Athabasca University
FACULTY OF SCIENCE & TECHNOLOGY
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Adaptivity and Personalization in Educational Systems

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Adaptivity and Personalization in Learning Systems

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How can we make learning systems more adaptive, intelligent and personalized

- In different settings such as desktop-based, mobile and ubiquitous settings
- In different situations such as for formal, informal and non-formal learning
- Based on a rich student model that combines learner information and context information
- Supporting learners as well as teachers
- Using techniques from artificial intelligence, data mining, visualization, etc.
- Develop approaches, add-ons and mechanisms that extend existing learning systems

Adaptivity and Personalization in Learning Systems

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- Considering students' characteristics and context
  - Learning styles
  - Cognitive traits
  - Motivational aspects
  - Context information (environmental context & device functionalities)
  - Combining students' characteristics with context
- Providing teachers with intelligent support
  - Awareness of course quality
  - Awareness of students' progress, characteristics and needs
  - Easy access to educational log data
  - Identification of students at risk of failing a course
- Different settings
  - Learning management systems
  - Mobile / Ubiquitous learning

Adaptivity and Personalization in Learning Systems

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  - **Learning management systems**
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Why Considering Cognitive Abilities in Learning Management Systems?

Why Learning Management Systems?

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- are used by most educational institutions
- Examples: Moodle, Blackboard, Sakai, ATutor
- are developed to support teachers to create, administer and teach online courses
- provide a lot of different features
- domain-independent
- provide only little or in most cases no adaptivity

Why Working Memory Capacity?

- There are several cognitive traits/abilities that are highly relevant for learning (e.g., working memory capacity, inductive reasoning ability, associate learning skills, information processing speed, etc.)
- Working memory capacity (WMC) is a very important trait for learning
- WMC enables humans to keep active a limited amount of information for a very brief period of time.
- Miller (1956) found that people can remember 7+/-2 chunks of information.
- Learners with high WMC can remember almost double the amount of information than learners with low WMC
- However, typically learning systems do not consider this individual differences in WMC

Benefits

- Aim of research:
  - Identify WMC automatically based on students' behaviour in a course
  - Provide teachers with recommendations on how to help students
  - Provide students with adaptive support to accommodate their WMC

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How to Automatically Identify Cognitive Abilities in Learning Management Systems?

Automatic Identification of Working Memory Capacity (WMC)

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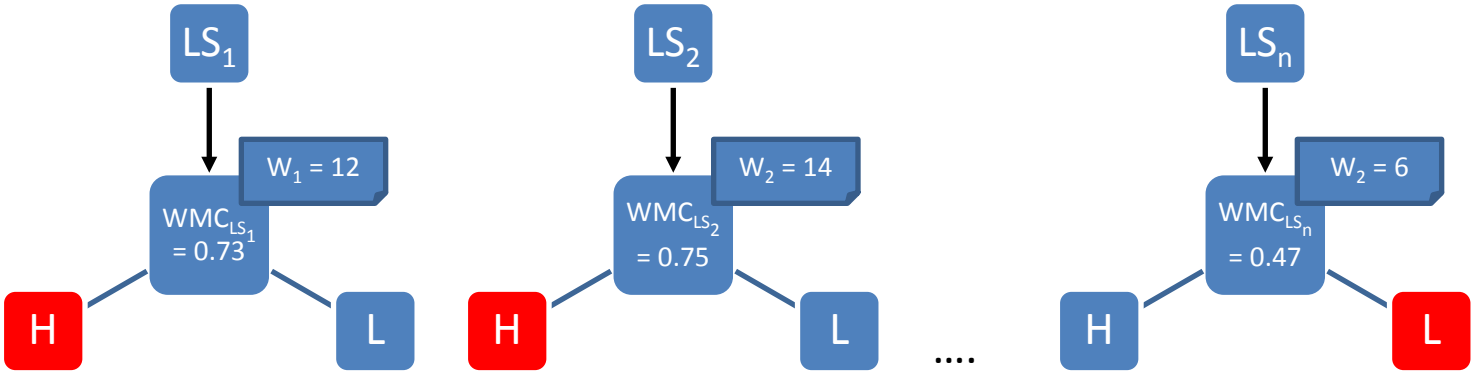
- Monitor students' behaviour for indications of low or high WMC:
  - Linear/non-linear navigation
  - Constant reverse navigation
  - Simultaneous tasks
  - Ability to retrieve information effectively from long-term memory
    - Recall information from different sessions
    - Revisiting already learned materials in different session
  - Relationship with learning style

[Ting-Wen Chang]

Calculating WMC

Measure Total WMC of a student from all learning sessions (LSs)



$$\text{Total WMC} = \frac{\sum_{i=1}^{n} WMC_{LS_i} \times w_i}{\sum_{i=1}^{n} w_i} = \frac{0.73\times11+0.75\times14+0.47\times6}{11+14+6} = \frac{21.35}{31} = 0.69 \text{ (HWMC)}$$

$$\begin{cases} HWMC\ if\ WMC_{LS_i} > 0.5 \\ LWMC\ if\ WMC_{LS_i} < 0.5 \\ Blanced\ if\ WMC_{LS_i} = 0.5 \end{cases}$$

Evaluation

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- Study with 63 students
  - Asked students to perform Web-OSPAN task
  - Gathered data from students' behaviour in an online course
- Investigated difference between Web-OSPAN results and results from our approach
- Results:
  - Error rate: 0.191 (on a scale of 0 to 1)

Evaluation

- Improvements through computational intelligence techniques
  - Use neural networks to classify behaviours
  - Use optimization algorithms (genetic algorithms, ant colony optimization, particle swarm optimization) to find out the weight of patterns
  - Results:

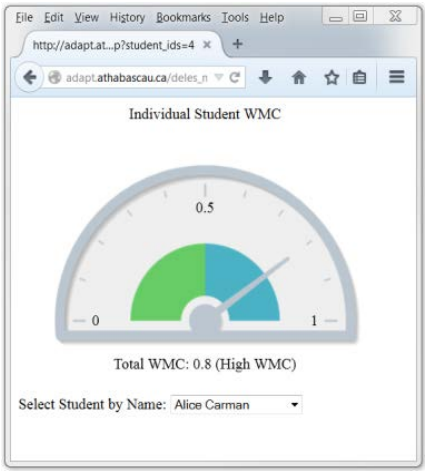
Approach	Error
Literature-based approach	0.1910
ANN	0.1376
GA	0.1484
ACS	0.1685
PSO	0.1654

[Jason Bernard, Ting-Wen-Chang]

Visualization of WMC

- Once WMC is identified, we also want to use it
- Visualization of information to students/teachers
- Users can select a student and see their WMC

Demo ...



Why Learning Styles?

- Complex research area with several open research questions
- Learners have different ways in which they prefer to learn
- If these preferences are not supported, learners can have difficulties in learning
- Previous studies showed that providing learners with courses that fit their learning styles has potential to help learners in learning

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
    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“

Visualization of Learning Style

- We also identify students' learning styles in a similar fashion and visualize this information to teachers
- Users can select a student and see their learning styles

Demo …

How to Provide Recommendations to Teachers based on Students' Working Memory Caapcity?

Recommendations for Teachers based on Students' Cognitive Abilities

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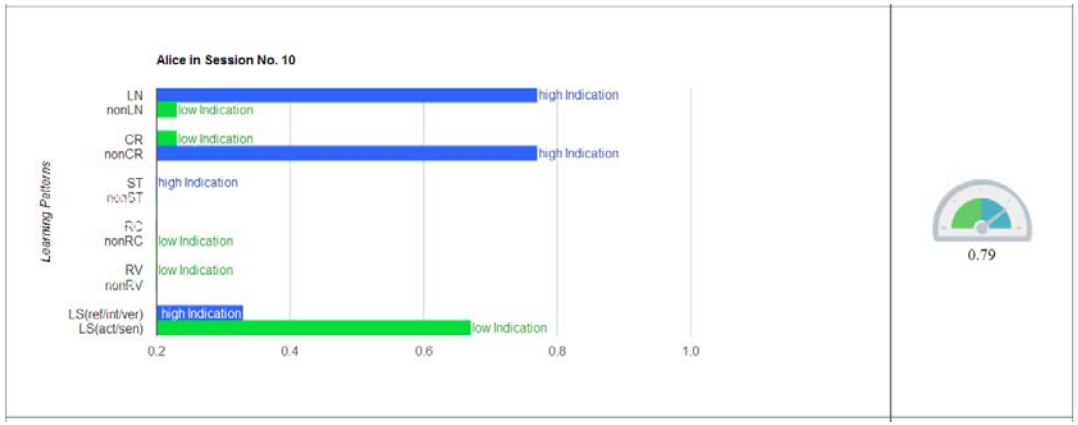
- Research Aim
  - Points out learning sessions/chapters where students' behaviour does not match with their identified WMC
  - Provide teachers with recommendations on how to support students with respect to their WMC

Demo ...



How to Provide Recommendations to Students based on their Working Memory Caapcity?

Automatic Recommendations based on Students' Cognitive Abilities

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- Research aim
  - Provide students with automatic recommendations to individually support their learning based on their WMC
- Adaptive mechanism
  - What recommendation shall the system show?
  - When shall the system provide a recommendation?
  - Which recommendation should be provided?
  - Do students follow recommendations?

[Ting-Wen Chang, Jeff Kurcz]

What recommendations?

No.	Asking the student to
R1	**take notes** when he/she learns a learning object
R2	**request help** if he/she have any question by posting or asking teachers about this learning object
R3	**post the ideas**, thought, or reflection about what he/she learnt in this learning object
R4	**summarize** what he/she learnt about this learning object
R5	**rehearsal by revisiting** the content of this learning object
R6	**use concept / mind maps** to easier remember content of this learning object

When to show a recommendation?

- Show recommendation either before or after a learning object has been viewed
- Two methods for deciding on when to show a recommendation
  - Time-based (how much time has a student spent on a learning object)
  - Probability-based (based on students' WMC)

When to show a recommendation?

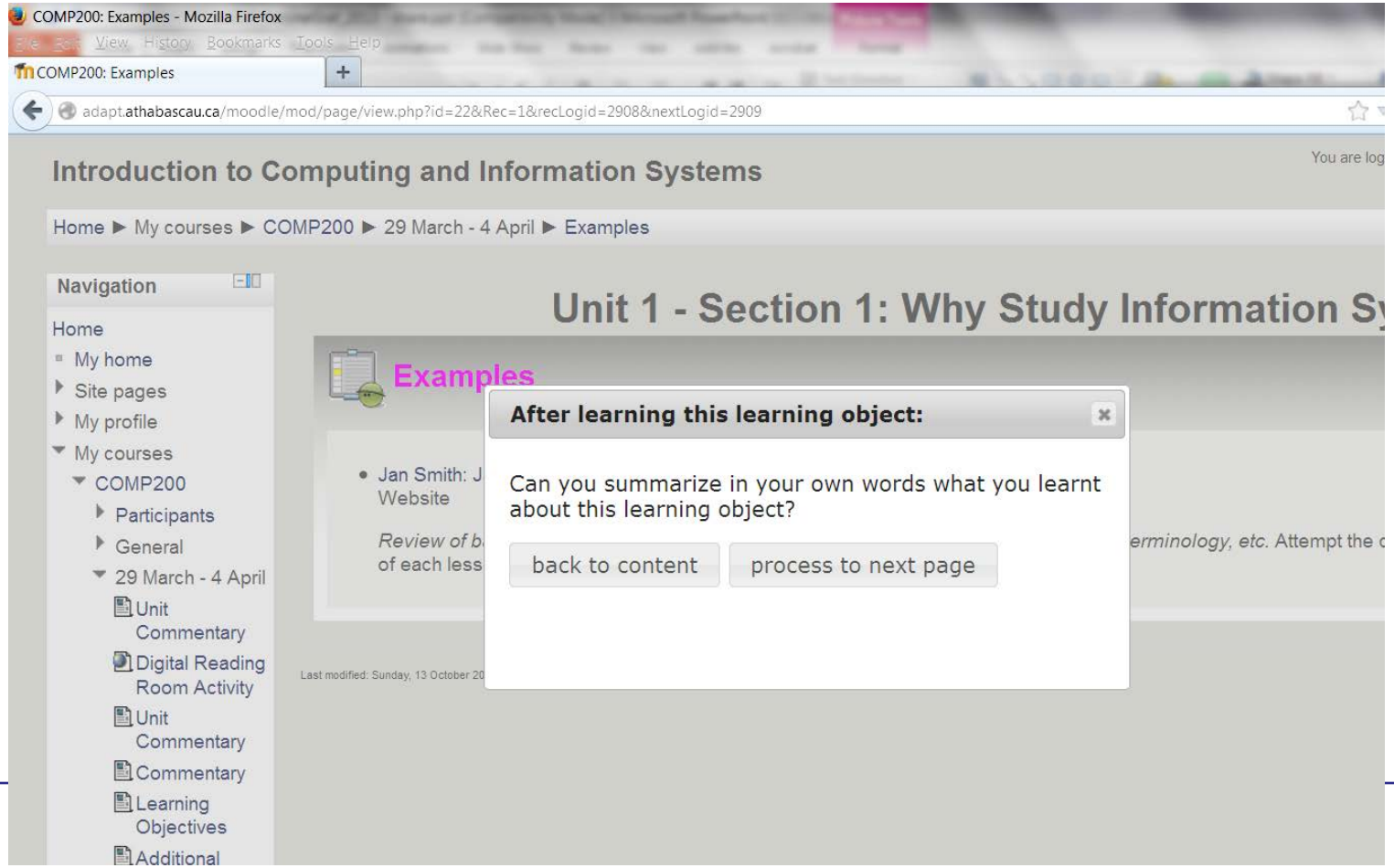
No.	Asking the student to	When (before / after learning)	Method
R1	**take notes** when he/she learns a learning object	before	probability-based
R2	**request help** if he/she have any question by posting or asking teachers about this learning object	after	probability-based time-based
R3	**post the ideas**, thought, or reflection about what he/she learnt in this learning object	after	probability-based
R4	**summarize** what he/she learnt about this learning object	after	probability-based time-based
R5	**rehearsal by revisiting** the content of this learning object	after	time-based
R6	**use concept / mind maps** to easier remember content of this learning object	after	probability-based

When to present which recommendations?

- For each type of learning object, it has been determined whether a recommendation makes sense or not
- For each type of learning object, recommendations are ranked based on how well they fit for a learning object
- Consider whether time-based or probability-based method is activated
- Consider whether a recommendation has been followed or not

Demo

Demo …


COMP200: Examples - Mozilla Firefox
COMP200: Examples
adapt.athabascau.ca/moodle/mod/page/view.php?id=22&Rec=1&recLogid=2908&nextLogid=2909
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Unit Commentary
Commentary
Learning Objectives
Additional
Unit 1 - Section 1: Why Study Information Sy
Examples
After learning this learning object:
Can you summarize in your own words what you learnt about this learning object?
back to content
process to next page

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How to provide teachers with intelligent support based on learning styles?

Why is there a need to extend LMS to better support teachers?

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- LMS are designed for supporting teachers
- However, there are still some open issues in online teaching (e.g., little feedback for teachers)
- But LMS gather huge amounts of data
- These data can be used in different ways:
  - Provide feedback about learners and their progress
  - Provide feedback about courses and their quality
  - Provide feedback on how well courses work for learners
  - Identify learners who have difficulties
  - Identify learning materials that cause difficulties
  - etc.

Analyzing Courses with Respect to Learning Styles

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- Focus on providing teachers with feedback on how well their courses work for students with different learning styles
- Research Aim:

  Provide teachers with a tool to

  - see how well their courses supports students with different learning styles and their cohort of students
  - investigate how to improve their courses
  - get recommendations on how to improve their courses

[Moushir El-Bishouty, Kevin Saito]

Demo

Demo …


Course Analyzer
Show Calculation Steps
Show Data Tables
Analysis Settings
Select a Course:
TEST505 for Testing
Mode:
General
Cohort
Course Structure
TEST505 for Testing
Section ID:45
News forum (Discussion Forum Activity)
Introduction
Appliation (Real-life Application)
Material (Content)
Media (Animation)
Exercise
Quiz1 (Self-Assessment Test)
Practise (Exercise)
Discussion (Discussion Forum Activity)
EX (Example)
Quiz2 (Reflection Quiz)
Readings (Additional Reading Material)
Summary (Conclusion)
Section 1
Section ID:48
Simulation Settings
Add LO (Drag and Drop)
Reflection Quiz
Self-Assessment Test
Discussion Forum Activity
Additional Reading Material
Animation
Exercise
Example
Real-Life Application
Remove LO (Drag and Drop)
Drop LO here to remove
Select the Course Suitable Learning Object Types
RQ SAT DFA ARM Ani Exe Exa RLA
Test
Original
Course Before Modification
Course After Modification
Section Before Modificat
Active
Reflective
Sensing
Intuitive
Visual
Verbal
Sequential
Global
0%
25%
50%
The support level for diverse learni
Section Before Modification
Section After Modification
Course
Learners
Strong
Moderate
Balanced
The support level for current learners' learning styles

Questions

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