Learning Analytics and Future R&D Opportunities

Stakeholders
- Institutions
- Teachers
- Learners
- Parents

Technologies
- EDM
- RecSys
- Statistical Analysis

Learning Analytics
- Competences
  - Critical thinking
- Constraints
  - Interpretation
  - Privacy
  - Ethics

Objectives
- Reflection
- Prediction

Educational Data
- Open
- Protected

Centres for Learning Sciences and Technologies
Lecture by Hendrik Drachsler at RWTH Aachen, Germany, June 20, 2012
Goals of the lecture

LA Framework  Survey  Findings  Conclusions
A view on Learning Analytics

The Learning Analytics Framework
Learning Analytics

Stakeholders vs. LA Framework

Opinions from the stakeholders toward the dimensions of the LA framework
Extrapolate opinions from different target groups:

(a) what is the current understandings and the expectations on LA

(b) is there a common understanding of LA
Learning Analytics Questionnaire

- 4 weeks available
- 156 people after clean up
- 121 people full records

Participants

- Higher Education: 74.8%
- K-12: 11.0%
- Vocational: 8.4%
- Others: 5.8%
Participants - Roles

- Teachers: 44%
- Researchers: 36%
- L. Designers: 26%
- Managers: 16%
Participants - Reach

Responses from 31 countries [UK (38), US (30), NL (22)]
Stakeholders

data
subjects
data
clients
Stakeholders

(a) who was expected to benefit the most from learning analytics

- Teachers
- Parents
- Institutions
- Learners
Stakeholders

(a) who was expected to benefit the most from learning analytics

Outcomes:
1. Teachers
2. Learners
3. Institutions
4. Parents

- Teachers
- Parents
- Institutions
- Learners
Stakeholders

(b) how much will learning analytics influence bilateral relationships?

- Teachers
- Parents
- Institutions
- Learners
Stakeholders

(b) how much will learning analytics influence bilateral relationships?

Outcomes:
1. Teacher-student 84%
2. Student-teacher 63%
3. Student-student 46%
4. Teacher-teacher 41%
Objectives

Reflection

(Glahn, 2009)
Objectives

Reflection

Prediction

(Glahn, 2009)
Objectives

The importance of 3 generic objectives:

(a) reflection
(b) prediction
(c) unveil hidden information
Objectives

In which way learning analytics will change educational practice in particular areas?

\[ n = 119 \]

- 11% no changes at all
- 43% small changes
- 45% extensive changes
Objectives

In which way learning analytics will change educational practice in particular areas?

- Item 2: Timely information about learning
- Item 8: Better insights by institutions in their courses
- Item 5: Easier grading
- Item 6: Objective assessment
**Educational Data**

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<th>dataTEL</th>
<th>PSLC DataShop</th>
<th>Mulce</th>
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# Educational Data

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<tr>
<td>Learning management system (e.g., Blackboard, Moodle)</td>
<td>111</td>
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<td>Student information system</td>
<td>73</td>
<td>58%</td>
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<td>External services (e.g., Google docs, Facebook, Twitter, slideshare, iTunes U)</td>
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<td>51%</td>
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<td>Intranet</td>
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<td>44%</td>
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<td>Wiki platform</td>
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<td>Social networking platform</td>
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<tr>
<td>E-portfolio system (e.g., Mahara)</td>
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<tr>
<td>Mobile platform (e.g., Apps, e-books)</td>
<td>36</td>
<td>29%</td>
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<tr>
<td>other (please specify)</td>
<td>8</td>
<td>6%</td>
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<tr>
<td>Sensor data (e.g., location data)</td>
<td>5</td>
<td>4%</td>
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**Researcher:**

1. Added context information (n=43, means 3.42)

**Teacher:**

1. Added context information (n=52, means 3.42)

**Manager:**

1. Sharing within the institution (n=16, means 3.63)
2. Anonymisation (n=19, means 3.53)
Technologies

Prediction

Technologies


Technologies

Trust in accurate and appropriate LA results ...

1. View on learning progress
2. Predict learning resource
3. Assessment
4. View on engagement
5. Compare learners
6. Prediction of peers
7. Prediction of learner performance
Constraints

1. Legal protection
2. Privacy
3. Ethics
4. Ownership
Constraints

Effect size of LA on ...

not at all  a little  very much

privacy  ethics  data ownership  data openness  transparency
Competences
Competences

1. E-literacy
2. Interpretation skills
3. Self-directedness
4. Ethical understanding
Competences

1. Numerical skills
2. IT literacy
3. Critical reflection
4. Evaluation skills
5. Ethical thinking
6. Analytical skills
7. Self-directedness
Competences

Item 3: Critical reflection

Item 7: Self-directedness

Item 1: Numerical skills

Item 5: Ethical thinking
Competences

70.2% (n=85) believed that learners were NOT competent enough to independently learn from learning analytics.
Limitations
Limitations

1. Dominance of responses from the HE sector

2. Absence of students

3. Low awareness of LA; Only surveyed innovators and early adopters

4. Mainly opinions from western cultures
Survey summary

Main findings of the survey according to the LA framework
Stakeholders

1. Main beneficiaries of LA are learners and teachers followed by organisations.

2. Biggest benefits would be gained in the teacher-to-student relationship.

3. Learners require teacher support to learn from LA.
1. Main beneficiaries of LA are learners and teachers followed by organisations.

2. Biggest benefits would be gained in the teacher-to-student relationship.

3. Learners require teacher support to learn from LA.
1. Reflection support is main objective from the stakeholders view ...
2. ...by revealing hidden information about learners
1. Reflection support is main objective from the stakeholders view ...
2. ...by revealing hidden information about learners

Reflection support only for teacher student relationship?
1. Context information from learners and the learning process

2. Anonymisation is the second most important data attribute

3. Willingness to share if data is anonymised
1. Context information from learners and the learning process

2. Anonymisation is the second most important data attribute

3. Willingness to share if data is anonymised

Can we achieve a collection of reference datasets?
1. Trust in LA algorithms is not well developed

2. High confidence on gaining a comprehensive view of the learning progress
1. Trust in LA algorithms is not well developed

2. High confidence on gaining a comprehensive view of the learning progress

How accurate can we measure a learning progress?
1. Data ownership is the most important topic

2. LA lead to breaches of privacy but privacy and ethical aspects are of lesser importance

3. Many organisations have ethical boards and guidelines in place
1. Data ownership is the most important topic

2. LA lead to breaches of privacy but privacy and ethical aspects are of lesser importance

3. Many organisations have ethical boards and guidelines in place

Do we need new policies for data ownership and privacy?
1. Skepticism that LA will lead to more independence of learners to control their learning process

2. Training need to guide students to more self-directedness and critical reflection
1. Skepticism that LA will lead to more independence of learners to control their learning process

2. Training need to guide students to more self-directedness and critical reflection

Do we need mandatory courses on statistics for the edu. sector?
Future R&D

picture by Tom Raftery  http://www.flickr.com/photos/traftery/4773457853
10 years of TEL RecSys research in one BOOK

Chapter 1: Background

Chapter 2: TEL context

Chapter 3: Extended survey of 42 RecSys

Chapter 4: Challenges and Outlook

Recommender Systems for Learning

Chapter 1: Background
Chapter 2: TEL context
Chapter 3: Extended survey of 42 RecSys
Chapter 4: Challenges and Outlook

10 years of TEL RecSys research in one BOOK


About this group

This group covers all references of the Springer handbook on 'Recommender Systems for Learning' (RSFL) that will be published in 2012. The group will be further extended by new relevant articles that appear for this fast emerging field. The bibliography of the different chapters are tagged with the following keywords to provide a fast access to the relevant references: RSFL_chapter_1, RSFL_chapter_2, etc. Sign up and feel free to contribute your own relevant publications and references to the community.
## Available TEL datasets

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Recommender Technologies

RECOMMENDER SYSTEMS

Supported Tasks
- Find novel items
- Find peers
- Find good pathways
- Predict learning performance

OPERATION
- Architecture
  - Centralized
  - Distributed
- Location
  - At information source
  - At recommendation server
  - At user side
- Mode
  - Push mode (active)
  - Pull mode (active)
  - Passive mode

APPROACH

USER MODEL
- Representation
  - History-based model
  - Vector-space model
  - Semantic networks
  - Associative networks
  - Classifier-based models
  - User-item ratings matrix
  - Demographic features
  - Ontology
  - Value-focused models
  - Outranking relations
  - Optimization models
  - Disaggregation models
- Generation
  - Initial
    - Empty
    - Manual
    - Stereotyping
    - Training set
    - Heuristic
  - Learning
    - Not necessary
    - Machine learning
    - Clustering
    - Classifiers
    - Dimensionality reduction

DOMAIN MODEL
- Representation
  - Index/List
  - Taxonomy
  - Ontology
- Generation
  - Manual
  - Machine learning
  - Clustering
  - Classifiers
  - Dimensionality reduction

PERSONALIZATION
- Method
  - Raw retrieval
  - Manually selected
  - Stereotype-based
  - Content-based
  - Collaborative filtering
  - Knowledge-based
  - Hybrid
- Algorithm
  - Type
    - Model-based
    - Memory-based
    - Hybrid
    - Case-based
  - Technique
    - Attribute-based
    - Item-to-item
    - User-to-user
    - Hybrid
- Output
  - Suggestion
  - Prediction
  - Ratings
## Analysis according to the framework

### Supported tasks

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## Analysis according to the framework

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### Domain model

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## Analysis according to the framework

### Personalization Approach

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Analysis according to the framework

Supported tasks
- Find Novel Items
- Find Peers
- Find Pathways
- Predict Student Performance
- Most Suitable Learning Environment

Domain model
- Representation
- Generation

User model
- Method
- Vector-space models

Personalization Approach
- Collaborative filtering
- Content-based
- Rule-based
- Hybrid
- Model-based
- Memory-based
- Hybrid
- Attribute-based
- Item-to-item
- User-to-user
- Hybrid
- Vector-space model
TEL RecSys:: Ideal research design

1. A selection of datasets for your RecSys task

2. An offline study of different algorithms on the datasets

3. A comprehensive controlled user study to test psychological, pedagogical and technical aspects

4. Rollout of the RecSys in real-life scenarios
TEL RecSys:: Open issues

1. Evaluation
2. Datasets
3. Context
4. Visualization
5. Virtualization
6. Privacy
Addressing the issues:: **LinkedUP**

### Network of supporting organisations
*(see 3.2 Spreading excellence, exploiting results, disseminating knowledge)*

#### 3 stages of the LinkedUp competition

**Stage 1 - Initialisation**
- Lowest requirements level for participation
- Initial prototypes and mockups, use of data testbed required
- 10 to 20 projects are expected

**Stage 2**
- Medium requirements level for participation
- Working prototypes, minimum amount of data sources, clear target user group
- 5 to 10 projects are expected

**Stage 3**
- Deployment in real-world use cases
- Sustainable technologies, reaching out to critical amount of users
- 3 to 5 projects are expected

#### Participation criteria

**LinkedUp Challenge Environment**
- LinkedUp Evaluation Framework
- Methods and Test Cases
- LinkedUp Data Testbed
- Competitor ranking list

**LinkedUp Support Actions**
- Dissemination (events, training)
- Data sharing initiatives
- Community building & clustering
- Technology transfer
- Cashprice awards & consulting
Addressing the issues: LinkedUP

Network of supporting organisations
(see 3.2 Spreading excellence, exploiting results)

Stage 1 - Initialisation

Stage 2
- Lowest requirements level for participation
- Initial prototypes and mockups, use of data testbed required
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Stage 3
- Medium requirements level for participation
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- 5 to 10 projects are expected

Stage 4
- Deployment in real-world use cases
- Sustainable technologies, reaching out to critical amount of users
- 3 to 5 projects are expected

LinkedUP Challenge Environment
- LinkedUP Evaluation Framework
- Methods and Test Cases
- LinkedUP Data Testbed
- Competitor ranking

Become part of the LinkedUP network and win up to 15000 Euros, attendance at international workshops and conferences
Addressing the issues:

**LinkedUP**

**Evaluation Framework**

**Domain (education) aspects (DEA)**
- **DEA.1** Effectiveness of learning (e.g., higher skill level, or grades)
- **DEA.2** Efficiency of learning (e.g., less study time for equal outcomes)
- **DEA.3** Attractiveness of learning (e.g., increases motivation or offers new insights by combining data sources)

**Technical aspects (TA)**
- **TA.1** Data coverage (e.g., amount of used data sources, size of dataset, data quality)
- **TA.2** Scalability (e.g., possibility to scale up to large datasets and add new data sources)
- **TA.3** Performance (e.g., response time, amount of bugs)
- **TA.4** Accuracy (e.g., information retrieval measures like Precision, Recall, F1)

**Usability aspects (UA)**
- **UA.1** Understandability (e.g., difficulty of logical, or navigation concept)
- **UA.2** Learnability (e.g., effort to get used to a new software)
- **UA.3** Collaboration patterns (e.g., connection to social networks and other user information)

**Deployment aspects (DA)**
- **DA.1** User scenario (e.g., matching to LinkedUp vision and project target group)
- **DA.2** Reach (e.g., number of target domains and users)
- **DA.3** Privacy (e.g., privacy regulations or user agreements)
- **DA.4** Multi-linguality (e.g., number of supported languages, access to data in other languages)
Development of the Evaluation Framework

P1: Initialisation
M0-M6: Preparation

P2: Establishment and Evaluation
M7-M18: Competition cycle

P3: Exit and Sustainability
M18-M24: Finalising

EF proposal
Expert validation

Draft
Competition

Review of EF

New version
Refinement of EF

Final release of EF

Documentation Dissemination

Literature review Cognitive Mapping

Group Concept Mapping

Practical experiences and refinement

Stefan Dietze 25/05/12
Group Concept Mapping

- Group Concept Mapping resembles the Post-it notes problem solving technique and Delphi method.
- GCM involves participants in a few simple activities (generating, sorting and rating of ideas) that most people are used to.

**GCM is different in two substantial ways:**
1. Robust analysis (MDS and HCA)
   GCM takes up the original participants contribution and then quantitatively aggregate it to show their collective view (as thematic clusters).

2. Visualisation
   GCM presents the results from the analysis as conceptual maps and other graphical representations (pattern matching and go-zones).
Example: EU FP7 Handover

- 105 criteria about accurate handover training interventions
- Sorting on **similarity in meaning**
- Rating on **importance and feasibility**
A point map
Group Concept Mapping

A cluster map
A group concept map: shows all the specific ideas about a particular topic. indicates how ideas are related to other ideas. identifies groups of ideas (clusters) under more general categories. indicates how much emphasis should be placed on a particular idea or cluster.
Rating Map importance

Cluster Legend
Layer Value
1 3.57 to 3.63
2 3.63 to 3.70
3 3.70 to 3.76
4 3.76 to 3.82
5 3.82 to 3.88
Rating Map feasibility

Cluster Legend
Layer Value
1 3.12 to 3.27
2 3.27 to 3.43
3 3.43 to 3.59
4 3.59 to 3.74
5 3.74 to 3.89
Practical experiences and refinement

- Competitions
- Review of EF
- Refinement of EF
- New version
- Draft

3x
Many Thanks::Questions?

This presentation is available at: slideshare.com/Drachsler

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Supporting projects: