Incorporating Learning Styles in Learning Management Systems

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- Research assistant at Vienna University of Technology
- Background in Information Systems
- Research interests
  - Adaptivity in e-learning systems
  - Student modelling
  - Learning styles and cognitive traits
  - Peer assessment
  - Game-based learning
  - Artificial intelligence

Why shall we consider learning styles in LMS?

- Learning Management Systems (LMS) are commonly and successfully used in e-education but they provide the same course for all learners

- Learners have different needs

- Adaptivity increases the learning progress, leads to better performance, and makes learning easier

- **Adaptive systems aim at providing adaptivity**
  - AHA!
  - TANGOW
  - INSPIRE
  - …

- **Limitations**
  - development of course is complicated
  - 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 (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 and successfully used in e-education
  - provide only little or in most cases no adaptivity

How can we incorporate learning style in LMS?

- Two steps:
  - Detection of learning styles
    - Collaborative student modelling (questionnaires)
    - Automatic student modelling
      - Get information from behaviour of students
      - Get information from additional sources
  - Providing adaptivity according to the identified learning styles

- General aims:
  - Concept for LMS in general, implementation in Moodle (Case studies are running)
  - Show how to extend LMS, so that they are able to identify learning styles and generate adaptive courses automatically
  - Teachers should have as little as possible additional effort

Felder-Silverman Learning Style Model (1/2)

- **FSLSM is one of the most often used learning style models in technology enhanced learning**
- **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
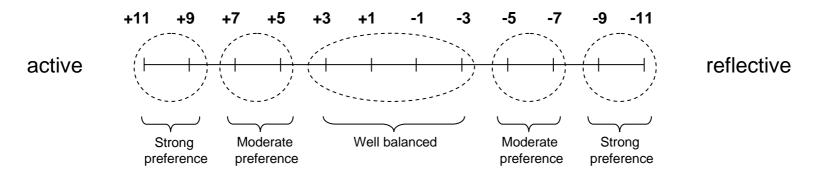   standard procedures – challenges
  - Visual – Verbal
    learning from pictures – learning from words
  - Sequential – Global
    learn in linear steps – learn in large leaps
    good in using partial knowledge – need „big picture"
    serial – holistic

- **Scales of the dimensions:**

active | +11 +9   +7   +5   +3   +1   -1   -3   -5   -7   -9   -11 | reflective

Strong preference | Moderate preference | Well balanced | Moderate preference | Strong preference

→ Strong preference but no support → problems

- **Differences to other learning style models:**
  - describes learning style in more detail
  - represents also balanced preferences
  - describes tendencies
  - is often used in e-learning

How to identify learning styles?

- **Collaborative student modelling**
  - "Index of Learning Styles" questionnaire
    - 44 questions (11 for each dimension)
    - Online available
  - Problems with questionnaires
    - 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 behavior
  - Advantages of this appraoch:
    - Students have no additional effort
    - Can be updated frequently → higher tolerance
  - Problems with this approach:
    - Get enough reliable information to build a robust student model
      → certain amount of data about the behavior
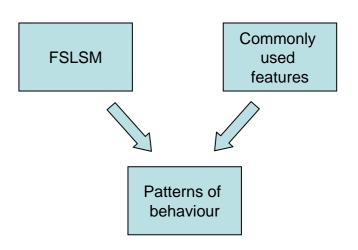   → additional information related to learning styles

- **DeLeS = De**tecting **Le**arning **S**tyles

- Basic concept
  - Define relevant patterns of behaviour
  - Extract data about patterns from the LMS database
  - 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

- 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
  - Examples
  - Tests
    (self-assessment and marked)
  - Exercises
  - Communication tools
    (forum, chat)

FSLSM

Commonly used features

Patterns of behaviour

Patterns of Behaviour

Active/Reflective

Visits of forum (act)

Postings in forum (act)

Visits of chat (act)

Postings in chat (act)

Visits of exercise (act)

Time spent on exercises (act)

Time spent on examples (ref)

Time spent on content objects (ref)

Sequential/Global

Correct answers: detail/overview (seq)

Performance of marked tests (seq)

Performance of self-assessment tests (seq)

Visits of outline (glo)

Time spent on outline (glo)

Skips learning objects (glo)

Visits of course overview page (glo)

Time spent on course overview page (glo)

Sensing/Intuitive

Correct answers: facts/concepts (sen)

Revisions of marked tests (sen)

Revisions of self-assessment tests (sen)

Duration of marked tests (sen)

Duration of self-assessment tests (sen)

Visits of exercises (int)

Time spent on exercises (int)

Visits of self-assessment tests (sen)

Visits of examples (sen)

Time spent on examples (sen)

Visual/Verbal

Visits of forum (ver)

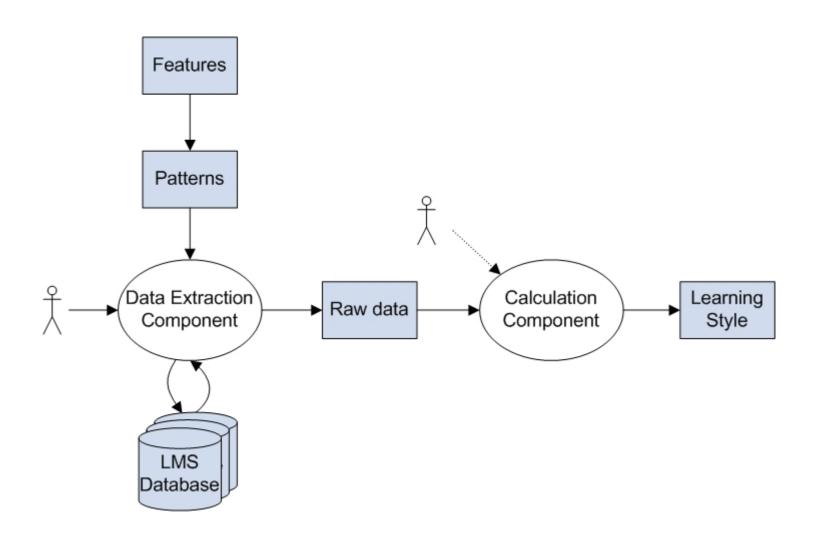Postings in forum (ver)

Visits of chat (ver)

Postings in chat (ver)

Time spent on graphics (vis)

Correct answers: graphics (vis)

Evaluation and application of DeLeS

- **Extended Moodle to track all required data**
  - Additional meta-data for distinguishing between certain kinds of learning objects (e.g. content/example/outline or self-assessment/marked_test/exercise)
  - Additional meta-data to specify certain learning objects in more detail (e.g. kind of questions, inclusion of graphics)
  - Extended tracking features regarding revisions on tests

- **Case study with about 120 students is running**

Improving the detection of learning styles

- **Investigations about learning styles and cognitive abilities**
  - Abilities to perform any of the functions involved in cognition whereby cognition can be defined as the mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment.
  - Cognitive abilities are more or less stable over time
  - Most important abilities for learning
    - Working memory capacity
    - Inductive reasoning ability
    - Information processing speed
    - Associative learning skills

- **Cognitive Trait Model (CTM)**
  - Student model that includes information about cognitive traits
  - Gathers information about the learner according to behaviour
  - Cognitive traits are stored in CTM

  → CTM can still be valid after a long period of time
  → CTM is domain independent and can be used in different learning environments, thus supports life long learning

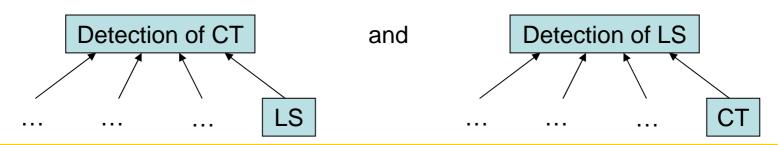# Relationship between Cognitive Traits and Learning Styles

Why shall we relate cognitive traits and learning styles?

- Case 1: Only one kind of information (CT and LS) is considered
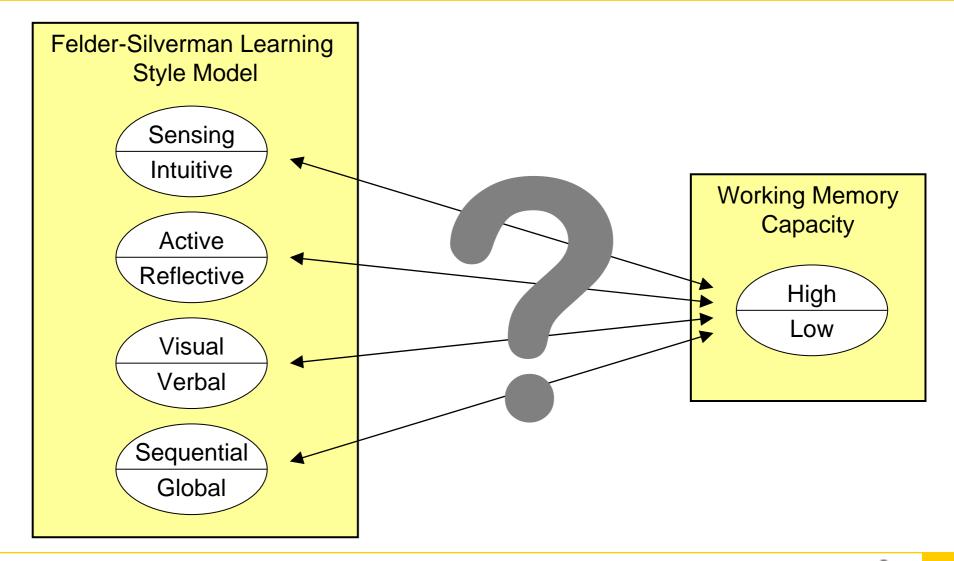 - → Get some hints about the other one

$$\boxed{\text{CT}} \rightarrow \boxed{\text{LS}} \qquad \text{or} \qquad \boxed{\text{LS}} \rightarrow \boxed{\text{CT}}$$

- Case 2: Both kinds of information are considered
  → The information about the one can be included in the identification process of the other and vice versa
  → The student model becomes more reliable

$$\boxed{\text{Detection of CT}} \qquad \text{and} \qquad \boxed{\text{Detection of LS}}$$

...   . $\boxed{\text{LS}}$ ...   . $\boxed{\text{CT}}$

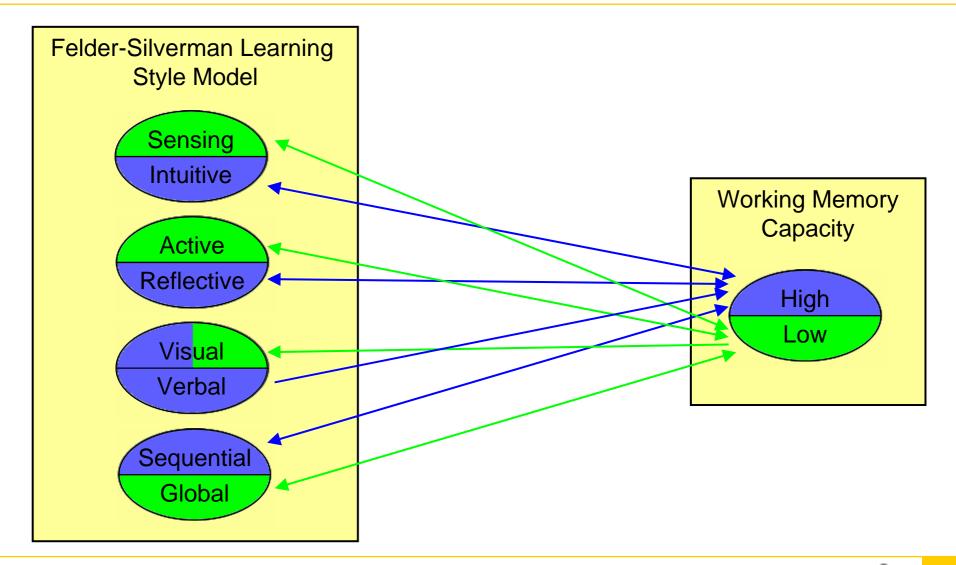|	High WMC	Low WMC
Felder-Silverman Learning Style Dimensions	**Reflective** Beacham, Szumko, and Alty (2003) Hadwin, Kirby, and Woodhouse (1999) Kolb (1984) Summervill (1999) Witkin et al. (1977)	**Active**
	Intuitive Bahar and Hansell (2000) Davis (1991) Ford and Chen (2000) Hudson (1966) Kinshuk and Lin (2005) Scandura (1973) Witkin et al. (1977)	**Sensing**
	Verbal or Visual Beacham, Szumko, and Alty (2003) Simmons and Singleton (2000) Wey and Waugh (1993)	**Visual**
	Sequential Beacham, Szumko, and Alty (2003) Ford and Chen (2000) Huai (2000) Liu and Reed (1994) Mortimore (2003) Witkin et al. (1977)	**Global**

	High WMC	Low WMC
Cognitive Styles	Field-independent Al-Naeme (1991) Bahar and Hansell (2000) El-Banna (1987) Pascual-Leone (1970)	Field-dependent
	Divergent Bahar and Hansell (2000)	Convergent
	Serial Huai (2000)	Holistic

- **Participants**
  - 225 students from Austria
- **Detecting learning style**
  - ILS questionnaire
- **Detecting working memory capacity**
  - WebOSpan Task
    - Simple operations such as 1+(2*3) = 6 are presented
    - Participant has to answer with true or false
    - After each operation, a word is displayed
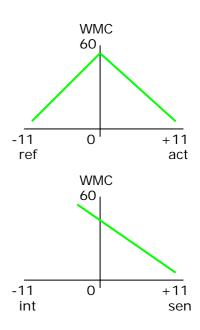   - After 2-6 operations, all words have to be typed in

Results

- **Active/reflective:**
  - Low WMC <-> strong active
  - Low WMC <-> reflective preference
  - High WMC <-> balanced learning preference

- **Sensing/intuitive:**
  - Low WMC <-> sensing learning preference
  - High WMC <-> balanced learning preference
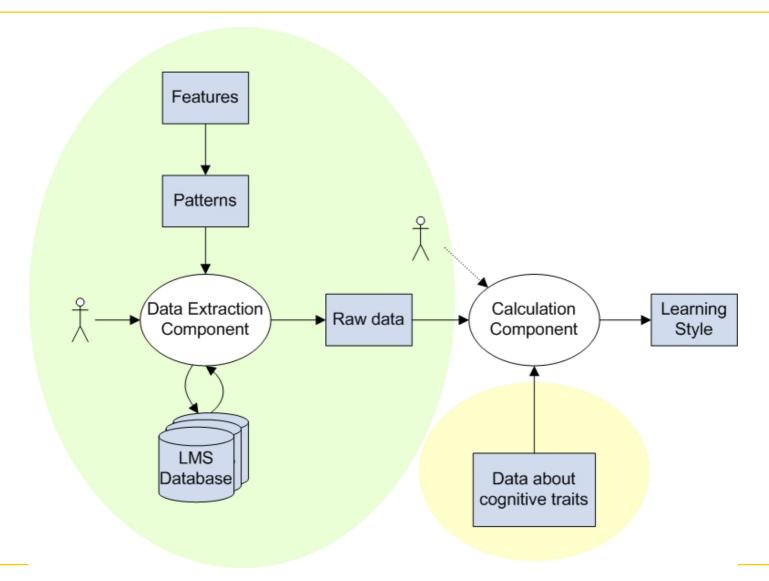
- **Visual/verbal:**
  - Low WMC -> visual learning preference
  - Verbal learning preference -> high WMC

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

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

How to provide adaptivity?

- Add-on to an existing LMS which enables the 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)

Structure of a course

Chapter 1:

        Examples

        Self-assessment

        Exercises

        Overview

        Content with/without outlines between subchapters

        Conclusion

        Examples

        Self-assessment

        Exercises

        Conclusion

Chapter 2:

        …

- 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

- **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

- **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

- 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

Adaptivity regarding learning styles

- **Two different approaches to provide adaptivity**
  - Provide courses that fit to the preferred learning styles
    - → Aims at short term goal:
      Makes learning easier and increases the progress
  - Provides courses that do not fit to the learners' preferred styles
    - → Aims at long term goal:
      challenging learners and encouraging them to train learning according to their weak preferences provides them with important life skills

Incorporating learning styles in Moodle (1/2)

- **Implemented add-on for Moodle (Version 1.6.3)**
- **University course about object-oriented modelling with about 400 students**
- **Procedure:**
  - Students filled out ILS questionnaire
  - Courses were automatically generated according to their learning styles
  - Moodle presented the adapted course (as recommendation) to each student
  - Students are nevertheless able to access all learning objects and take a different learning path

Incorporating learning styles in Moodle (2/2)

- **Research question**
  - Does adaptivity have an effect on learning?
- **Research design**
  - Three groups:
    - Courses that fits to the students' learning styles
    - Courses that does not fit to the students' learning styles (challenge learners)
    - Standard course which includes all learning objects
- **Aims of future research**
  - Show the effects of the different groups of student with respect to their learning styles
  - Finding differences between the groups (e.g. marks, time students spent on the course, how often they took an alternative learning path, …)

Conclusion

- Incorporating the individual needs of students in e-education is an important issue. Therefore, the needs of learners have to be known and a suitable adaptation strategy has to be adopted.

- Providing adaptivity in LMS combines the advantages of LMS and adaptive systems, which leads to a more supportive learning environment for learners

Questions

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