



SoLAR Webinar, 6th August, 2019

Learning Analytics as Educational Knowledge Infrastructure

Simon Buckingham Shum

University of Technology Sydney
Professor of Learning Informatics
Director, Connected Intelligence Centre

@sbuckshum • <http://cic.uts.edu.au>

<http://Simon.BuckinghamShum.net>





Deep acknowledgements to the team whose joint work has shaped my thinking...

<https://cic.uts.edu.au/about/people>



Simon Knight
Lecturer



Ágnes Sándor
Honorary Associate



Shibani Antonette
Lecturer



Radhika Mogarkar
Applications Developer



Andrew Gibson
Research Fellow
(Reflective Writing Analytics)



Kirsty Kitto
Senior Lecturer
(Data Science)



Carlos Prieto
PhD Student
(Learning Analytics)



Gabrielle Gardiner
Senior Manager



Sophie Abel
PhD Student



Roberto Maldonado
Martinez
Research Fellow
(Educational Data Science)



Vanessa Echeverria
Barzola
PhD Student



Ming Liu
Research Fellow
(Educational Data Science)

An extraordinary sensor, modelling and prediction infrastructure



“infrastructure”

educational
infrastructure
we can trust?

ethically and scientifically

People are literally on the streets protesting against AI in education

We need trust-building conversations for an informed dialogue. A luddite rebellion won't help anyone...



7:15 PM - 26 Apr 2019

<https://twitter.com/AGavrielatos/status/1121704316069236739>

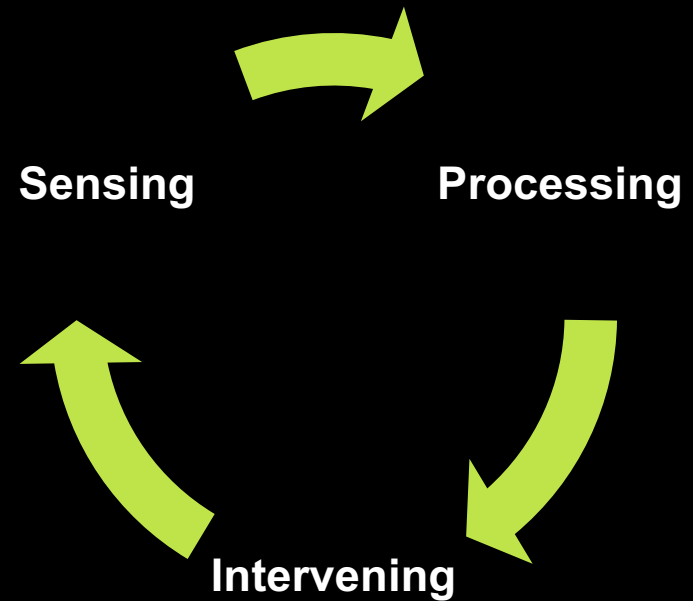
Proposition for today:

We're now in a transitional phase — we're laying foundations for the next

educational
knowledge
infrastructure



Machines see the world through
computational models
analysing new forms and volumes of digital data





If we are tracking **learner activity** through the lens of data / analytics / AI we better have a very good idea...

how those lenses are cut

who cut them, for whom

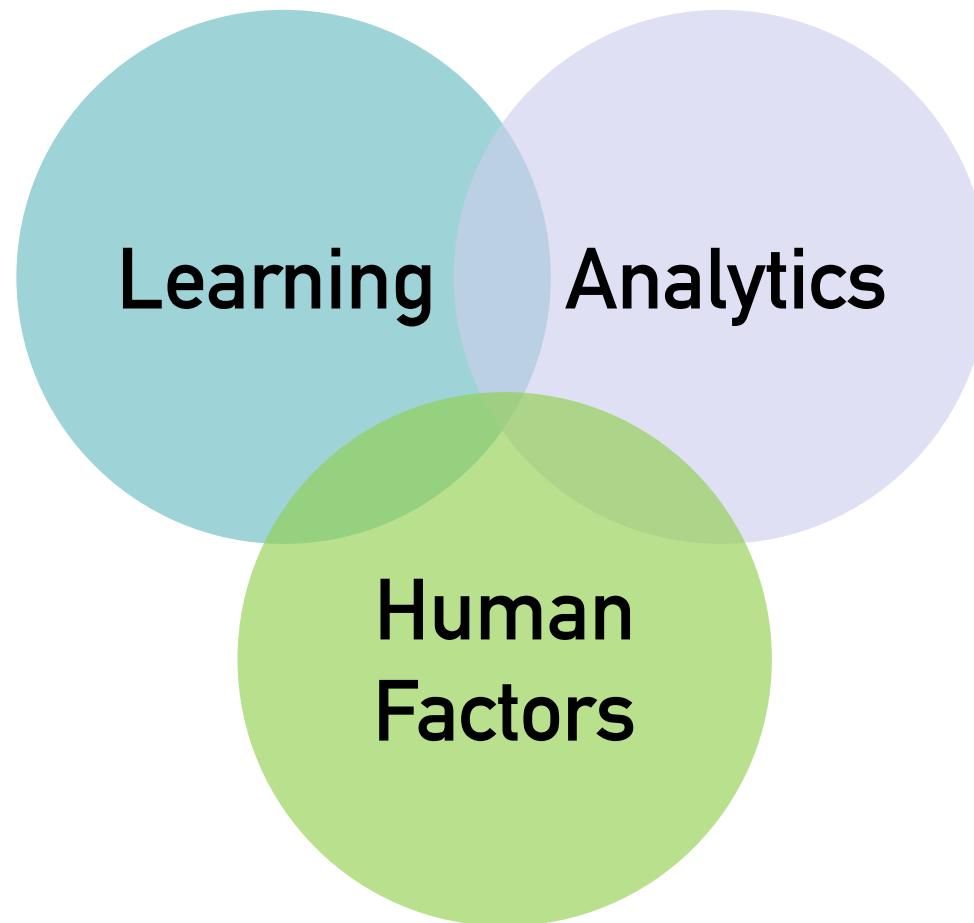
how they distort the view

We need

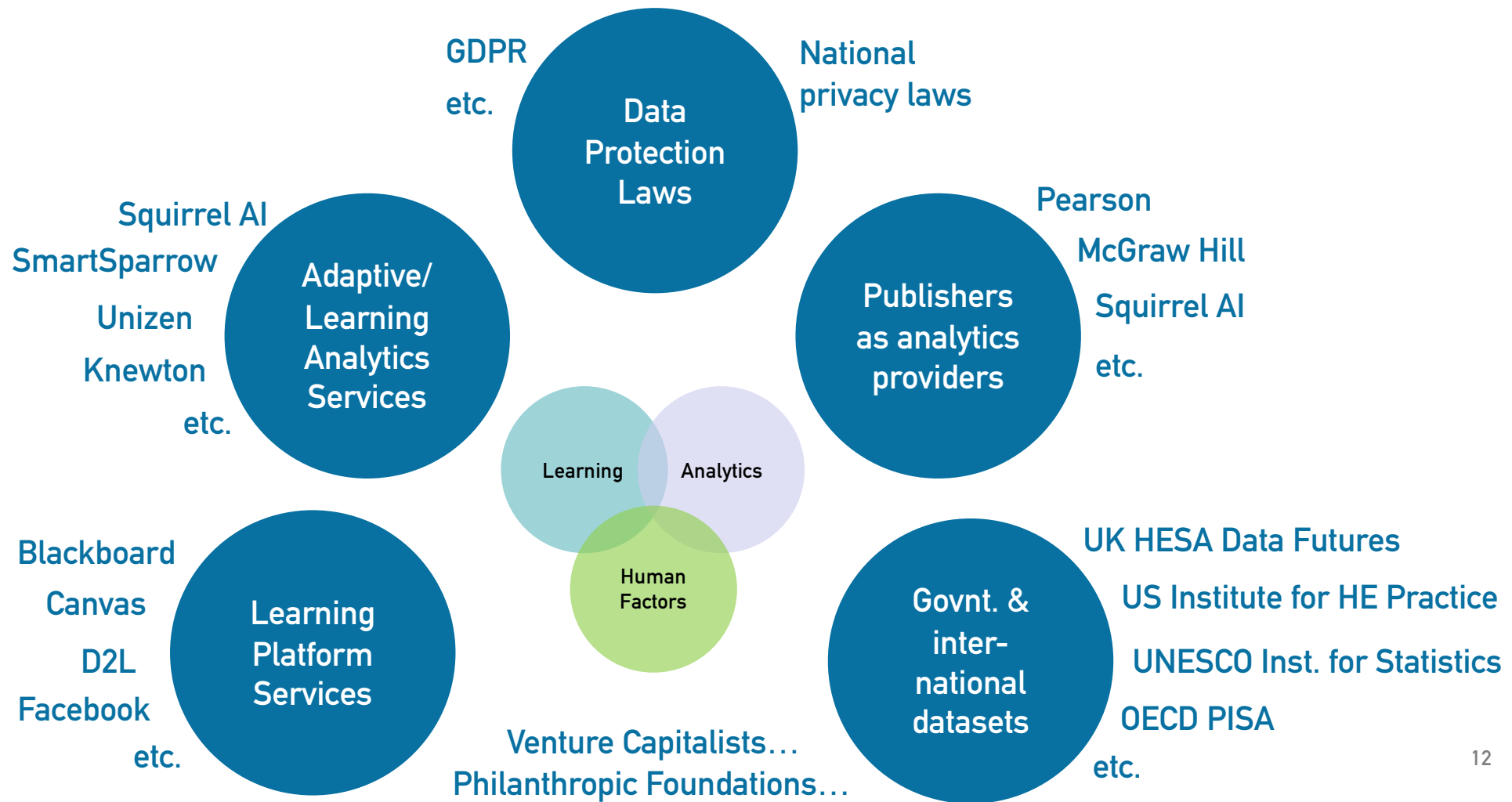
wholistic (systemic, human-centred)

lenses to design, monitor and evaluate
data-intensive educational infrastructure.

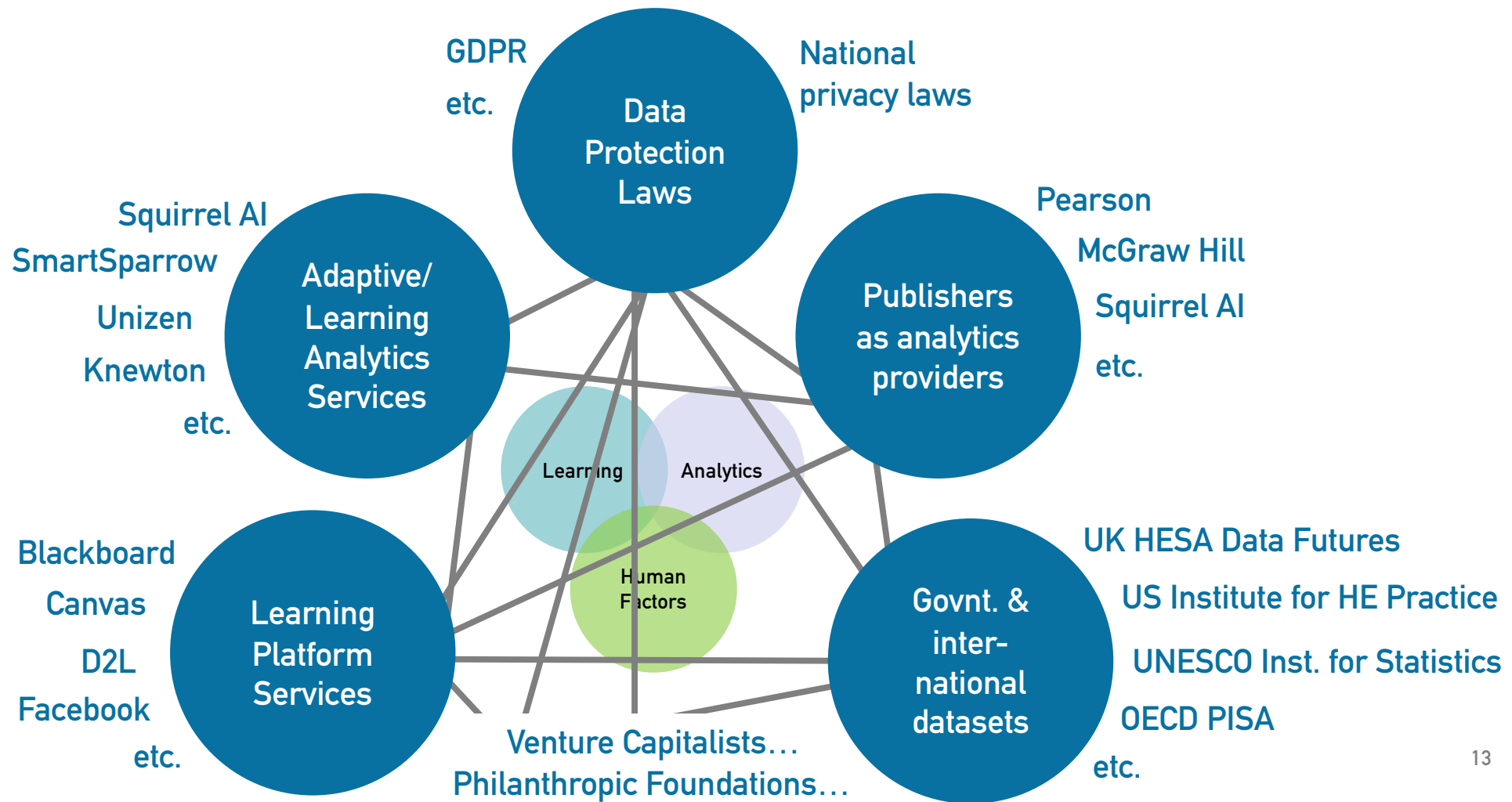
Learning Analytics: A Human-Centred Design Discipline



A rapidly changing educational data/analytics ecosystem...



A rapidly changing educational data/analytics ecosystem...

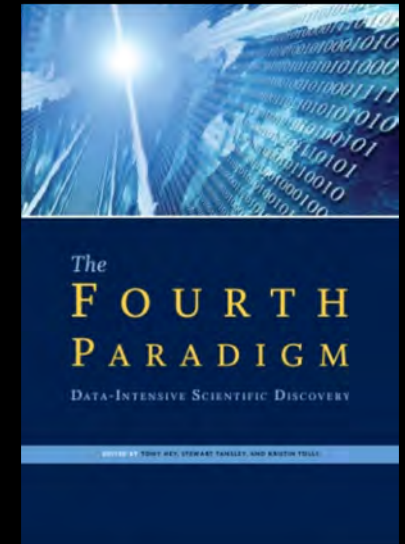


Expand from...

“The Fourth Paradigm”

a Computer Science vision of how research is building on the
Empirical, Theoretical and Computational paradigms
moving into a **Data-Intensive** paradigm

<https://www.microsoft.com/en-us/research/publication/fourth-paradigm-data-intensive-scientific-discovery>



To see the wider systems...

“Knowledge Infrastructures”

a critical lens on how **human+technical systems** in science
interoperate to **construct, share, contest and sanction knowledge**

<http://hdl.handle.net/2027.42/97552>

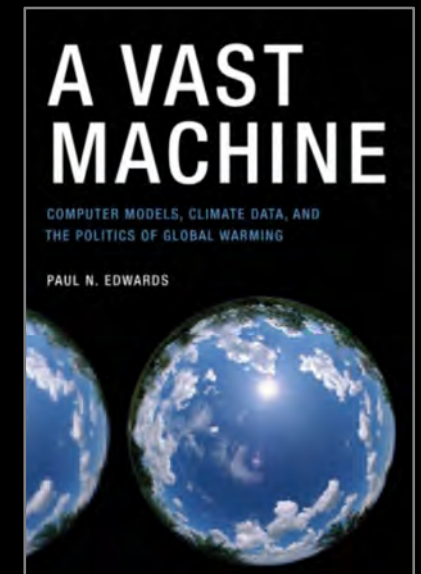


e.g. Paul Edwards on...

climate science

How do **global data, models, visualisations, science and politics** combine to produce knowledge about the past, present and future, and how do they handle uncertainty?

<https://mitpress.mit.edu/books/vast-machine>



That's what a knowledge infrastructure looks like after nearly 200 years' evolution

“Computer Models, Climate Data, and the Politics of Global Warming”

“Computer Models, Learning Data, and the Politics of Education” ...??

“Knowledge Infrastructures”

“robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds.”

Routine, well-functioning knowledge systems include the world weather forecast infrastructure, the Centers for Disease Control, or the Intergovernmental Panel on Climate Change — individuals, organizations, routines, shared norms, and practices.

“Knowledge Infrastructures”


“Infrastructures are not systems, in the sense of fully coherent, deliberately engineered, end-to-end processes.

...ecologies or complex adaptive systems [...] made to interoperate by means of standards, socket layers, social practices, norms, and individual behaviors.”

“Knowledge Infrastructures”

“Infrastructures are not systems, in the sense of fully coherent, deliberately engineered, end-to-end processes.

...ecologies or complex adaptive systems [...] made to interoperate by means of standards, socket layers, social practices, norms, and individual behaviors.”



I think we can see the educational ecosystem here

“Knowledge Infrastructures”

“I intend the notion of knowledge infrastructure to signal parallels with other infrastructures [...] Yet this is no mere analogy [...]

Get rid of infrastructure and you are left with claims you can't back up, facts you can't verify, comprehension you can't share, and data you can't trust.” (p.19)

“Knowledge Infrastructures”

...perform 3 key functions...



Monitoring



Modelling



Memory

Knowledge Infrastructure concepts

metadata friction

“People long ago observed climate and weather for their own reasons, within the knowledge frameworks of their times.

You would like to use what they observed — not as they used it, but in new ways, with more precise, more powerful tools.

[...]

So you dig into the history of data. **You fight metadata friction, the difficulty of recovering contextual knowledge about old records.”**

(p.xvii)

Knowledge Infrastructure concepts

metadata friction

cf. Reanalysis of educational data
(your own and others') using
computational methods

“People long ago observed climate and weather for their own reasons within the knowledge frameworks of their times.

You would like to use what they observed — not as they used it, but in new ways, with more precise, more powerful tools.

[...]

So you dig into the history of data. You fight metadata friction, the difficulty of recovering contextual knowledge about old records.”

(p.xvii)

Knowledge Infrastructure concepts

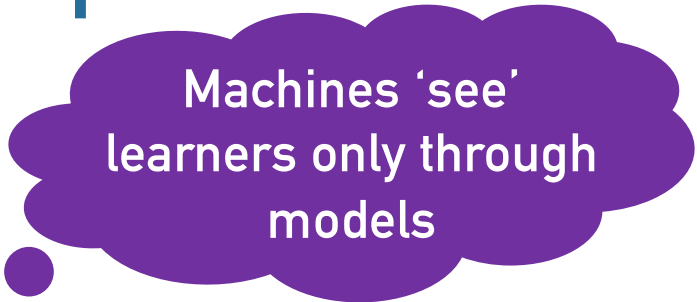
Models, models, models...

“Everything we know about the world’s climate — past, present, and future — we know through models.” (p.xiv)

“I’m not talking about the difference between “raw” and “cooked” data. I mean this literally. Today, no collection of signals or observations [...] becomes global in time and space without first passing through a series of data models.” (p.xiii)

Knowledge Infrastructure concepts

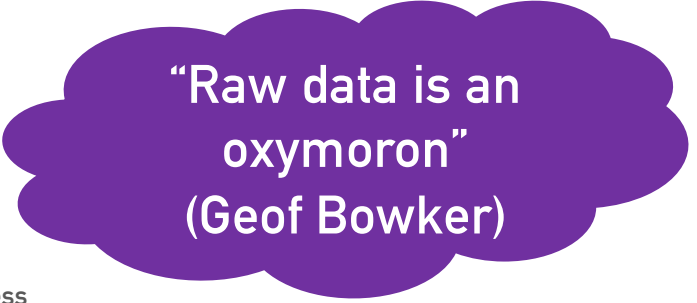
Models, models, models...



Machines 'see'
learners only through
models

“Everything we know about the world’s climate — past, present, and future — we know through models.” (p.xiv)

Today, no collection of signals or observations [...] becomes global in time and space without first passing through a series of data models.” (p.xiii)



“Raw data is an
oxymoron”
(Geof Bowker)

Knowledge Infrastructure concepts

infrastructural inversion

“The climate knowledge infrastructure never disappears from view, because it functions by infrastructural inversion: continual self-interrogation, examining and reexamining its own past. The black box of climate history is never closed.”

Knowledge Infrastructure concepts

infrastructural inversion

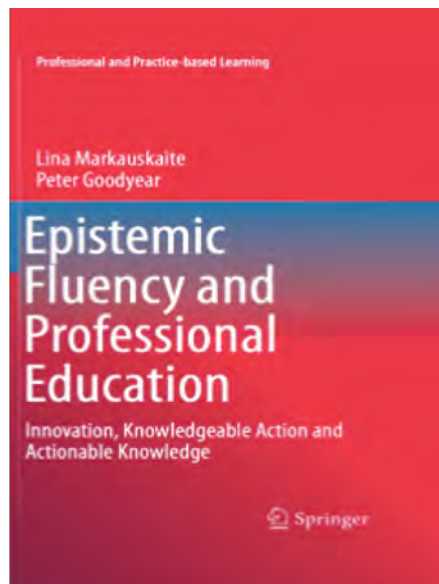
“The climate knowledge infrastructure never disappears from view, because it functions by infrastructural inversion: continual self-interrogation, examining and reexamining its own past. The black box of climate history is never closed.”

We must keep lifting the lid on learning analytics infrastructures

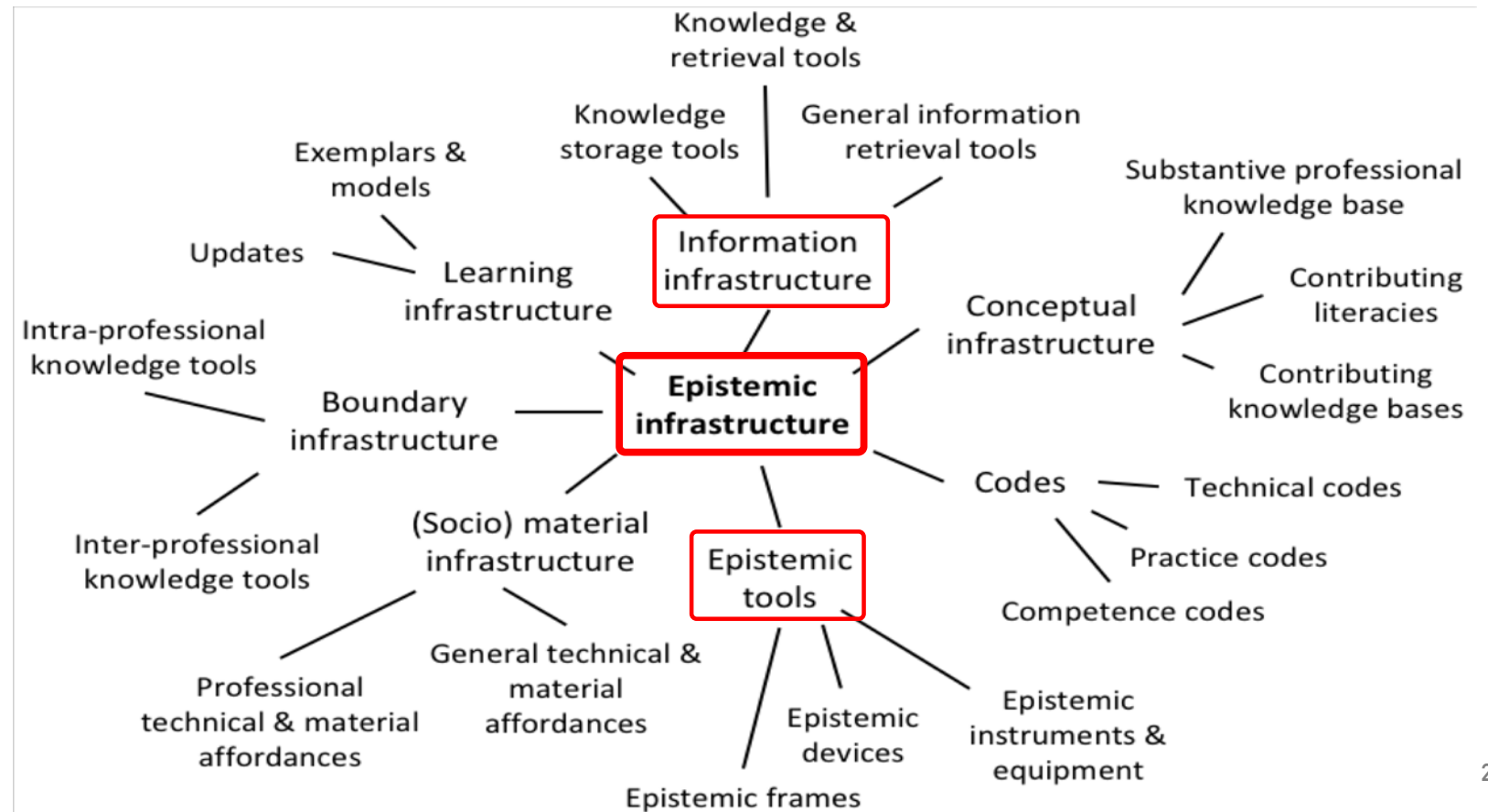
We must equip learners and educators to engage critically with such tools

Epistemic Infrastructure taxonomy for professional knowledge

Partic contributions at the “Micro-KI” level: how professionals construct their EI



Markauskaite, L. & Goodyear, P. (2017). *Epistemic Fluency and Professional Education: Innovation, Knowledgeable Action and Actionable Knowledge* (Springer, 2017), p.376



In what senses might Learning Analytics constitute,
or at least contribute to, an emerging

knowledge
infrastructure
?

In what senses might Learning Analytics constitute, or at least contribute to, an emerging KI?

1

KI concepts seem to apply to critical perspectives on LA

2

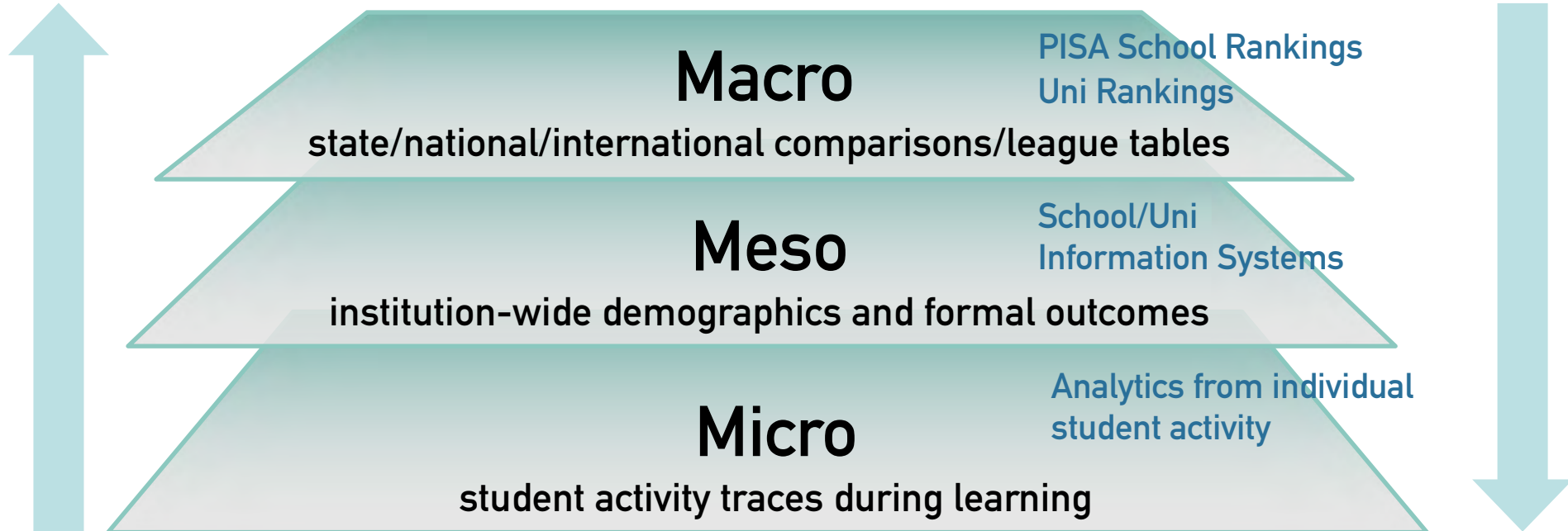
LA is starting to display KI properties at different levels of the system

LA is only 10 years old, and there's much to do. But knowing what functioning KIs look like could help us prioritise.

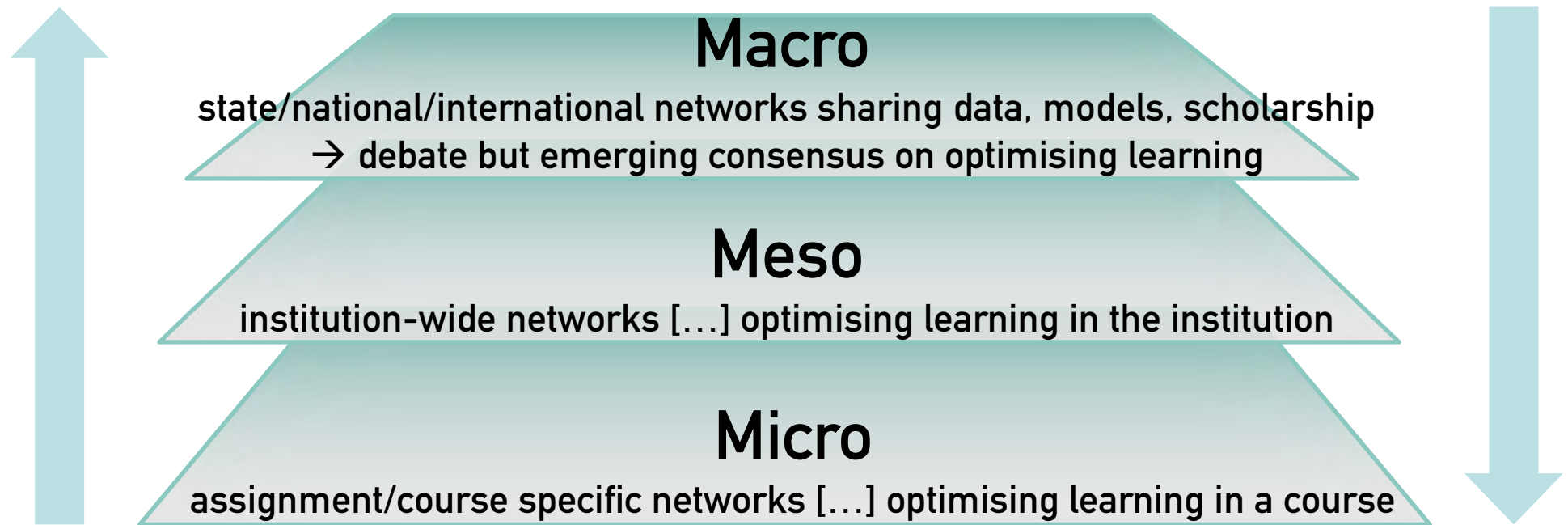
Macro/Meso/Micro Learning Analytics

Aggregation of user traces enriches meso + macro analytics with finer-grained process data

Breadth + depth from macro + meso levels add power to micro analytics



Macro/Meso/Micro Educational KI





If Learning Analytics were Climate Science...

Trusted data sources *

Validated models *

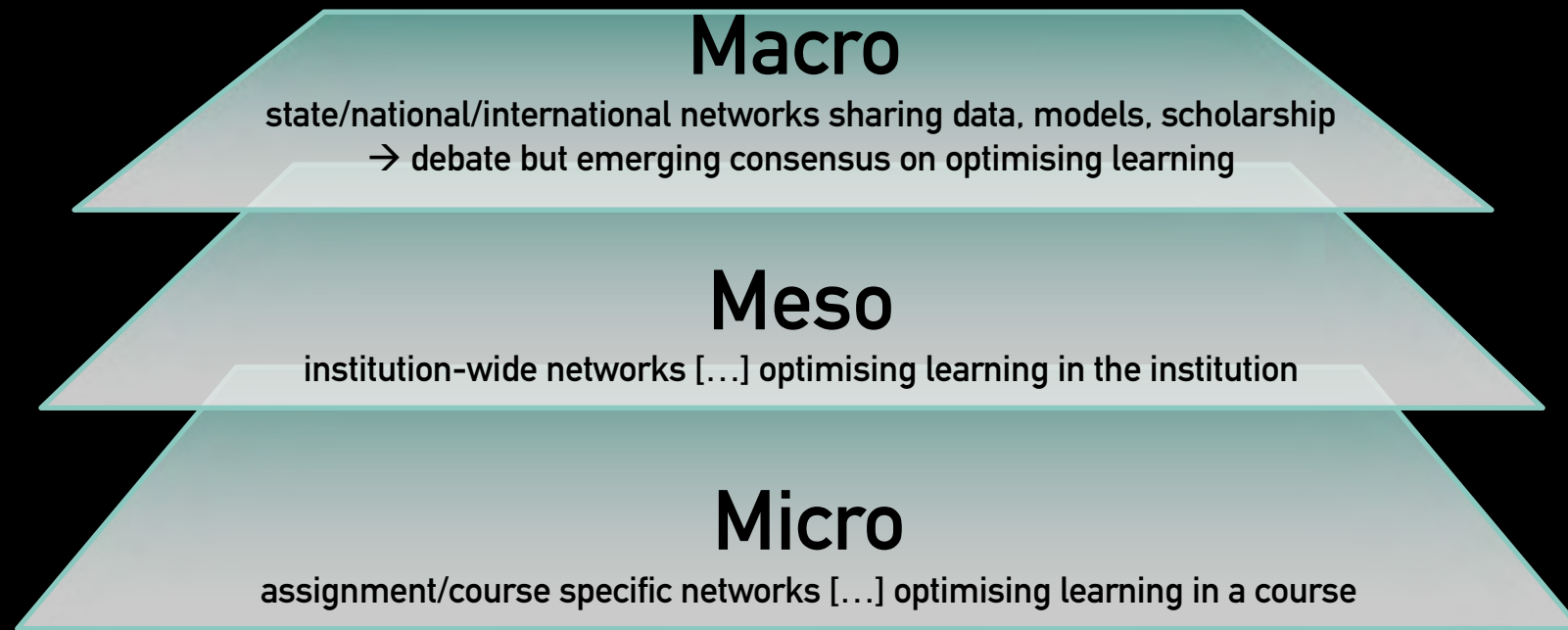
Interoperable data flows and models *

Established research methodologies *

Government policy held accountable to international
scientific consensus *

* all under rigorous scholarly review and debate

If the challenge is to build education's KI, what are the practical implications for LA?



Accountability: ground models in educ. research + learning sciences

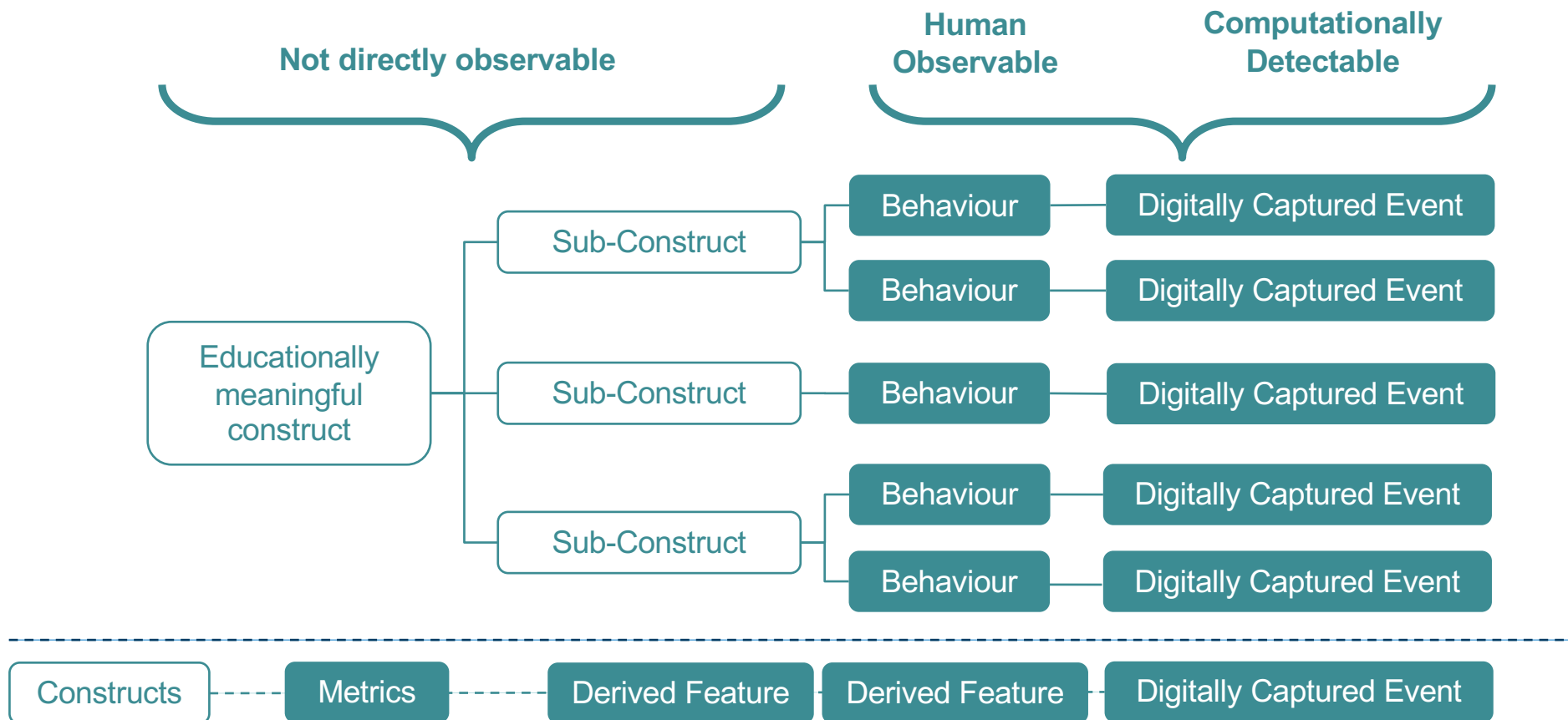
Impact policy + practice: make the evidence base accessible

Share models (and data?) Climate data \neq Learner data

Macro

state/national/international networks sharing data, models, scholarship
→ debate but emerging consensus on optimising learning

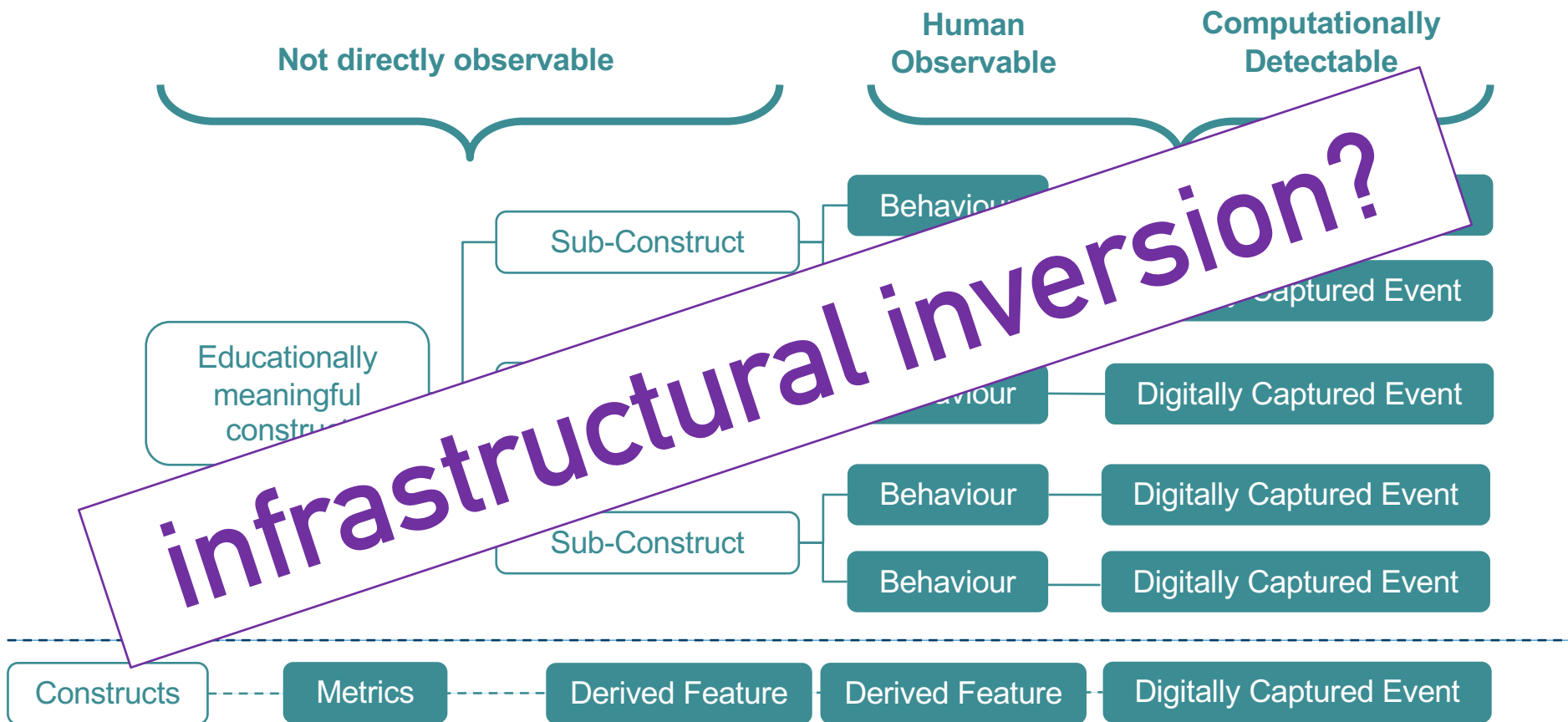
Ground models in learning sciences + educ. research



Adapted from: Wise, A., Knight, S., Buckingham Shum, S. (In Press) Collaborative Learning Analytics. In: Cress, U., Rosé C., Wise A., & Oshima, J. (Eds.) *International Handbook of Computer-Supported Collaborative Learning*. Springer

See also: Buckingham Shum, S. (2016). *Envisioning C21 Learning Analytics*. Keynote Address, LASI-Asia, Seoul. <https://cic.uts.edu.au/lasi-asia-keynote2016>

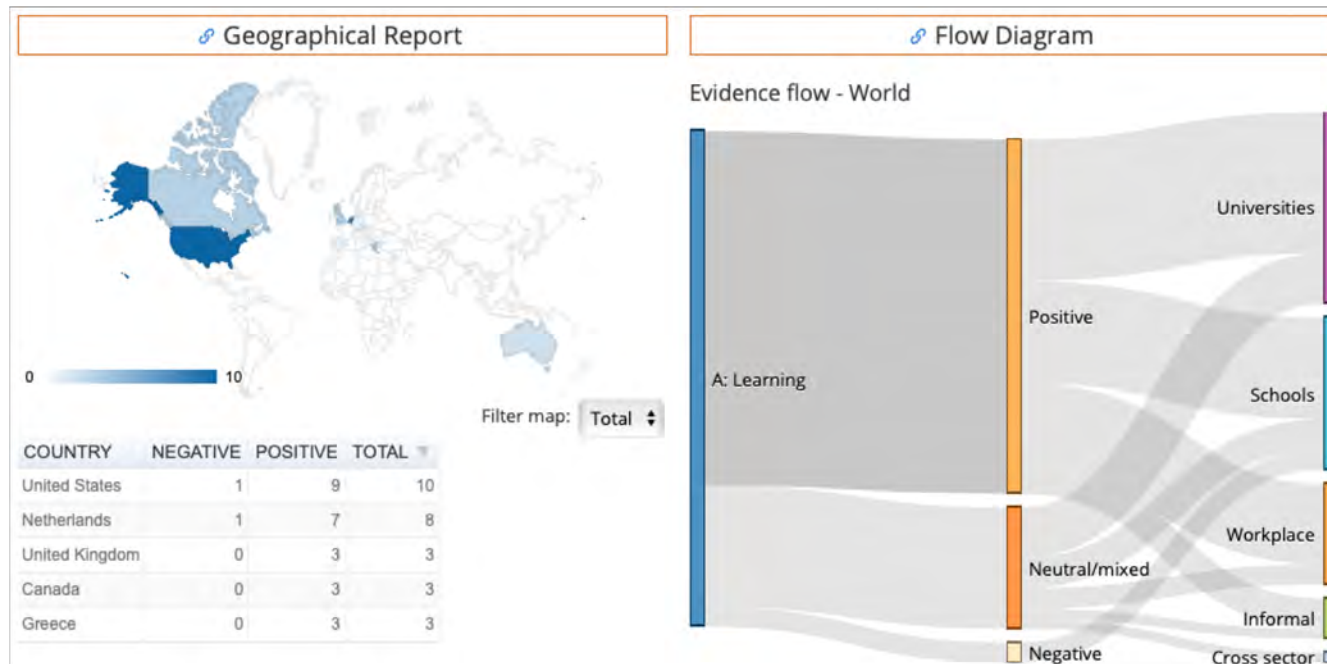
Ground models in learning sciences + educ. research



Adapted from: Wise, A., Knight, S., Buckingham Shum, S. (In Press) Collaborative Learning Analytics. In: Cress, U., Rosé C., Wise A., & Oshima, J. (Eds.) *International Handbook of Computer-Supported Collaborative Learning*. Springer

See also: Buckingham Shum, S. (2016). *Envisioning C21 Learning Analytics*. Keynote Address, LASI-Asia, Seoul. <https://cic.uts.edu.au/lasi-asia-keynote2016>

Impact policy + practice: make the evidence base accessible



<http://evidence.laceproject.eu>

In principle, as variation reduces (e.g. timescale, geography, methodology), so do the KI challenges. So MACRO to MESO should help simplify the KI.

But institutions still have long histories

Institutional data and knowledge are still notoriously slippery to curate

And institutionalized teaching practices slow to change

“data management”

“progressive pedagogy”

“knowledge management”

“authentic assessment”

Meso

institution-wide networks [...] optimising learning in the institution

**Nonetheless, it's at the MESO + MICRO layers
where LA can really add to KI**

**Enable data flows
Tune analytics for the institution's specific needs
Co-design with stakeholders**



Meso

institution-wide networks [...] optimising learning in the institution

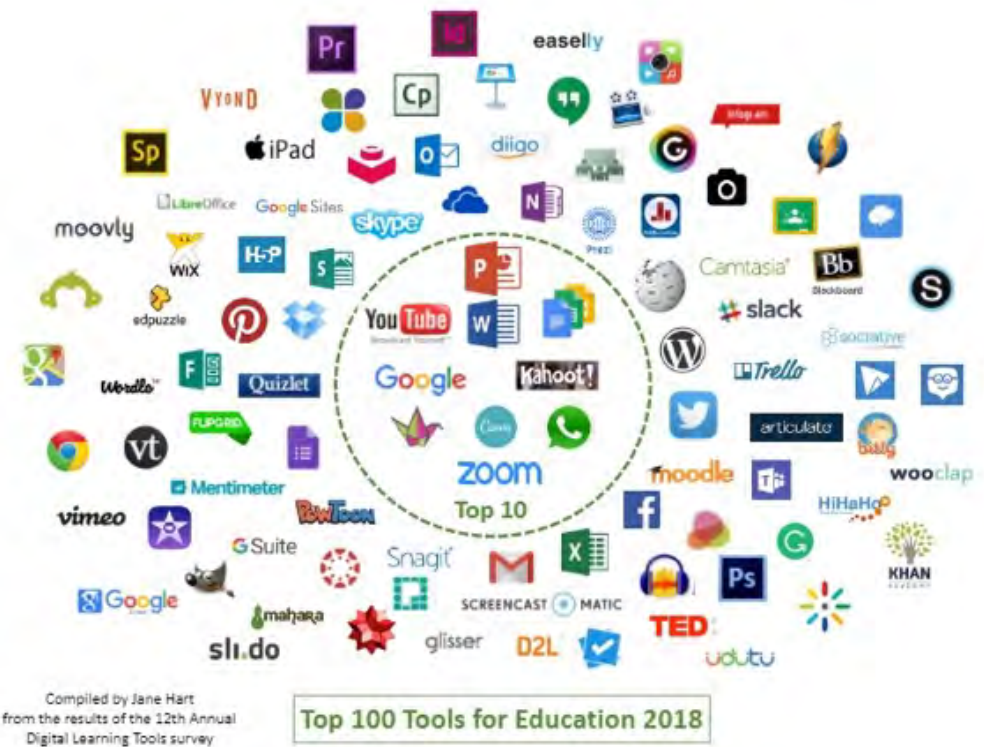
Micro

assignment/course specific networks [...] optimising learning in a course

Envisioning the learning ecosystem beyond the LMS, in the wild

“How are we going to deliver
LA over that type of
complexity?”

Kirsty Kitto: Designing Learning Analytics Ecosystems (LASI 2019)
<https://www.beyondlms.org/blog/LASIworkshop>



Towards LA data flows over an emergent ecosystem: LA-API infrastructure designed for huge diversity in data + analytics

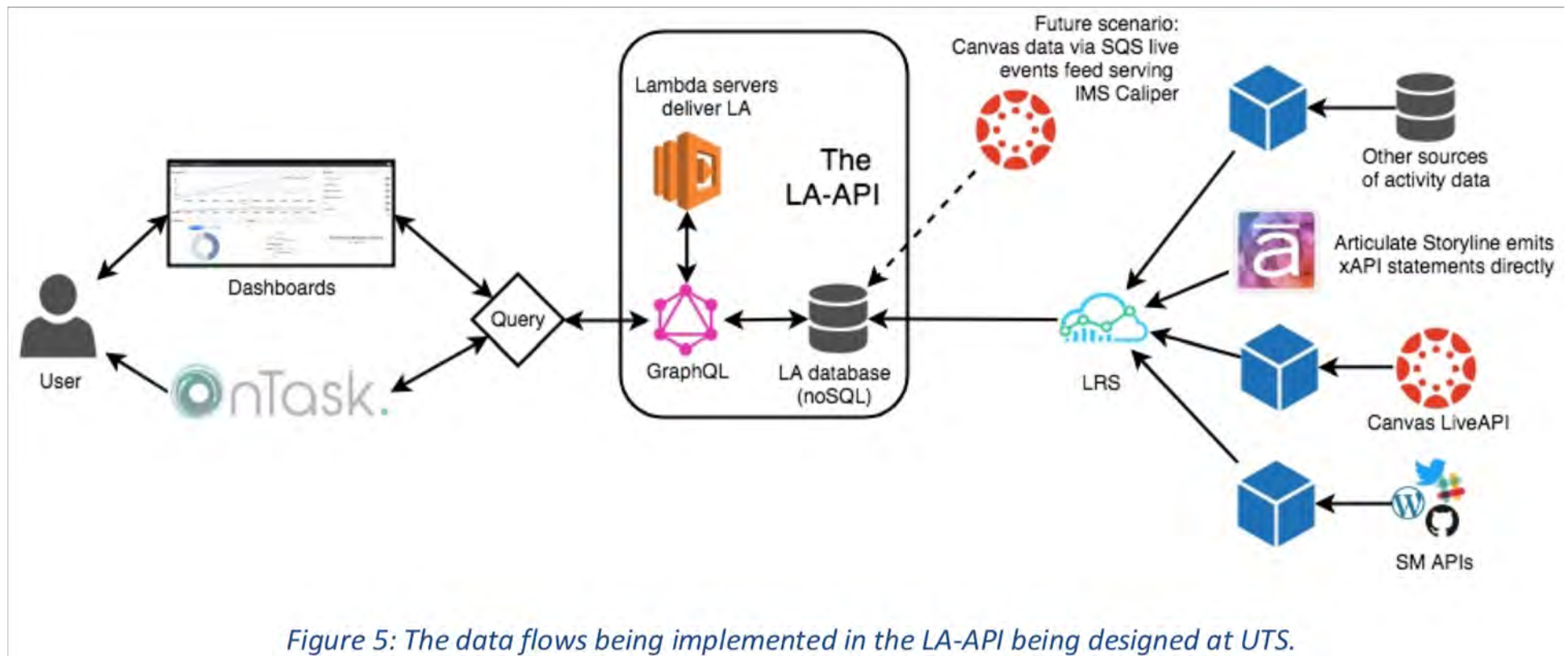


Figure 5: The data flows being implemented in the LA-API being designed at UTS.

generalisable models without sacrificing context-sensitivity

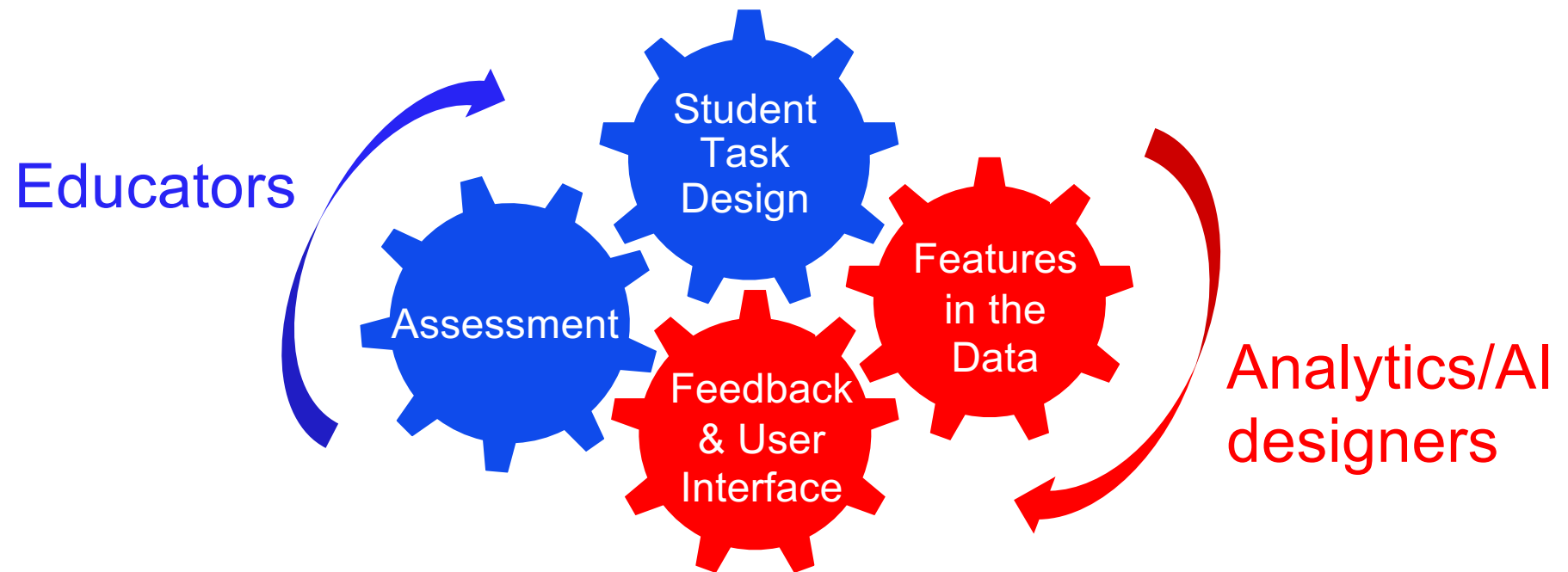
Meso

institution-wide networks [...] optimising learning in the institution

Micro

assignment/course specific networks [...] optimising learning in a course

Framework @UTS for educators to **co-design** Analytics/AI → **augment teaching practice**



AcaWriter feedback tuned for Civil Law



NOTE: Computers don't understand writing like humans. So, AcaWriter may highlight rhetorically good sentences that actually make no sense, or leave un-highlighted a sentence that you feel is really good. It's fine to disagree with the feedback — but it's also your job to check your facts!

Analytical Report	Feedback	Examples
<p>The analytical report highlights salient rhetorical moves AcaWriter identified in your essay for reflection. For more specific feedback, go to the Feedback tab.</p> <h3>Rhetorical Moves</h3> <ul style="list-style-type: none">S Summarises or signals the authors goalsP Perspective or stanceE Emphasis to highlight key ideasN Novel improvements in ideasC Contrasting idea, tension or critical insightB Background information and previous workS Surprising or unexpected findingQ Question or gap in previous knowledgeT Trend or tendency related to ideas		
<p>Technology is an enabler in providing greater access to justice through its ability to connect people with legal needs to legal assistance, information, and advice. T With the increasing popularity of internet-enabled hand held devices and laptop computers, there is a tendency to assume that even the socio-economically vulnerable in our society have access to technology and the skills to use online services with confidence. This is not necessarily the case.</p> <p>Examples of the application of technology to provide legal information and assistance include case studies, guides and virtual legal advice clinics. S C The 2012 Review does not address the role of courts in serving the legal needs of the community. The court system is not regarded as a part of the wider legal assistance services. C This omission questions the role of the court in facilitating access to its services, including dispute resolution and trials. It also identified uses of technology to expand the delivery of services, many of which are transferable to an online court. These services include e-access for remote communities, availability outside of business hours, interactive processes and virtual appearances. S This essay will discuss uses of technology to expand the delivery of services, many of which are transferable to an online court.</p>		

Building UTS trust with an “AcaWriter micro-KI”

- A pedagogically robust writing exercise was rated **significantly more useful with the addition of AcaWriter**
- Students who used AcaWriter made **significantly more academic rhetorical moves** in their revised essays
- A significantly higher proportion of AcaWriter users **improved their drafts** (many students degraded them across drafts)
- Students who used AcaWriter produced higher graded submissions **if they engaged deeply with AcaWriter’s feedback**

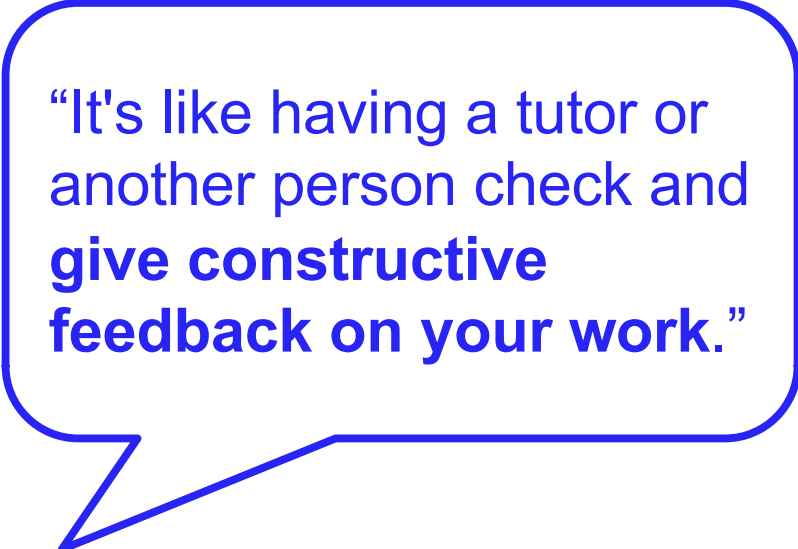
Shibani, A., Knight, S. and Buckingham Shum, S. (2019). Contextualizable Learning Analytics Design: A Generic Model, and Writing Analytics Evaluations. *Proc. 9th International Conference on Learning Analytics & Knowledge (LAK19)*. ACM Press, NY, pp. 210-219. DOI: <https://doi.org/10.1145/3303772.3303785>. Open Access Eprint: <https://tinyurl.com/lak19clad>

Shibani, A. (2019, In Prep). *Augmenting Pedagogic Writing Practice with Contextualizable Learning Analytics*. Doctoral Dissertation, Connected Intelligence Centre, University of Technology Sydney

Building the AcaWriter micro-KI → educator trust

“Overall, since we’ve been working with CIC around written communication over the course of the last four of five semesters, **we have seen marked improvement in students’ written communication.** Overall their individual assignment pass-rate is going up... We are seeing improvements in the number of students who are either **meeting or exceeding the expectations** around written communication”

Building the AcaWriter micro-KI → student trust



“It's like having a tutor or another person check and **give constructive feedback on your work.**”

Building the AcaWriter micro-KI → student trust

“When you’re editing your own writing, **you automatically think that your work sounds good** and that all your ideas and views have been clearly conveyed. This exercise was useful in the sense that it **indicated areas where I needed to be more explicit, which on my own I would not have noticed.**”

Building the AcaWriter micro-KI → student trust

“I think what is being taught is something I was already aware of. However, by being forced to actually identify **ways of arguing, along with the types of words used to do so**, it has broadened my perspective. I think I will be **more aware of the way I am writing now.**”

co-design techniques

educators trust analytics when they can see
that they're really shaping the design

Learning Analytics Deck for co-design

<http://ladeck.utscic.edu.au>

Carlos Prieto's PhD: 'Playing cards' to help stakeholder communication as they design a new kind of analytics tool

Title	Social Networks	Resource
Color type		
Icon		Description
		Facebook, Twitter, Snapchat, Line, Instagram, Slack



a) Learning objective -LO

Learning Objective

Write down a Learning Objective

b) Testing Site -TS

Classroom

The first prototype will be deployed in a classroom

c) Analytics type -AT

Predictive

Used for making the prediction of future values and identifying unknown events

d) Data source -DS

Browser History

Pages visited using Chrome, Firefox...

e) Analytics Method -AM

NLP

Natural Language Processing uses computer algorithms to analyse human natural language

f) Privacy - PR

Private

g) User interface -UI

Timeline

A chart that depicts how resources are used over time

h) Developer tools - Dev

JS

Wild card

Wild card

Resources

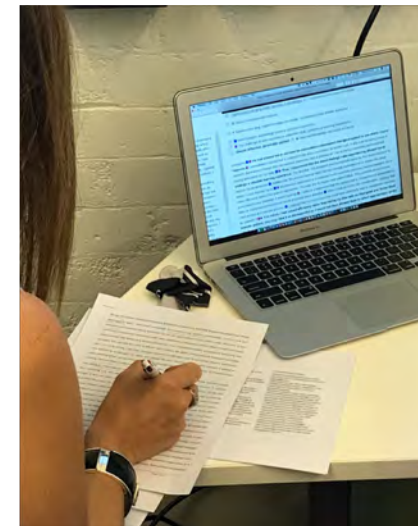
Time Money

Co-design with educators to tune writing analytics

```
jupyter Affect test notebook Last Checkpoint: 11 hours ago (autosaved)
File Edit View Insert Cell Kernel Widgets Help
+ -> Run Code
In [103]: checkAffect(paras[1],4.5)
26 words matched out of 4035 total words in the text - 0.644361833952912 percent
ability >> 4.85
developed >> 4.5
male >> 4.5
taken >> 4.52
medication >> 4.56
failed >> 5.5
learnt >> 4.8
improved >> 4.61
disrespectful >> 4.65
learning >> 4.8
issue >> 4.55
improve >> 4.61
rush >> 6.55
intriguing >> 5.18
excellent >> 5.15
impressed >> 4.82
admiration >> 5.52
skills >> 4.94
discovered >> 5.7
learning >> 4.8
disrespectful >> 4.65
gave >> 4.57
positive >> 5.5
motivated >> 5.09
```

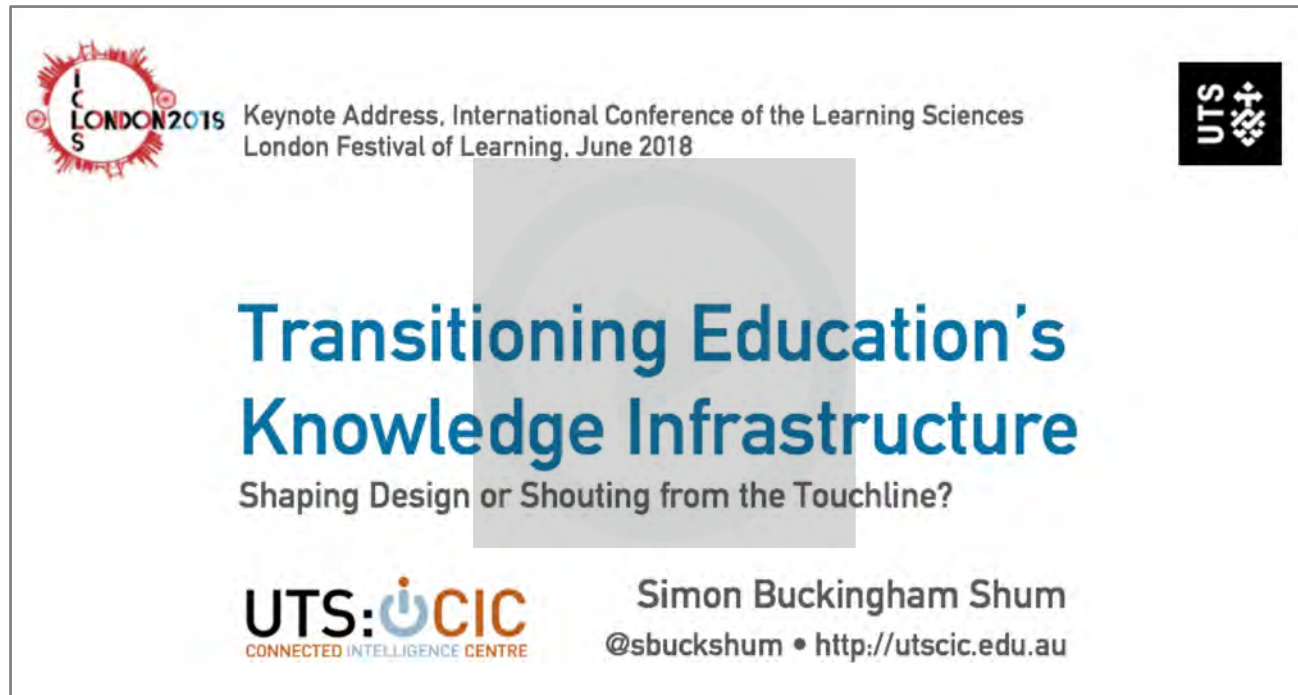
Goal: calibrate the parser detecting affect in reflective writing, working through sample texts


Rapid prototyping with a Jupyter notebook to agree on thresholds




More on LA + KI...

(in particular on LA's relationship to the learning sciences)




 Keynote Address, International Conference of the Learning Sciences
London Festival of Learning, June 2018



Transitioning Education's Knowledge Infrastructure

Shaping Design or Shouting from the Touchline?

 **UTS:uCiC**
CONNECTED INTELLIGENCE CENTRE

Simon Buckingham Shum
@sbuckshum • <http://utscic.edu.au>

<http://simon.buckinghamshum.net/2018/06/icls2018-keynote>

More on Human-Centred AIED & Learning Analytics...

Collections of insider accounts from teams who are building these infrastructures: how do they engage with issues of epistemology, pedagogy, politics, ethics...?

Human-Centred Learning Analytics. *Journal of Learning Analytics*, 6(2), pp. 1–94 (Eds.) Simon Buckingham Shum, Rebecca Ferguson, & Roberto Martinez-Maldonado

Learning Analytics and AI: Politics, Pedagogy and Practices. *British Journal of Educational Technology (50th Anniversary Special Issue)*, (Eds.) Simon Buckingham Shum & Rose Luckin. (late 2019)

What's the Problem with Learning Analytics? *Journal of Learning Analytics*. Invited Commentaries on Neil Selwyn's LAK18 Keynote Talk, from Carolyn Rosé, Rebecca Ferguson, Paul Prinsloo & Alfred Essa (late 2019)

Human-Centred Analytics/AI in Education

By [sbs](#) on May 4th, 2019 | [Edit](#)

A heads-up that three collections will hit the streets this year focused on how we can design so that human needs and values are well and truly centre-stage in educational tools powered by data, analytics and AI. It will be good to have detailed 'insider accounts' from researcher/developers who are reflecting deeply on how values are baked into their design practices and the infrastructures they are building, and how different stakeholders can engage meaningfully in shaping design. I'm excited about the papers shaping up for these volumes, so watch out for their releases mid- and end-2019...

**JOURNAL OF
LEARNING ANALYTICS**

BJET | British Journal of
Educational Technology

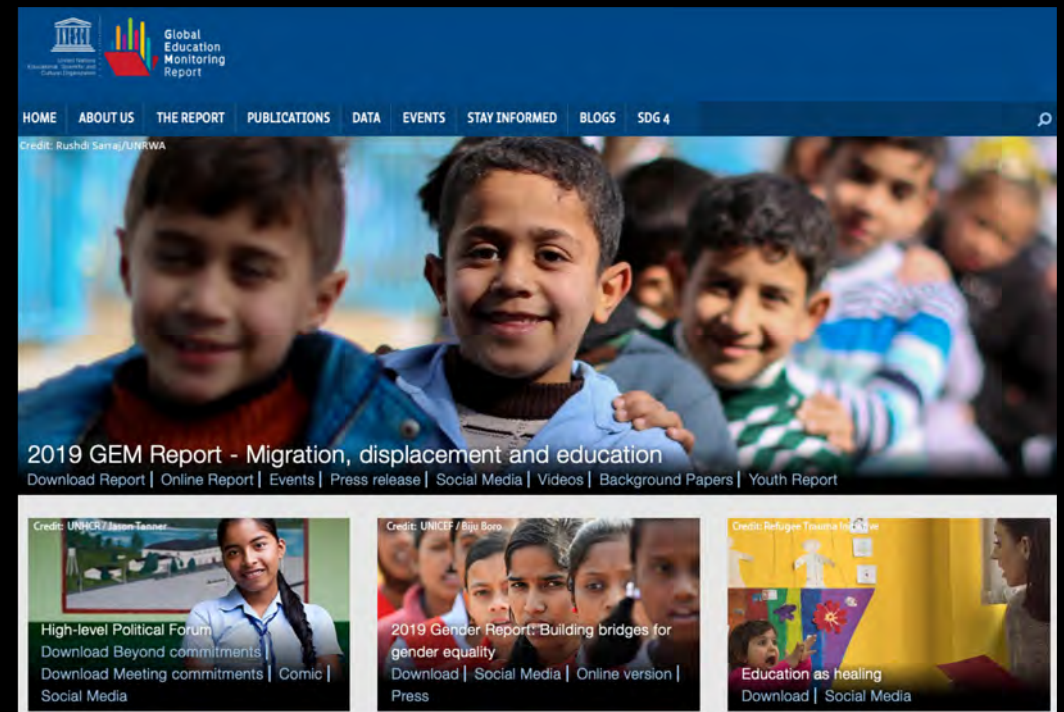
Reflections on the future educational KI

Are we aspiring for an
“Intergovernmental Panel on Learning?”

Is part of this already in place?...

UNESCO Global Education Monitoring
Report <https://en.unesco.org/gem-report>

A conventional form of educational KI



Reflections on the future educational KI

Commercial platforms and their R&D programs are **'vertical Knowledge Infrastructures'** at national and increasingly international scales

Knowledge about learners from proprietary platforms, primarily ITS (but expanding beyond no doubt)

All the usual questions and concerns around multinational platforms, data ownership, commercial products in education...

The top screenshot is from the Squirrel AI Learning website. It features a navigation bar with 'HOME', 'ABOUT', 'PARTNER', the Squirrel AI Learning logo (with Chinese characters '松鼠AI·智适应'), 'PRESS', 'CONNECT', and 'GALLERY'. The main heading is 'What is Squirrel AI Learning?'. Below this, it states: 'Squirrel AI Learning is the first pure-play AI-powered adaptive education provider in China.' and 'We provide the personalized and high-quality K-12 after-school tutoring at an affordable price.' There is also a small graphic with the text 'Squirrel AI Learning AI-K12 Education' and 'Let Each Child Have an AI Student Teacher'.

The bottom screenshot is from the Pearson website. It shows a navigation bar with 'Pearson', 'PreK-12 Education', 'Higher Education', 'Industry & Professional', and 'About Us'. Below the navigation, there is a section titled 'Looking at the big picture' with the subtext 'helps us personalize a learning path for every student' and an image of a student and a teacher. Below this is a section titled 'Data, Analytics, & Adaptive Learning' with the subtext 'The importance of using data and analytics in education is growing rapidly; the power of data is fundamental to improving the performance of individual students.' and a paragraph of text: 'Educators make important decisions every day. Using our technology and services to connect infrastructure, instruction, and assessment, we can create holistic views of the student, classroom, and institution that can be used to make a measurable impact on student learning and success. Our capabilities in data, analytics, and adaptive learning — and our leading efficacy research — enable us to design a smarter, adaptive learning path for every student.'

Conclusion

We know how a mature, functioning Knowledge Infrastructure operates, and the influence it can have on science, policy and practice (not that this is straightforward)

Insights into KI structure and dynamics should help the LA community focus its efforts to invent an educational KI that can be sustained, and trusted

Your feedback welcomed!

@sbuckshum • Simon.BuckinghamShum@uts.edu.au • Simon.BuckinghamShum.net