Improving Student Modeling: The Relationship between Learning Styles and Cognitive Traits

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Motivation and Aims

- Knowledge
- Goals
- Cognitive Traits
- Learning Style
- Motivation
- General Preferences

How to get this information?
- Ask the students
- Initial questionnaires or test
- Track the behavior of the students
Motivation and Aims

Why relate cognitive traits (CT) and learning styles (LS)?

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

  \[
  \text{CT} \rightarrow \neg\text{LS} \quad \text{or} \quad \text{LS} \rightarrow \neg\text{CT}
  \]

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

- Detection of CT and Detection of LS
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
    better in single answer-tests – better in open-end tests
    patient / not patient with details
  - 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
Lin, Kinshuk and Patel, 2003

Includes cognitive traits such as

- Working Memory Capacity
- Inductive Reasoning Ability
- Information Processing Speed
- ...

Cognitive traits are more or less persistent → CTM can still be valid after a long period of time

→ CTM is domain independent and can be used in different learning environments, thus supporting life long learning
Relationship between FSLSM and WMC

Felder-Silverman Learning Style Model

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

Working Memory Capacity

- High
- Low
Sensing and intuitive learners have similar characteristics to convergent and divergent learners

- Hudson, 1966 (thinking style)
  - Convergent:
    - Good in seeing information leading to a restricted answer or solution
    - Score better in single answer tests
  - Divergent:
    - More creative
    - Good in finding a greater variety of answers to a problem
    - Score better in open end tests

[http://www.learningandteaching.info]
Sensing-Intuitive Dimension and WMC

- Convergent/Divergent and High/Low WMC
  - Study by Bahar and Hansell, 2000
    - About 400 students
    - Tests on convergency/divergency and WMC
    - Results:
      - convergent $\leftrightarrow$ low WMC
      - divergent $\leftrightarrow$ high WMC

- Sensing $\leftrightarrow$ convergent $\leftrightarrow$ low WMC
- Intuitive $\leftrightarrow$ divergent $\leftrightarrow$ high WMC
Sensing-Intuitive Dimension and WMC

- Concreteness / Abstractness
  - Field-dependency (FD) and field-independency (FI) proposed by Witkin et al., 1977
    - Field dependent learners learn best when given a larger context, or "field," in which to embed new learning
    - Field independent learners can learn material that is separated from its context.
  - Several experiments about FD/FI and preferences for concrete/abstract learning material
    - Ford and Chen, 2000
    - Davis, 1991
    → FD ↔ concrete material (= sensing)
    → FI ↔ abstract material (= intuitive)
Sensing-Intuitive Dimension and WMC

- Several experiments about FD/FI and high/low WMC
  - Al-Naeme, 1991
  - Bahar and Hansell, 2000
  - El-Banna, 1987
  → FD ↔ low WMC
  → FI ↔ high WMC

→ Sensing ↔ field dependent ↔ low WMC
→ Intuitive ↔ field independent ↔ high WMC
Active-Reflective Dimension and WMC

- Kolb’s learning style theory (1984)
  - Convergers
    - More practical
    - Finding one solution to a problem
    - More attracted to technical problems than to social or interpersonal issues
    - Active experimentation
  - Divergers
    - Perform well in idea-generation
    - Reflective observations
  \(\rightarrow\) similar to Hudson’s definition
- Relation to active and reflective dimension
  - Convergers tend to be more active – by doing something
  - Divergers tend to be more reflective – by watching
  \(\rightarrow\) Active ↔ convergers ↔ low WMC
  \(\rightarrow\) Reflective ↔ divergers ↔ high WMC
Active-Reflective Dimension and WMC

- Relation to field-dependency and field-independency
  - According to Witkin et al., 1977 FD learners are more socially oriented and prefer interaction as well as communication
  
  ➔ Active ↔ field-dependent ↔ low WMC
  ➔ Reflective ↔ field-independent ↔ high WMC
Verbal-Visual Dimension and WMC

- Study by Beacham, Szumko, and Alty, 2003 about dyslexia
  - Dyslexia refers to a specific learning difficulty regarding written language
  - Effect of different presentation modes in e-learning courses for dyslexic students
  - 30 students
  - Performed Index of Learning Styles
    - 97% have a visual learning style
    - 3% have a verbal learning style (mild-verbal)

- Studies about dyslexia and working memory capacity
  - Study by Simmons and Singleton, 2000
    - Dyslexic students had done very poor in inferential questions
    - Working Memory deficiency was identified as a cognitive cause
  - Study by Beacham, Szumko, and Alty, 2003
    - Weakness in working memory, sound processing, co-ordination and motor skill, and visual processing

→ Visual ← dyslexic ← low WMC
→ Verbal/Visual ← high WMC
Sequential–Global Dimension and WMC

- **Study by Huai, 2000**
  - Relationship between working memory capacity and long-term memory capacity to serial and holistic learning style
  - Serial learning style is strongly related to a sequential one
  - Holistic learning style is strongly related to a global one
  - About 140 students
  - Results:
    - serial ↔ high WMC
    - holistic ↔ low WMC
  
  → Sequential ↔ serial ↔ high WMC
  → Global ↔ holistic ↔ low WMC
Sequential–Global Dimension and WMC

- **Relation to field-dependency and field-independency**
  - FI learners can learn material that is separated from its context and perceives information analytically → sequential
  - FD learners learn best when given a larger context, in which to embed new learning and perceives information globally → global

  → Sequential ↔ field-independent ↔ high WMC
  → Global ↔ field-dependent ↔ low WMC

- **Study by Beacham, Szumko and Alty, 2003 (dyslexia)**
  - Higher preference (14 % higher) of global learning style among dyslexic learners (low WMC)

  → Sequential ↔ high WMC
  → Global ↔ low WMC
Relationship between FSLSM and WMC

Felder-Silverman Learning Style Model

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

Working Memory Capacity

- High
- Low
Conclusion & Future Work

- Relationship between Felder-Silverman Learning Style Model and Working Memory Capacity

- Result
  - Low WMC $\leftrightarrow$ Sensing, Active, Visual, Global
  - High WMC $\leftrightarrow$ Intuitive, Reflective, Visual/Verbal, Sequential

- Future work
  - Study aiming at comparing data about LS and CT
    - Verifying the results
    - Investigating how strong the influences are
  - Use the relationship in a web-based educational system to make the student model more reliable
  - Further investigations concerning other cognitive traits (e.g. inductive reasoning ability, associative learning skills, ...)