Women's Postgraduate College for Internet Technologies

Technische Universität Wien

Vienna University of Technology

An Exploratory Study of the Relationship between Learning Styles and Cognitive Traits

Sabine Graf
Vienna University of Technology
Austria
graf@wit.tuwien.ac.at

Taiyu Lin, Lynn Jeffrey
Massey University
New Zealand
t.lin@massey.ac.nz,
l.m.jeffrey@massey.ac.nz

Kinshuk
Athabasca University
Canada
kinshuk@ieee.org

fFORTE

bm:bwk

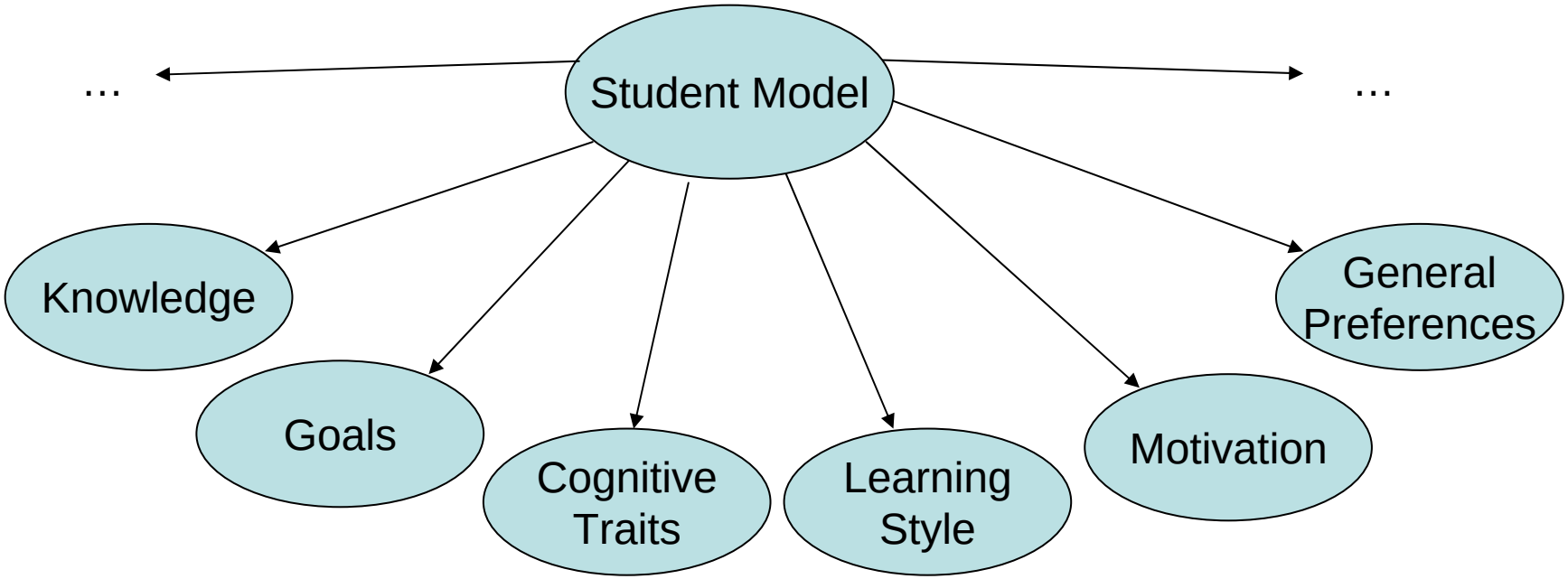
esf

Why shall we incorporate LS & CT?

- Learners have different needs
  - Background knowledge
  - Learning goals
  - Learning styles
  - Cognitive traits
  - …
- Incorporating these needs increase the learning progress, leads to better performance, and makes learning easier

→ Adaptive systems

Student Modelling



- How to get this information?
  - Ask the students
  - Initial questionnaires or test
  - Track the behaviour of the students

Aim

- Find mechanisms that use whatever information about the learner is available to get as much reliable information to build a more robust student model
- Investigate relationship between learning styles and cognitive traits

  → Additional data

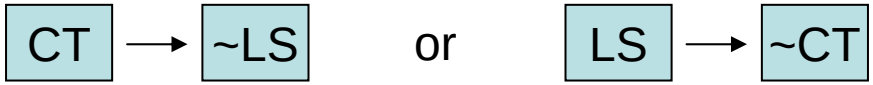
  → Improve the identification process of both (LS and CT) in adaptive learning environments

Relationship between Cognitive Traits and Learning Styles

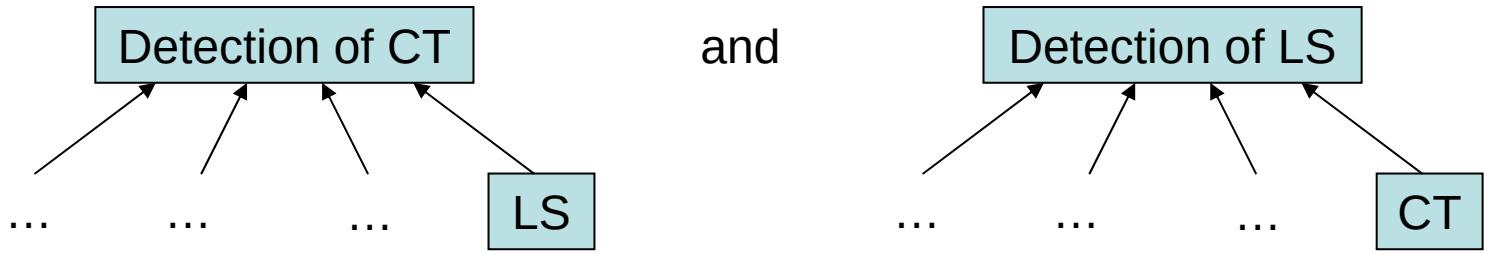
Why shall we relate cognitive traits and learning styles?

- Case 1: Only one kind of information (CT or LS) can be detected in the system

  → Get some hints about the other one



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



Felder-Silverman Learning Style Model

- Richard M. Felder and Linda K. Silverman, 1988
- Each learner has a preference on each of the four dimensions
- Dimensions:
  - Active – Reflective
    learning by doing – learning by thinking things through
    learning by discussing & group work – work alone
  - Sensing – Intuitive
    concrete material – abstract material
    more practical – more innovative and creative
    patient and careful/not patient and careful 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"
    interested in details – interested in the overview

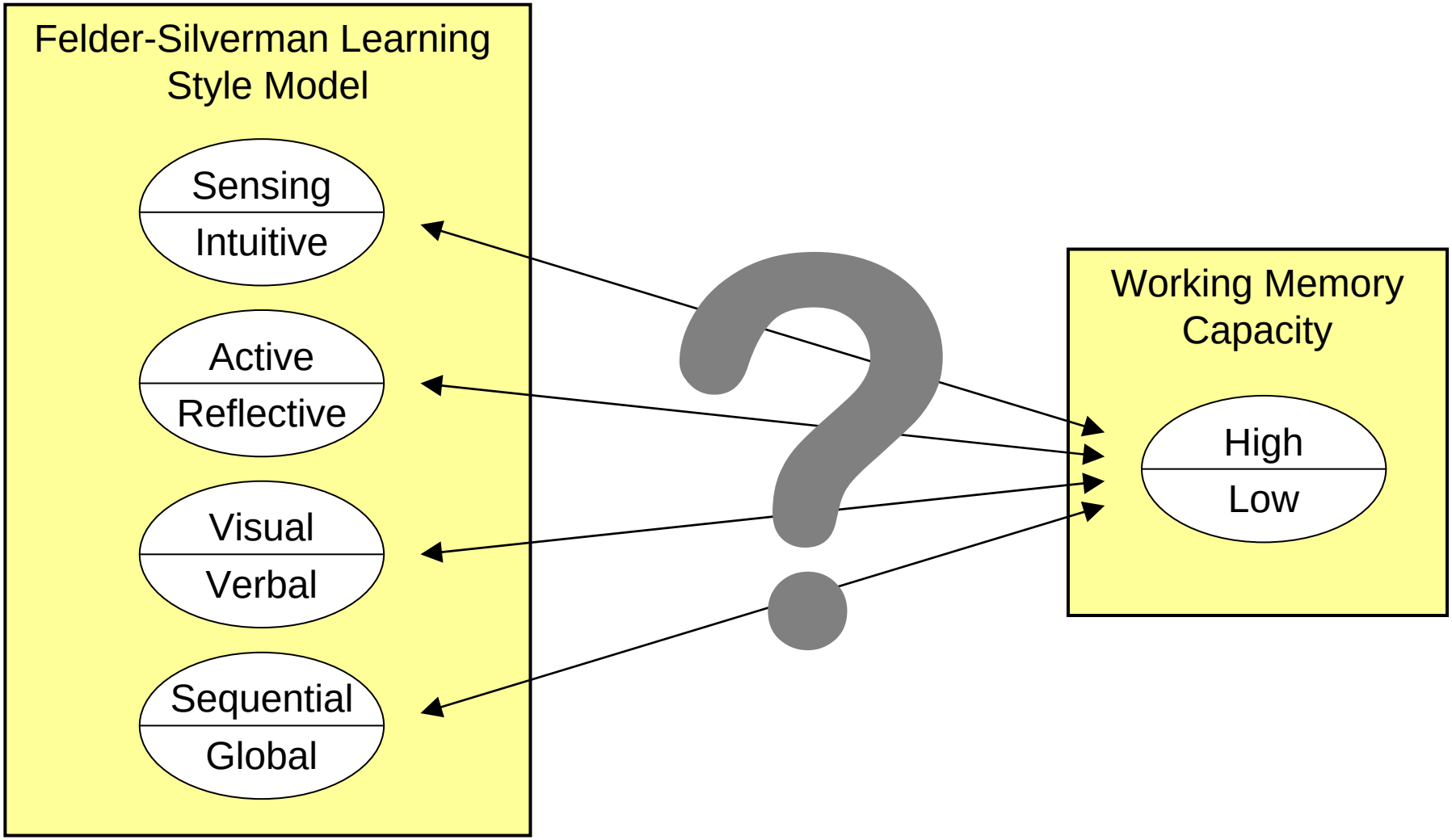
Cognitive Trait Model (CTM)

- Lin, Kinshuk and Patel, 2003
- CTM is a student model that profiles learners according to their cognitive traits
- 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

Working Memory Capacity (WMC)

- Also known as short-term memory
- Researchers does not agree on the structure of WMC, they agree that it consists of storage and operational sub-systems
- Allows us to keep active a limited amount of information (7+/-2 items) for a brief period of time

Relationship between FSLSM and WMC

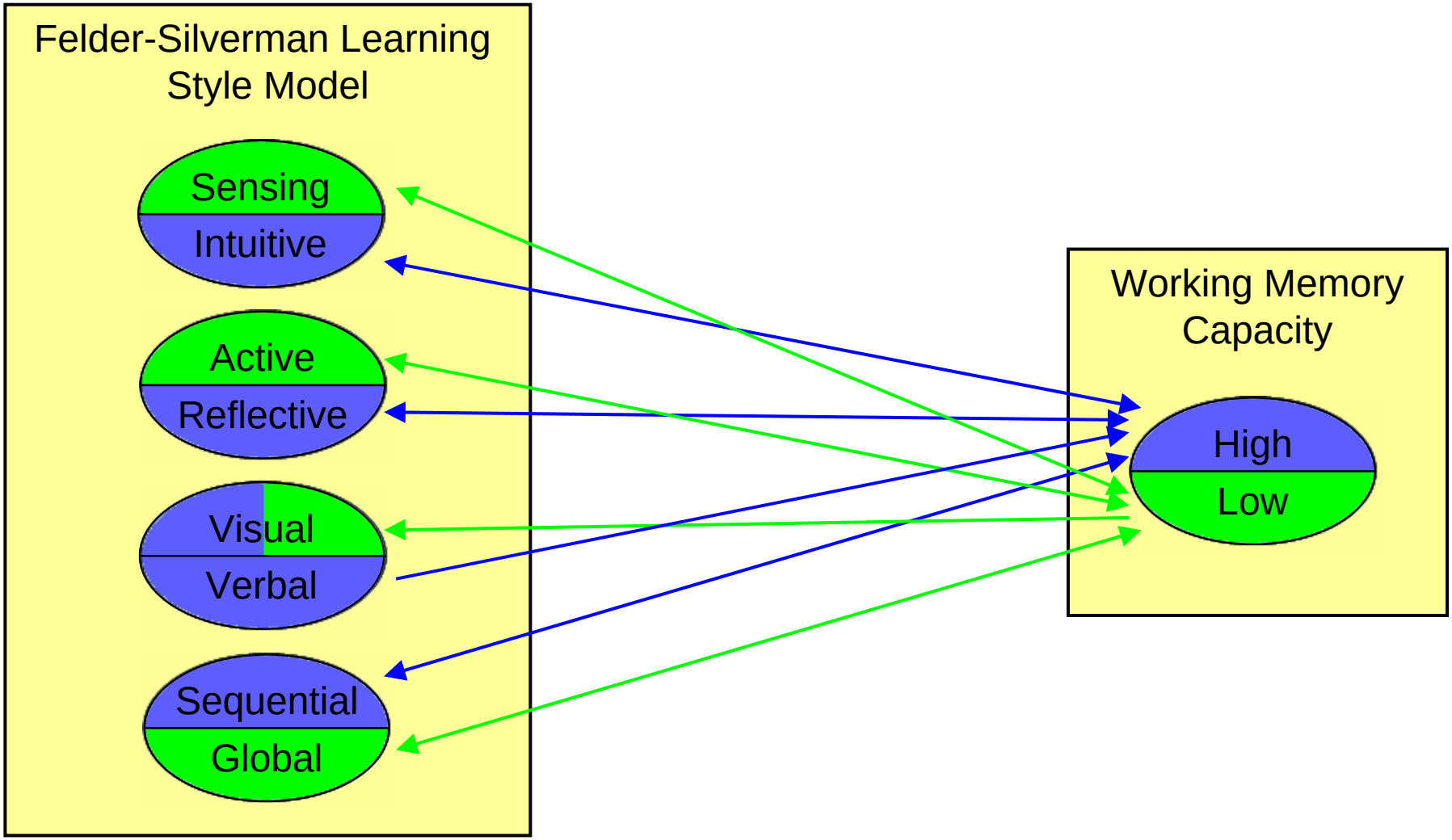


Literature Research

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

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

Relationship between FSLSM and WMC

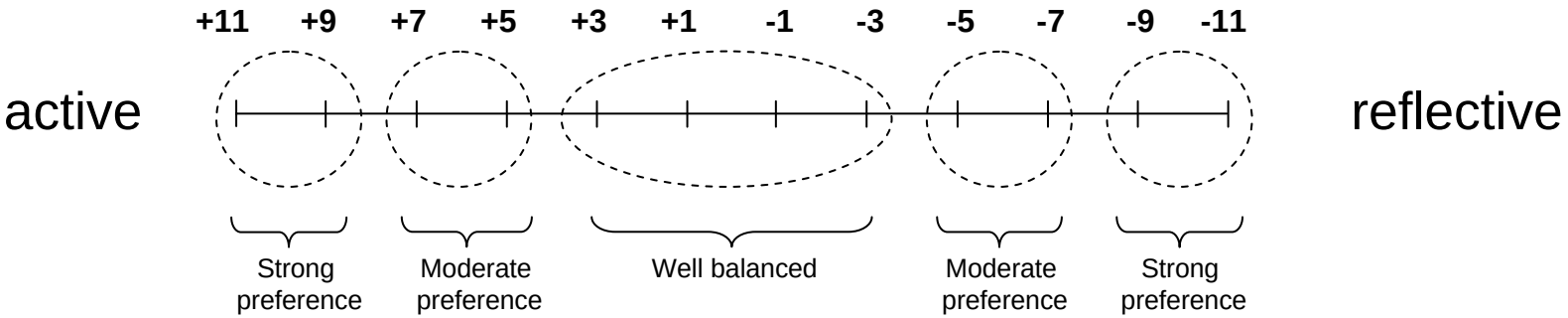


Exploratory Study

- To verify the relationship identified from the literature
- 39 participants:
  - 20 students from Austria
  - 19 students from New Zealand
- Instruments:
  Learning styles and working memory capacity were identified by questionnaire/test

Identify Learning Styles according to FSLSM

- Index of Learning Style (Felder & Soloman, 1997)
  - 44-item questionnaire (11 questions per dimension)
  - Each learner is characterized by four values from +11 to -11



- Questionnaire is available in English

Identifying working memory capacity

- From Simple Span Task to Web-OSpan Task
  - Simple Span Task: participants have to remember a series of stimulus items (digits or words)
  - Complex Span Task: Researchers agree that WMC covers also operational aspects rather than only storage aspects
  - Several versions exist, the operation word span task becomes the most popular task to measure WMC
- Web-OSpan Task (Lin, 2005)
  - 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
  - Overall 60 operations and 60 words
  - WMC is measured by the number of correct recalled words
- Available in English and German

Verifying the relationship between visual/verbal dimension and WMC

- Two conclusions from the identified relationship:
  1. Learners with verbal learning style → HWMC
     (but learners with HWMC → visual or verbal learning style)
  2. Learners with LWMC → visual learning style
     (but learners with visual learning style → HWMC or LWMC)
- Ad 1: only two students with verbal learning style

  → no conclusions are possible
- Ad 2: we analyzed the visual part of the dimension
  - H0: learners with LWMC have the same or a more verbal/balanced preference as learners with HWMC
  - H1: learners with LWMC have a highly visual learning style
  - Confidence level: 95 % ($\alpha = 0.05$)

  → Result of t-test confirms H1 significantly

Verifying the relationship between sensing/intuitive dimension and WMC

- Internal consistency reliability test

  → 3 questions of the sensing/intuitive dimension were considered as low reliable and therefore removed from further analysis

- Identified relationship from literature:
  1. Sensing learning style ↔ LWMC
  2. Intuitive learning style ↔ HWMC
- Regression analysis shows tendency
- Pearson correlation test (0.05 level):
  - Significant correlation between learning style and time students spent on the task
  - Significant correlation between time and WMC

→ Results tends to support the identified relationship

Verifying the relationship between sensing/intuitive dimension and WMC

- Incorporating differences in language skills
  - Austrian student: all students had very good German skills and good English skills

    English was considered as good enough for the questionnaire and Web-OSPAN was performed in German
  - New Zealand students: only few native English speakers and at least half of them had only moderate English skills

    For ILS English skills were sufficient, but for Web-OSPAN good language skills are crucial

→ analyze results of Austrian participants only
  - Pearson correlation test (0.05 level):
    - Significant correlation between learning style and WMC

→ For students with good language skills, the identified relationship is significantly supported

Verifying relationship between other dimensions and WMC

- Results of Pearson correlation test showed no significant correlation

→ Further analysis are necessary

Conclusion and Future Work

- Based on a study from literature, the results of the visual/verbal and sensing/intuitive dimension were confirmed by our explorative study
- For the two other dimensions, no significant correlations were found
- Future work
  - Performing a study with larger sample size
    - Get more significant information
    - Get more data to analyse the results in more detail (e.g. investigate hidden variables such as groups of characteristics)
  - Use benefits of the verified relationship in a web-based educational system which detects learning styles and cognitive traits

    → the detection process of LS and CT will be improved by the additional information from the relationship