Learning Analytics for ‘end-users’:
from Human-centred Design to Multimodal Data Storytelling

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Acknowledgement of country

I would like to acknowledge the Traditional Owners of the land on which I am today, the Yalukit Willam clan of the Boon Wurrung People, and the Traditional Owners of the land where you all are at the moment.

I would like us to pay our respects to their Elders past, present and emerging. We acknowledge and respect their continuing relationship to the lands upon which we meet.
The power of storytelling

“We dream in narrative, daydream in narrative, remember, anticipate, hope, despair, believe, doubt, plan, revise, criticize, construct, gossip, learn, hate and love by narrative” Barbara Hardy - (1968, 5)
Storytelling in Journalism

Educators can adjust online classes to fit learning styles

Published April 15, 2020
By Shavana De La Rosa
Contributor, K-12

Dive Brief:
- Educators must balance many learning preferences as students adjust to online learning, which will be a good fit for some and difficult for others. District Administration reports. Some students will struggle

University Guide 2022
Online learning

How has the pandemic changed the way you’ll learn?

As students gradually return to campus, many universities will be offering blended learning - mixing face-to-face lectures with the best of digital teaching

The 2022 league table

Rachel Hall
@rachela_hall
Sat, 11 Sep 2021 21:00 AEST

Many universities are shifting large lectures online because they believe it's a better way for students to learn. Photograph: Martin Doherty/Getty Images

person teaching to motivate you and to meet new people? Some universities are offering a variety of options to suit different learning styles and personal circumstances.
Storytelling in Academia

[Diagram comparing Drama structure to Scientific paper structure]

Data-driven Storytelling

“data-driven storytelling is the ability to turn raw data into easy-to-read and easy-to-understand plain stories that help us turn insights into action”
Dashboards are **not** delivering their promises

**Students** find it difficult to interpret/act on data to improve learning (Bodily & Verbert, 2017; Jivet et al., 2018; Matcha et al., 2019; Valle et al., 2021)

….and the same applies to **teachers** (Mangaroska & Giannakos, 2018).

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Bodily, R., & Verbert, K. (2017). Trends and issues in student-facing learning analytics reporting systems research. LAK’17


Mangaroska, K., & Giannakos, M. N. (2018). Learning analytics for learning design: A systematic literature review of analytics-driven design to enhance learning. IEEE TLT
The Learning Analytics “loop”
The Learning Analytics “loop”

“User” (Learner) <<Interaction>> Digital devices
The Learning Analytics “loop”
The Learning Analytics “loop”

“User” (Learner)

<<Interaction>>

<<Dashboard>>

Digital devices

Data

Analytics
The Learning Analytics “loop”
The **ideal** Learning Analytics “loop”

- **Educators**
- **“User” (Learner)**
- **“Other users” (Learners)**

<<Dashboard>>

<<Interaction>>

**Digital devices**

**Data**

**Analytics**
The real Learning Analytics situation

Motivations
Feelings
Dispositions

Human
The real Learning Analytics situation

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

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The real Learning Analytics situation

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<<Interaction>>

Human

Peers
The real Learning Analytics situation

<<Interaction>>

Educators

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The real Learning Analytics situation

Educators
- Motivations
- Feelings
- Dispositions
- Personal issues
- Trauma
- World views

Human

Peers

Learning design
- Epistemic design
- Set design
- Social design
The real learning Analytics situation

Do students/educators have a problem that can be addressed using their data?
The real learning Analytics situation

Situation

Educators

Motivations
Feelings
Dispositions
Personal issues
Trauma
World views

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Data

Meaning
The real Learning Analytics situation

Educators
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Situation
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Interaction

Analytics
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- Meaning
The real Learning Analytics situation

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The real Learning Analytics situation

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  - Social design

**Stories**
- Data
- Meaning

**Analytics**
“Humans think in stories rather than in facts, numbers or equations ....

Yuval Noah Harari
Outline

- Human centredness
- Multimodality
- Storytelling
What is human-centredness?
From a learning analytics perspective...

**Human centredness** has been identified in other fields as a characteristic of systems that have been carefully designed by:
- identifying the **critical stakeholders**,
- their **relationships**, and
- the **contexts** in which those systems will function

User-centred design

User-centred design

User-centred design

An emancipatory perspective for Learning Analytics?

“Learners are not to be seen as passive beneficiaries of a superior control entity. With respect to software adaptations, if Learning Analytics has to play a role, it should be limited to one of awareness and recommendation.”

User-centred design

Co-creation (co-design)

“Human-centred design is concerned less with assuring that artifacts work as intended (by their producers, designers, or other cultural authorities) than with enabling many individual or cultural conceptions to unfold into uninterrupted interfaces with technology.”

Klaus Krippendorff

Design Thinking in Learning Analytics

“What aspects of the classroom or the learning activity happening in the classroom you would like to make more visible?”
Understand

Learner-data journey mapping

Design Thinking in Learning Analytics

Co-design techniques to elicit student and educator perspectives (e.g. “Teacher Superpowers”, and “Learning/Data Journey mapping” *)

LA-Deck: LA design cards

Design Thinking (link) in Learning Analytics

Co-Designing a Real-Time Classroom Orchestration Tool to Support Teacher–AI Complementarity

Kenneth Holstein, Bruce M. McLaren, and Vincent Aleven
Deliver

Testing the same prototypes with

Students

Teachers
Design Thinking in Learning Analytics

What about DBR?
DBR + Design thinking

Outline

- Human centredness
- Multimodality
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The **real** Learning Analytics situation

- Educators
- Human
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<<Interaction>>
Multimodality in Learning Analytics

“Multimodal data is used in recognition of the plurality of ways that students may demonstrate or communicate knowledge, interests and intent”

Worsley et al. 2021
“The goal of MMLA is to support learning experiences that may be collaborative, hands-on, and face-to-face, **de-emphasizing the computer screen** as the primary form or object of interaction”

Worsley et al. 2021
Resulting multi-channel **data streams**

Physiological wristbands
Audio data

Audio devices
Positioning data

Localisation sensors
### Action log data

<table>
<thead>
<tr>
<th>Timestamp</th>
<th>User</th>
<th>Action</th>
</tr>
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<td>Leader</td>
<td>Connect oximeter</td>
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<tr>
<td>01:00</td>
<td>Nurse 2</td>
<td>Prepare medication</td>
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<tr>
<td>01:20</td>
<td>Nurse 3</td>
<td>Check vital signs</td>
</tr>
<tr>
<td>01:55</td>
<td>Leader</td>
<td>Provide medication</td>
</tr>
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<td>02:01</td>
<td>Nurse 2</td>
<td>Connect IV device</td>
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<td>02:04</td>
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<td>Log actions</td>
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<tr>
<td>02:32</td>
<td>Nurse 2</td>
<td>Check vital signs</td>
</tr>
</tbody>
</table>
Inductive step with teachers
Deductive step: filling the holes from theory
Multimodal Matrix: overview

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dimensions of collaboration

Echeverria, V. 2020 Designing Feedback for Collocated Teams using Multimodal Learning Analytics. PhD thesis
Multimodal Matrix: overview

dimensions of collaboration

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stanzas

03:22.0
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03:22.3

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<td>RN1.speaking</td>
<td>RN1.EDA_peak</td>
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<td>RN1.next_to_patient</td>
<td>RN2.ventilations</td>
<td>RN2.speaking</td>
<td>RN2.EDA_peak</td>
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<td>RN1.around_patient</td>
<td>RN1.compressions</td>
<td>patient.speaking</td>
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<tr>
<td>RN1.bed_head</td>
<td>RN1.compressions</td>
<td>RN1.listening</td>
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<td>RN1.trolley_area</td>
<td>RN1.compressions</td>
<td>RN2.listening</td>
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<td>RN1.physical_intensity</td>
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Time:

- 03:22.0
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Stanzas:

- Task Phase 1
- Task Phase 2

Multimodal observations
## Multimodal Matrix: overview

**Dimensions of collaboration**

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### Stanza

- Task Phase 1
- Task Phase 2

### Segment
Mapping from **positional Codes** to digital codes in the Multimodal Matrix

**Machine coding**

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Classifying raw accelerometer data

→ low/medium/high physical activity

Machine coding
Thresholding raw EDA traces to focus on what’s interesting: EDA peaks + low physical activity
Observers (e.g. researchers or students) use a tablet-based annotation tool to log **key actions**.
Working towards automatically identifying who is speaking and listening/sec.

Machine coding
Outline

- Human centredness
- Multimodality
- Storytelling
What is **data storytelling**?

An information *compression* technique for communicating *insights* to an audience through the combination of *data, visuals, and narrative*

Brent Dykes. 2015. Data storytelling: What it is and how it can be used to effectively communicate analysis results. Applied Marketing Analytics. 1, 4, 299-313.
We want to move from this.....

Survey results: summer learning program on science

**PRE: How do you feel about doing science?**
- Bored: 19%
- Not great: 11%
- OK: 40%
- Kind of interested: 25%
- Excited: 5%

**POST: How do you feel about doing science?**
- Bored: 12%
- Not great: 6%
- OK: 38%
- Kind of interested: 14%
- Excited: 30%
...towards data stories like this...

**Pilot program was a success**

**How do you feel about science?**

BEFORE program, the majority of children felt just OK about science.

AFTER program, more children were Kind of interested & Excited about science.

![Graph showing changes in student feeling about science before and after the pilot program](image)

Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).
Pilot program was a success

How do you feel about science?

BEFORE program, the majority of children felt just OK about science.

11% Bored  12% Not great  40% OK

25% Kind of interested  30% Excited  14%

AFTER program, more children were Kind of interested & Excited about science.

Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).
... or identifying the indicators that may be most useful to make decisions...

Pilot program was a success

After the pilot program,

68%

of kids expressed interest towards science, compared to 44% going into the program.

Based on survey of 100 students conducted before and after pilot program (100% response rate on both surveys).
Layered data storytelling prototype
Put to the test with nursing students
Select the critical incidents by clicking on the buttons below.
You performed the first vital signs check after the handover.

After the patient complains of **chest tightness** it is very important to assess his/her vital signs

Here, you missed assessing the vital signs of the patient after the patient experience **chest tightness**
RN1 stopped the medication less than 5 minutes after patient’s adverse reaction.

Well done! After chest tightness and erythematous rash you stopped the IV Fluid.

You administered IV Fluid Antibiotic.

Vital Signs Assessment

Administer and Stop IV Antibiotic

Perform ECG

Call the doctor

Arousal
It is recommended to **perform an ECG** after the patient complains of chest tightness.
RN1, RN3 and RNL presented several arousal peaks throughout the simulation. RN2 presented a few arousal peaks.
A report as a data storytelling channel

Narrative + Visuals

Hello Ms. Kerrington,

I noticed that most of your students completed Step 1.4 which has the maximum number of attempts feature, so I've analyzed the log data from that step.

Learning goal: Step 1.4 targets MS-ESS3-5 and the stability and change CCC. Students need to be able to recognize the scale of the timeline and interpret the graphical data.

Take a look at global temperature over Earth’s past.

Answered correctly on the first attempt
- Period 1 - 46% (6/13)
- Period 2 - 79% (11/14)
- Period 3 - 75% (9/12)

How many multiple attempts were needed (by workgroup)?
- 2 attempts were needed by those who didn’t answer correctly on the first attempt.

What was the most common incorrect answer on the first attempt?
- Most students chose “It was ALWAYS MUCH COLDER than today”
- Students who followed a different pattern, by period:
  - Period 1
    - 397583, 397597 - It was ALWAYS MUCH WARMER than today, then answered correctly.
  - Period 2
    - 397640 - It was ALWAYS THE SAME temperature as today, then chose the correct answer
  - Period 3 (all followed primary pattern)

Researcher Insight: This suggests that students’ prior knowledge that current global temperatures are the highest they have been in recent history is overriding their analysis of the actual data presented in the timeline of Earth’s history.

A navigation slideshow as a data storytelling channel

Visuals + Narrative + Navigation

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Take away message 1: Human-centred design

A human-centred approach is critical in the design of any educational technology...
A human-centred approach is critical in the design of any educational technology...

...but even **more critical** to navigate the disruptions and potential risks triggered by the rapid development of AI, Data Analytics and surveillance tools.
Take away message 2: Multimodality

A call for embracing multimodality...

...not with the purpose of adding sensors to the learning spaces but to embrace the complexity of learning and human interaction.
Take away message 3: **Data Storytelling**

“Humans think in **stories** rather than in facts, numbers or equations ....

Yuval Noah Harari
Humans think in stories rather than in facts, numbers or equations .... and the simpler the story, the better

Take away message 3: Data Storytelling
Thanks!