MONASH University | COLAM Centre for Learning Analytics Monash

Unlocking the full potential

Next critical steps for learning analytics

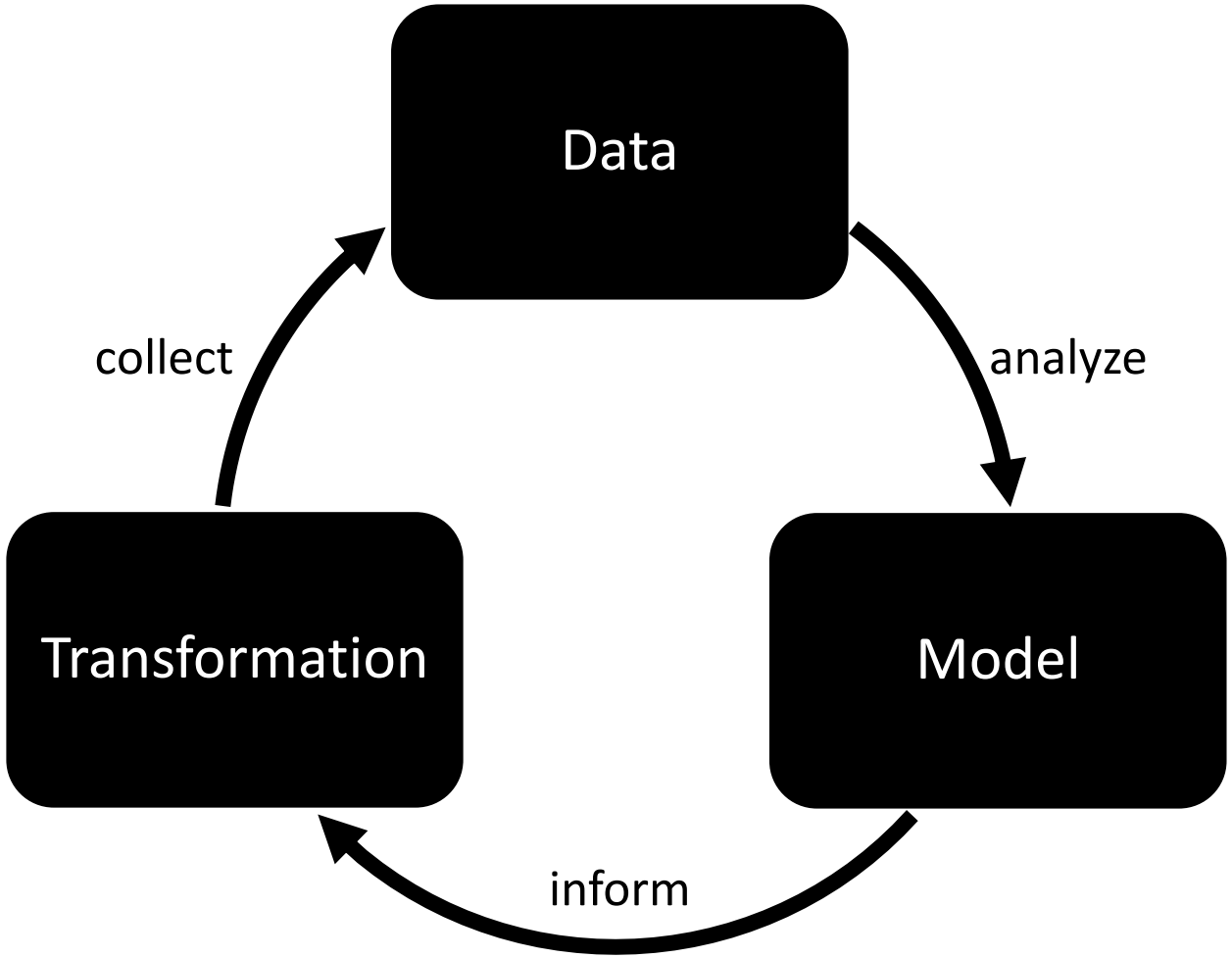
Dragan Gašević
@dgasevic

Oct 20th, 2022
Hong Kong Metropolitan University
[Online]

Learning Analytics

Much promise and high interest

Closing the loop



Gašević, D., Tsai, Y-S., Dawson, S., & Pardo, A. (2019). How do we start? An approach to learning analytics adoption in higher education. *International Journal of Information and Learning Technology, 36*(4), 342-353.

Challenge

Are measurements and results in learning analytics reliable?

Gašević, D., Greiff, S., Shaffer, D. W. (2022). Towards Strengthening Links between Learning Analytics and Assessment: Challenges and Potentials of a Promising New Bond. *Computers in Human Behavior, 134*, 107304.

Challenge

How we grow uptake of learning analytics?

Tsai, Y. S., Rates, D., Moreno-Marcos, P. M., Muñoz-Merino, P. J., Jivet, I., Scheffel, M., ... & Gašević, D. (2020). Learning analytics in European higher education—Trends and barriers. *Computers & Education, 155*, 103933.

COLAM

Key takeaway

We need to get serious about the quality of data and models

Key takeaway

Humans are central for adoption of analytics

COLAM

DATA – MODEL – TRANSFORMATION – FINAL REMARKS

Challenge

Can we trust measurements in learning analytics?

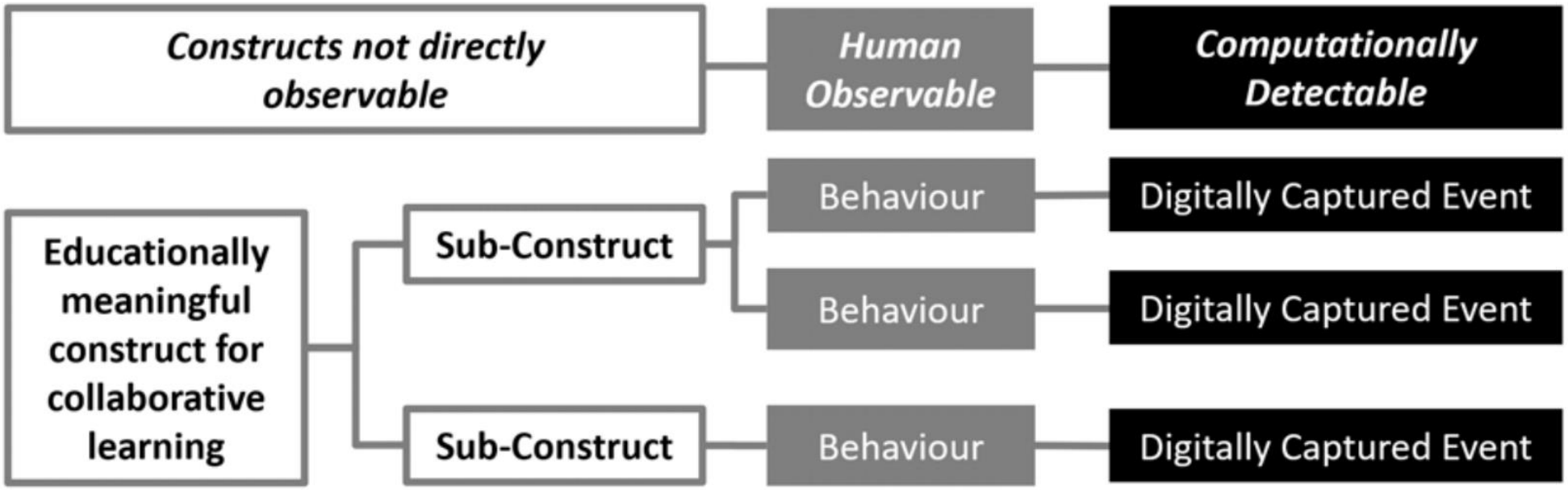
Challenges

Are data we use good proxies for what we want to measure?

Data quality can’t be fixed with AI (garbage-in-garbage-out)

Gašević, D., Tsai, Y-S., Dawson, S., & Pardo, A. (2019). How do we start? An approach to learning analytics adoption in higher education. *International Journal of Information and Learning Technology, 36*(4), 342-353.

From data to constructs



Martinez-Maldonado, R., Gaševic, D., Echeverria, V., Fernandez Nieto, G., Swiecki, Z., & Buckingham Shum, S. (2021). What Do You Mean by Collaboration Analytics? A Conceptual Model. *Journal of Learning Analytics, 8*(1), 126-153.

Three strategies for improving data

Gašević, D., Tsai, Y-S., Dawson, S., & Pardo, A. (2019). How do we start? An approach to learning analytics adoption in higher education. *International Journal of Information and Learning Technology, 36*(4), 342-353.

Improving validity

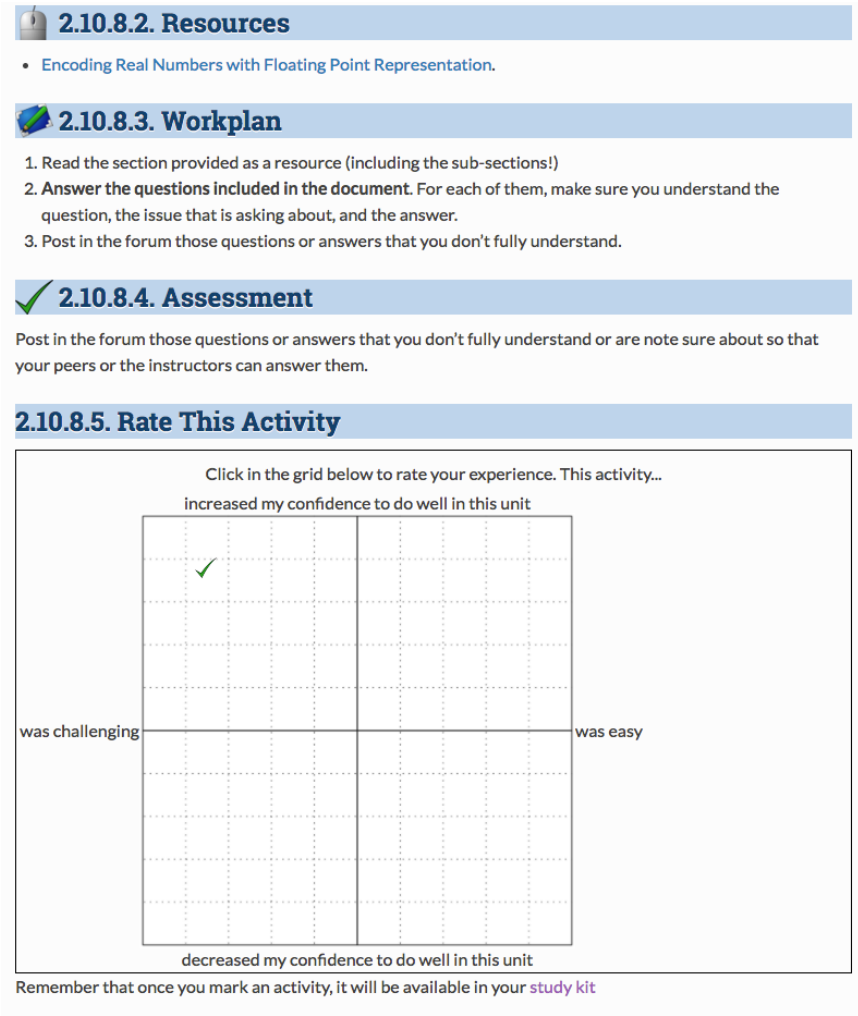
1

Introducing meaning to clicks

Trace-based self-reports

Jovanović, J., Gašević, D., Pardo, A., Dawson, S., & Whitelock-Wainwright, A. (2019). Introducing meaning to clicks: Towards traced-measures of self-efficacy and cognitive load. In *Proceedings of the 9th International Conference on Learning Analytics & Knowledge* (pp. 511-520).

Introducing meaning to clicks



2.10.8.2. Resources

- Encoding Real Numbers with Floating Point Representation.

2.10.8.3. Workplan

1. Read the section provided as a resource (including the sub-sections!)
2. **Answer the questions included in the document**. For each of them, make sure you understand the question, the issue that is asking about, and the answer.
3. Post in the forum those questions or answers that you don't fully understand.

2.10.8.4. Assessment

Post in the forum those questions or answers that you don't fully understand or are note sure about so that your peers or the instructors can answer them.

2.10.8.5. Rate This Activity

Click in the grid below to rate your experience. This activity...

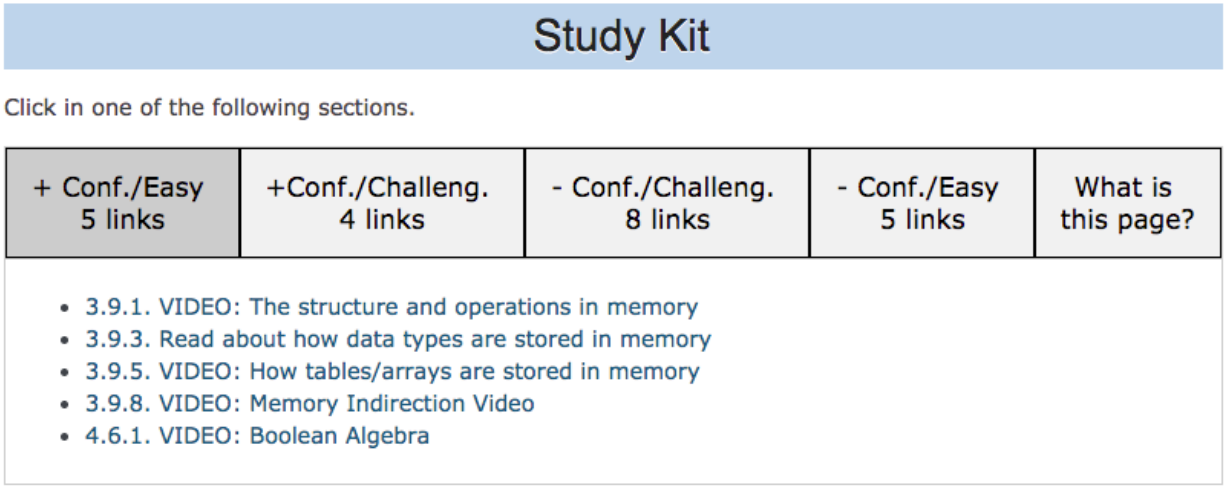
increased my confidence to do well in this unit

was challenging

was easy

decreased my confidence to do well in this unit

Remember that once you mark an activity, it will be available in your study kit



Study Kit

Click in one of the following sections.

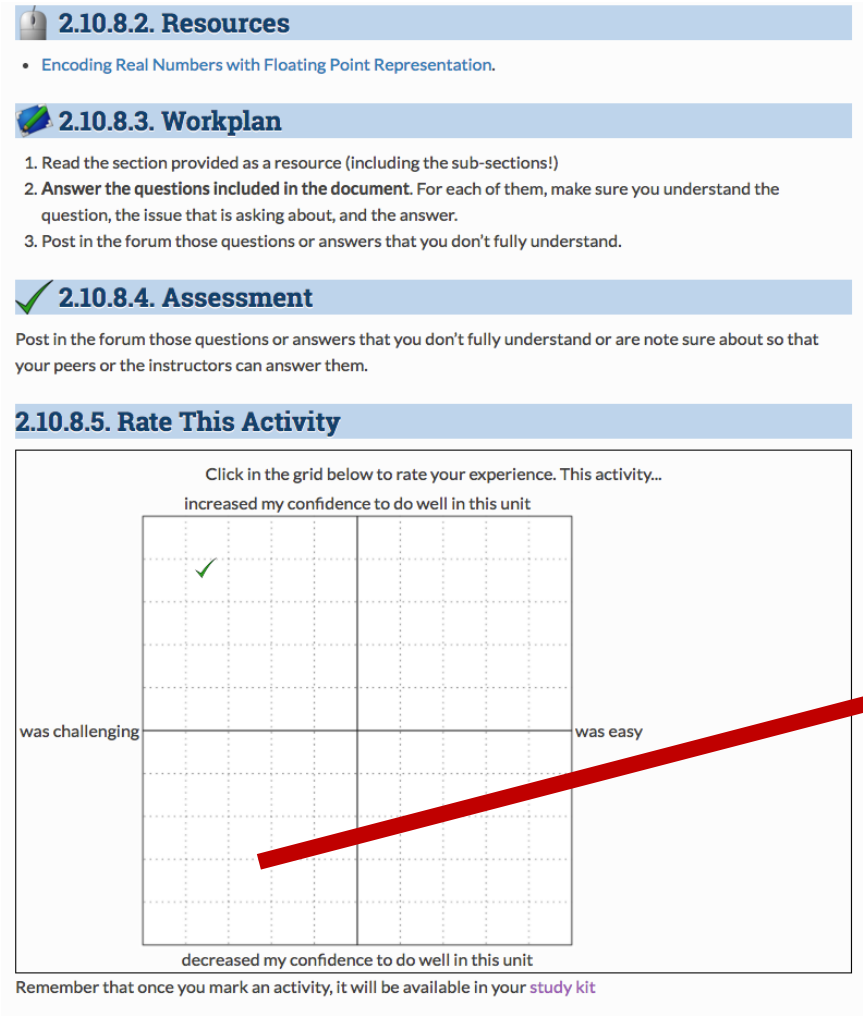
+ Conf./Easy 5 links	+Conf./Challeng. 4 links	- Conf./Challeng. 8 links	- Conf./Easy 5 links	What is this page?

- 3.9.1. VIDEO: The structure and operations in memory
- 3.9.3. Read about how data types are stored in memory
- 3.9.5. VIDEO: How tables/arrays are stored in memory
- 3.9.8. VIDEO: Memory Indirection Video
- 4.6.1. VIDEO: Boolean Algebra

Quid pro quo

Jovanović, J., Gašević, D. Pardo, A., Dawson, S., Whitelock-Wainwright, A. (2019), Introducing meaning to clicks: Towards traced-measures of self-efficacy and cognitive load. In *Proceedings of the 8th International Conference on Learning Analytics and Knowledge* (pp. 511-520). ACM Press: New York.

Introducing meaning to clicks



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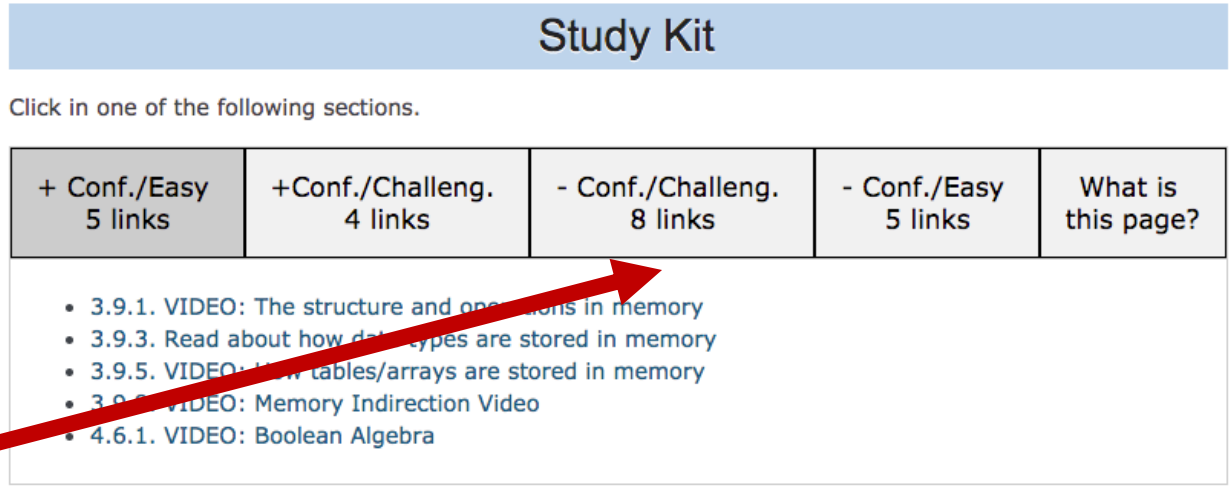

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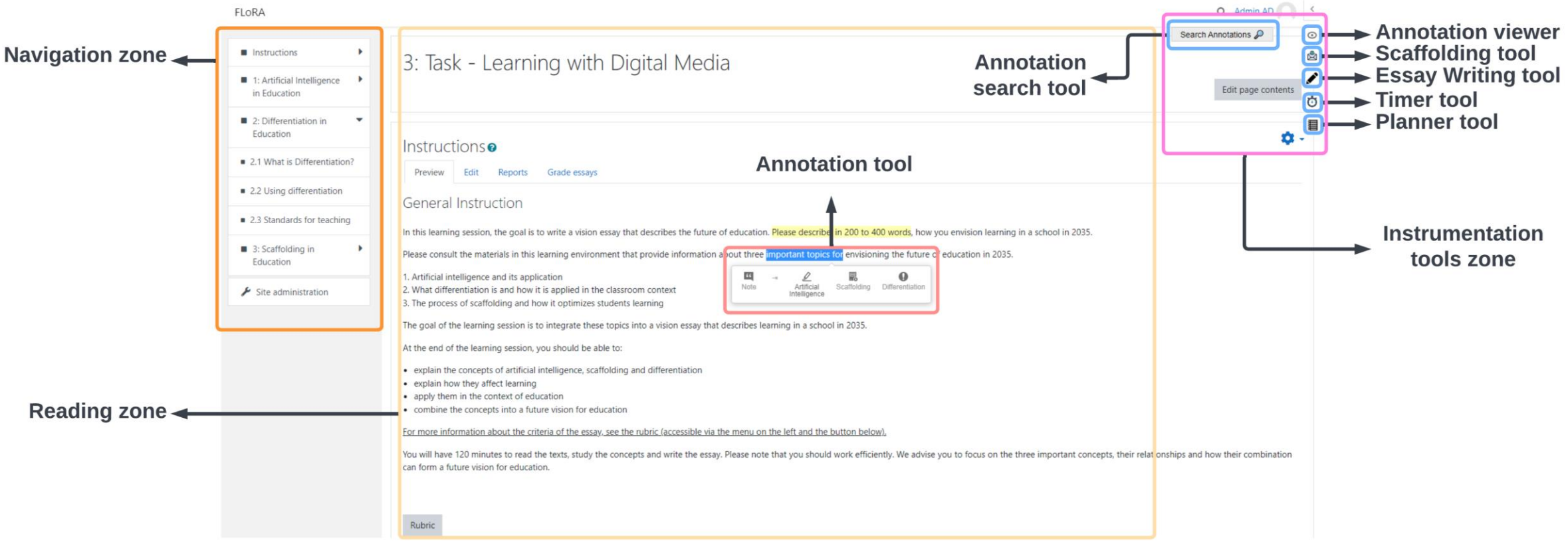
Improving validity

2

Create special instrumentation tools

Azevedo, R. (2015). Defining and measuring engagement and learning in science: Conceptual, theoretical, methodological, and analytical issues. *Educational psychologist*, *50*(1), 84-94.

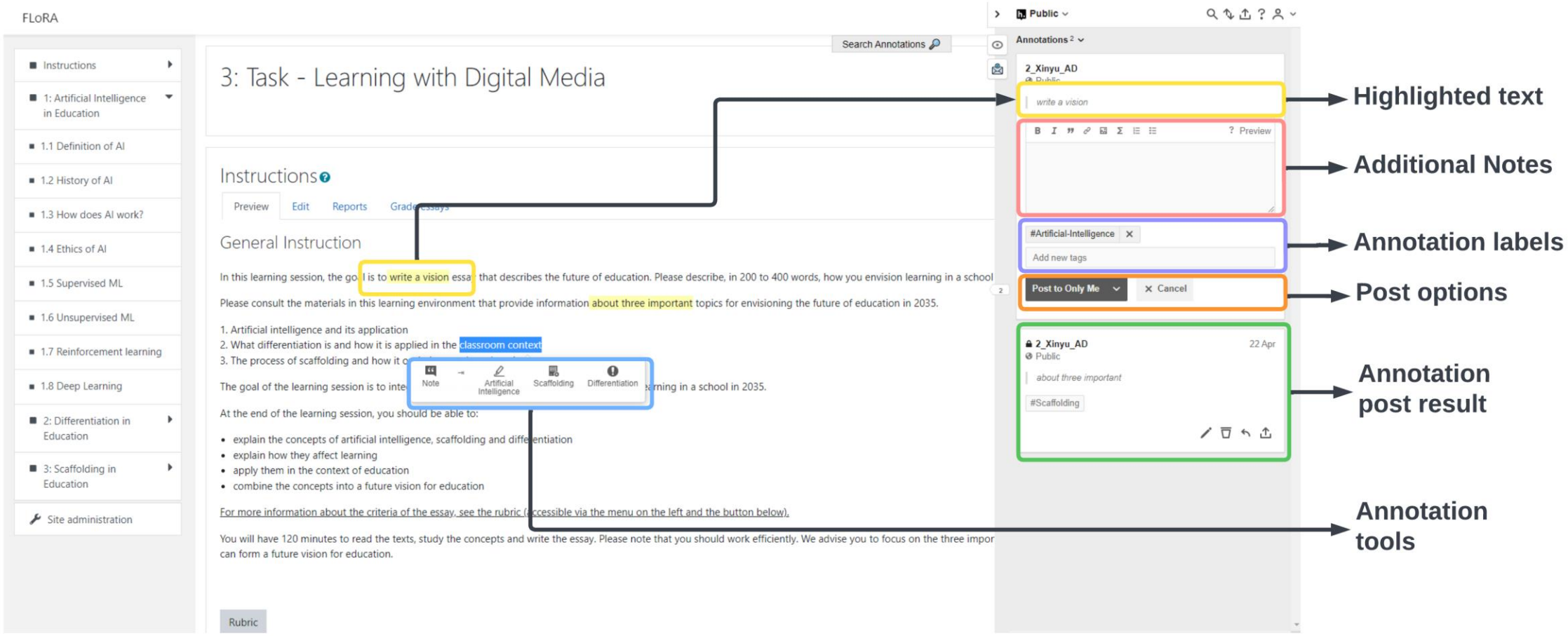
FLoRA



moodle + hypothes.is + extensions

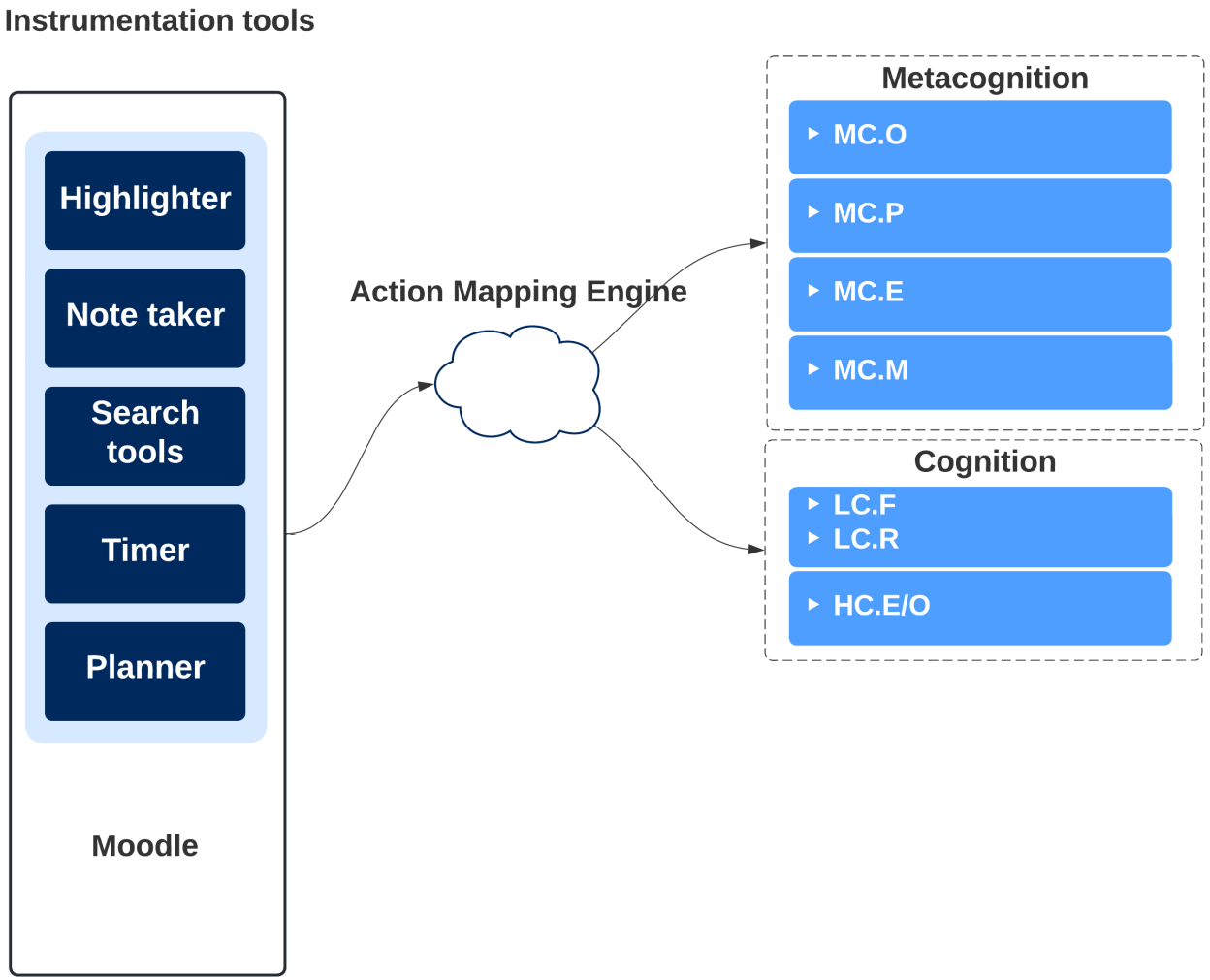
https://floraproject.org

FLoRA



https://floraproject.org

Mapping trace data to processes



van der Graaf, J., Lim, L., Fan, Y., Kilgour, J., Moore, J., Bannert, M., ... & Molenaar, I. (2021). Do instrumentation tools capture self-regulated learning?. In *Proceedings of the 11th International Learning Analytics and Knowledge Conference* (pp. 438-448).

Improving validity

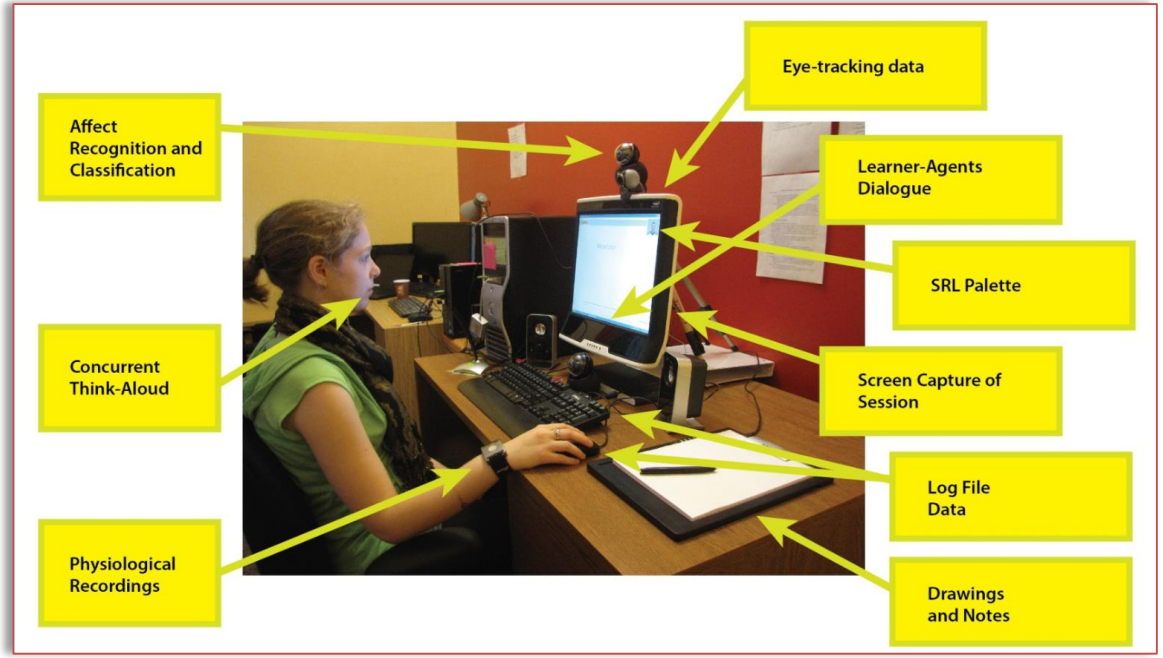
3

Combining multiple data channels

Azevedo, R. (2015). Defining and measuring engagement and learning in science: Conceptual, theoretical, methodological, and analytical issues. *Educational psychologist*, *50*(1), 84-94.

Multimodal and multichannel data

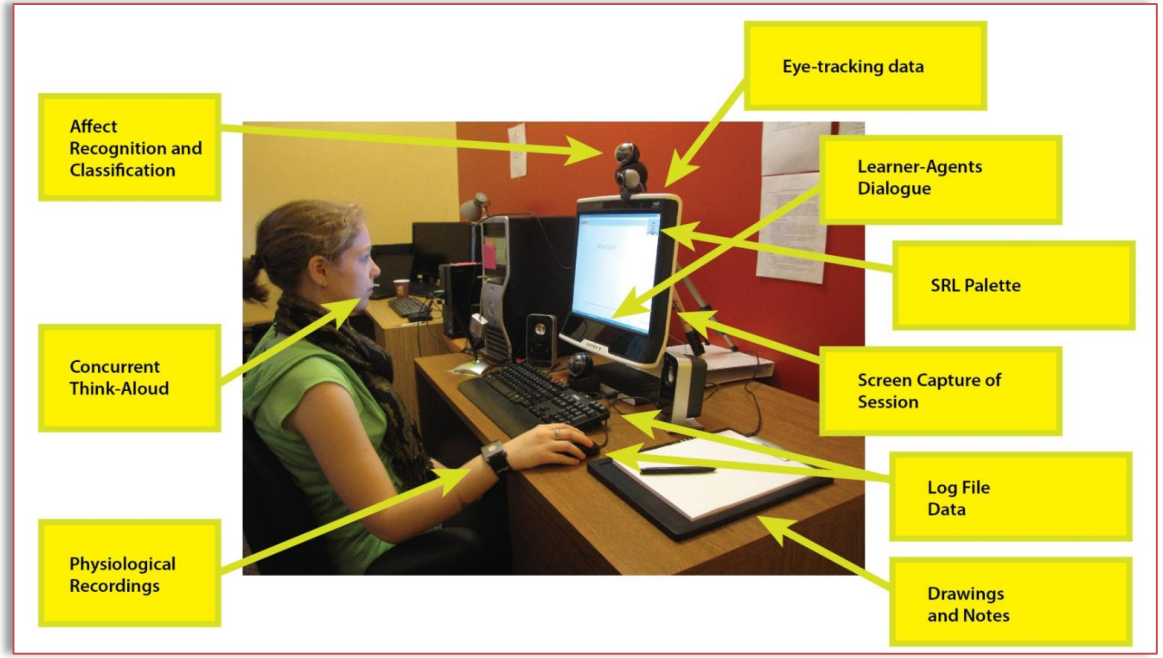
Self-regulated learning



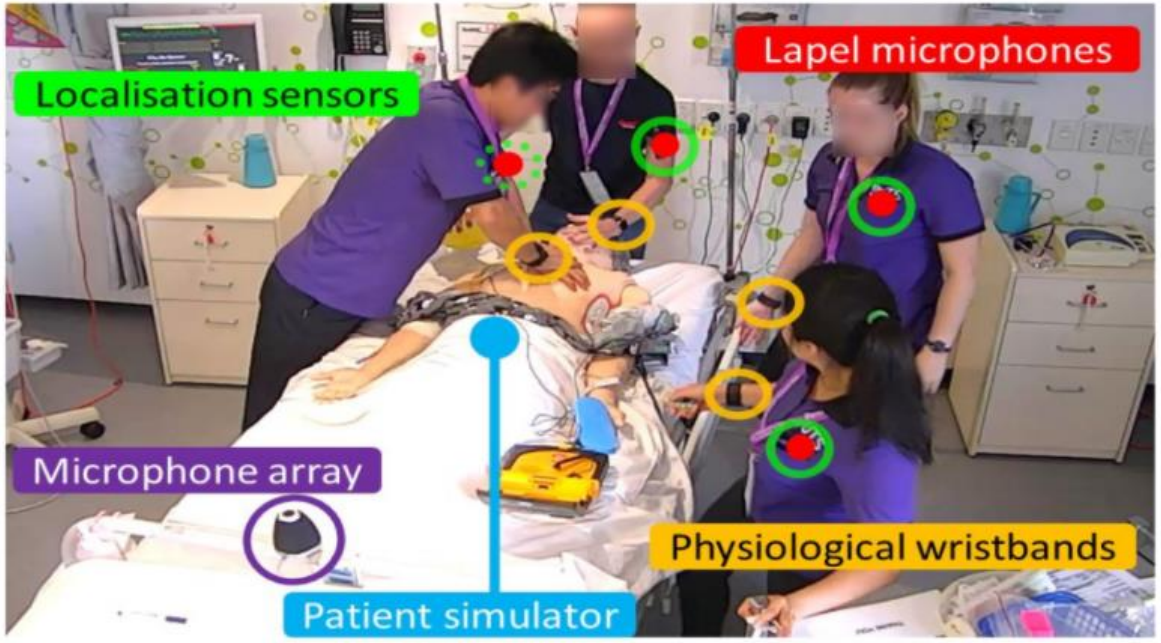
Centre for Learning and Living with AI

Multimodal and multichannel data

Self-regulated learning



Teamwork



Centre for Learning and Living with AI

Australian Government
Australian Research Council

From multichannel data to constructs

Raw trace data

15:06:06	/learn/announce
15:07:34	/learn/content
15:10:22	/learn/announce
15:11:01	/learn/content
15:12:27	/learn/content?type=detail&id=1002579286
17:49:58	/info
17:51:44	/learn/announce
17:51:46	/learn/content
17:52:02	/learn/content?type=detail&id=1002579307
17:52:38	/learn/content?type=detail&id=1002579307&cid=1002813724
17:56:32	/learn/content?type=detail&id=1002579307&cid=1002813725
20:44:19	/info

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20:44:30	/learn/announce
20:44:32	/learn/content
20:44:34	/learn/content?type=detail&id=1002579275
20:44:41	/learn/score
20:44:41	/learn/custom?id=1002062038
20:44:42	/learn/announce
20:44:44	/learn/content?type=detail&id=1002579275&cid=1002813499
20:44:45	/learn/content?type=detail&id=1002579275&cid=1002813500
11:53:47	/info
11:53:50	/learn/announce
11:53:52	/learn/content?type=detail&id=1002579275&cid=1002813500
10:05:40	/learn/content
10:05:45	/learn/content?type=detail&id=10

Multi data channels:
Navigational log data
Peripheral data
Eye-tracking data

Fan, Y., Lim, L., van der Graaf, J., Kilgour, J., Raković, M., Moore, J., ... & Gašević, D. (2022). Improving the measurement of self-regulated learning using multi-channel data. *Metacognition and Learning*, in press.

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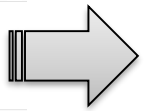

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Learning actions

Action label 1
Action label 2
Action label 2
Action label 3

~~

Action label 4
Action label 2
Action label 3
Action label N

Multi data channels:
Navigational log data
Peripheral data
Eye-tracking data

Actions such as:
Relevant_reading
Write_essay
Note_editing

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Action label 4
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SRL processes

Process 1
Action 1 -> Action 2
Process 2
Action 2 -> Action 3

~~

Process 3
Action 4 -> Action 2 -> Action 3
Process N
Action N -> Action N

Mapping with SRL theory:
Process 1 -> Orientation
Process 2 -> Monitoring
Process 3 -> Evaluation

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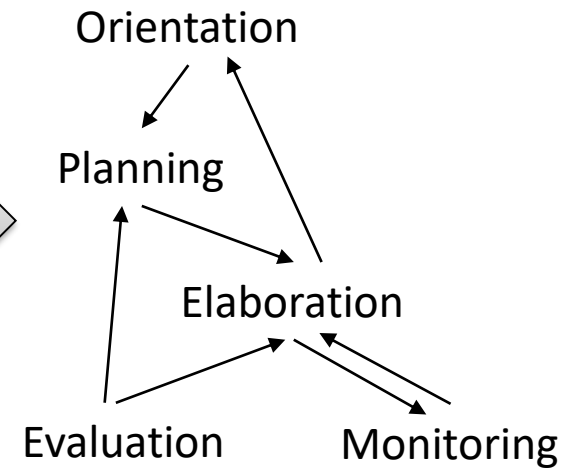
Self-regulated learning



Modelling (e.g.,
process mining, ENA)

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Validation

Using other data sources to improve and validate measurement

Fan, Y., van der Graaf, J., Lim, L., Raković, M., Singh, S., Kilgour, J., ... & Gašević, D. (2022). Towards investigating the validity of measurement of self-regulated learning based on trace data. *Metacognition and Learning*, in press.

Measurement sensitivity

Data channels differ in what they can capture

DATA– **MODEL** – TRANSFORMATION –
FINAL REMARKS

Learning context

To what models can be generalized in learning analytics?

Gašević, D., Dawson, S., Rogers, T., Gašević, D. (2016). Learning analytics should not promote one size fits all: The effects of course-specific technology use in predicting academic success. *The Internet and Higher Education, 28*, 68–84.

What shapes generalizability?

Instructional conditions shape learning analytics results

Gašević, D., Dawson, S., Rogers, T., Gašević, D. (2016). Learning analytics should not promote one size fits all: The effects of course-specific technology use in predicting academic success. *The Internet and Higher Education, 28*, 68–84.

What shapes generalizability?

Students matter the most in learning analytics

Jovanović, J., Saqr, M., Joksimović, S., & Gašević, D. (2021). Students matter the most in learning analytics: The effects of internal and instructional conditions in predicting academic success. *Computers & Education, 172*, 104251.

Opportunity

Analytics of learning strategies

Analysis methods

Analytics of learning strategies

Unsupervised machine learning

+

Sequence mining

Process mining

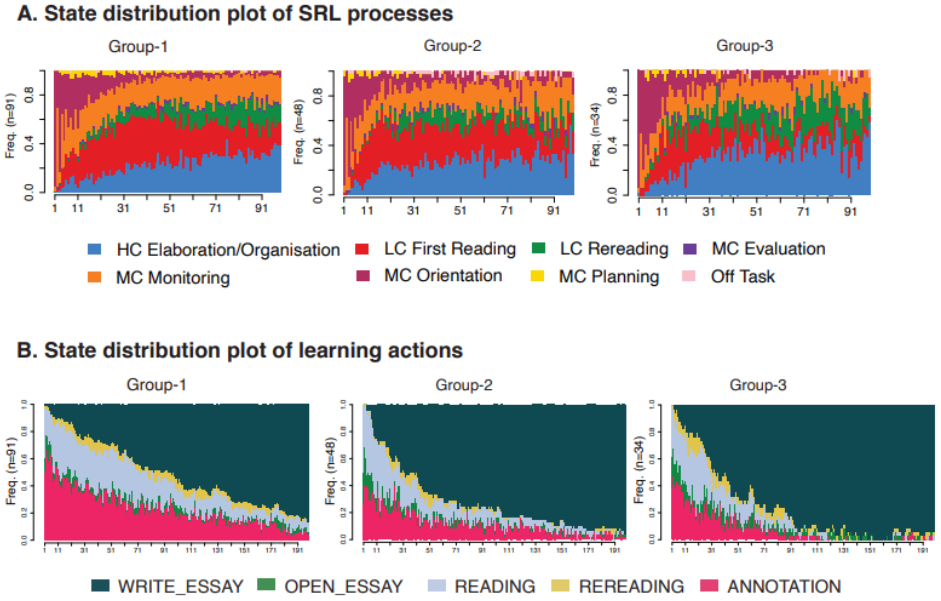
Network analysis

Key findings (1/3)

Analytics of learning strategies

Regulation of strategies is consistent with relevant theory

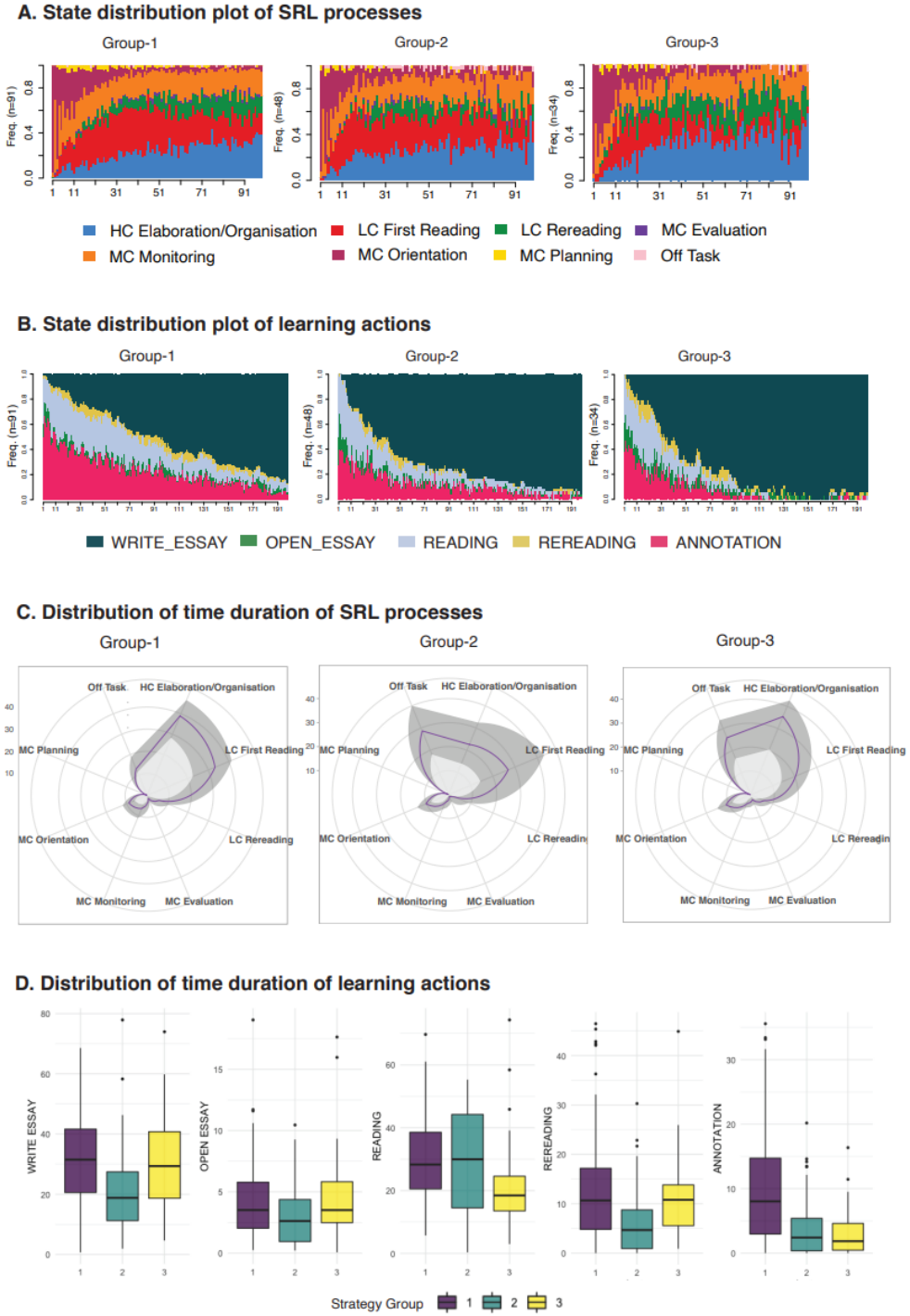
Gašević, D., Jovanović, J., Pardo, A., & Dawson, S. (2017). Detecting Learning Strategies with Analytics: Links with Self-reported Measures and Academic Performance. *Journal of Learning Analytics*, *4*(2), 113–128.



Characterizing learning strategies

Group 1 - Read First, Write Next
Group 2 - Read and Write Simultaneously
Group 3 - Write Intensively, Read Selectively

Srivastava, N., Fan, Y., Rakovic, M., Singh, S., Jovanovic, J., Van Der Graaf, J., ... & Gasevic, D. (2022). Effects of Internal and External Conditions on Strategies of Self-regulated Learning: A Learning Analytics Study. In *Proceedings of the 12th International Learning Analytics and Knowledge Conference* (pp. 392-403).



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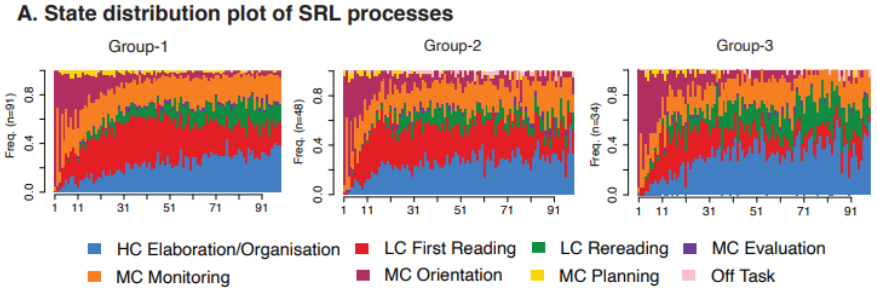
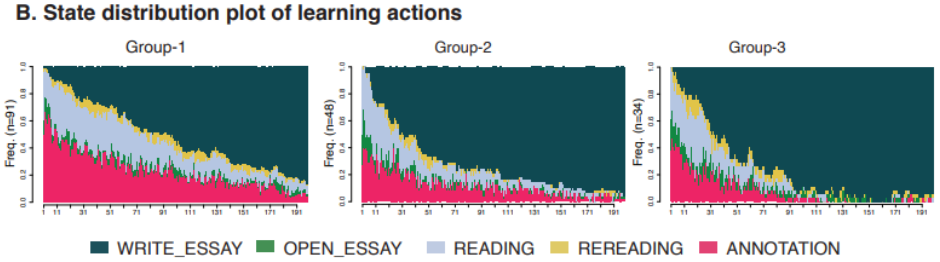
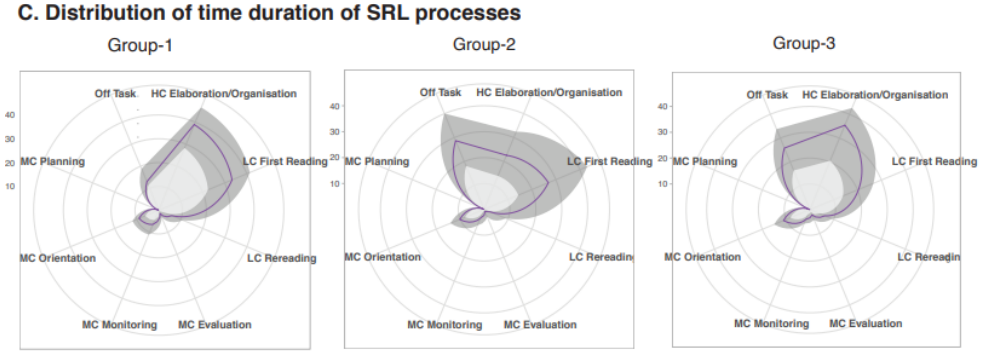
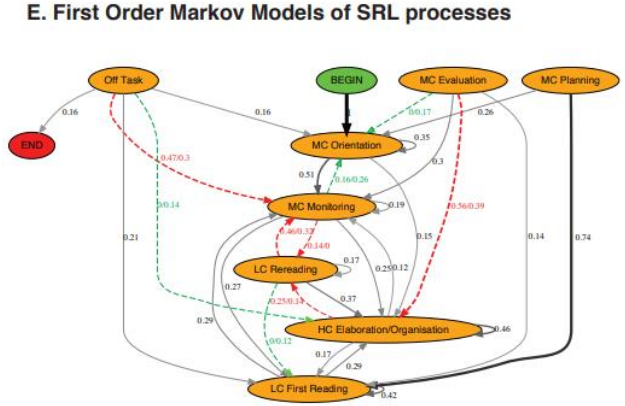
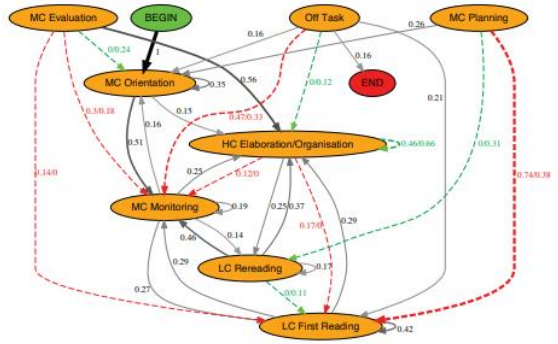




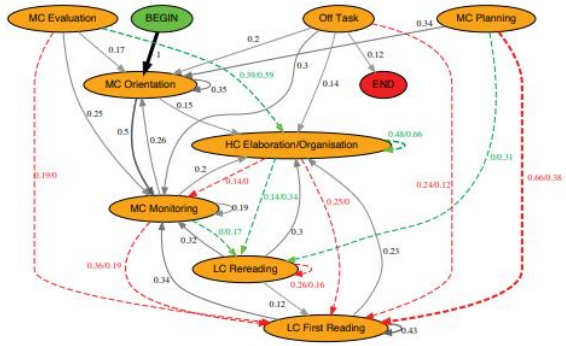




FOMM Comparison between Group-1 and Group-2



FOMM Comparison between Group-1 and Group-3



FOMM Comparison between Group-2 and Group-3

Characterizing learning strategies

Group 1 - Read First, Write Next
Group 2 - Read and Write Simultaneously
Group 3 - Write Intensively, Read Selectively

s of Internal and External Conditions on Strategies of Self-
cs and Knowledge Conference (pp. 392-403).

Key findings (2/3)

Analytics of learning strategies

Strategies are predictive of academic performance

Fincham, O. E., Gašević, D., Jovanovic, J. M., & Pardo, A. (2019). From Study Tactics to Learning Strategies: An Analytical Method for Extracting Interpretable Representations. *IEEE Transactions on Learning Technologies*, *12*(1), 59–72. https://doi.org/10.1109/TLT.2018.2823317

Key findings (3/3)

Analytics of learning strategies

Explain underling learning processes and mechanisms

Fan, Y., Saint, J., Singh, S., Jovanovic, J., & Gašević, D. (2021). A learning analytic approach to unveiling self-regulatory processes in learning tactics. In *Proceedings of the 11th International Learning Analytics and Knowledge Conference* (pp. 184-195).

Ultimate goal

Models of *individual* learners

An idiographic approach
Identify learning signatures of individual learners

Malmberg, J., Saqr, M., Järvenoja, H., & Järvelä, S. (2022). How the monitoring events of individual students are associated with phases of regulation: A network analysis approach. Journal of Learning Analytics, 9(1), 77-92.

Beyond accuracy – model *fairness*

Sha, L., Raković, M., Das, A., Gašević, D., & Chen, G. (2022). Leveraging Class Balancing Techniques to Alleviate Algorithmic Bias for Predictive Tasks in Education. *IEEE Transactions on Learning Technologies, 15*(4), 481-492.

Explainable analytics to support *learning about learning*

Khosravi, H., Shum, S. B., Chen, G., Conati, C., Tsai, Y. S., Kay, J., ... & Gašević, D. (2022). Explainable artificial intelligence in education. *Computers and Education: Artificial Intelligence, 3*, 100074.

DATA– MODEL – **TRANSFORMATION** –
FINAL REMARKS

Interaction

Dashboards

Matcha, W., Ahmad Uzir, N., Gašević, D., Pardo, A. (2020). A Systematic Review of Empirical Studies on Learning Analytics Dashboards: A Self-Regulated Learning Perspective. *IEEE Transactions on Learning Technologies, 13*(2), 226 - 245.

Interaction

Dashboards can be harmful

Matcha, W., Ahmad Uzir, N., Gašević, D., Pardo, A. (2020). A Systematic Review of Empirical Studies on Learning Analytics Dashboards: A Self-Regulated Learning Perspective. *IEEE Transactions on Learning Technologies, 13*(2), 226 - 245.

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Direction

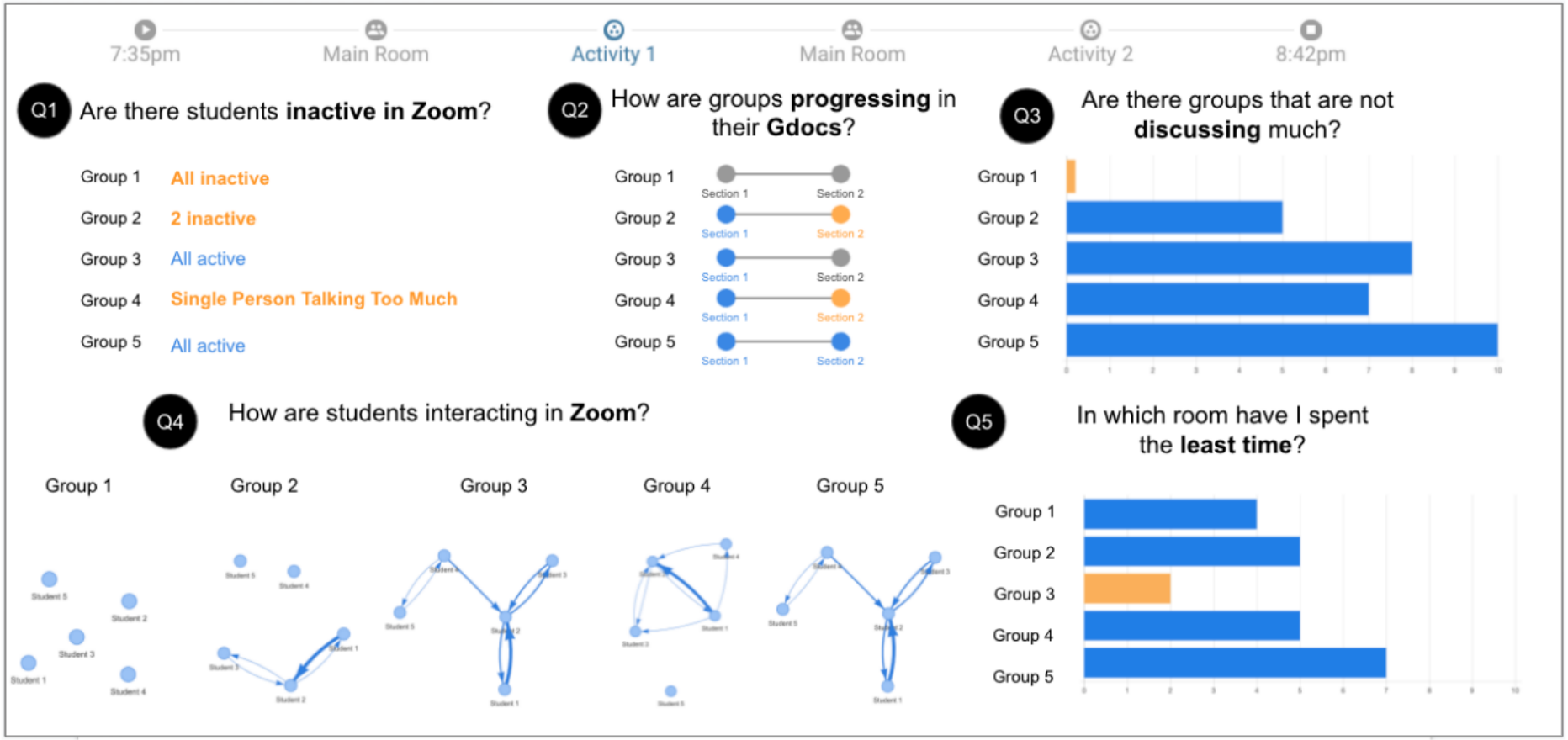
Analytics in the loop
(human is already in the loop!)

Shneiderman, B. (2022). *Human-Centered Artificial Intelligence*. Oxford University Press

ZoomSense

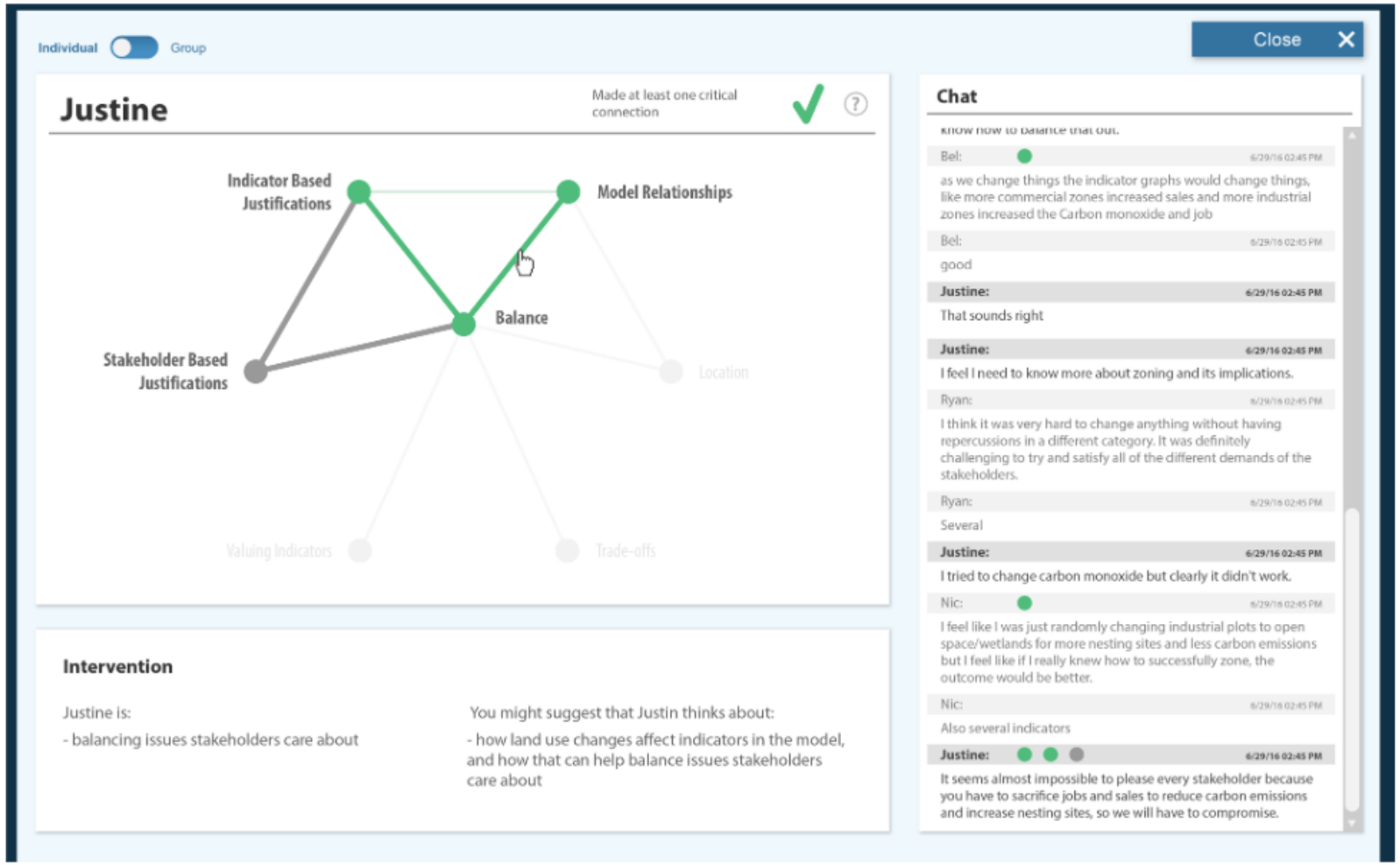
https://zoomsense.io

Data storytelling



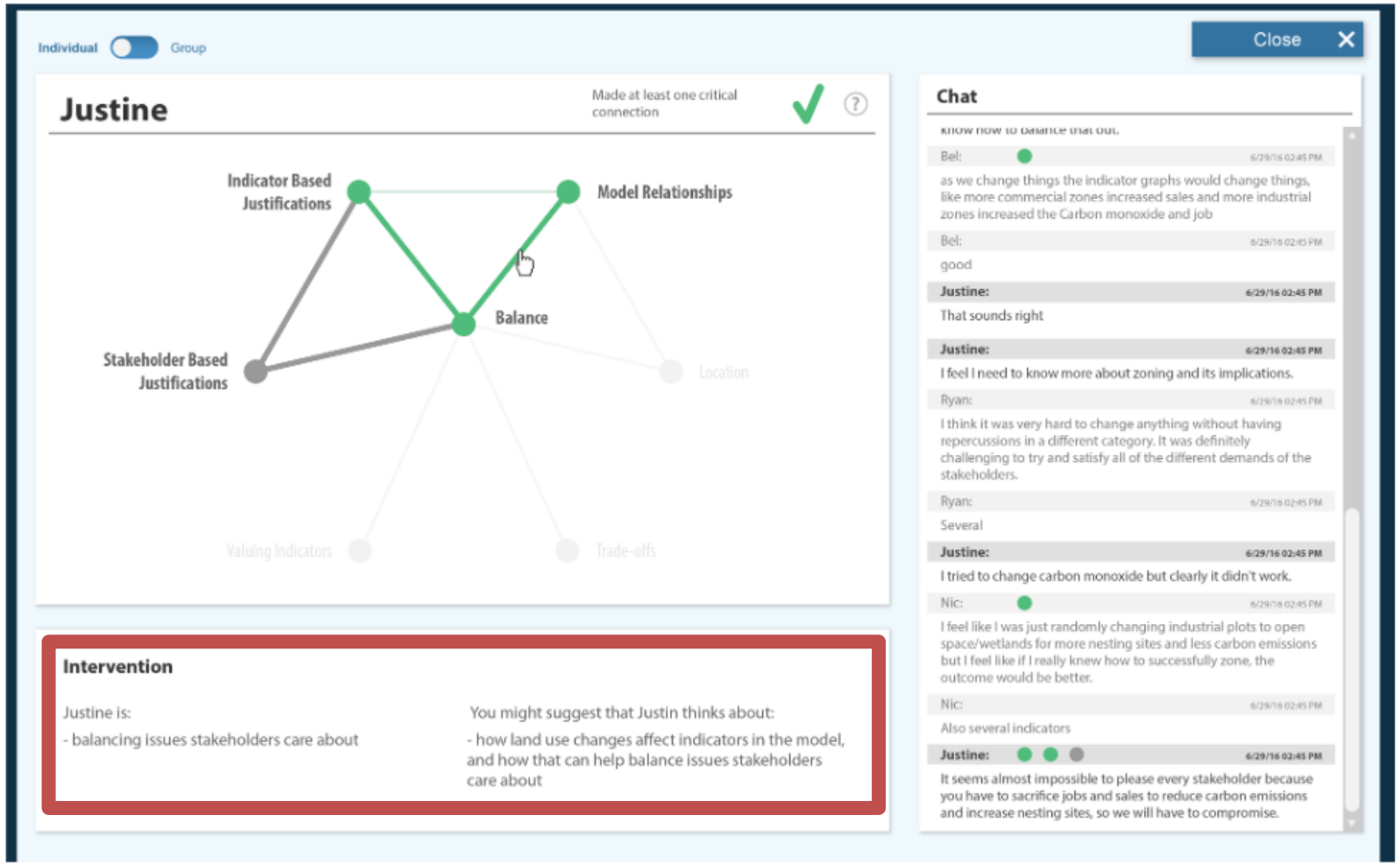
Pozdniakov, S., Martinez-Maldonado, R., Tsai, Y. S., Cukurova, M., Bartindale, T., Chen, P., ... & Gasevic, D. (2022). The Question-driven Dashboard: How Can We Design Analytics Interfaces Aligned to Teachers' Inquiry?. In *Proceedings of the 12th International Learning Analytics and Knowledge Conference* (pp. 175-185).

Recommendations for teachers



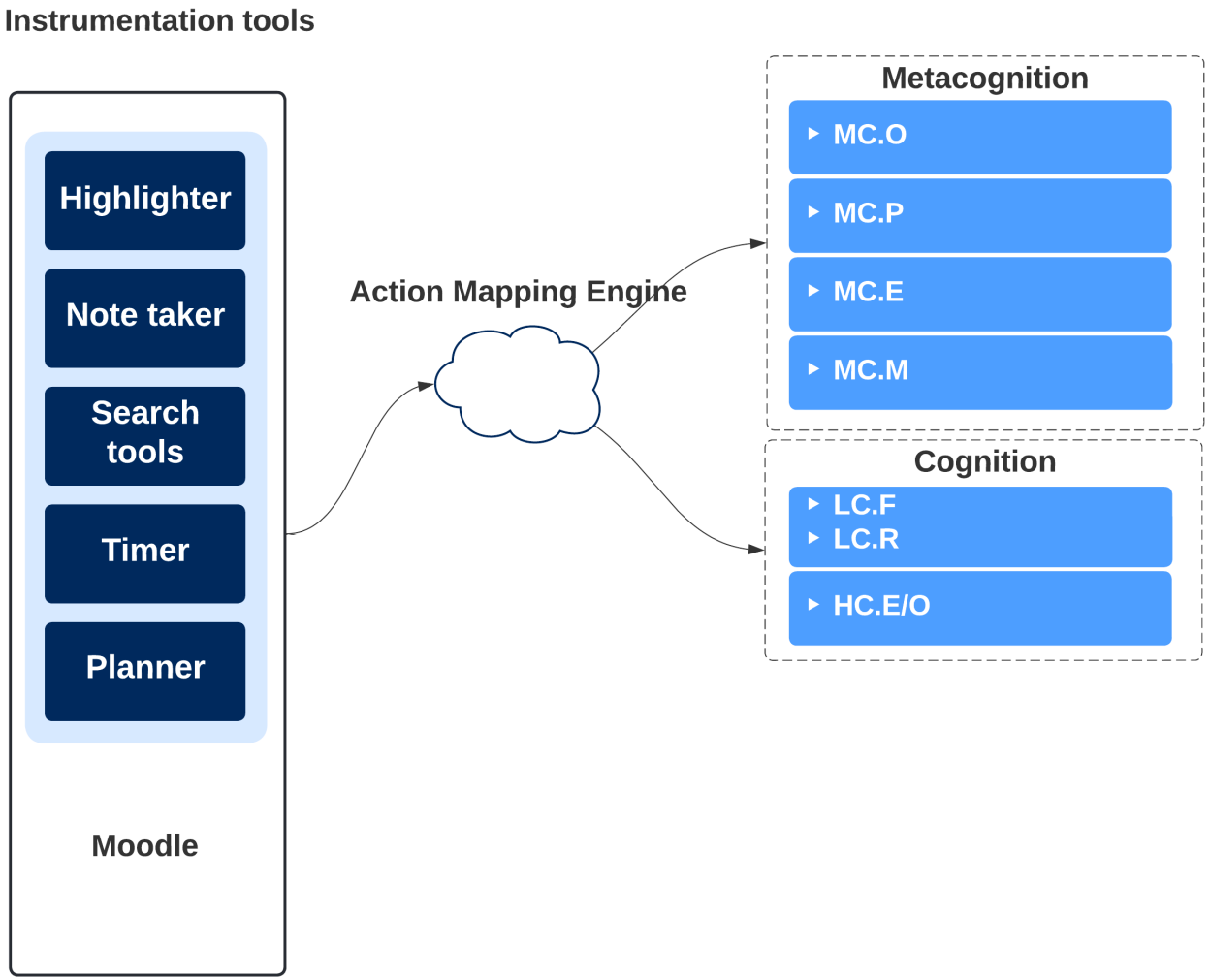
Martinez-Maldonado, R., Gašević, D., Echeverria, V., Fernandez Nieto, G., Swiecki, Z., & Buckingham Shum, S. (2021). What Do You Mean by Collaboration Analytics? A Conceptual Model. *Journal of Learning Analytics*, *8*(1), 126-153.

Recommendations for teachers



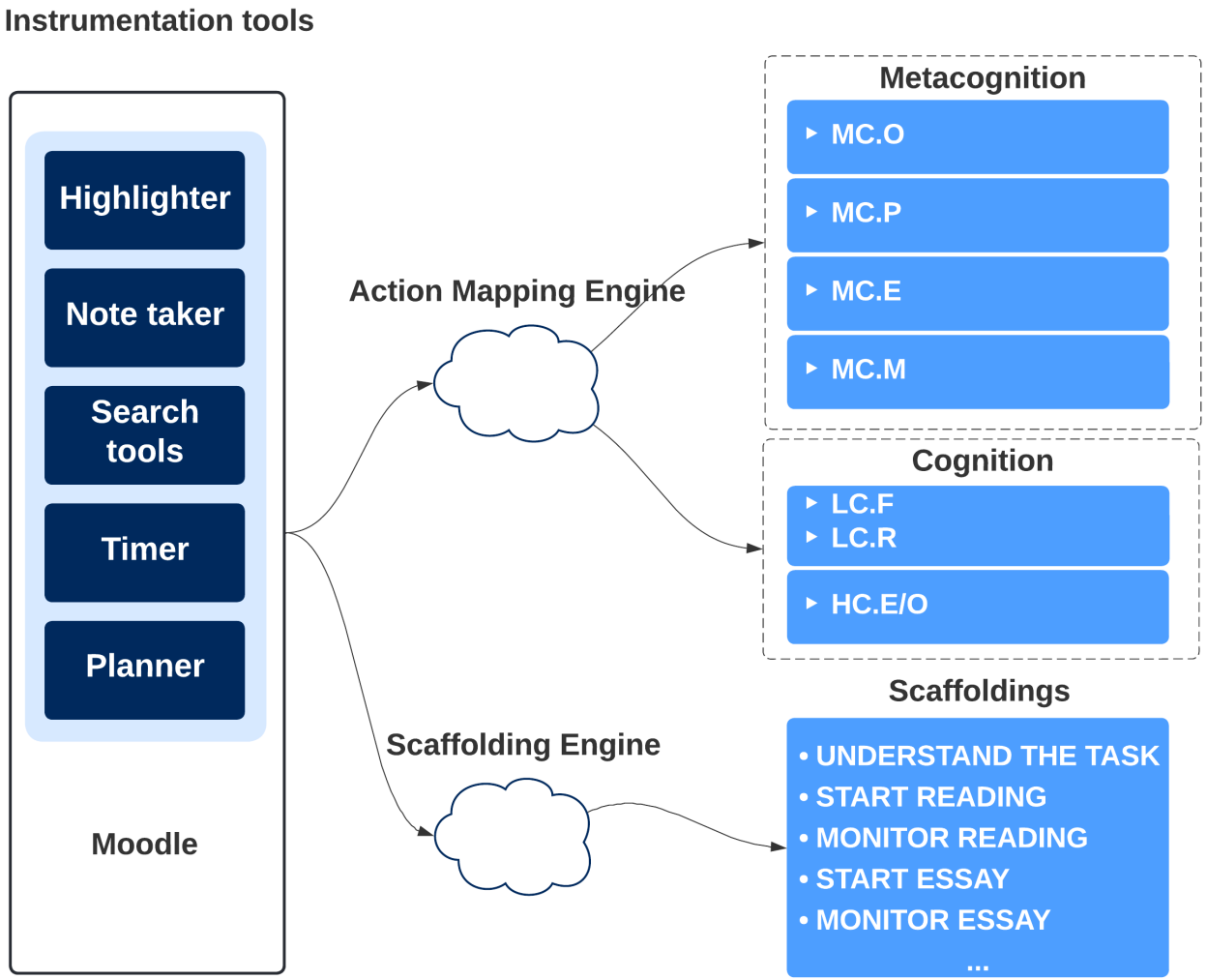
Martinez-Maldonado, R., Gašević, D., Echeverria, V., Fernandez Nieto, G., Swiecki, Z., & Buckingham Shum, S. (2021). What Do You Mean by Collaboration Analytics? A Conceptual Model. *Journal of Learning Analytics*, *8*(1), 126-153.

Mapping trace data to processes



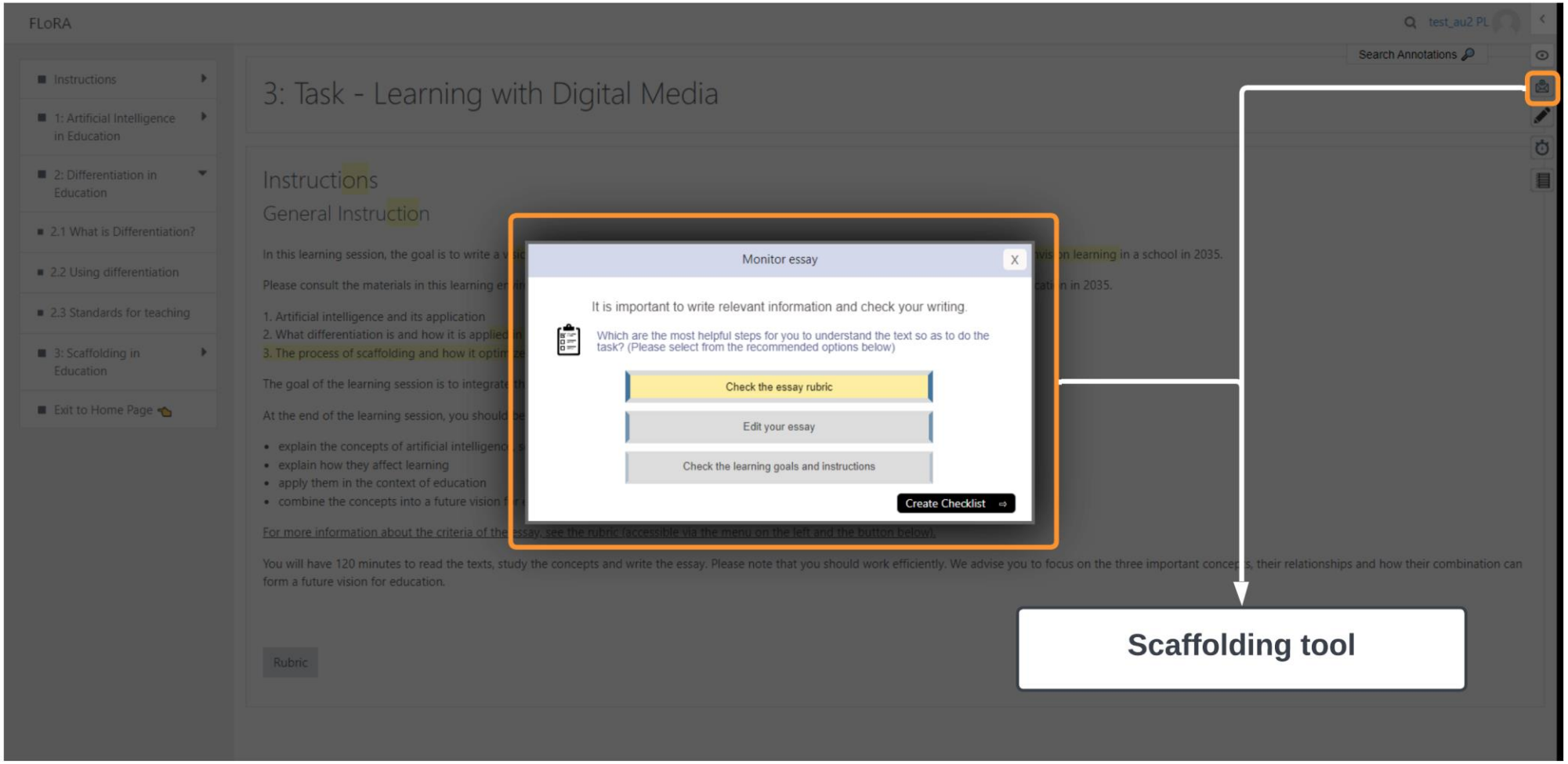
van der Graaf, J., Lim, L., Fan, Y., Kilgour, J., Moore, J., Bannert, M., ... & Molenaar, I. (2021). Do instrumentation tools capture self-regulated learning?. In *Proceedings of the 11th International Learning Analytics and Knowledge Conference* (pp. 438-448).

Analytics-based personalized scaffolding



Srivastava, N., Fan, Y., Rakovic, M., Singh, S., Jovanovic, J., van der Graaf, J., ... & Gašević, D. (2022). Effects of Internal and External Conditions on Strategies of Self-regulated Learning: A Learning Analytics Study. In *Proceedings of the 12th International Learning Analytics and Knowledge Conference* (pp. 392-403).

Analytics-based personalized scaffolding



Srivastava, N., Fan, Y., Rakovic, M., Singh, S., Jovanovic, J., Van Der Graaf, J., ... & Gasevic, D. (2022). Effects of Internal and External Conditions on Strategies of Self-regulated Learning: A Learning Analytics Study. In *Proceedings of 12th International Learning Analytics and Knowledge Conference* (pp. 392-403).

Open challenge

Integrating personalized scaffolds into task design

Fan, Y., Li, T., Tsai, Y-S., Rakovic, M., Singh, S., Li, X.,… Gašević, D. (2022). How learners perceive and benefit from personalised SRL scaffoldings: a qualitative study. *Journal of Computer Assisted* learning, submitted.

Opportunity

Analytics to enhance feedback quality

Automatic detection of properties of feedback

Osakwe, I., Chen, G., Whitelock-Wainwright, A., Gašević, D., Cavalcanti, A. P., & Mello, R. F. (2022). Towards automated content analysis of educational feedback: A multi-language study. *Computers and Education: Artificial Intelligence, 3*, 100059.

Opportunity

Towards automatic feedback

Cavalcanti, A. P., Diego, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Ferreira Mello, R. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, 2, 100027.

Opportunity

Towards automatic feedback

Automatic feedback increases student performance

Cavalcanti, A. P., Diego, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Ferreira Mello, R. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, 2, 100027.

Opportunity

Towards automatic feedback

No evidence that

human feedback is more effective than automatic feedback

Cavalcanti, A. P., Diego, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Ferreira Mello, R. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, 2, 100027.

Challenges

Towards automatic feedback

No evidence that automatic feedback eases instructors' workload

Cavalcanti, A. P., Diego, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Ferreira Mello, R. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, 2, 100027.

Challenges

Towards automatic feedback

Main method used for automatic feedback provision is the comparison with a desired answer in some subject

Cavalcanti, A. P., Diego, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Ferreira Mello, R. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, 2, 100027.

DATA– MODEL – TRANSFORMATION –

FINAL REMARKS

Stop the game of low hanging fruit and start measuring what matters

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Moving away from the idea of *homogenous* learner models

Human-centred learning analytics

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Unlocking the full potential

Next critical steps for learning analytics

Dragan Gašević
@dgasevic

Oct 20th, 2022
Hong Kong Metropolitan University
[Online]