CAN DATA AND ANALYTICS SUPPORT LEARNING (AND TEACHING)

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Learning analytics evolved from the increased opportunities to collect and make use of data about learning and learning contexts

(Gašević, Jovanović, Pardo, & Dawson, 2017)
Recent research in learning analytics, however, recognises the significance of building upon educational theory in order to enable the use of advanced machine learning methods for modelling behavioural, cognitive, and social processes associated with learning.

(Dawson, Drachsler, Rosé, Gašević, & Lynch, 2016)
Very little research to date has addressed the understanding of learning in analytics approaches.

Learning involves a stable and persisting change in what a person knows and is able to do - the processes that result in learning (learning activities) can be and often are distinguished from the products of learning (learning outcomes).

Identify the potential to yield more productive insights into learning, teaching and the learning environment.
Promising learning analytics applications are being developed which use learner generated data and other relevant information in order to personalise and continuously adapt the learning environment

(Long & Siemens, 2011)
Benefits from learning analytics include three perspectives: summative, real-time, and predictive (Ifenthaler, 2015)
<table>
<thead>
<tr>
<th>Summative</th>
<th>Real-time</th>
<th>Predictive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Governance</strong></td>
<td><strong>Organisation</strong></td>
<td><strong>Learning design</strong></td>
</tr>
<tr>
<td>• Apply cross-institutional comparisons</td>
<td>• Analyse processes</td>
<td>• Analyse pedagogical models</td>
</tr>
<tr>
<td>• Develop benchmarks</td>
<td>• Optimise resource allocation</td>
<td>• Measure impact of interventions</td>
</tr>
<tr>
<td>• Inform policy making</td>
<td>• Meet institutional standards</td>
<td>• Increase quality of curriculum</td>
</tr>
<tr>
<td>• Inform quality assurance processes</td>
<td>• Compare units across programs and faculties</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Teacher</strong></td>
</tr>
<tr>
<td></td>
<td>• Analyse processes</td>
<td>• Compare learners, cohorts and courses</td>
</tr>
<tr>
<td></td>
<td>• Monitor processes</td>
<td>• Analyse teaching practices</td>
</tr>
<tr>
<td></td>
<td>• Evaluate resources</td>
<td>• Increase quality of teaching</td>
</tr>
<tr>
<td></td>
<td>• Track enrolments</td>
<td>• Understand learning habits</td>
</tr>
<tr>
<td></td>
<td>• Analyse performance</td>
<td>• Compare learning paths</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Analyse learning outcomes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Track progress towards goals</td>
</tr>
<tr>
<td><strong>Student</strong></td>
<td><strong>Learning design</strong></td>
<td><strong>Teacher</strong></td>
</tr>
<tr>
<td>• Increase productivity</td>
<td>• Monitor learning progression</td>
<td>• Identify learners at risk</td>
</tr>
<tr>
<td>• Apply rapid response to critical incidents</td>
<td>• Create meaningful interventions</td>
<td>• Forecast learning progression</td>
</tr>
<tr>
<td>• Analyse performance</td>
<td>• Increase interaction</td>
<td>• Plan interventions</td>
</tr>
<tr>
<td></td>
<td>• Monitor learning progression</td>
<td>• Modify content to meet cohorts’ needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Student</strong></td>
</tr>
<tr>
<td></td>
<td>• Receive automated interventions and scaffolds</td>
<td>• Optimise learning paths</td>
</tr>
<tr>
<td></td>
<td>• Take assessments including just-in-time feedback</td>
<td>• Adapt to recommendations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase engagement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase success rates</td>
</tr>
</tbody>
</table>

(Ifenthaler, 2015)
The implementation of a learning analytics system requires specialised staff and technological capabilities
(d’Aquín, Dietze, Herder, Drachsler, & Taibi, 2014)
Capabilities deficit. (Ifenthaler, 2017)
(So far) no wide-scale organisational implementation of learning analytics exist
Basic reporting

Reporting dashboard

Cross-system data integration

Predictive capabilities

Adaptive and personalised learning

Sharing of data
Readiness assessment

- Organisational readiness
  - Policies
  - Practice
- Technical readiness
  - System implementation
  - Data warehouse
- Staff readiness
  - Analytics
  - Data management

Create implementation strategy

Sustainable solutions

Policies

Data management

System implementation

Practice

Learning design

Data warehouse

Analysts

(Roll & Ifenthaler, 2017)
Challenges for establishing learning analytics systems are the interaction and fragmentation of information as well as their contextual idiosyncrasies.

(Gašević, Dawson, Rogers, & Gašević, 2016)
Table 1. Student profile – comparison of institutions predicting pass/fail rates

<table>
<thead>
<tr>
<th>Institution</th>
<th>N</th>
<th>$R^2$</th>
<th>Adjusted $R^2$</th>
<th>$R^2$-SVR</th>
<th>Predictive accuracy (SVM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNI1</td>
<td>244494</td>
<td>0.4635</td>
<td><strong>0.4633</strong>*</td>
<td>0.4889</td>
<td><strong>0.817</strong></td>
</tr>
<tr>
<td>UNI2</td>
<td>217039</td>
<td>0.4528</td>
<td><strong>0.4526</strong>*</td>
<td>0.4603</td>
<td>0.796</td>
</tr>
<tr>
<td>UNI3</td>
<td>127218</td>
<td>0.431</td>
<td><strong>0.4306</strong>*</td>
<td>0.4595</td>
<td>0.796</td>
</tr>
<tr>
<td>UNI4</td>
<td>114432</td>
<td>0.372</td>
<td><strong>0.3716</strong>*</td>
<td>0.3807</td>
<td>0.766</td>
</tr>
<tr>
<td>UNI5</td>
<td>88026</td>
<td>0.4379</td>
<td><strong>0.4374</strong>*</td>
<td>0.4430</td>
<td>0.807</td>
</tr>
<tr>
<td>UNI6</td>
<td>84510</td>
<td>0.3641</td>
<td><strong>0.3635</strong>*</td>
<td>0.3530</td>
<td><strong>0.763</strong></td>
</tr>
<tr>
<td>UNI7</td>
<td>76278</td>
<td>0.434</td>
<td><strong>0.4334</strong>*</td>
<td>0.4604</td>
<td>0.803</td>
</tr>
<tr>
<td>UNI8</td>
<td>73043</td>
<td>0.3718</td>
<td><strong>0.3711</strong>*</td>
<td>0.3562</td>
<td>0.783</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td></td>
<td>0.096</td>
<td>0.097</td>
<td>0.126</td>
<td>0.024</td>
</tr>
</tbody>
</table>

Note. * $p < .05$, ** $p < .01$, *** $p < .001$  

(Ifenthaler & Widanapathirana, 2014)
Table 2. Student profile – comparison of areas of study predicting pass/fail rates

<table>
<thead>
<tr>
<th>Areas of study</th>
<th>$N$</th>
<th>$R^2$</th>
<th>Adjusted $R^2$</th>
<th>$R^2$-SVR</th>
<th>Predictive accuracy (SVM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts &amp; Humanities</td>
<td>386059</td>
<td>0.4299</td>
<td>0.4297</td>
<td>0.45039</td>
<td>0.799</td>
</tr>
<tr>
<td>Business</td>
<td>269410</td>
<td>0.4054</td>
<td>0.4053</td>
<td>0.4360</td>
<td>0.780</td>
</tr>
<tr>
<td>Education</td>
<td>157693</td>
<td>0.4887</td>
<td>0.4885</td>
<td>0.5049</td>
<td>0.824</td>
</tr>
<tr>
<td>Law &amp; Justice</td>
<td>84663</td>
<td>0.4900</td>
<td><strong>0.4896</strong></td>
<td>0.5166</td>
<td><strong>0.827</strong></td>
</tr>
<tr>
<td>IT</td>
<td>57371</td>
<td>0.3732</td>
<td><strong>0.3726</strong></td>
<td>0.3586</td>
<td><strong>0.776</strong></td>
</tr>
<tr>
<td>Science &amp; Engineering</td>
<td>57234</td>
<td>0.4228</td>
<td>0.422</td>
<td>0.4234</td>
<td>0.800</td>
</tr>
<tr>
<td>$SD$</td>
<td></td>
<td>0.107</td>
<td>0.107</td>
<td>0.129</td>
<td>0.027</td>
</tr>
</tbody>
</table>

*Note. * $p < .05$, ** $p < .01$, *** $p < .001$*
Table 3. Learning profile - change of predictors (pass/fail) over the semester (16 weeks)

<table>
<thead>
<tr>
<th></th>
<th>Week 1-4</th>
<th>Week 5-8</th>
<th>Week 9-12</th>
<th>Week 13-16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adjusted $R^2$</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course A</td>
<td>0.4673</td>
<td>0.7613</td>
<td>0.8366</td>
<td>0.8592</td>
</tr>
<tr>
<td>Course B</td>
<td>0.4971</td>
<td>0.7572</td>
<td>0.8206</td>
<td>0.8359</td>
</tr>
<tr>
<td>Combined</td>
<td>0.4880***</td>
<td>0.7593***</td>
<td><strong>0.8273</strong>*</td>
<td><strong>0.8439</strong>*</td>
</tr>
<tr>
<td><strong>$R^2$-SVR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course A</td>
<td>0.4972</td>
<td>0.7571</td>
<td>0.8403</td>
<td>0.8563</td>
</tr>
<tr>
<td>Course B</td>
<td>0.5423</td>
<td>0.7856</td>
<td>0.8449</td>
<td>0.869</td>
</tr>
<tr>
<td>Combined</td>
<td>0.5284</td>
<td>0.7841</td>
<td>0.8602</td>
<td>0.8777</td>
</tr>
<tr>
<td><strong>Predictive accuracy (SVM)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course A</td>
<td>0.7498</td>
<td>0.8754</td>
<td>0.9326</td>
<td>0.9467</td>
</tr>
<tr>
<td>Course B</td>
<td>0.7694</td>
<td>0.8807</td>
<td>0.9351</td>
<td>0.9433</td>
</tr>
<tr>
<td>Combined</td>
<td>0.7644</td>
<td><strong>0.8879</strong></td>
<td><strong>0.9383</strong></td>
<td><strong>0.9463</strong></td>
</tr>
</tbody>
</table>

(Ifenthaler & Widanapathirana, 2014)
If the underlying learning analytics algorithms do not have access to the required information, benefits for learning and teaching cannot be produced.
Information required for learning analytics

Maximizing factors

Concern over privacy

Minimizing factors

Expected benefits

Decision

Sharing of information

(Ifenthaler & Schumacher, 2016)
Sharing of data.

(Ifenthaler & Schumacher, 2016)
To a large extend, students are the producers of data used in learning analytics systems, however, passive recipients of information provided in dashboards  
(Pardo & Siemens, 2014)
Learning analytics dashboards with features for students are still on an initial level and therewith the research on learning analytics features and students’ expectations

(Sclater, Peasgood, & Mullan, 2016)
Research needs to expand analytics methodology to combine self-reported data sources with those derived from trace data

(Gašević, Jovanović, Pardo, & Dawson, 2017)
Learning Analytics.

Very little research to date has addressed the understanding of learning in analytics approaches.

Learning Processes.

Learning involves a stable and persisting change in what a person knows and is able to do - the processes that result in learning (learning activities) can be and often are distinguished from the products of learning (learning outcomes).

Moving forward.

Identify the potential to yield more productive insights into learning, teaching and the learning environment.
(Ifenthaler, 2010)
(Eseryel, Law, Ifenthaler, Ge, & Miller, 2014)
Cognitive dimension

- Structural component
  - Domain-specific knowledge
  - Strategic knowledge

- Processual component
  - Information processing
  - Target goal setting

Metacognitive dimension

- Structural component
  - Knowledge of cognition
  - Task knowledge

- Processual component
  - Planning
  - Monitoring
  - Evaluation

Motivational dimension

- Structural component
  - Interest
  - Beliefs
  - Competence

- Processual component
  - Affective processes
  - Volitional strategies

(Lehrmann, Hähnlein, & Ifenthaler, 2014)
(Schumacher & Ifenthaler, 2017, adopted form Schmitz, 2001)
Students expect learning analytics features to support their learning processes and to provide recommendations to plan their learning activities

(Schumacher & Ifenthaler, 2017)
“That the system considers my personal schedule. I wouldn’t mind if the system knows ‘watching soccer with friends at 9 p.m.’ and advices me to work for another hour.” (interviewee 4)

“If the system would recognise other students dealing with the same content and suggests to connect to each other for exchanging ideas and for testing or even meeting in person.” (interviewee 20)

“... connected to my smartphone for receiving prompts ‘you haven’t done anything the last three days, how about starting now?’ Might be problematic for persons who are not able to learn under pressure, for me it would be great.” (interviewee 6)

“That exercises are offered for self-monitoring and that I am learning during the semester instead of delaying it to the end of the semester.” (interviewee 14)

“... that the dashboard contains all programs available and everyone can arrange his own dashboard functions and structure... and that I can choose a wallpaper.” (interviewee 6)

(Schumacher & Ifenthaler, 2017)
01 Learning history.  
02 Activity time.  
03 Recommendation.  
04 Goal setting.  
05 Study buddy.  
06 Self assessment.  
07 Content rating.  
08 Visual signals.  
09 Newsfeed.  
10 Study planer.  
11 Feedback.  

(Schumacher & Ifenthaler, 2017)
Very little research to date has addressed the understanding of learning in analytics approaches.

Learning involves a stable and persisting change in what a person knows and is able to do - the processes that result in learning (learning activities) can be and often are distinguished from the products of learning (learning outcomes).

Identify the potential to yield more productive insights into learning, teaching and the learning environment.
CURRICULUM
Requirements
Learning design
Sequencing
Learning objectives
Learning outcomes
Assessment
Evaluation

LEARNING ANALYTICS ENGINE
Pedagogical theories
Data mining
Structured data
Unstructured data
Natural language processing
Algorithms
Validation
Comparison
Patterns
Prediction

INSTITUTION
Strategies

LEARNER CHARACTERISTICS
Interest
Prior knowledge
Academic performance
Standardised inventories
Competencies
Socio-demographic data
Social media preferences
Learning strategies

TEACHER CHARACTERISTICS
Domain knowledge
Beliefs
Learning philosophies
Classroom management
Ability grouping
Learning support

ONLINE LEARNING ENVIRONMENT
Learning path & time
Interaction data
Content navigation
Discussion activity
Assessment
Performance
Ratings
Satisfaction

PERSONALISATION AND ADAPTATION ENGINE
Visualisation
Prompts
Scaffolding
Feedback
Recommendation
Gamification

REPORTING ENGINE
Dashboard
Heatmap
Statistics and graphs
Automated report

LEARNING DESIGN
Sequencing
Learning objectives
Evaluation

GOVERNANCE
Decision-making

(Ifenthaler, 2013, 2015)
There remains a gap in connecting how data traces and analytics of digital behaviour relate to individual learning processes.
Evaluation 01

Welcome to the new prompting feature.

How do you evaluate the access to your learning materials? (1="very good", 5="very bad")

1 2 3 4 5

Ok

(Schön & Ifenthaler, under review)
Student engagement and success does not arise by chance

(Tinto, 2009)
● 01 October 2017: Proposal due including title, abstract, keywords
● 15 October 2017: Notification and additional information for accepted authors
● 01 March 2018: Draft chapters due
● 01 April 2018: Chapters returned with reviewers’ comments
● 01 May 2018: Final chapters due

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