td>spoken words</td>
<td>3, 7, 15, 19, 27, 35</td>
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<td></td>
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<td>3, 7, 11, 23, 31, 39</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>difficulty with visual style</td>
<td>43</td>
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<td>Sequential</td>
<td>detail oriented</td>
<td>4, 28, 40</td>
<td>Global</td>
<td>overall picture</td>
<td>4, 8, 12, 16, 28, 40</td>
</tr>
<tr>
<td></td>
<td>sequential progress</td>
<td>20, 24, 32, 36, 44</td>
<td></td>
<td>non-sequential progress</td>
<td>24, 32</td>
</tr>
<tr>
<td></td>
<td>from parts to the whole</td>
<td>8, 12, 16</td>
<td></td>
<td>relations/connections</td>
<td>20, 36, 44</td>
</tr>
</tbody>
</table>

→ Allows building a more accurate model of the student
Design of the Study

- Object oriented modelling course at an university in Austria
- 127 students participated
- Moodle was used to provide additional learning material and learning opportunities
- Students need to perform 5 assignments and a final exam
- Student interaction with Moodle was tracked
- Students filled out the ILS questionnaire for providing information about their learning style preferences
Investigated Behaviour

- Incorporates only behaviour based on commonly used features in TEL
  - Content
  - Outlines
  - Examples
  - Self-assessment tests
  - Exercises
  - Discussion Forum
  - Navigation
  - General Patterns
Patterns of Behavior

• Content objects
  – Number of visits
  – Time student spent on content objects
  – Time student spent on content objects including graphics
  – Time student spent on content objects including only text

• Outlines
  – Number of visits
  – Time spent on outlines

• Self-assessment tests (SA-Tests)
  – Number of tests performed
  – Whether all available tests were performed at least once
  – Results on tests
  – Number of questions a learner answers twice wrong
  – Number of revisions before submission
  – Time spent on the test
  – Time a learner checked his/her results
  – Results on specific kinds of questions (facts/concepts, detail/overview, graphics/text, interpreting predefined solutions/generating new solutions)
Patterns of Behavior

• Exercises
  - Number of visits
  - Time students spent on exercises
  - Results on exercises
  - Number of revisions before submission (in combination with SA-Tests)
  - Results on questions about interpreting predefined solutions/generating new solutions (in combination with SA-Tests)

• Examples
  - Number of visits
  - Time spent on examples

• Discussion Forum
  - Number of visits
  - Time spent in the forum
  - Number of postings
Patterns of Behavior

- **Navigation**
  - Number of times, students skipped learning objects
  - Number of times, students jumped back to the previous learning object
  - Number of visits of the course overview page
  - Time students spent on the course overview page

- **General Patterns**
  - Scores on final exam
  - Scores on compulsory assignments
  - Overall time students spent in the course
  - Number of logins
  - Overall number of visited learning objects
Method of Analysis

• Requirements
  – Spending more than 5 minutes on the ILS questionnaire (41 students excluded)
  – Submitting at least 3 assignments (10 students excluded)
  – Performing the final exam (16 students excluded)

→ 75 Students fulfilled the requirements

• For calculating correlations between behaviour and learning style preferences, rank correlation analysis was used (Kendall’s tau)
## Results – Active/Reflective Dimension

<table>
<thead>
<tr>
<th>trythingsout</th>
<th>social oriented</th>
<th>think about material</th>
<th>impersonal oriented</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>forum_visit (-)</td>
<td>forum_visit (+)</td>
<td>forum_visit (+)</td>
</tr>
<tr>
<td></td>
<td>forum_stay (-)</td>
<td>forum_stay (+)</td>
<td>forum_stay (+)</td>
</tr>
<tr>
<td></td>
<td>quiz_que_codedev (-)</td>
<td>content_stay (+)</td>
<td>content_stay (+)</td>
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<tr>
<td></td>
<td>content_stay (-)</td>
<td>nav_skip (-)</td>
<td>nav_skip (+)</td>
</tr>
<tr>
<td></td>
<td>nav_skip (-)</td>
<td></td>
<td></td>
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</table>
# Results – Sensing/Intuitive Dimension

<table>
<thead>
<tr>
<th>existing ways</th>
<th>concrete material</th>
<th>careful with details</th>
<th>new ways</th>
<th>abstract material</th>
<th>not careful with details</th>
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</thead>
<tbody>
<tr>
<td>exercise_score (-)</td>
<td>exercise_score (-)</td>
<td>forum_visit (+)</td>
<td>selfass_ques_detail (+)</td>
<td>exercise_score (+)</td>
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<tr>
<td>slides_visit_diff (+)</td>
<td></td>
<td>selfass_ques_factual (+)</td>
<td>slide_visit_diff (-)</td>
<td>quiz_ques_codeint (+)</td>
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<td></td>
<td></td>
<td>selfass_ques_conceptual (+)</td>
<td>course_time (-)</td>
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<td>selfass_ques_graphics (+)</td>
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<td>course_activities (-)</td>
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</table>
## Results – Visual/Verbal Dimension

<table>
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<tr>
<th>pictures</th>
<th>spoken words</th>
<th>written words</th>
<th>difficulty with visual style</th>
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<tr>
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<td>example_visit (-)</td>
<td>forum_post (+)</td>
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<tr>
<td></td>
<td>example_visit_diff (-)</td>
<td>exercise_visit (-)</td>
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<td></td>
<td>example_stay (-)</td>
<td>exercise_stay (-)</td>
<td>outline_stay (-)</td>
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# Results – Sequential/Global Dimension

<table>
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<tr>
<th>detail oriented</th>
<th>sequential progress</th>
<th>from parts to the whole</th>
<th>overall picture</th>
<th>non-sequential progress</th>
<th>relations/connections</th>
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</thead>
<tbody>
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<td>navigation_overview_visit (-)</td>
<td>forum_visit (+)</td>
<td>quiz_revision (-)</td>
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<td>course_activities (-)</td>
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</tbody>
</table>
Conclusions & Future Work

• Investigated the correlations between students’ behaviour in a LMS and their learning style preferences
• Comparison of our results with other studies (e.g., usage of adaptation features, automatic student modelling, …)
  – Some of our results are in agreement with existing studies
  – Some are in agreement with FSLSM but are not typically used by studies
  – Some are not explicitly mentioned by FSLSM but appear in our data
• Resulting correlations can contribute in adaptive learning by
  – showing that students with different learning style preferences behave differently in TEL
    → give another indication for the potential of adaptivity based on learning styles
  – providing more information in order to develop more precise adaptation features
  – providing more information in order to improve automatic student modelling
Conclusions & Future Work

• Future Work
  – Incorporating our findings for improving automatic student modelling and the development of adaptation features
  – Further investigate the significant results which were not explicitly mentioned by FSLSM