Academic Analytics – Analysis and Mining of Educational Data to Support Teaching

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Motivation

- Online teaching is very difficult because
  - we don’t know our learners
  - we don’t see our learners
  - we don’t see what they are doing in an online course
  - we don’t see how they are doing
- Creating online courses is difficult too because
  - we don’t know what worked well or what didn’t

Motivation

- Learning systems collect and store huge amounts of data
  - Grades on assignments, quizzes, exams, etc.
  - Students' behaviour in an online course
    - Which learning objects does he/she visit
    - How long does a learner stay on those objects
    - Any content that the learner creates (e.g., through forums, chats, blogs, etc.)
    - And much more

Motivation

- However, those data are rarely used to benefit people involved in the learning and teaching process
- Why not?
  - Data are stored in huge databases
  - It is difficult for people with computer science background to get out any information from these data but it is impossible for people without computer science background

What can be learned from such data?

- How do learners behave?
  - Preferences and characteristics of learners
  - Risk levels of learners

  → To better support learners and increase learners' awareness
- How well do courses (or specific learning objects) work for learners?
  - Does a course support learning preferences?
  - Are there materials that cause significantly different behaviour by students (e.g., not visited, question questions significantly more often wrong, materials significantly less often looked at, etc.)

  → To improve (or better design) courses

What can be learned from such data?

- How well do particular learning strategies work?

  → To better support learners and increase learners' awareness

- How well do particular teaching strategies work?

  → To improve teaching

How can educational technology help?

- Two types of systems
  - Systems that mine and analyse data, and provide particular information (e.g., risk levels, learner preferences, etc.)
  - Systems that guide users to do their own investigations into the huge amount of data

Analysing and Mining Behaviour to Identify and Visualize Learning Styles and Cognitive Abilities

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Collaboration: Prof. Dr. Elvira Popescu (University of Craiova, Romania)

How to identify learning styles of students from their behaviour?

Awareness about learning styles:

- increases educators' and learners' understanding about how individual students learn
- allows educators to provide better support for their students
- enables students to understand and be aware of their strengths and weaknesses when it comes to learning

Learning style questionnaires have several disadvantages:

- take some time to fill out
- as learning styles can change over time, they would need to be filled out multiple times
- even if students want to fill them out properly, they might not be aware of how they are learning
- do not account for exceptions

How to identify learning styles of students from their behaviour?

Research Question:

How to automatically identify learning styles of students based on their behaviour in learning systems?

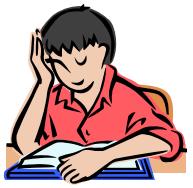
How to visualize this information in an effective way to educators?

Advantages of such approach:

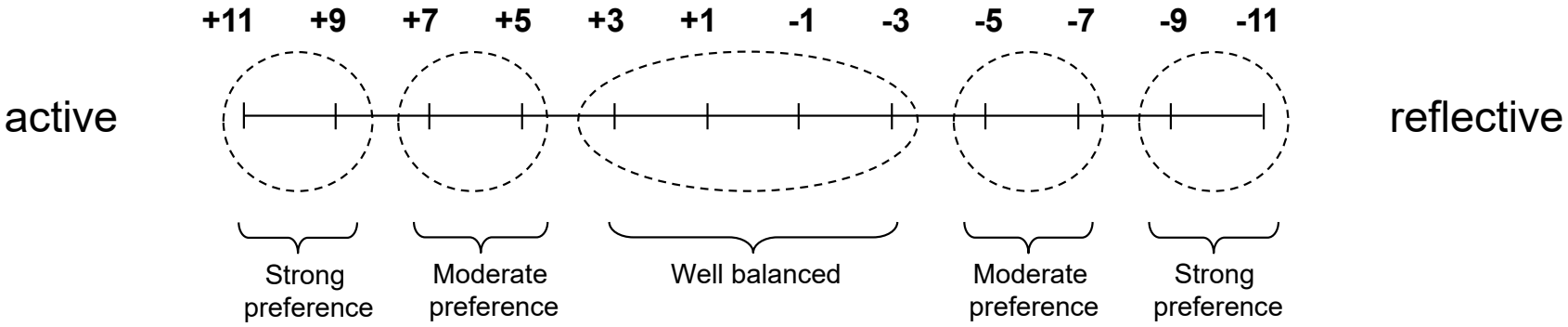
- Does not require any extra time from students
- Looks at what students actually prefer rather than what they think they prefer to do
- Can handle exceptional behaviour

Felder-Silverman Learning Style Model

- Each learner has a preference on each of the dimensions
- Dimensions:
  - Active – Reflective
  - Sensing – Intuitive
  - Visual – Verbal
  - Sequential – Global



- Scales of the dimensions:



Strong/moderate preference but no support → learning problems

How to identify learning styles of students?

- Investigations into relationships between students' behaviour and learning styles
  - Study 1: Relationship between 39 behaviour patterns and learning preferences

    → Several relationships were found for each learning style dimension
  - Study 2: Relationship between 39 behaviour patterns and learning style sub-dimensions

    → Several relationships were found for most learning style sub-dimension
  - Study 3: Differences in navigational behaviour patterns based on learning styles

    → Several transitions were found to be significant for each investigated learning style dimension

An approach for automatic learning style detection

- Design decision
  - Developing an approach for learning systems in general
  - Implementing and evaluating this approach in Moodle
- How does it work?
  - Used findings from previous investigations → 27 patterns
  - Calculation of learning styles is based on hints from patterns
  - A simple rule-based mechanism is used for this calculation (similar to the approach used in the questionnaire)

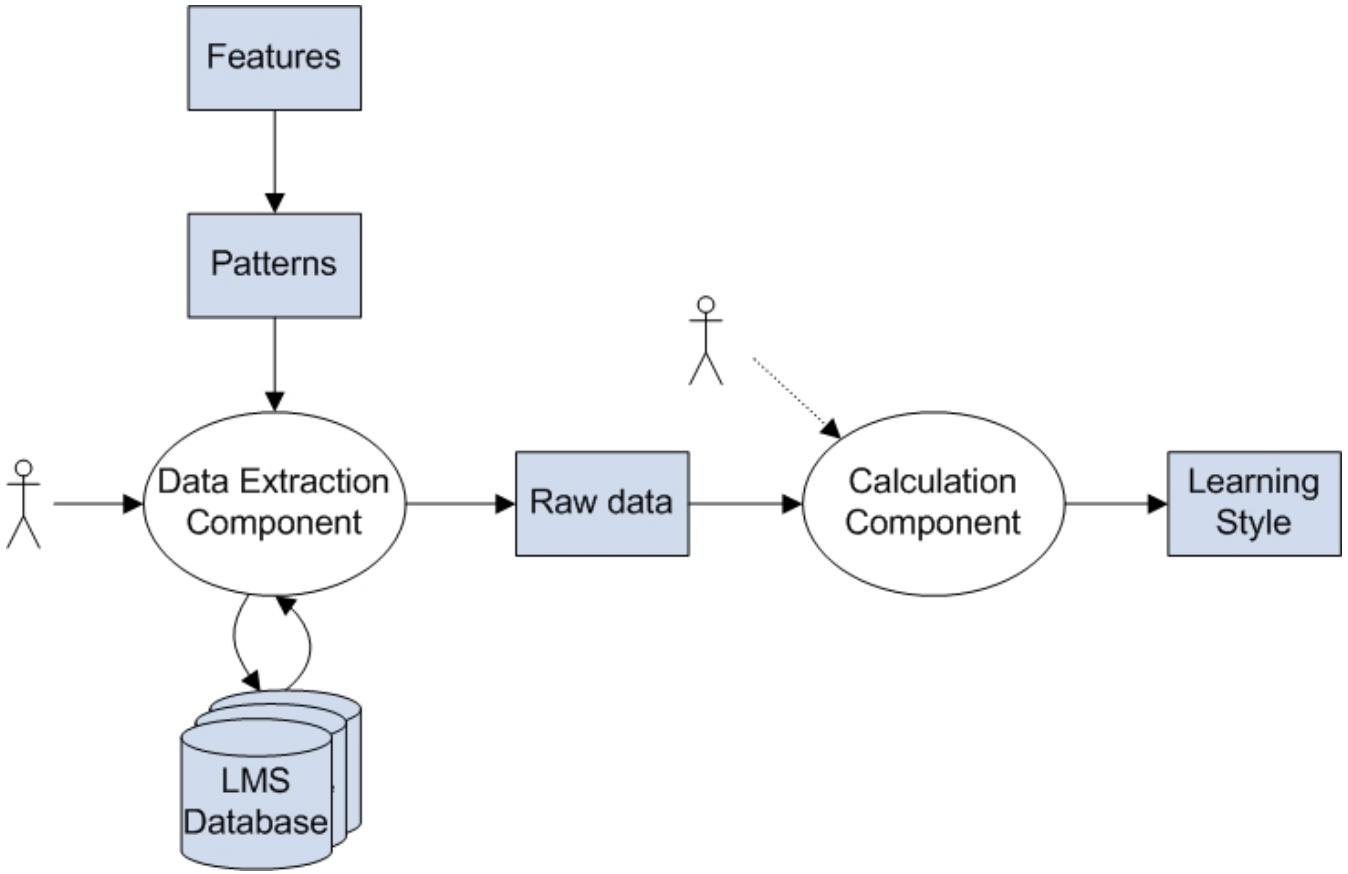
Evaluation

- Study with 75 students
  - Let them fill out the ILS questionnaire
  - Tracked their behaviour in a blended computer science course
- Results – Comparison between ILS and automatic approach

Active / Reflective	Sensing / Intuitive	Visual / Verbal	Sequential / Global
79.9 %	79.0 %	78.8 %	77.0 %

→ suitable instrument for identifying learning styles

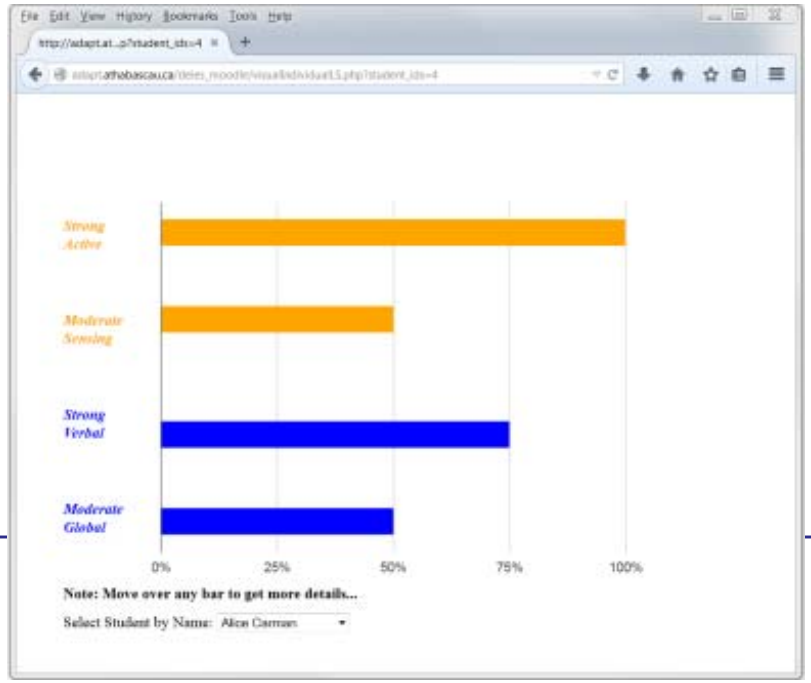
DeLeS – A Tool for Identifying Learning Styles



DeLeS – A Tool for Identifying Learning Styles

Visualizations of Learning Styles

- Plugin into Moodle to show learning styles
- Collaboration with Lyryx Inc. to provide learners with:
  - information about their learning styles,
  - an explanation of what their learning styles mean
  - personalized learning advice on how they can learn more effectively given their learning styles



Improving accuracy through computational intelligence algorithms

- Optimizing the relevance of each pattern through computational intelligence algorithms

Results:

Approach	Active / Reflective	Sensing / Intuitive	Visual / Verbal	Sequential / Global	Average
Artificial Neural Network (LSID-ANN)	80.2% (5)	79.0% (6)	84.0% (3)	79.7% (2)	80.7% (3)
Ant Colony System (LSID-ACS)	**81.9% (1)**	79.7% (3)	79.9% (4)	73.7% (6)	78.8% (6)
Genetic Algorithm (LSID-GA)	79.5% (7)	79.6% (4)	79.4% (6)	77.4% (4)	79.0% (5)
Particle Swarm Optimization (LSID-PSO)	80.5% (4)	79.4% (5)	79.6% (5)	76.8% (5)	79.1% (4)
Hybrid (LSID-SISO ACS)	**81.9% (1)**	**81.4% (1)**	**86.1% (1)**	**80.2% (1)**	**82.4% (1)**
Hybrid (LSID-SISO ANN)	**81.9% (1)**	80.0% (2)	84.4% (2)	79.6% (3)	81.5% (2)
Rule-based	79.9% (6)	79.0% (6)	78.8% (7)	70.2% (7)	77.0% (7)

Analyse Course Data to Identify and Visualize the Support Level of a Course for Students

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Collaboration:
Prof. Dr. Ahmed Aldraiweesh (King Saud University, Saudi Arabia)
Prof. Uthman Altur (King Saud University, Saudi Arabia)

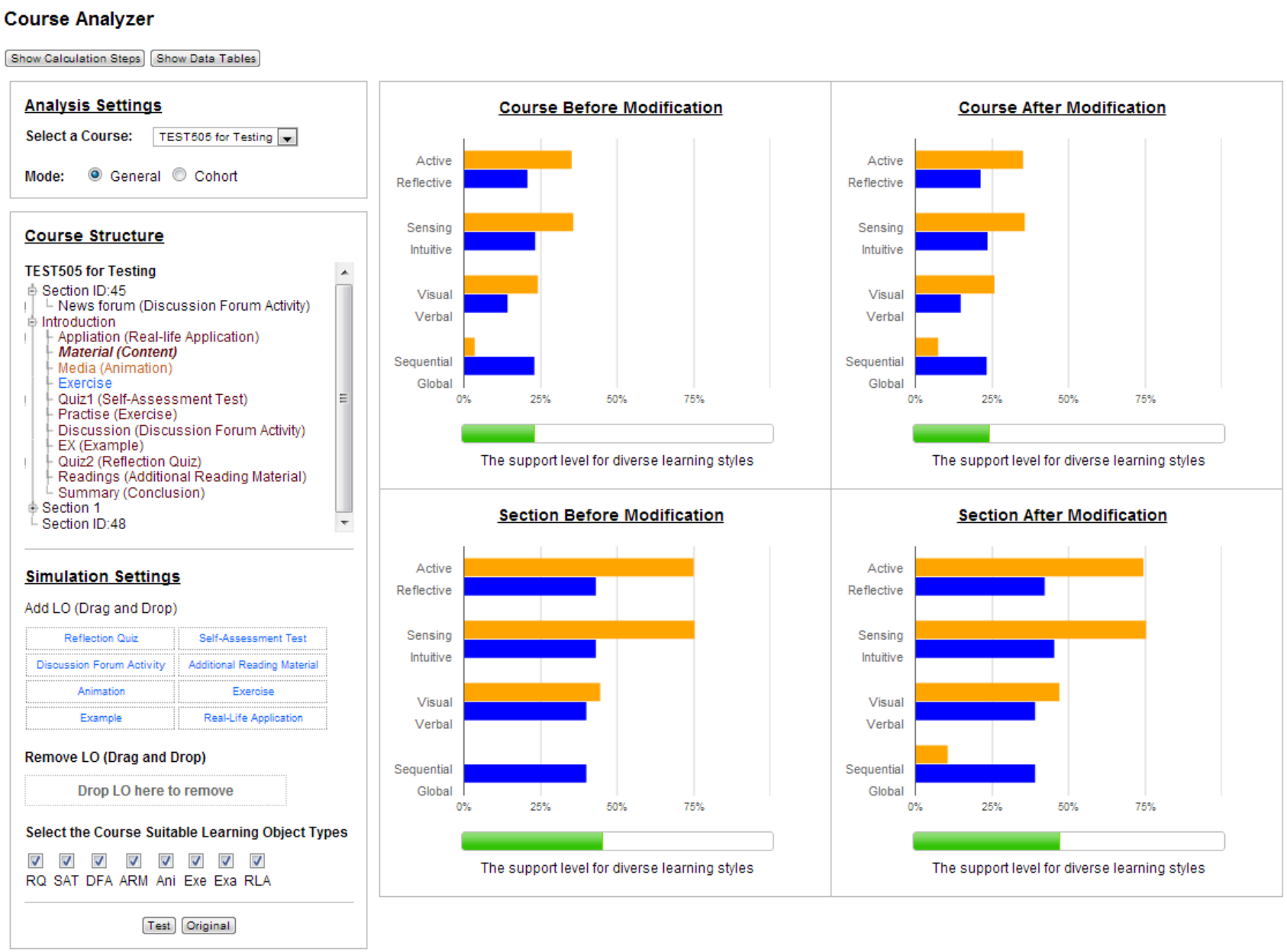
Course Design Analysis

- After creating learning materials and activities, we rarely assess whether those materials and activities have actually been helpful for learners.
- Goal: Providing educators with information about:
  - how well a course supports learners with different learning styles
  - how a course could be improved to better support learners with different learning style
  - what concrete actions can be done to improve a course
- 2 pilot studies (Canada und Saudi Arabia)

Approach to identify the support level

- Mapping between learning styles and supporting learning objects/activities
- Support level is based on:
  - Availability
  - Frequency
  - Sequence
- Several different visualizations

Course Analyser Interactive GUI



Course Analyser Interactive GUI

Course Recommender Interactive GUI

Course Design Analyse System

1st Pilot study:

- Online university course with 167 learning objects at Athabasca University
- Parameter of genetic algorithm was assessed

2nd Pilot study:

- Online university course with 8 units at College of Education at King Saud University (Saudi Arabia)
- 25 learners
- Educator used the system on the first four units to create the remaining 4 units

[Collaboration with Prof. Ahmed Aldraiweesh and Prof. Uthman Altur at King Saud University (Saudi Arabia)]

Providing educators with more information about their students' behaviour in online courses

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Collaboration:

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Motivation

- The use of learning systems is relatively new (compared to face-to-face learning)
- Our knowledge about how to best teach with such systems is therefore relatively limited
  - How do learners actually learn in such systems?
  - Which teaching strategies and course designs have a positive impact on students‘ learning?
  - How to effectively design online courses and learning materials?
- Learning systems produce huge amounts of data
- However, those amounts are so big that it is difficult to filter out useful information

Academic Analytics Approach

Goal: How to enable educators and learning designers to conduct detailed investigations into the complex educational data collected by learning systems?

Designed Academic Analytics Approach:

- Comprehensive access
  → asking any „questions to the data“
- Easy access
  → no computer science knowledge required
- Integrating the approach into a tool: Academic Analytics Tool (AAT)
  - simple analytics features
  - Export function

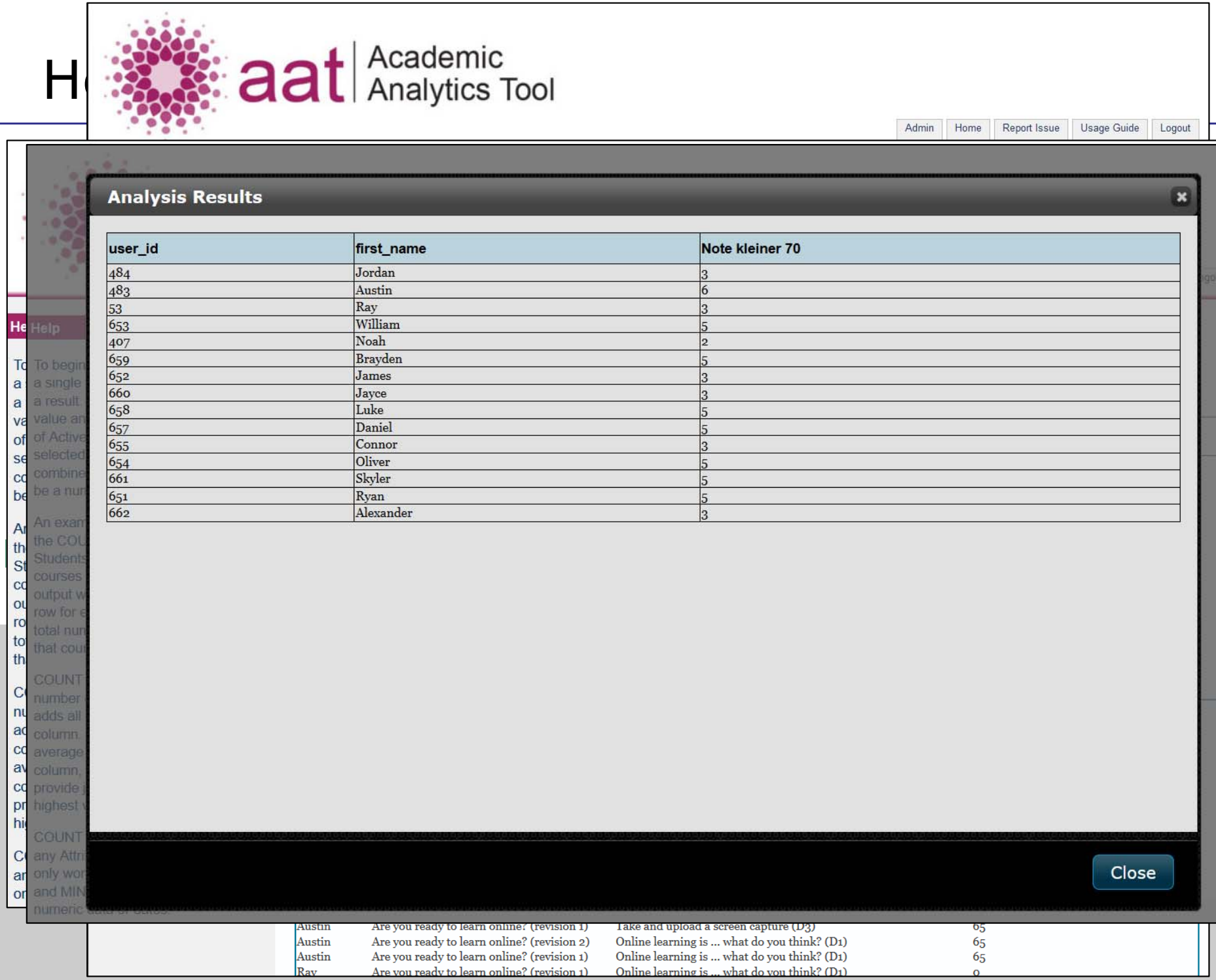
Examples of questions AAT can help to answer

- Which and how often are particular learning objects visited?
- On which learning objects do learners spend the most time?
- Do learners even visit certain types of learning objects (e.g., videos, quizzes, etc.)?
- Which quiz questions are most often answered incorrectly?
- Comparison between two teaching strategies for using forums in courses:
  - Which strategy leads to more postings, longer postings, more discussions, etc?
- Comparison between new and old version of a course:
  - Do students behave differently in the two versions?
  - Do students perform better on assignments or the whole course?
- Which student behaviour correlates with better grades?
- Does a particular teaching strategy lead to better grades?
- Does the teaching strategy has the same positive effect in different courses or different course domains?
- …

How does AAT work?

1. Select the learning system
2. Select the course(s)
3. Select the concepts and attributes
4. Export or analyse the results

Website:
http://academicanalytics.ca/


aat
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Analytics Tool
Admin
Home
Report Issue
Usage Guide
Logout
Analysis Results
user_id
first_name
Note kleiner 70
484 Jordan 3
483 Austin 6
53 Ray 3
653 William 5
407 Noah 2
659 Brayden 5
652 James 3
660 Jayce 3
658 Luke 5
657 Daniel 5
655 Connor 3
654 Oliver 5
661 Skyler 5
651 Ryan 5
662 Alexander 3
Close
Austin Are you ready to learn online? (revision 1) Take and upload a screen capture (D3) 65
Austin Are you ready to learn online? (revision 2) Online learning is ... what do you think? (D1) 65
Austin Are you ready to learn online? (revision 1) Online learning is ... what do you think? (D1) 65

Academic Analytics Tool

- Analyses to improve teaching:
  - Using data from course units, whole courses and courses over multiple semesters
  - To provide educators with more information about their students and courses
- Analysis to improve our understanding about teaching:
  - Using data from multiple courses, multiple course domains or even from whole educational institutions
  - To increase our knowledge about learning and teaching with digital media

Evaluation

Qualitative und quantitative study

- 6 learning designers
- Phase 1:
  - AAT was demoed
  - Training session with exercises (simulated data)
  - Feedback was collected during and after the training session
- Incorporating feedback to improve AAT
- Phase 2:
  - AAT was demoed
  - Training session with exercises (data from a whole educational institution)
  - Feedback was collected during and after the training session
  - Survey and interviews

Evaluation

- Results:
  - Usefulness and effectiveness: 4.11 (von 5)
  - User-friendliness: 3.04 (von 5)
  - Overall impression: 3.48 (von 5)
  - Feedback to improve AAT

Using AAT

- Study about forum usage

  Relationships between:

  - Participation of students in forums
  - Participation of educators in forums and
  - Students‘ performance

- Study about timing of assignment submissions

  Relationships between:

  - Submission time of the assignment
  - Grades on assignments

Using AAT – Study about timing of assignment submissions

Data:

- Online Master program in Information Systems und Distance Education (DE) at a Canadian university
- All courses (n=26 for IS; n=22 for DE) over 3 years
- Before data cleaning:
  - IS: 1967 assignments from 214 students
  - DE: 6863 assignments from 836 students
- After data cleaning:
  - IS: 1125 assignments from 183 students
  - DE: 5441 assignments from 807 students

Using AAT – Study about timing of assignment submissions

Two potential problems in the data:

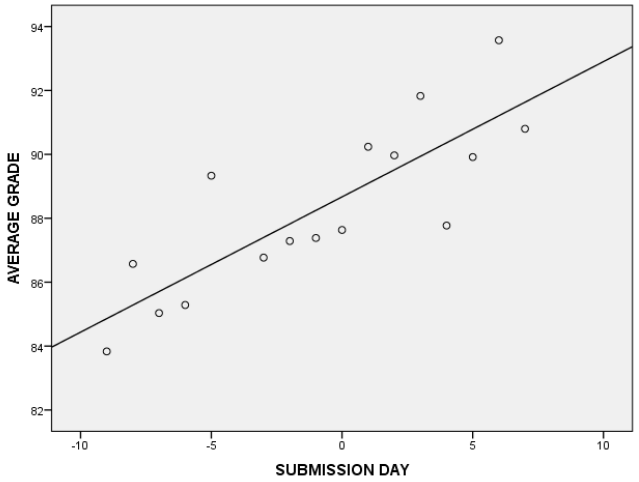
- Very uneven distribution of submissions
- Sumission time is measured by seconds

Transformation of data

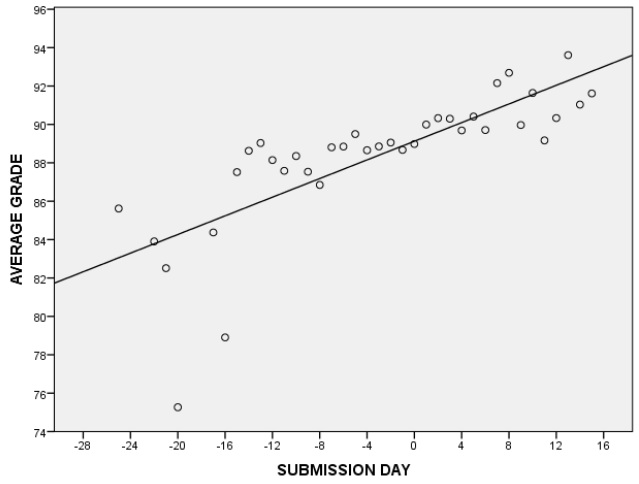
- Exact submission time → Submission day
- Grade → Average grade for each day (≥5 data points)

IS		DE
r	ρ	ρ
0.827	**0.876**	**0.914**

→ **It makes a different how early an assignment is submitted**



IS



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Questions

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