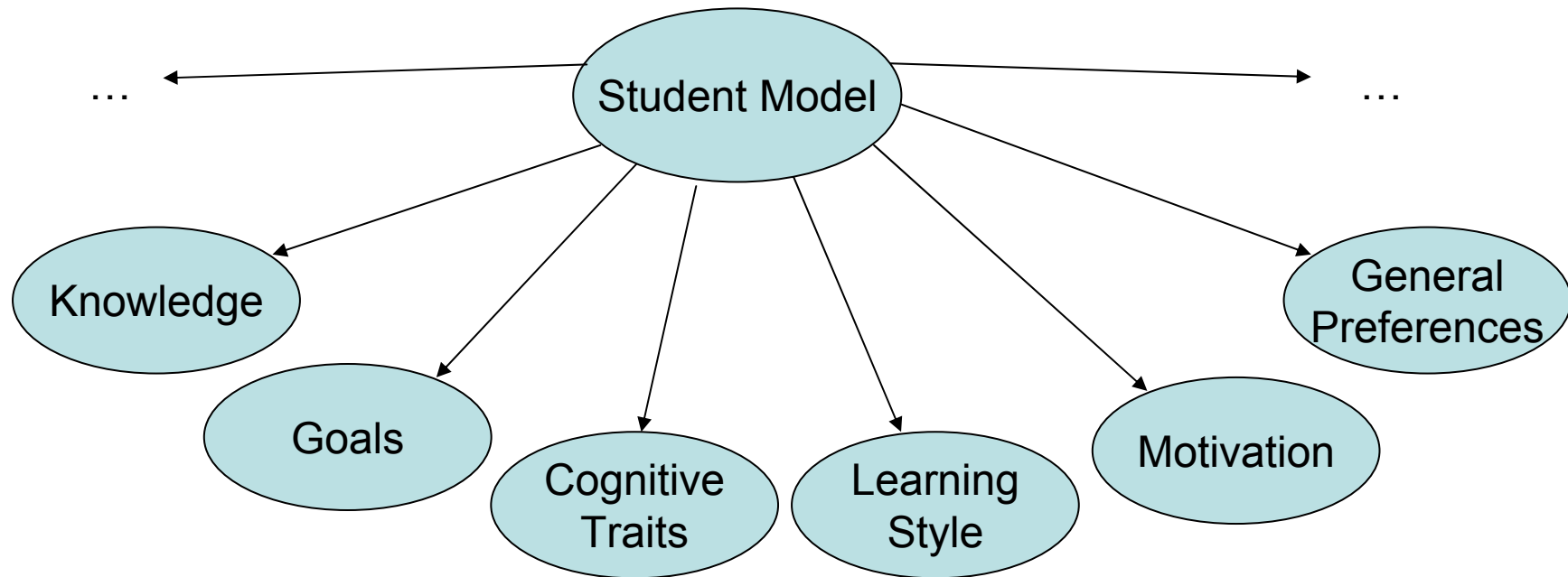

Learning Styles and Cognitive Traits – their Relationship and its Benefits in Computer-Based Educational Systems

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- Motivation of incorporating learning styles and cognitive traits
- Felder-Silverman Learning Styles Model (FSLSM)
 - Description of learning style dimensions
 - How to detect learning styles
 - Adaptivity based on learning styles
- Cognitive Trait Model (CTM)
 - Description of CTM
 - Implementation
 - Adaptivity based on cognitive traits
- Relationship between FSLSM and CTM
 - Motivation/Benefits of the relationship
 - Relationship between each dimension of FSLSM and WMC
 - Results

Why shall we incorporate LS & CT?

- Learners have different needs
 - Knowledge
 - Learning goals
 - Learning styles
 - Cognitive traits
 - ...
 - Incorporating these needs improves the learning progress
- adaptive systems



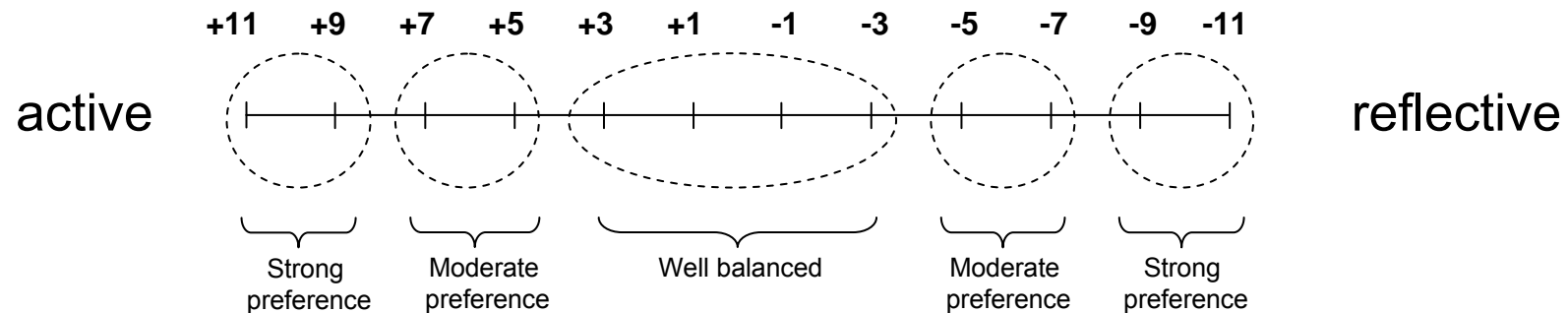
- How to get this information?
 - Ask the students
 - Initial questionnaires or test
 - Track the behavior of the students

Felder-Silverman Learning Style Model

- Richard M. Felder and Linda K. Silverman, 1988
- 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
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

FSLSM – How to find out the learning style?

- Index of Learning Style (Felder & Soloman, 1997)
 - 44-item questionnaire (11 questions per dimension)



- Track learners behavior and infer the learning style from it
 - Using Bayesian networks to detect learning styles (García et al., 2006)
 - Detecting learning styles in learning management systems (Graf and Kinshuk, 2006)

Some examples:

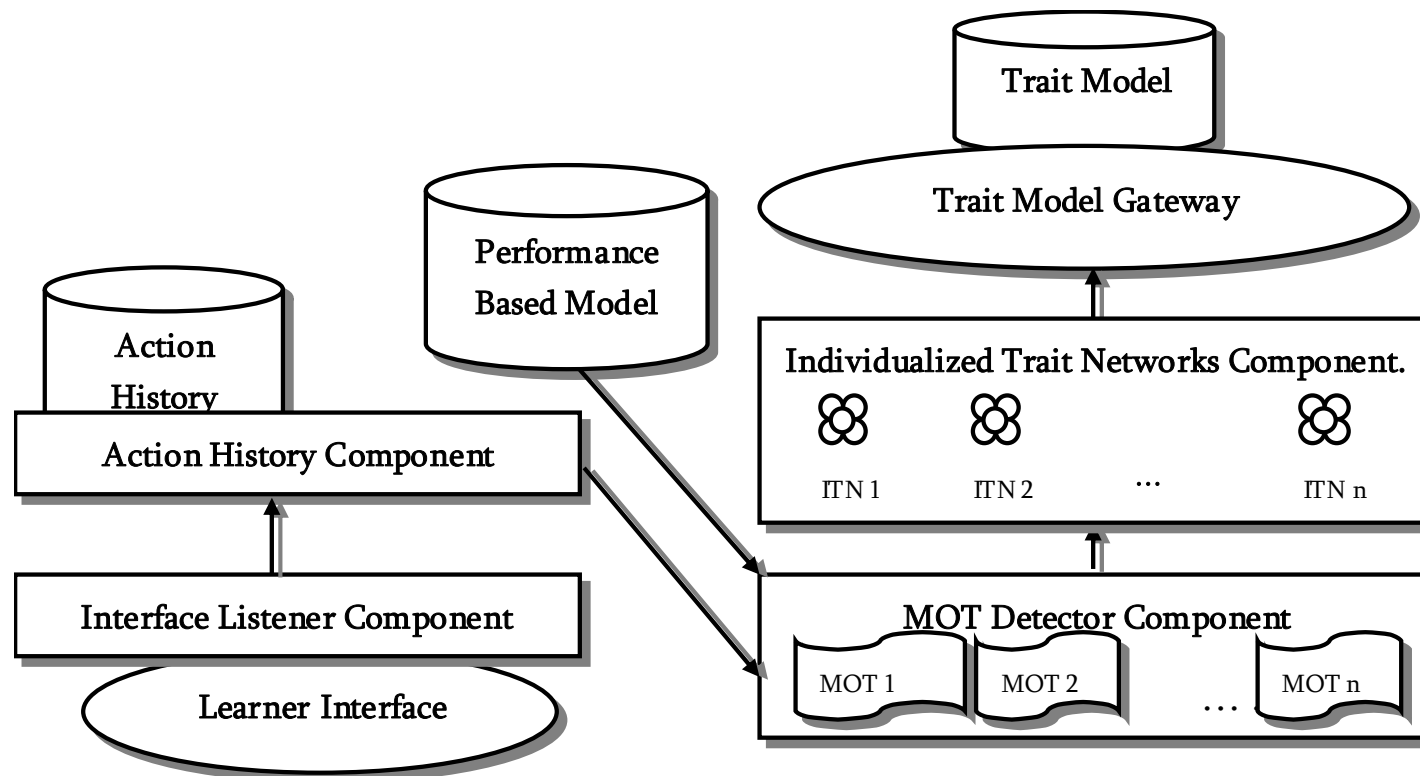
- Number of exercises (active, sensing)
- Number of examples (reflective, sensing)
- Incorporating discussions (active, verbal)
- Sequencing of LOs in a course
 - Examples first (sensing)
 - Exercises/tests at the end of a course (global)
- Use of overviews (global)
- ...

Cognitive Trait Model (CTM)

- 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

Cognitive Trait Model (CTM)

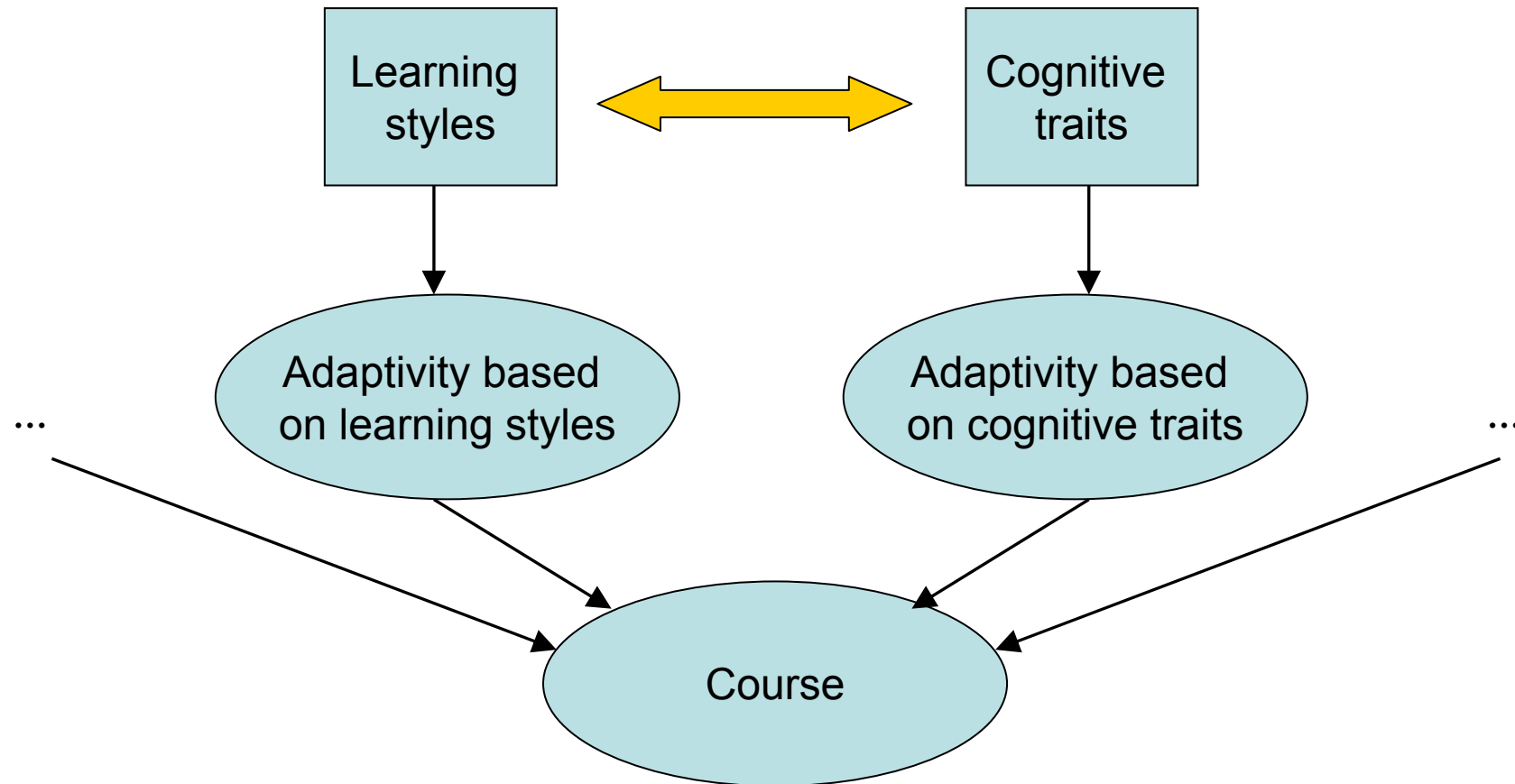
Implementation of CTM:



Adaptivity according to cognitive traits

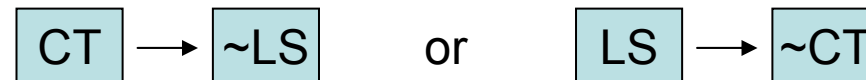
- Number of links
- Relevance of links
- Amount/detail of content
- Concreteness of content
- Structureness of content
- Number of information resources

Different types of adaptivity

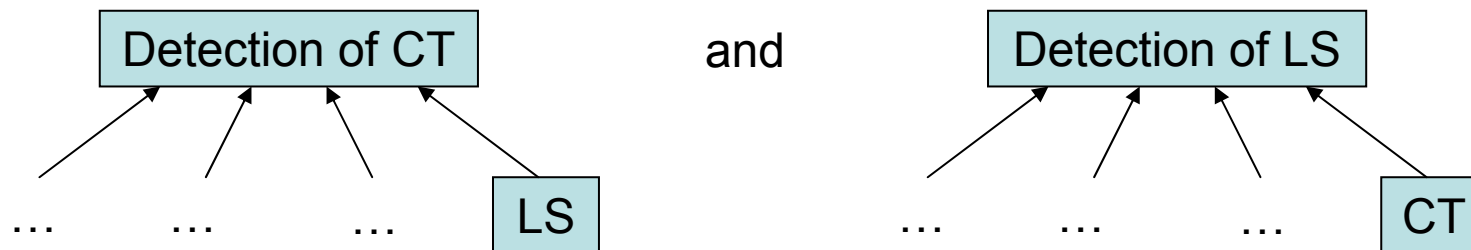


Why relate cognitive traits (CT) and learning styles (LS)?

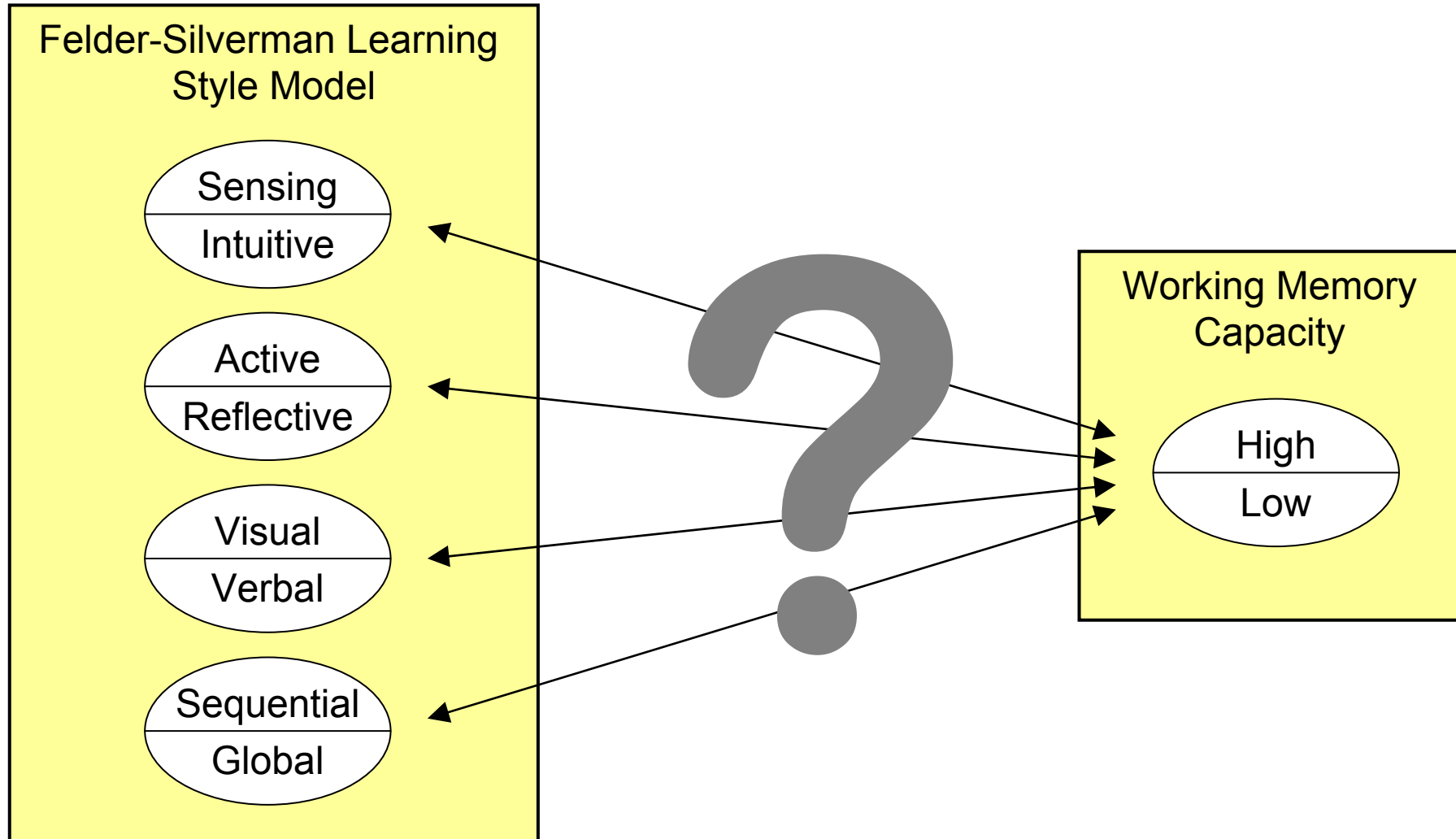
- Case 1: Only one kind of information (CT and LS) is included
→ Get some hints about the other one



- 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

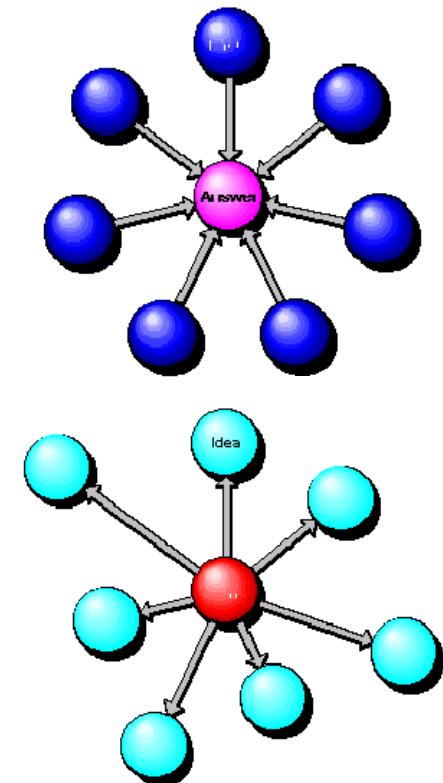


Relationship between FSLSM and WMC



Sensing-Intuitive Dimension and WMC

- 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>]

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

- Sensing ↔ convergent ↔ low WMC
- Intuitive ↔ divergent ↔ high 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)

- 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

- 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
 - 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
- Active ↔ convergers ↔ low WMC
- Reflective ↔ divergers ↔ high 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

- Note-taking in lectures
 - Study by Hadwin et al. (1999)
High WMC → perform better when notes are given
- Reflective ↔ high 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, and co-ordination and motor skill
- Visual ← dyslexic ↔ low WMC
- Verbal/Visual ↔ high WMC

- Study by Wey and Waugh (1993)
 - Instructions based on text-only or text and graphics
 - Results:
 - Text-only: field-independent learners perform better
 - Text & graphics: no significant differences
 - field-dependent learners have difficulties with text-only instructions
- Visual ← Field-dependent ↔ low WMC
- Verbal/Visual ↔ high 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 (but poor results in the long run)
 - holistic ↔ low WMC (but good results in the long run)

→ Sequential ↔ serial ↔ high WMC

→ Global ↔ holistic ↔ low WMC

Sequential–Global Dimension and WMC

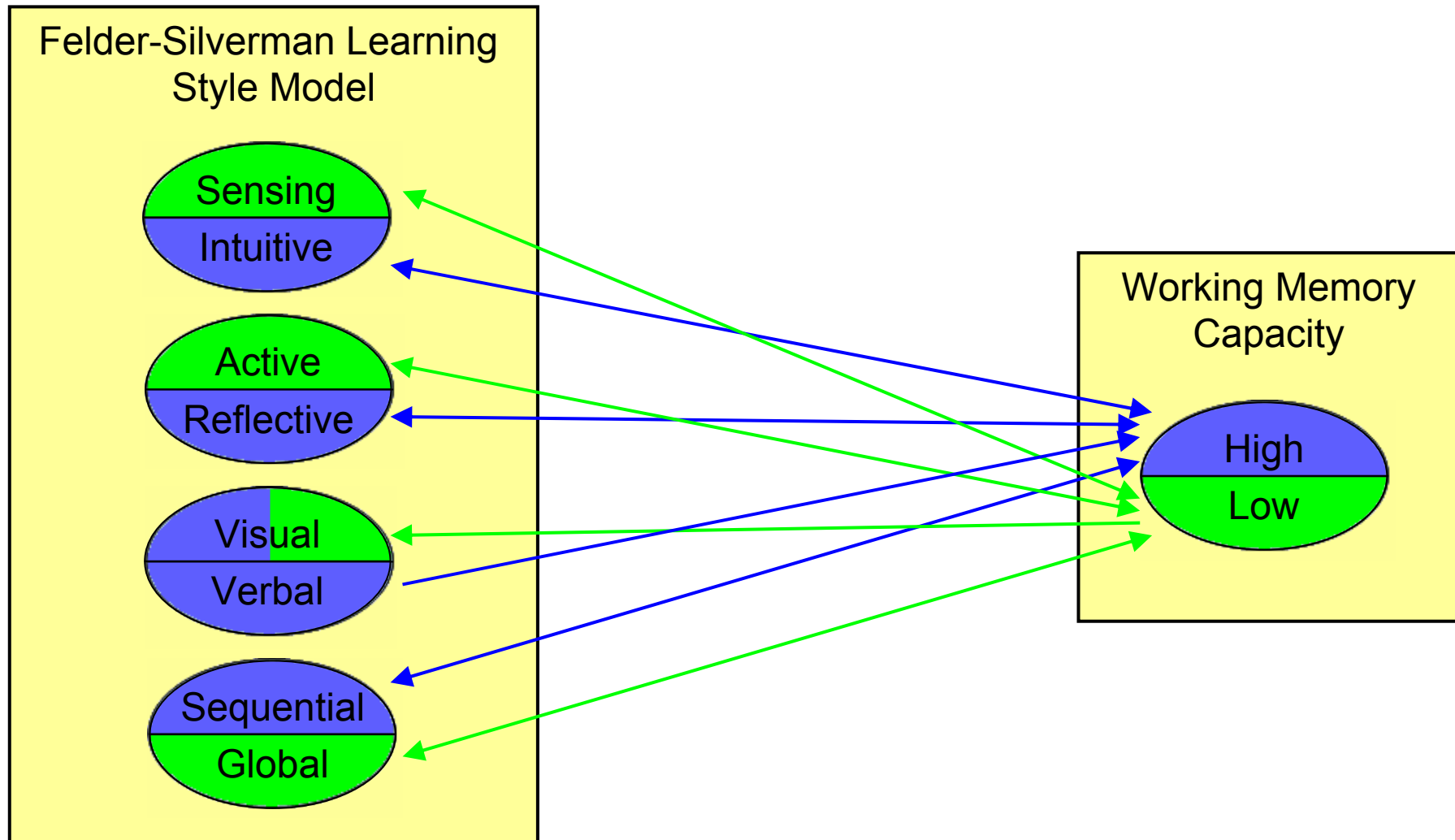
- Relation to field-dependency and field-independency
 - FI learners can learn material that is separated from its context and perceives information analytically
→ sequential
 - FD learners learn best when given a larger context, in which to embed new learning and perceives information globally
→ global

- 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



- Introduced Felder-Silverman Learning Style Model and Cognitive Trait Model
- Relationship between Felder-Silverman Learning Style Model and Working Memory Capacity
- Benefits
 - Additional information → more adaptivity
 - Improving the detection process of CT and LS → more reliable student model
- Ongoing/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, ...)