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Learning Analytics and Learning Design: Empirical Studies and Future Plans

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Culture Computing and Multimodal Information Research

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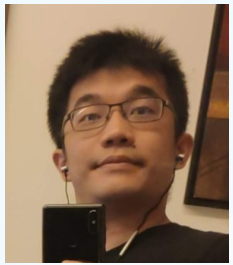
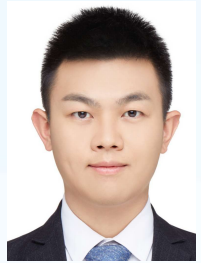

Zuo Wang


Ruilun Liu


Ying Zhao


Chao Wang

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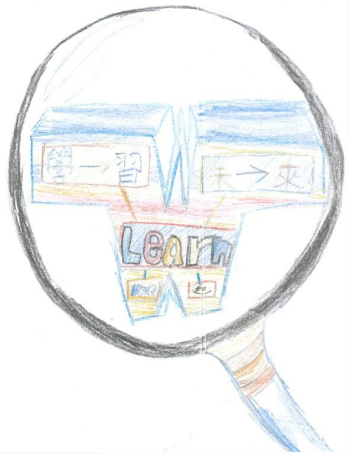
University Grants Committee

Outline

- **LA, LD and the Connections**
- LA Projects
  - Collaborative learning analytics: Wikiglass
  - Maker learning analytics: LAVR/CLEVR
- IDEALS - Towards Successful Integration of LA & LD
  - An Example
- Future Opportunities and Challenges



Poll: Learning Analytics (LA)

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LA is for _____ learning.

A. "supporting"
B. "understanding"
C. "analyzing"
D. "visualizing"
E. All of the above

LEARNING ANALYTICS is the measurement, collection, analysis and reporting of data about *learners and their contexts*, for purposes of understanding and optimising *learning and the environments* in which it occurs.

---- SoLAR, 2011

LA and The LA Loop

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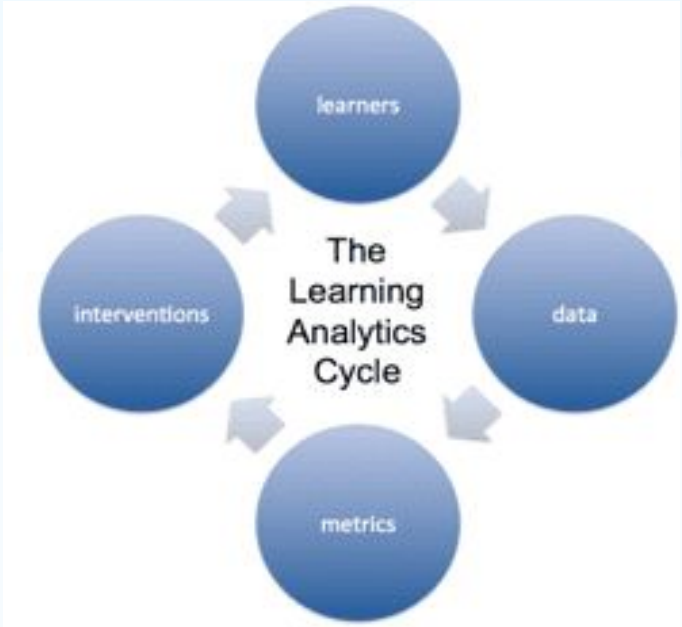
- Two bases
  - Learners' data
  - Analytic methods
- Dual roles
  - Understanding learning
  - Improving learning
- (Untold) Underpinning
  - Learning theories
- Applications:
  - Student/teacher/admin-facing dashboards
  - Adaptive systems
  - …



Clow, D. (2012). The learning analytics cycle: closing the loop effectively. *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*.

Subdomains in Learning Analytics

- Visual analytics
- Writing analytics
- Predictive learning analytics
- Multimodal learning analytics
- Collaborative learning analytics
- Maker learning analytics
- …

Koh, E. & Hu, X. (2023). Learning analytics for learning: Emerging international trends and case studies from the Asia Pacific. In *The Springer International Handbook on Educational Development in the Asia Pacific*. Springer.

Collaborative Learning Analytics

To enhance collaborative learning

Computer-supported Collaborative Learning (CSCL)

- Support **knowledge co-construction** (Kwon et al., 2014)
- Enhance **interaction** skills and **critical thinking**
  - In line with **socio-constructivist** approach
- Complex (Chu et al., 2013)
  - Multi-levels: group, individual
  - Participation, contribution, interaction
  - Co-evolution across time

A Typical Wiki

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5. When was this page last edited

4. Who last edited this Wiki page

6. View revision history

2. Content

1. Sidebar (for navigation)

3. Authors of this page

Wiki Revision Page

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Select two versions for comparison

1. Date and time of a revision
2. Who did this revision
3. Latest word count
4. No. of words added/deleted in this revision

"Cancel" this version
(i.e., revert to an earlier version)

Learning Analytics in CSCL Environment

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- Scaffold student collaboration (Chu et al., 2013; Hmelo-Silver & Jeong, 2021)

- Monitor learning progress

- Provide sustainable feedback throughout the process

A pioneering learning analytic tool
© 2015 – 2023

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Wikiglass

Innovations in Wikiglass

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Target users:	Languages	Wiki platforms	Wiki content

• Teachers and students from
  • **Secondary schools**
  • **Primary schools**
	• English
	• **Chinese**
		• PBworks
		• BlueSpice
		• Moodle Wiki
		• ….
			• Quantity
			• **Quality**
			• **Originality**

Two secondary schools in HK
Two primary schools in HK and mainland China
12 grades, 48 classes
One university in HK

Video demonstrations: http://ccmir.cite.hku.hk/index.php/wikiglass/

System Architecture of Wikiglass

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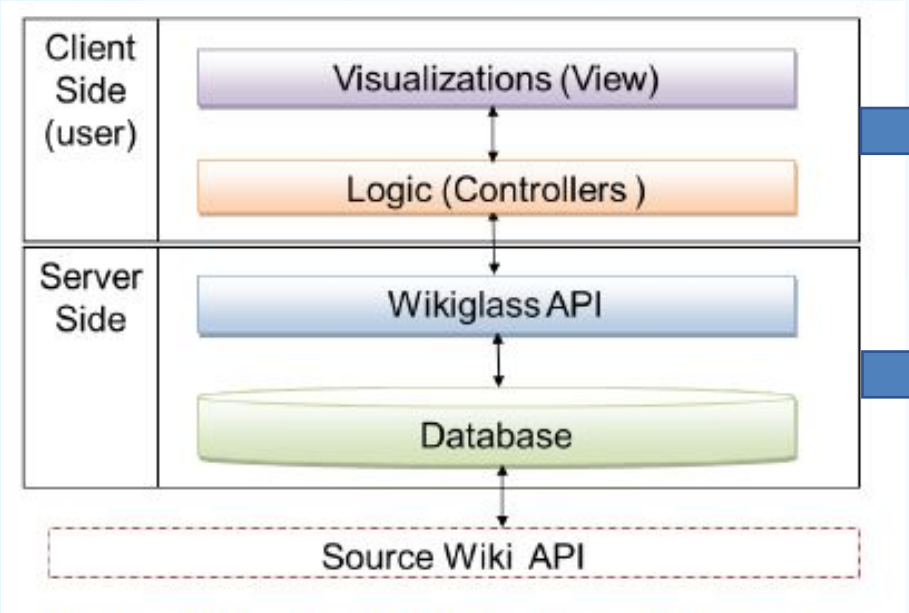


Data Processing and Visualizations

Data collection and preprocessing

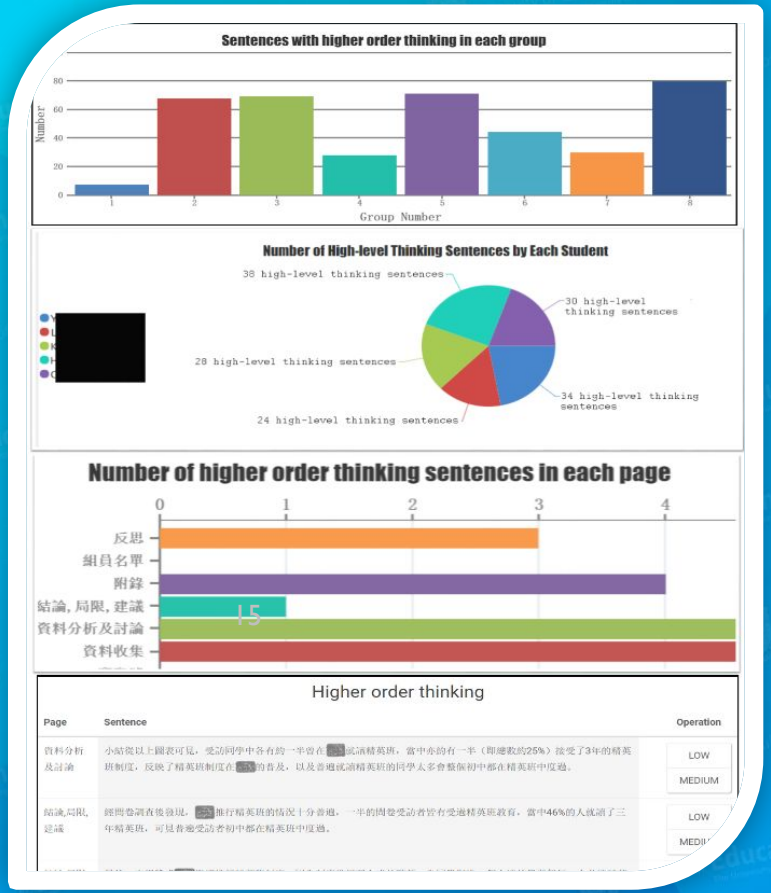
Raw data from Wiki:

1. **Student information**
2. **Page content**
3. **Revision record**

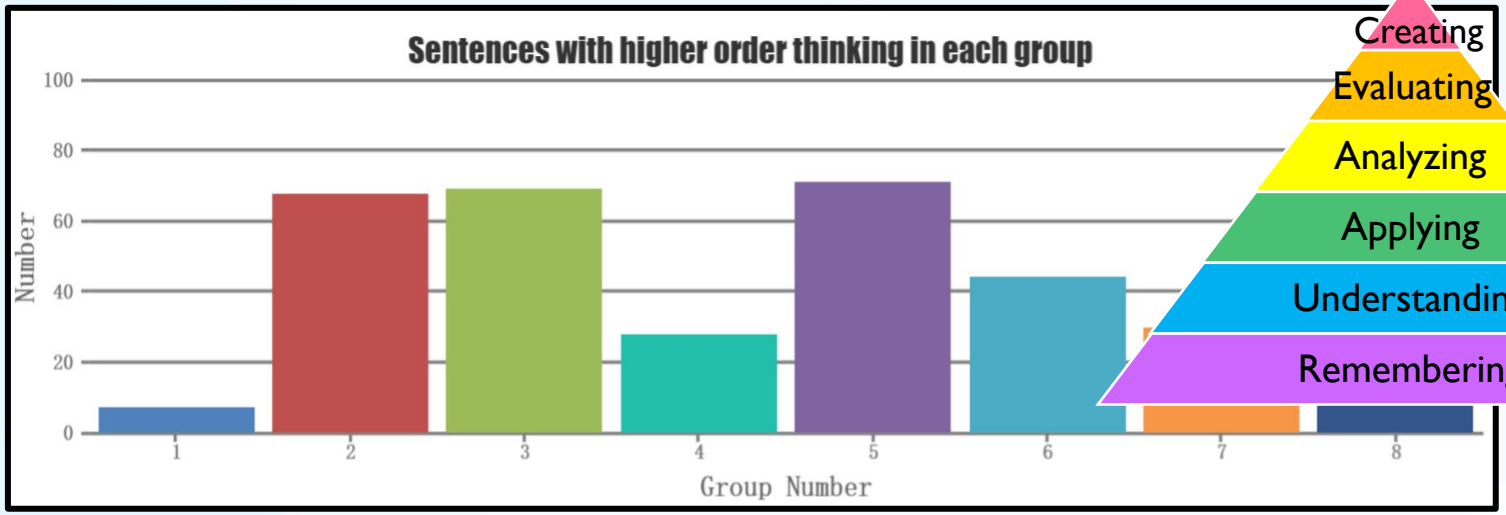
Hu, X., Ip, J., Sadaful, K., Lui, G., & Chu, S. (2016, April). Wikiglass: a Learning Analytic Tool for Visualizing Collaborative Wikis of Secondary School Students. In *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge, LAK'16*, pp. 550-551. ACM.

Statistics Mode

STATISTICS | TIMELINE



Quality of Contribution



High

Mid

Low

Hu, X. (2017). Automated recognition of thinking orders in secondary school student writings. *Learning: Research and Practice*, 3(1), 30-41.

Categories adapted from Bloom Taxonomy

Original	Category	Semantic interpretation	Description	Possible purposes of writing
Level 1 Level 2	Level 1	Knowledge and comprehension (data gathering)	The students describe the facts, understandings, feelings, actions and experiences from resources gathered through investigation or second-hand materials	Definition, information statement, action description and so on
Level 3 Level 4	Level 2	Analysis (data analysis)	The students attempt to deconstruct the investigation experience, analyse evidences, differentiate/contrast results and causes, and so on	Data interpretation, comparison and so on
Level 5 Level 6	Level 3	Synthesis and evaluation (conclusion drawing)	The students attempt to draw conclusions, propose suggestions and new ideas, evaluate alternative solutions	Reasoning, argumentation, evaluating and so on

Feature Engineering

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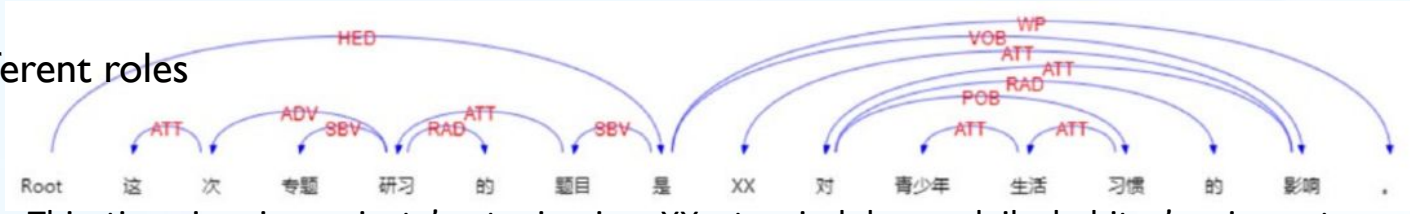
- Lexical
  - Ngram and Skipped Ngram, POS tagging
- Syntactic roles
  - terms with different roles



- Semantic relations

Qiao, C., & Hu, X. (2019). Text classification for cognitive domains: A case using lexical, syntactic and semantic features. *Journal of Information Science*

Interactions of Group Members

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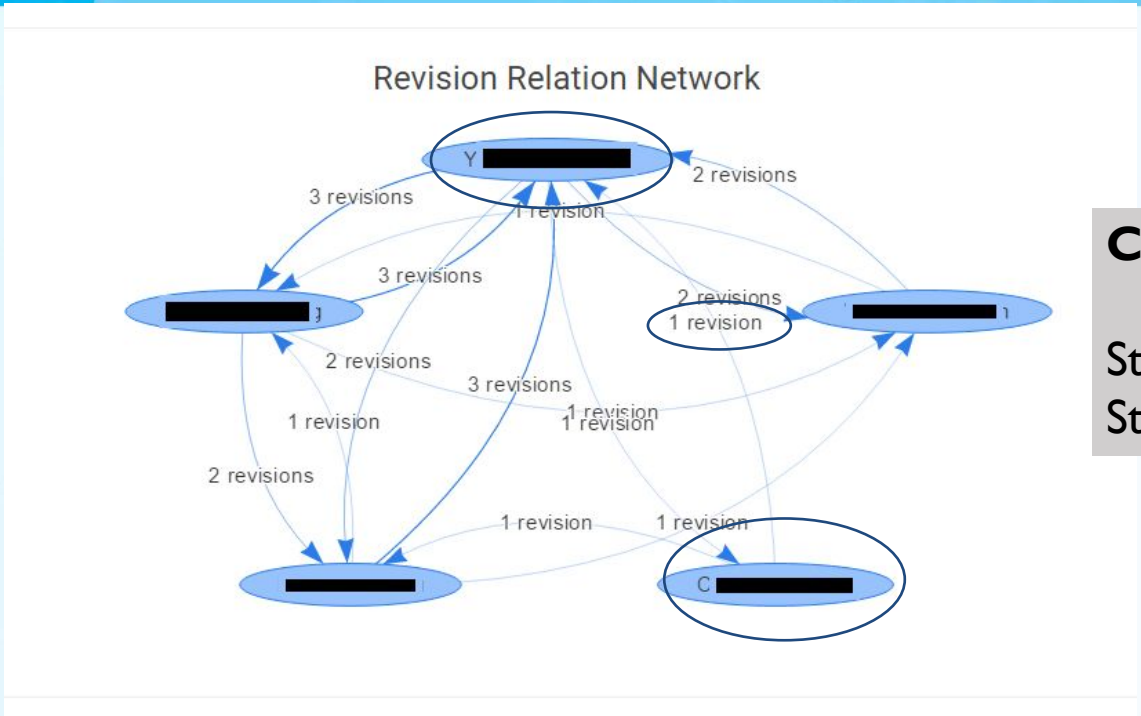
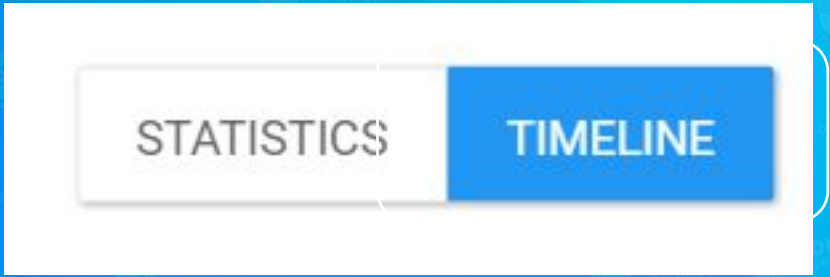


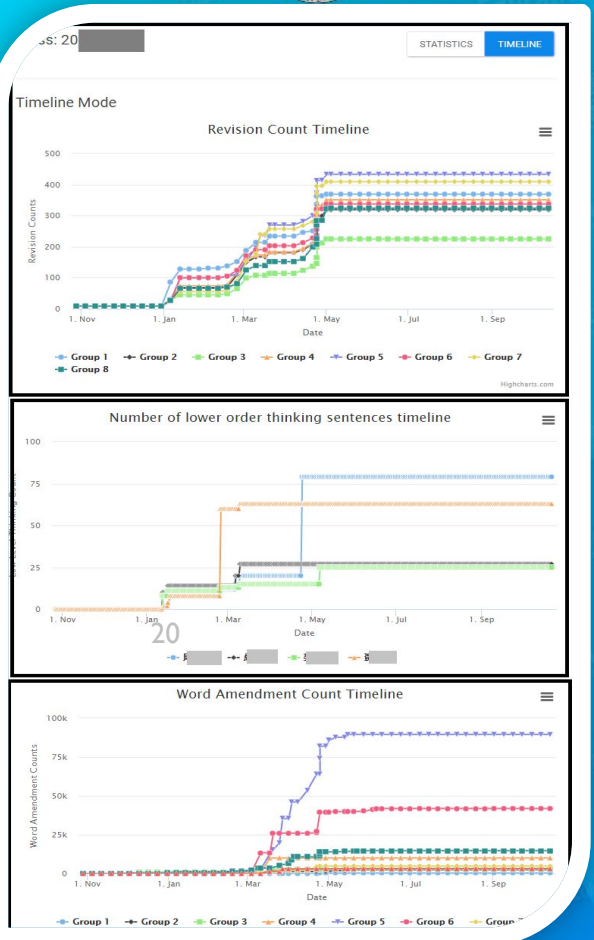
Collaborative work

Student C has **revised** Student Y's work

Hu, X., Yang, C., Qiao, C., Lu, X., & Chu, S. K. (2017). New Features in Wikiglass, a Learning Analytic Tool for Visualizing Collaborative Work on Wikis. In *Proceedings of the 7th International Learning Analytics & Knowledge Conference (LAK'17)*, Vancouver, Canada, 616-617. ACM.

Timeline Mode





Classroom Interventions

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	Study 1	Study 2	Study 3	Study 4
Context	A government-subsidized secondary school in Hong Kong	A secondary school with a high banding in Hong Kong	An **under-resourced** primary school in mainland China	A government-subsidized primary school in Hong Kong
People	**S.1 to S.3 (grades 7 – 9)**	**S.4 (grade 10)**	**Grade 5**	**Grade 5**
Subject(s)	**Liberal Studies**	**Chinese Language**	1. **Chinese** 2. **Mathematics**	**General Studies**
Project nature	A semester-long **group inquiry project** on a current issue	1. Group **argumentative** writing exercise 2. Individual writing exercise	Multiple exercises on **assigned topics**	A semester-long **group inquiry project** on science

Summary of Findings

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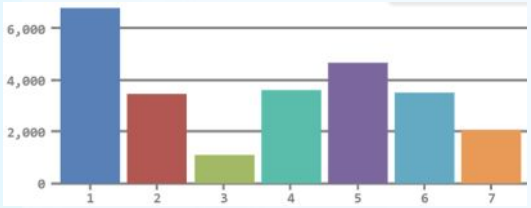
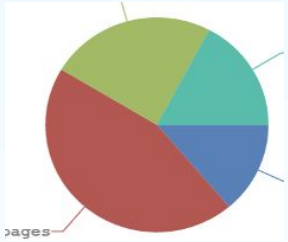
- Social influence of LA-enabled **group awareness information**



Inter-group



Intra-group

- Facilitates regulations: self-regulation; co-regulation; socially-shared regulation
- Considerations in LA design and implementation

Hu, X., Ng, J. & Chu, S. (2022). Implementing learning analytics in wiki-supported collaborative learning in secondary education: A framework-motivated empirical study. *International Journal of Computer-Supported Collaborative Learning.*

Subdomains in Learning Analytics

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- Visual analytics
- Writing analytics
- Predictive learning analytics
- Multimodal learning analytics
- Collaborative learning analytics
- **Maker learning analytics**
- …

Koh, E. & Hu, X. (2023). Learning analytics for learning: Emerging international trends and case studies from the Asia Pacific. In *The Springer International Handbook on Educational Development in the Asia Pacific*. Springer.

Maker Learning Analytics

To enhance maker activities

Virtual Reality (VR) Content Creation as A Maker Activity

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- VR in Education (Huang & Liaw, 2018)
  - *Constructivist,* multi-sensory
  - Immersive, interactive, imaginary
- Maker activity: Student agency & higher-order competencies
  - *Constructionist* approach: Learners as **creators** (Lin et al., 2020)
  - Authentic: Create real-world products
- **VR Creation**: VR + Maker activity (Hu, Ng & Lee, 2019; Ng, Wang & Hu, 2022)

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Design LA Support: Need Analysis

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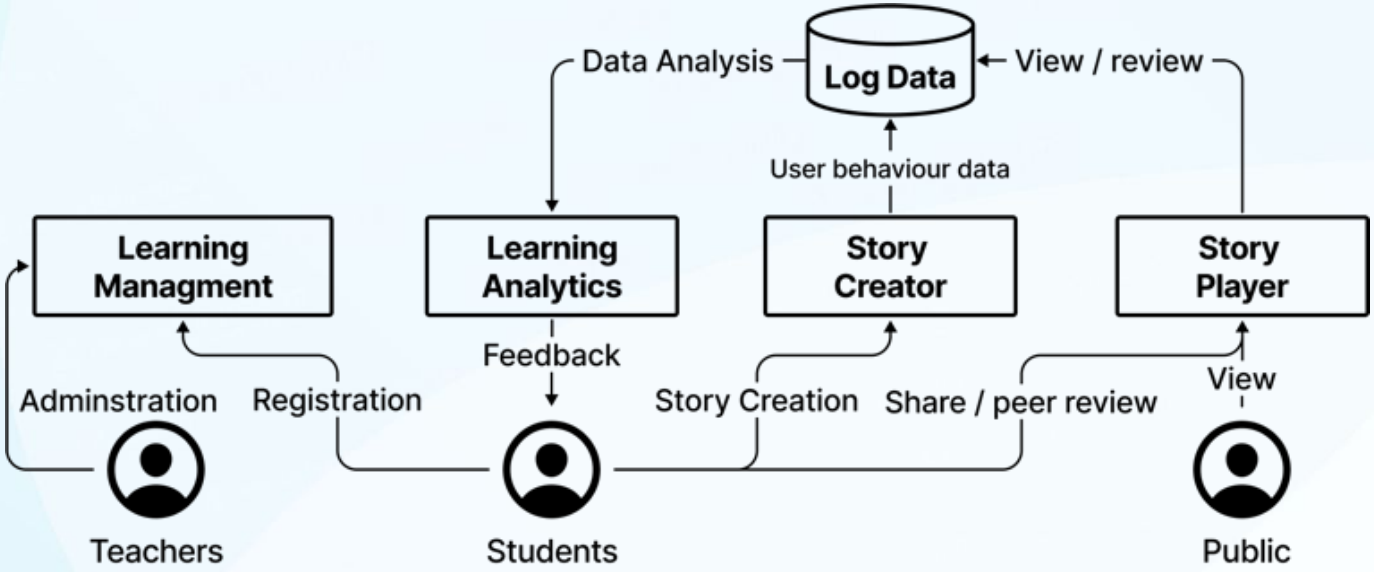
- Method: Interview (N = 27 with high, mid, low performances)
  - Based on Zimmerman's (2013) Self-Regulated Learning (SRL) model
    e.g., "How did you monitor your progress during VR content creation?"
  - Grounded Theory based content analysis

- Need support for monitoring and reflection; improving artefacts

Ng, J. T. D., Wang, Z., & Hu, X. (2022). Needs analysis and prototype evaluation of student-facing LA dashboard for virtual reality content creation. In *LAK22: 12th International Learning Analytics and Knowledge Conference* (pp. 444-450).

LAVR: a Learning Analytics enabled VR content creation platform



Wang, Z., Ng, J. T. D., Liu, R. & Hu, X. (Jul. 2022). Learning analytics enabled virtual reality content creation platform: System design and preliminary evaluation. *The 22nd IEEE International Conference on Advanced Learning Technologies (ICALT).*

LAVR Platform

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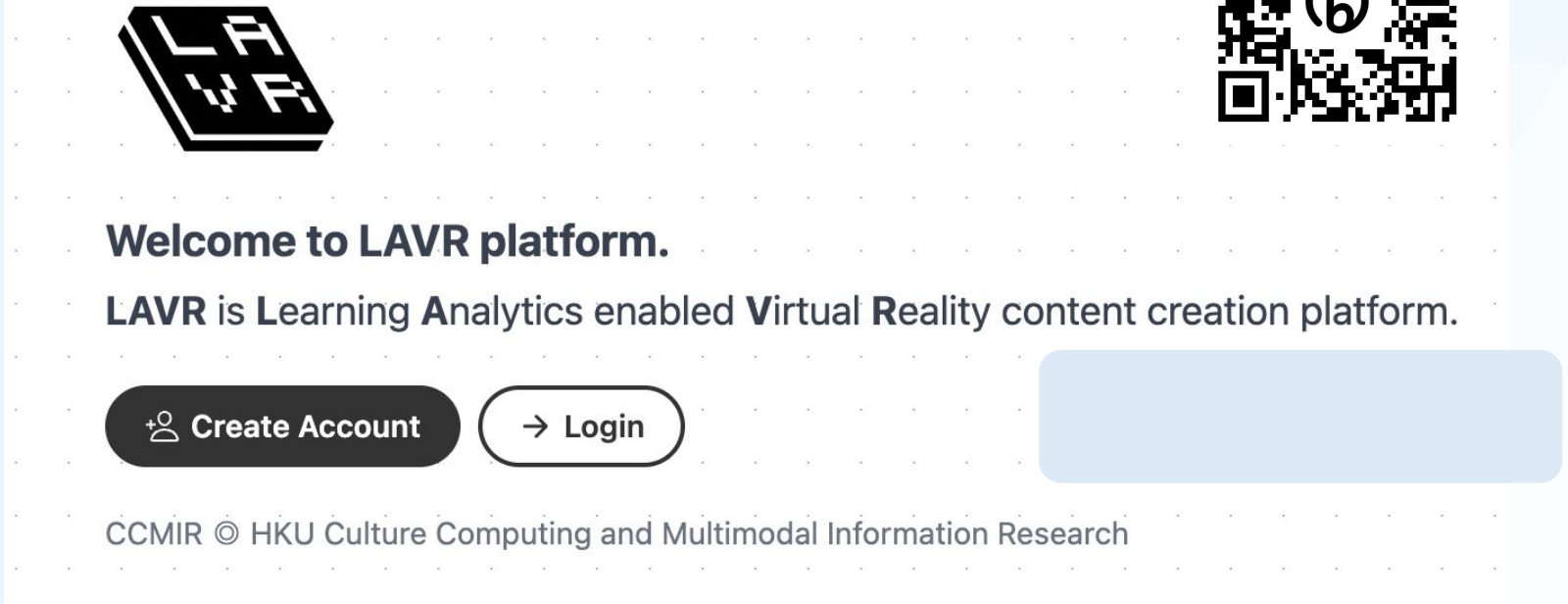
https://lavrplatform.com/



“WYSIWYG” Editor

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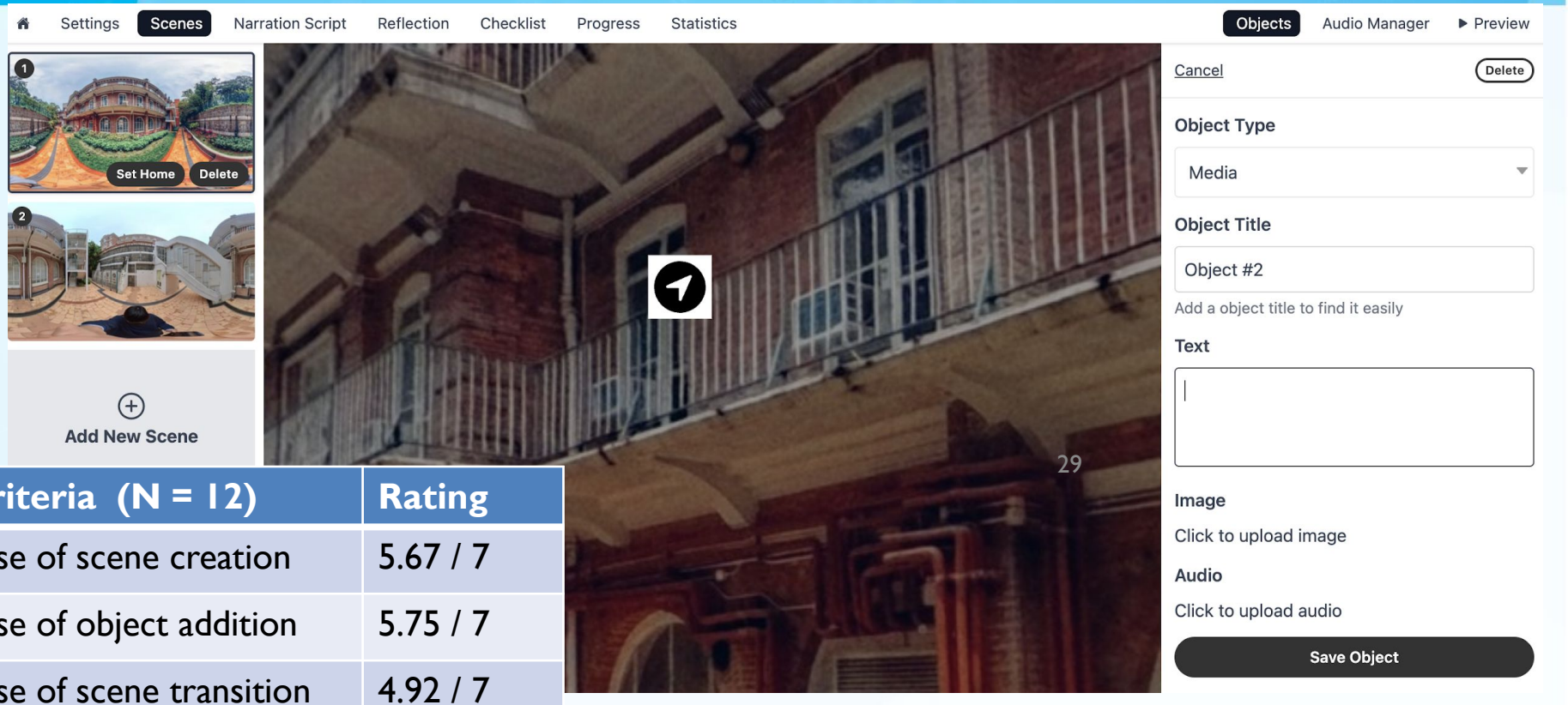

Criteria (N = 12)	Rating
Ease of scene creation	5.67 / 7
Ease of object addition	5.75 / 7
Ease of scene transition	4.92 / 7

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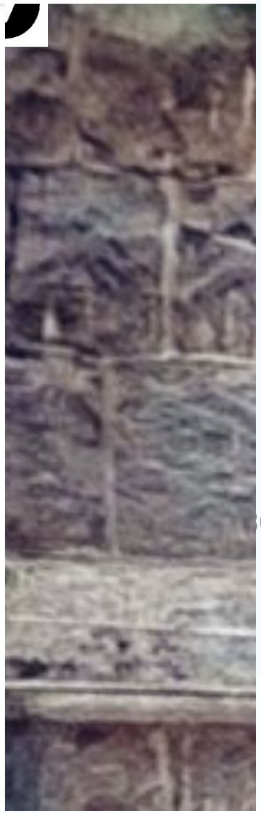
Settings | Scenes | Narration Script | Reflection | Checklist | Progress | Statistics

Script | **Feedback**

Eliot Hall stood the test of time and still represented a dignified presence on the campus, even with the advent of technology like big data. It was interesting to think about how big data could be used to protect cultural heritage sites such as Eliot Hall, where valuable architectural history was at risk of being lost. The intricacies of historical buildings like Eliot Hall and Ruyi, a prop from the Qing Dynasty court drama of the same name, are difficult to document and preserve. However, applying big data technology could enable digital replicas to be generated, providing accurate virtual renditions of their architectural features. This approach could have potential applications in preserving the history and architecture of other iconic buildings, just like how Pokemon Go employed this technology to bring significant cultural sites to life for a new generation.

* The feedback here is **automatically** generated by the system.

Save



Narration Writing Tool

Criteria	Rating
Usefulness of feedback to narration	5.25/7

LAVR (LA for VR creation)

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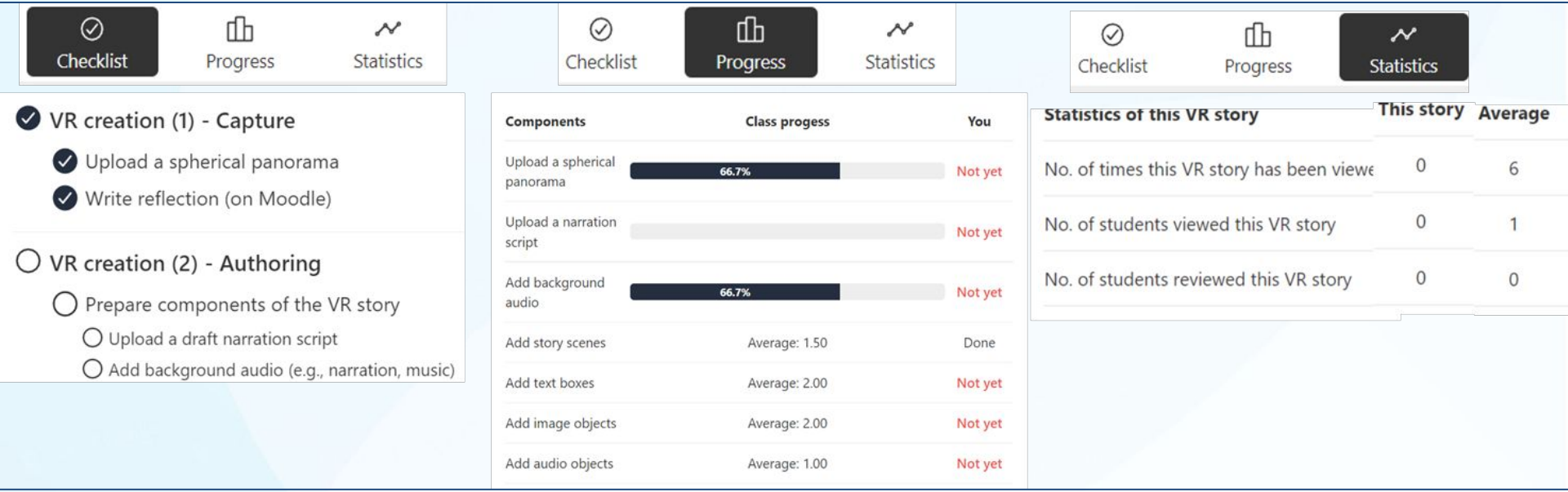
- Support SRL in Maker Activity



Ng, J… Hu, X. (2023). Leveraging LMS logs to analyze self-regulated learning behaviours in a maker-based course. In *LAK'23*.

Ng, J., Wang, Z. & Hu, X. (2022). Needs analysis and prototype evaluation of student-facing LA dashboard for virtual reality content creation. In *LAK'22*.

Student Opinions on LA functions

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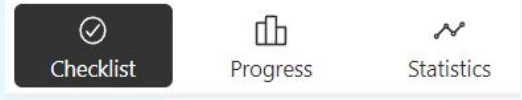


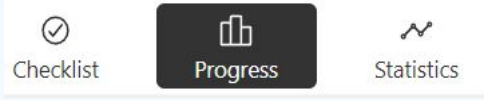
- VR creation (1) - Capture
  - Upload a spherical panorama
  - Write reflection (on Moodle)
- VR creation (2) - Authoring
  - Prepare components of the VR story
    - Upload a draft narration script
    - Add background audio (e.g., narration, music)

An **interactive** function

Useful for **reminding** us about deadlines

Helps me **check and trace my progress**

Motivates me better **manage my time**



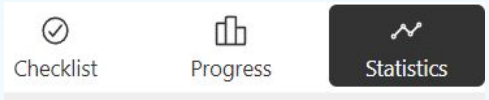
Components	Class progess	You
Upload a spherical panorama	66.7%	Not yet
Upload a narration script		Not yet
Add background audio	66.7%	Not yet
Add story scenes	Average: 1.50	Done
Add text boxes	Average: 2.00	Not yet

This allows me to **compare my progress** with my classmates'

Motivates me to complete the tasks

Sets a rough **expectation** on the work quality

It should be **optionally** displayed



Statistics of this VR story	This story	Average
No. of times this VR story has been viewe	0	6
No. of students viewed this VR story	0	1
No. of students reviewed this VR story	0	0

Criteria	Rating
Usefulness of checklist	5.58/7
Usefulness of progress statistics	5.67/7

Gallery of Student-made VR Stories

Thean Hou Temple (Malaysia)

Using smartphones for VR experience

- Enjoy more VR stories at https://lavrplatform.com/discover

CLEVR: Collaborative Learning

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Multimodal Experiment with CLEVR

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VR Creation for K-12 Schools

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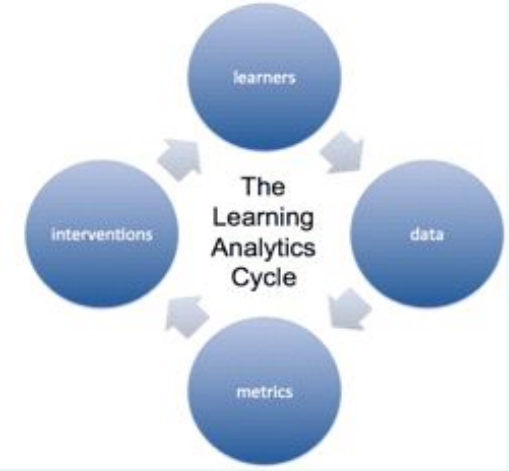
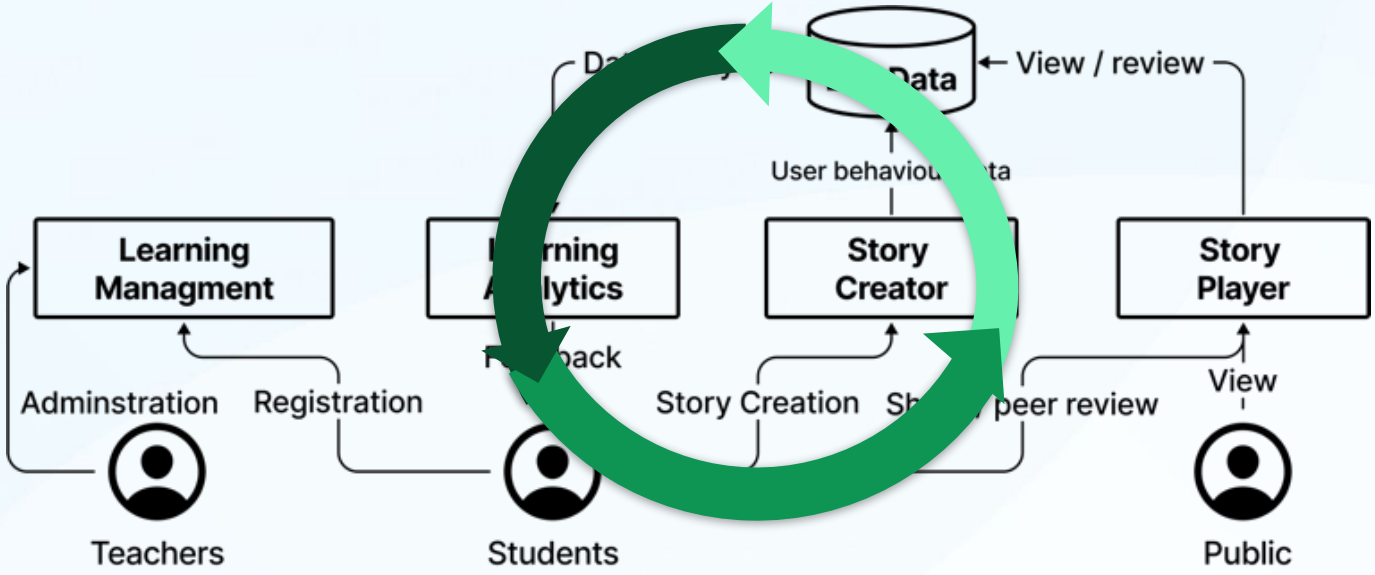
- An environment conservation project
  - 12 primary schools in Hong Kong
- A general research fund project
  - Collaborative VR creation in secondary schools
  - How **learning analytics** can support collaborative VR maker activities

Research Grants Council

Reflection





LAVR Architecture

Wang, Z., Ng, J. T. D., Liu, R. & Hu, X. (2022). Learning analytics enabled virtual reality content creation platform: System design and preliminary evaluation. *The 22nd IEEE International Conference on Advanced Learning Technologies (ICALT)*.

The LA Loop: Updated

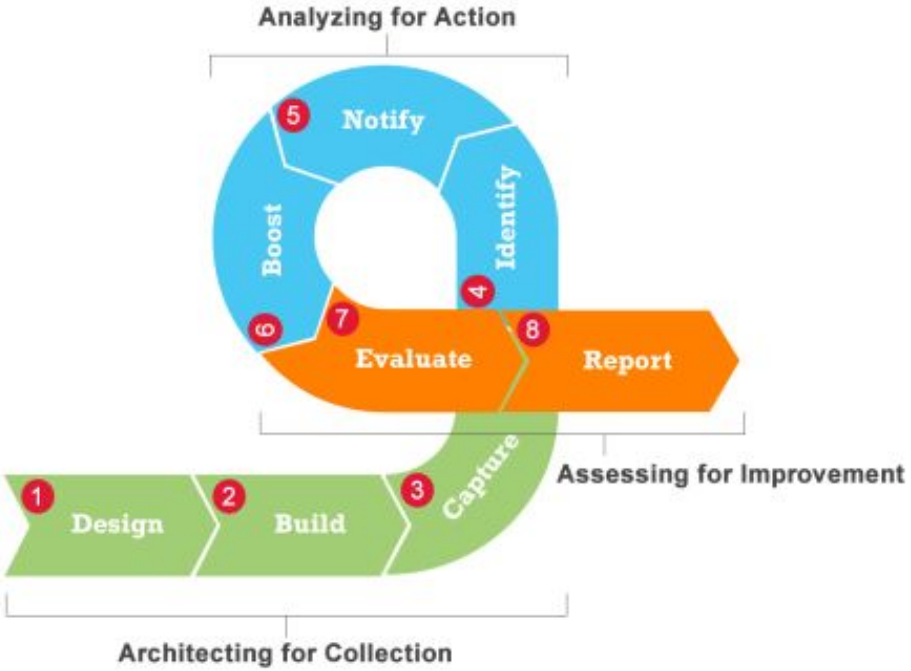


Figure 1: Integrated Closed-loop Learning Analytics Scheme

Syed, M., Anggara, T., Duan, X., Lanski, A., Chawla, N. & Ambrose, G. A. (2018) Learning Analytics Modular Kit: A Closed Loop Success Story in Boosting Students *Proceedings of the International Conference on Learning Analytics & Knowledge*.

LD and Connection with LA

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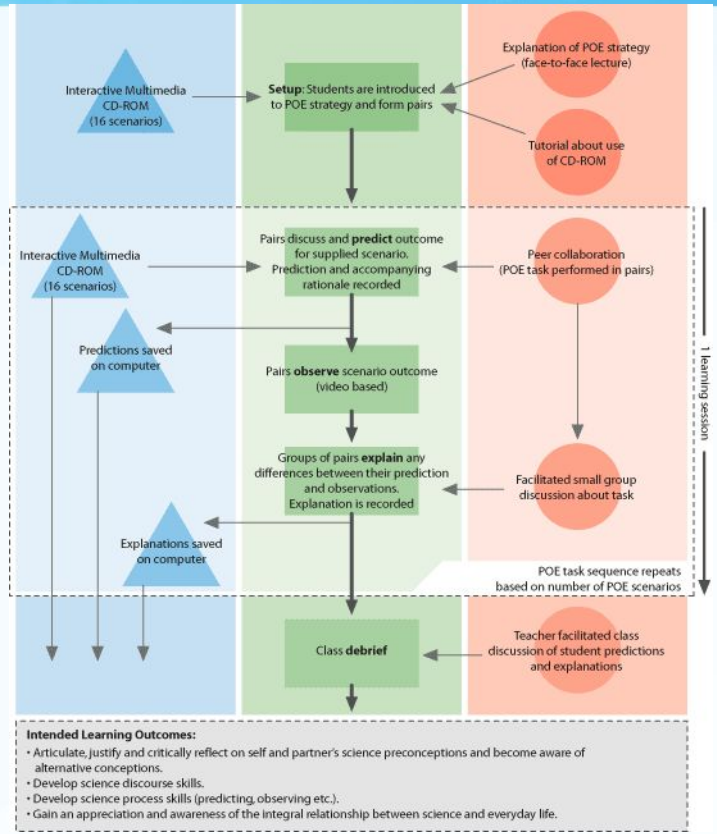
Lockyer, L., & Dawson, S. (2011, February). Learning designs and learning analytics. In *Proceedings of the **1st international conference on learning analytics and knowledge*** (pp. 153-156).

- "Learning Designs are ways of describing an **educational experience**"
- Representation or design language
- Measure of effectiveness



A conceptual framework linking LD with LA

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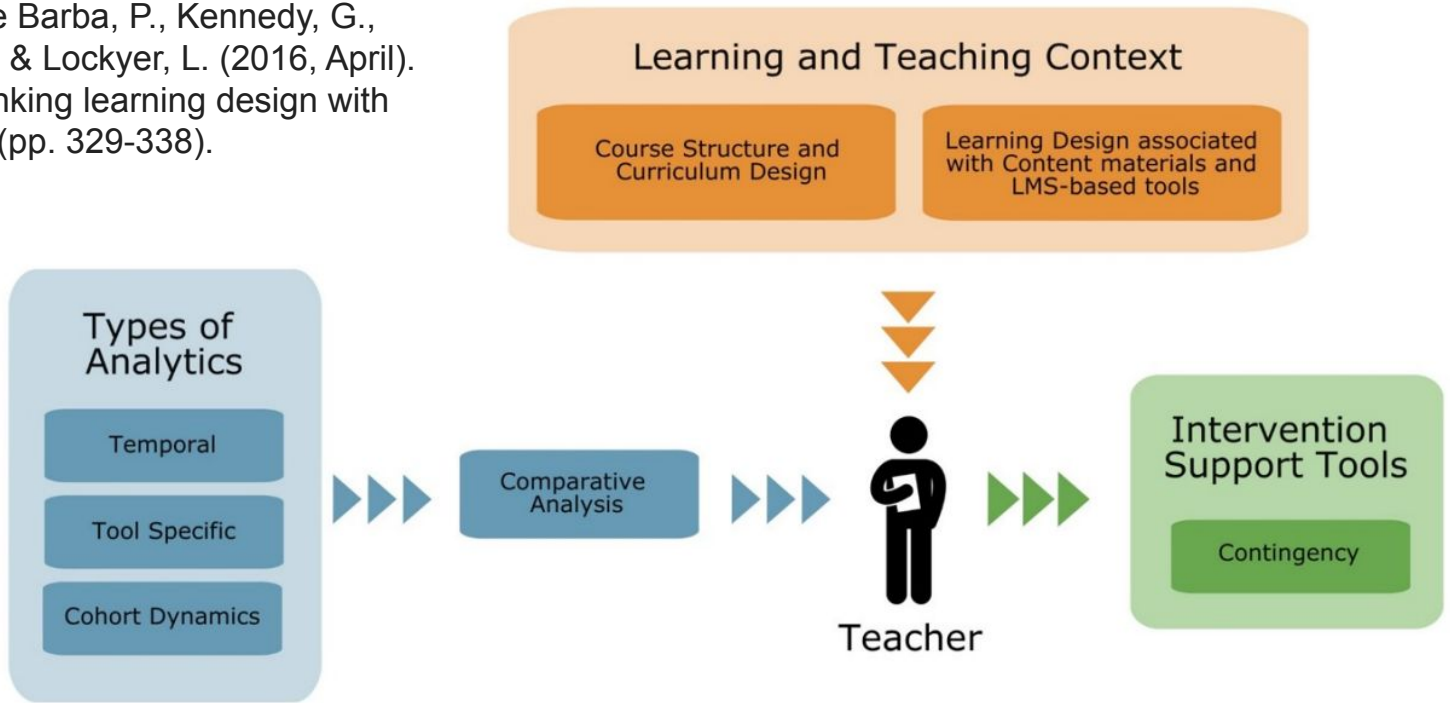
Bakharia, A., Corrin, L., De Barba, P., Kennedy, G., Gašević, D., Mulder, R., ... & Lockyer, L. (2016, April). A conceptual framework linking learning design with learning analytics. In *LAK* (pp. 329-338).



A Layered Framework

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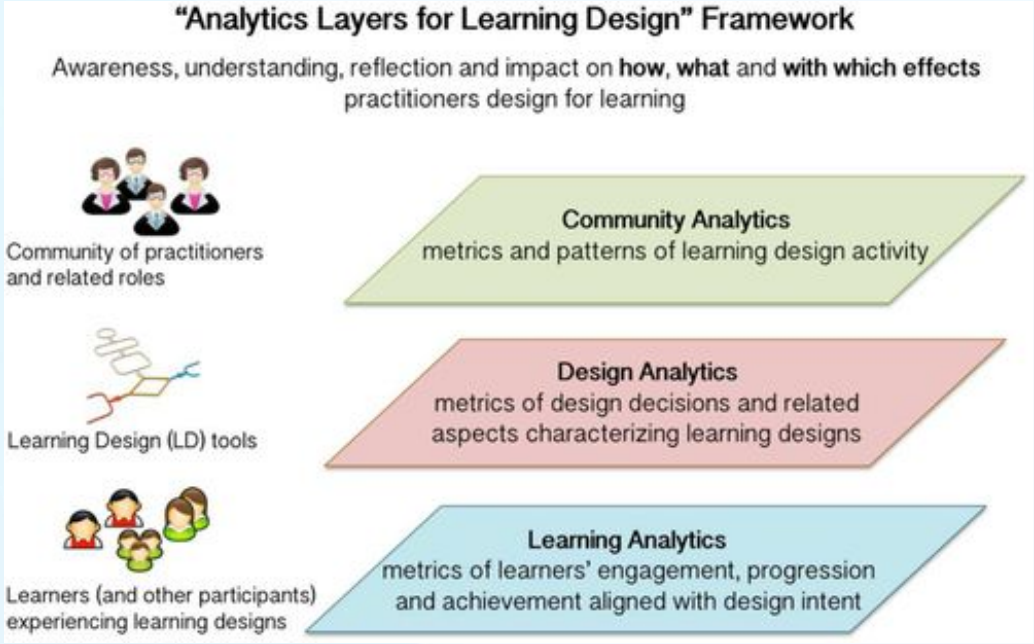
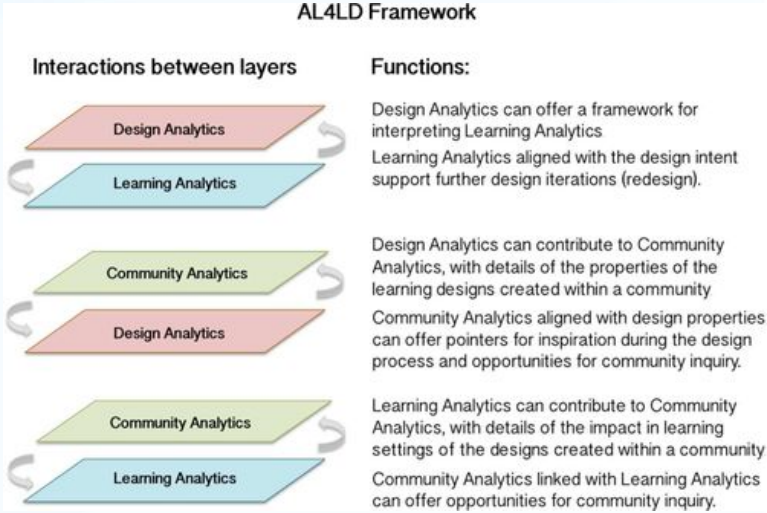
Hernández-Leo, D., Martinez-Maldonado, R., Pardo, A., Muñoz-Cristóbal, J. A., & Rodríguez-Triana, M. J. (2019). Analytics for learning design: A layered framework and tools. *British Journal of Educational Technology*, *50*(1), 139-152.





Outline

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- **IDEALS - Towards Successful Integration of LA & LD**
  - An Example
- Future Opportunities and Challenges

Learning Design Studio@HKU

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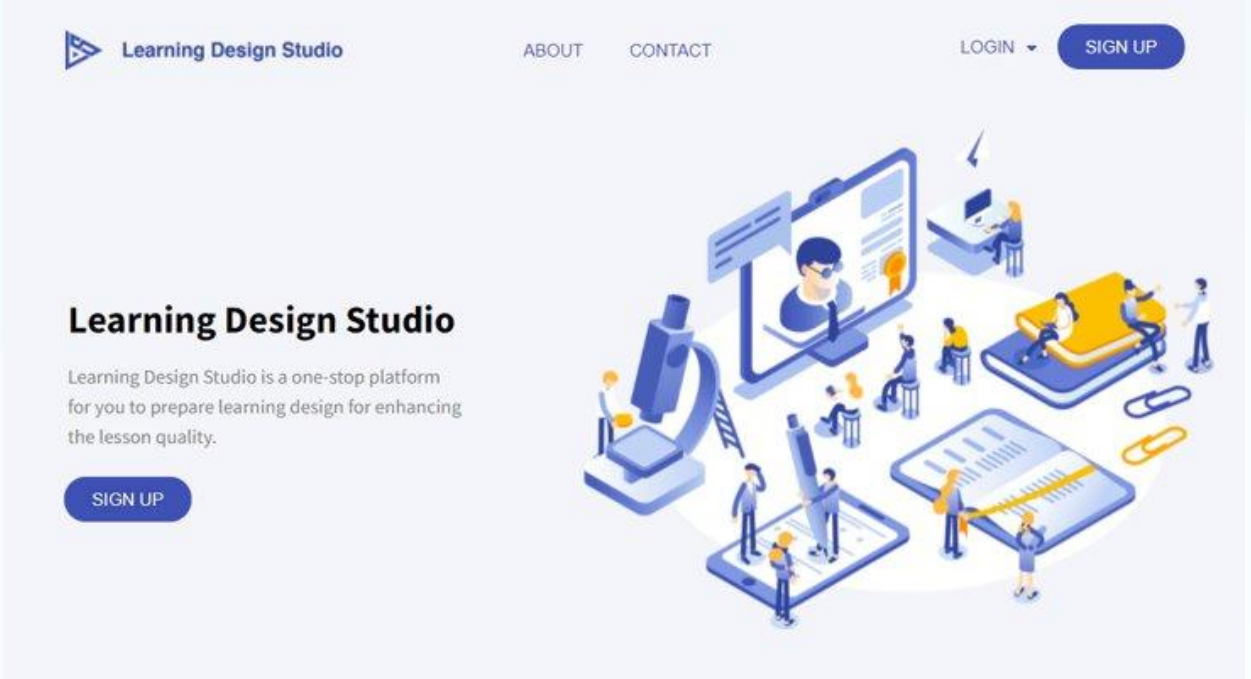
- Design tool
- Design language
- Shared resources & collaboration space for LD community



Learning Design Studio@HKU

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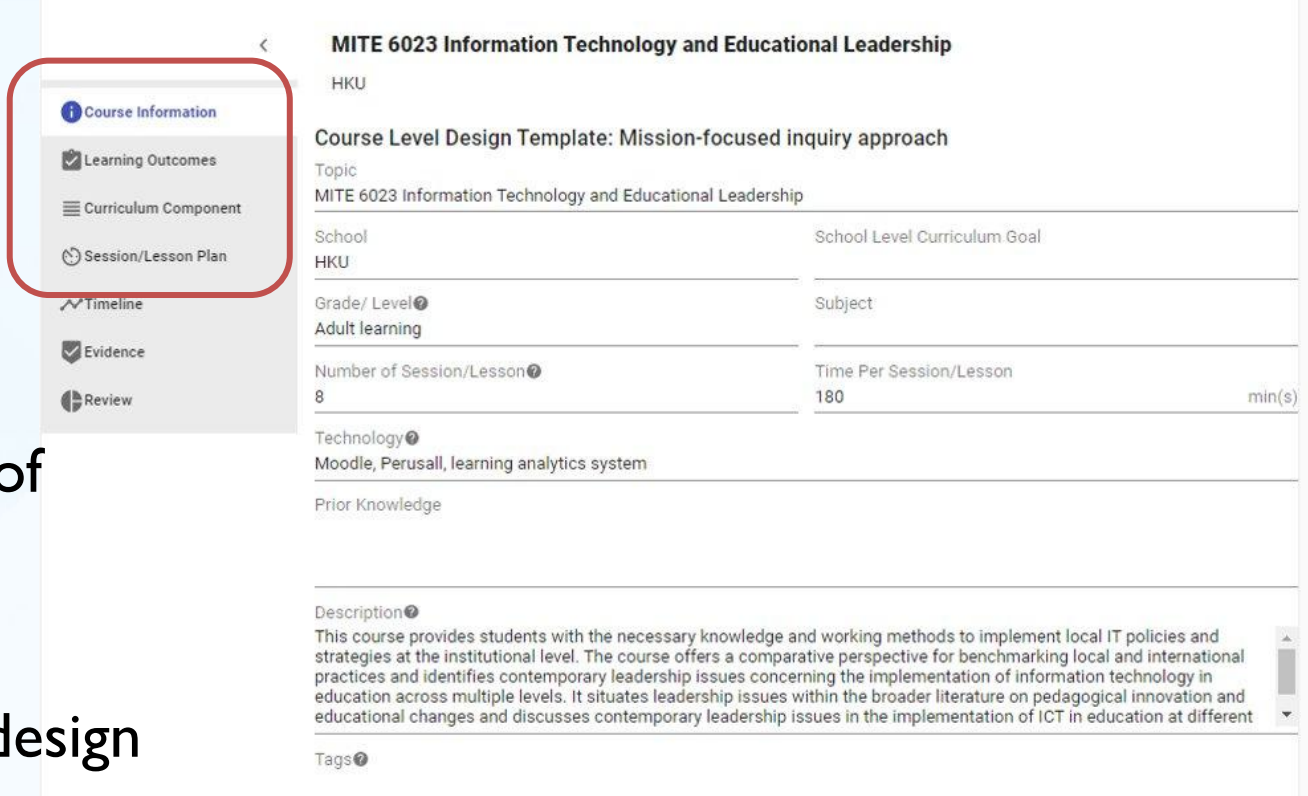
Four levels of design



- Making the levels of design explicit
- Explicit guidance through levels of design

Design Analytics

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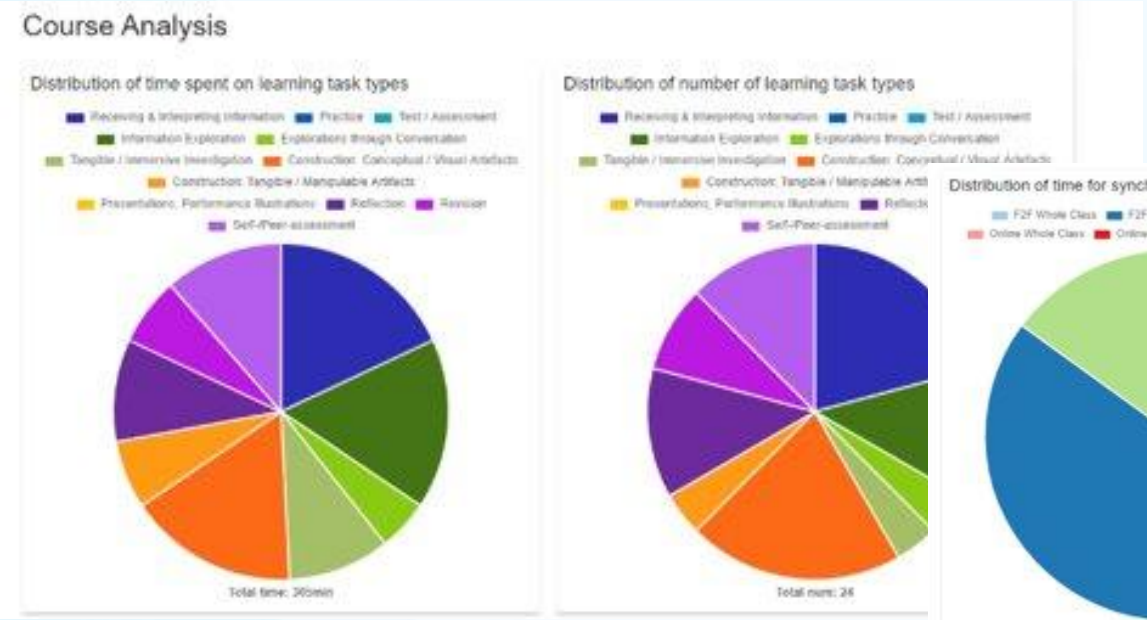

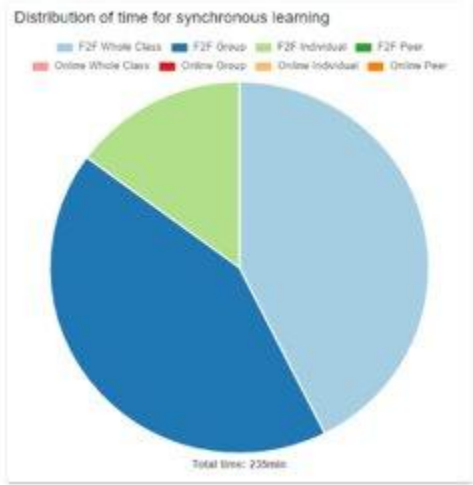

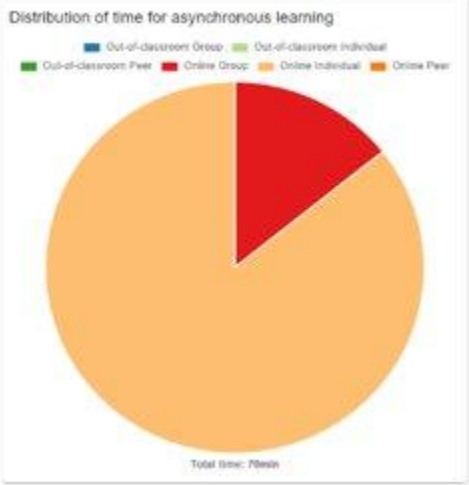

Design Analytics

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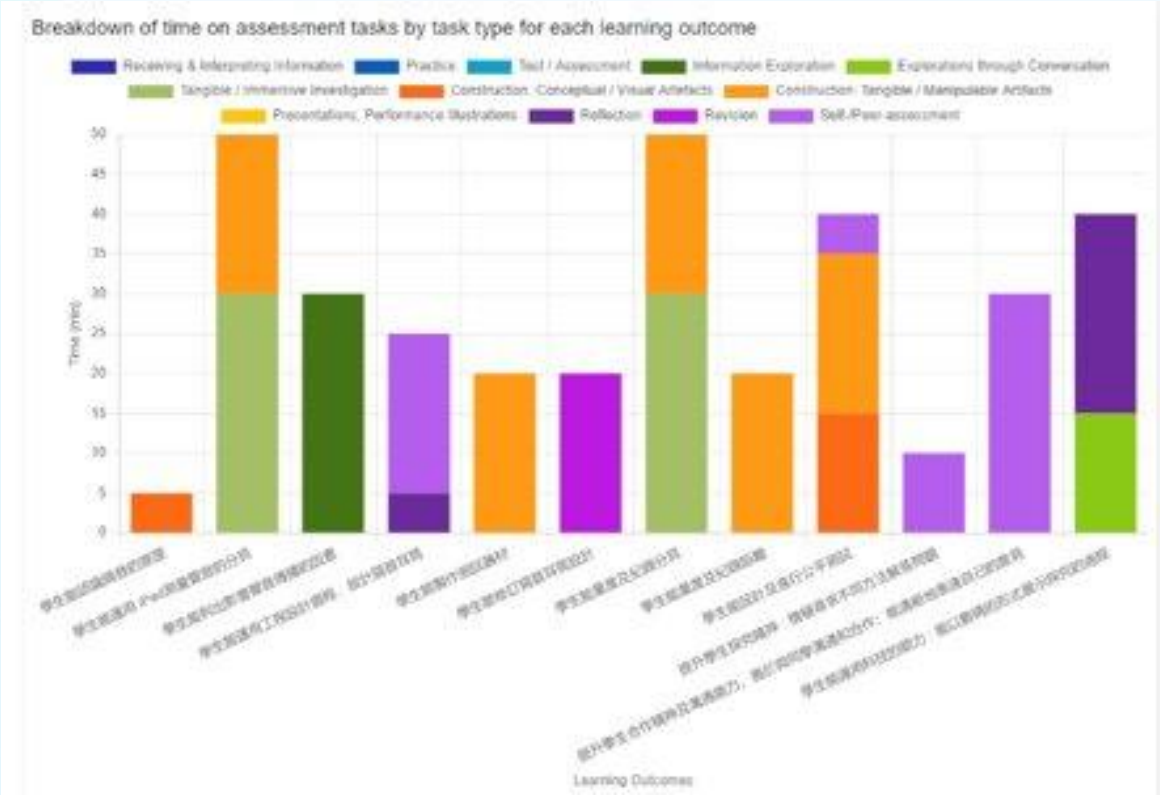

Pattern Library in LDS

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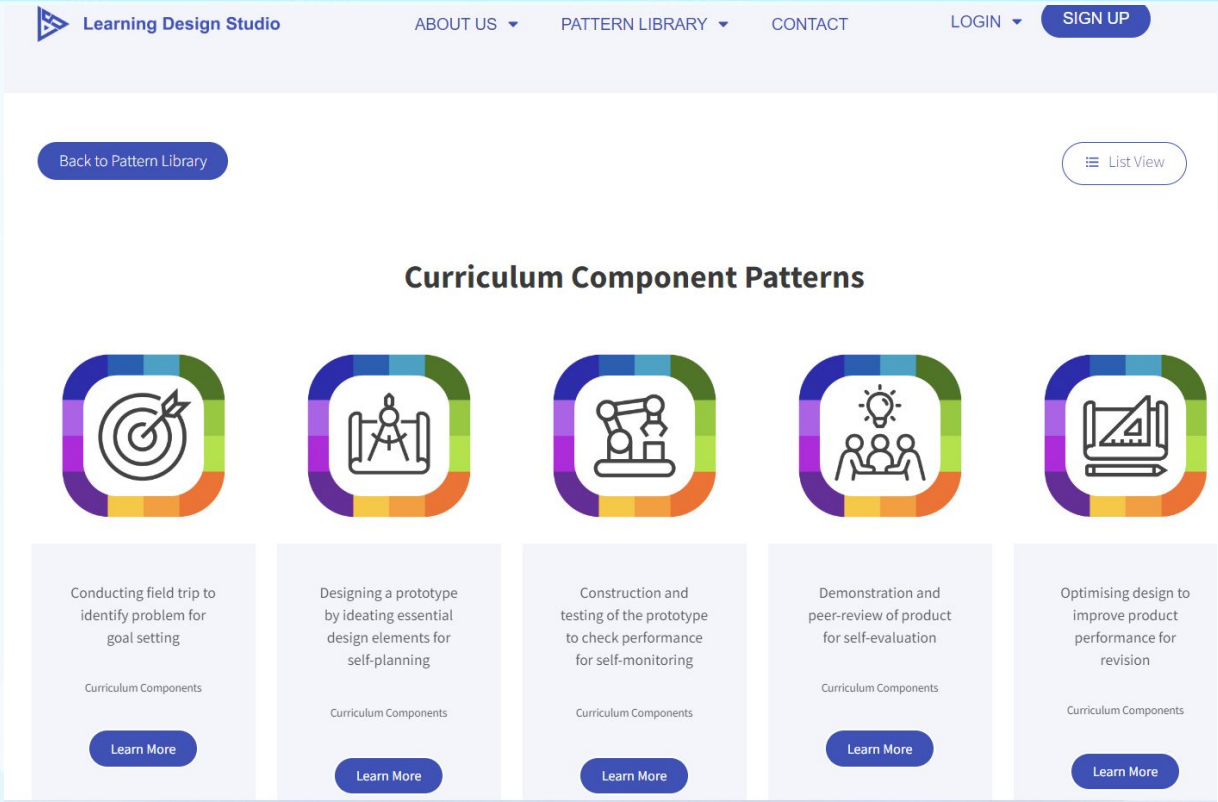

IDEALS

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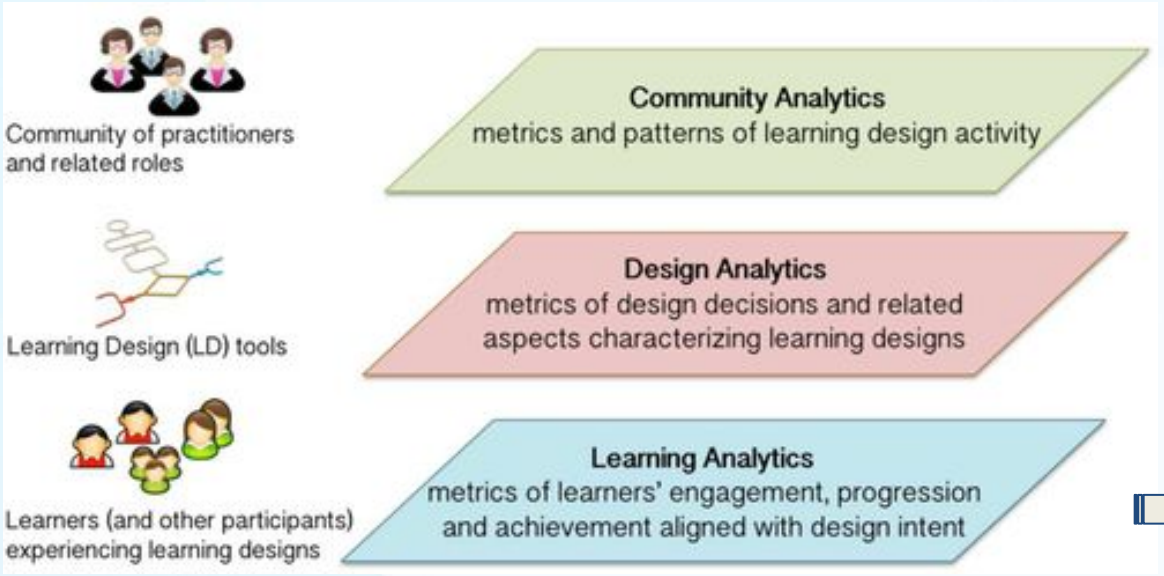
Intelligent DEsign-Aware Learning analytics empowered 21C L&T System



IDEALS

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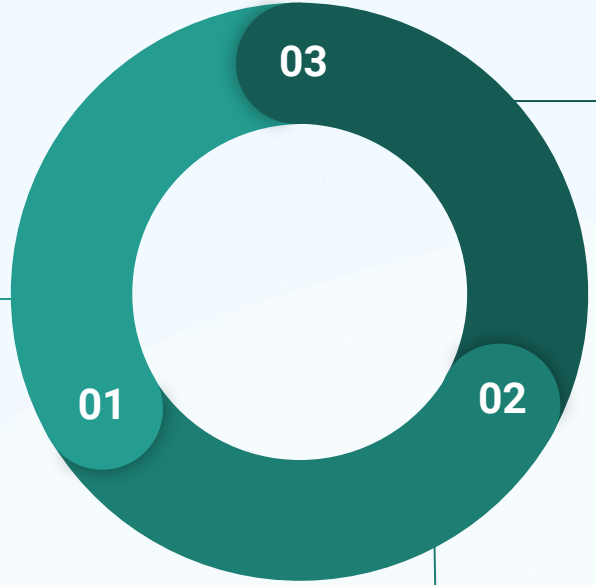

Learning Management System

Learning Design

Learning Analytics

An Example

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Case Analysis: CCCH9051: Digitizing Cultural Heritage in Greater China

Course level pattern: Iterative User-centered Design

CCs	Understanding the context of use to identify problem scenario for goal setting	Role play to explore perspectives to specify user requirements for goal setting	Iterative construction to enhance the performance of digital artefacts for self-planning and self-monitoring	Demonstration and peer-review of digital artefacts for self-evaluation
Key Tasks	Lecture for obtaining information • Construct and present a mind map to make understanding explicit	Lecture for obtaining information * Role play for exploring multiple perspectives *Reflect on real-life scenario Student survey for formative assessment and/or prompt reflection	* Site visit for generating artefacts Lecture for obtaining information Hands-on exploration of artefact * Co-construction of artefacts using digital platforms Well-designed criteria for evaluating self/peer performance * Process, select and organize information	Lecture for obtaining information * In-class presentation for sharing deliverables from productive learning tasks Well-designed criteria for evaluating self/peer performance

Highlighting key task sequence under each CC

LD of CCCH9051

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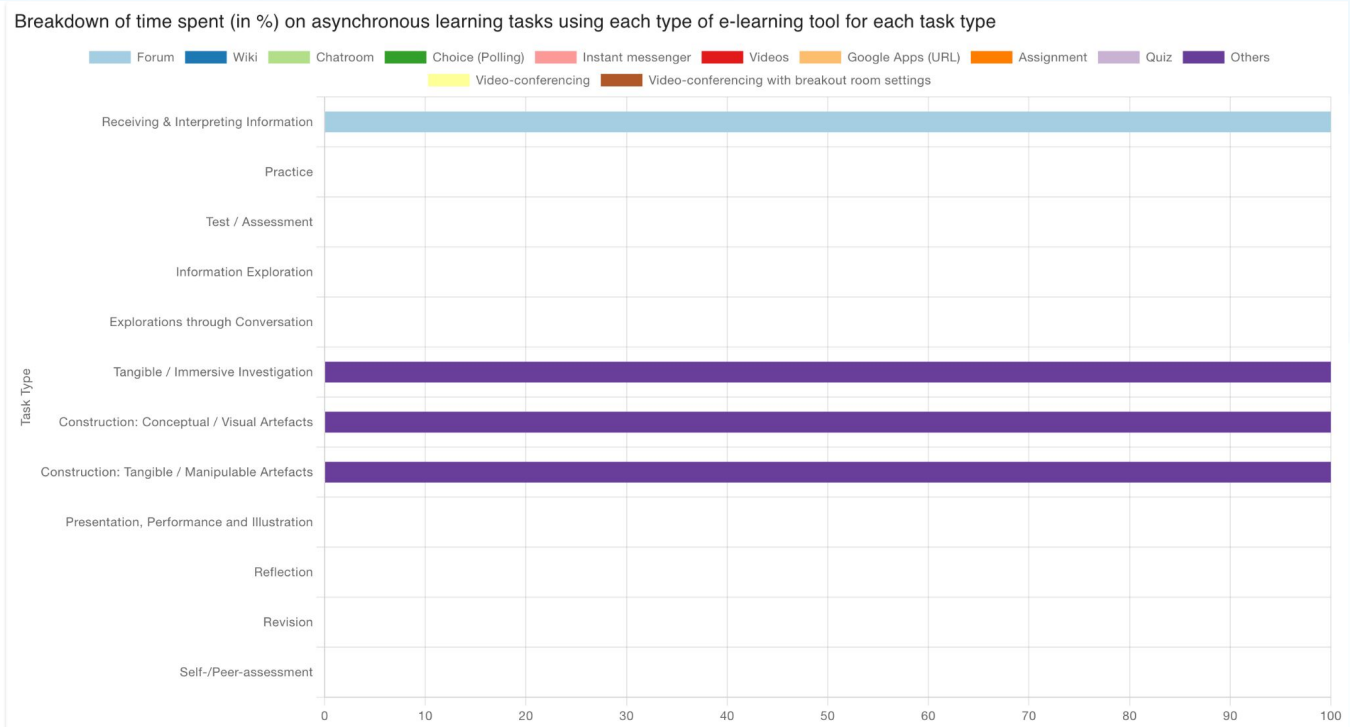
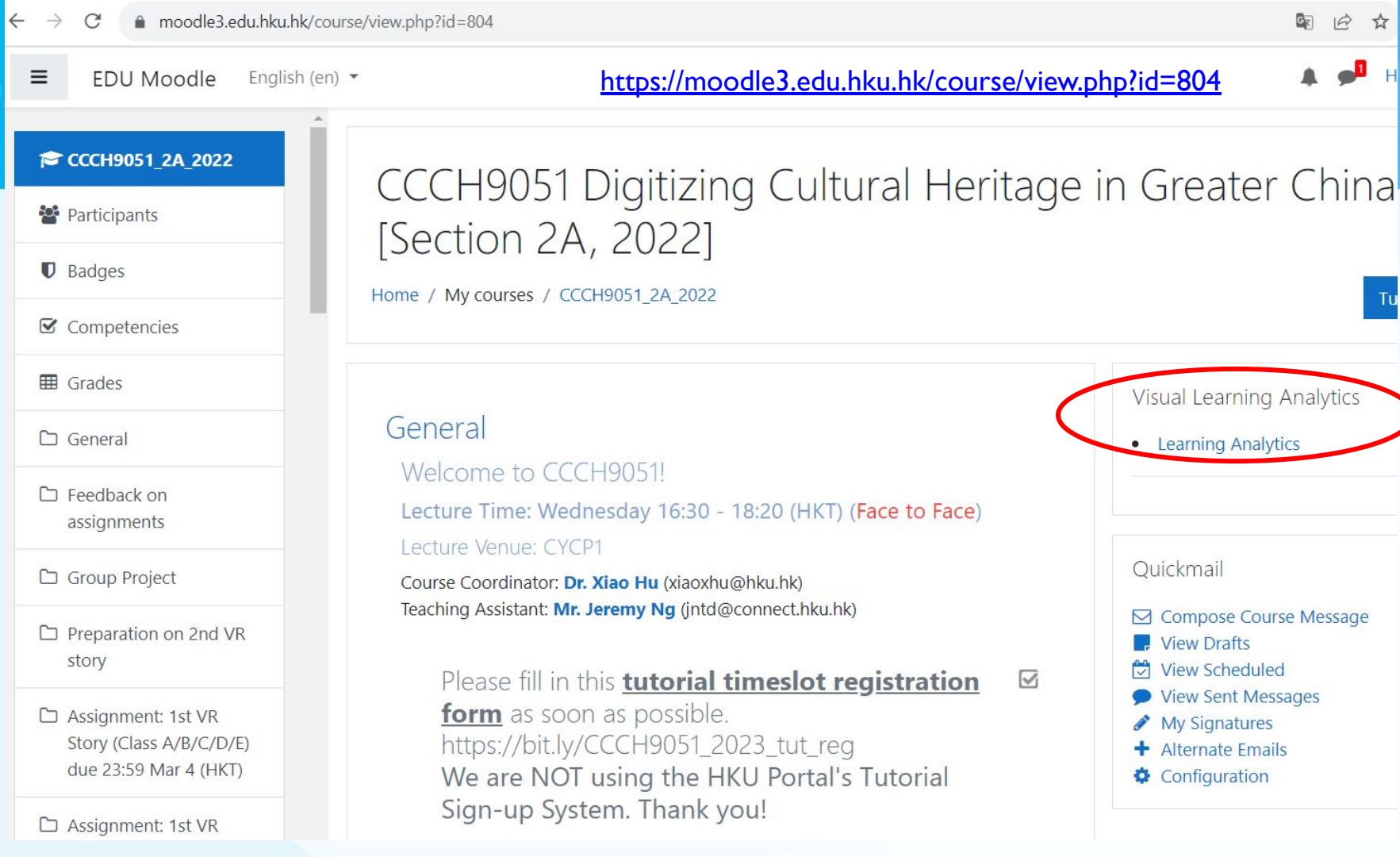
https://lds-gen.cite.hku.hk/publicsharing/$2y$10$y4oPkfOvJLsHoQyxBnJyZu8xm7X7c520Kcbons1YoHGTtoisNAIjq

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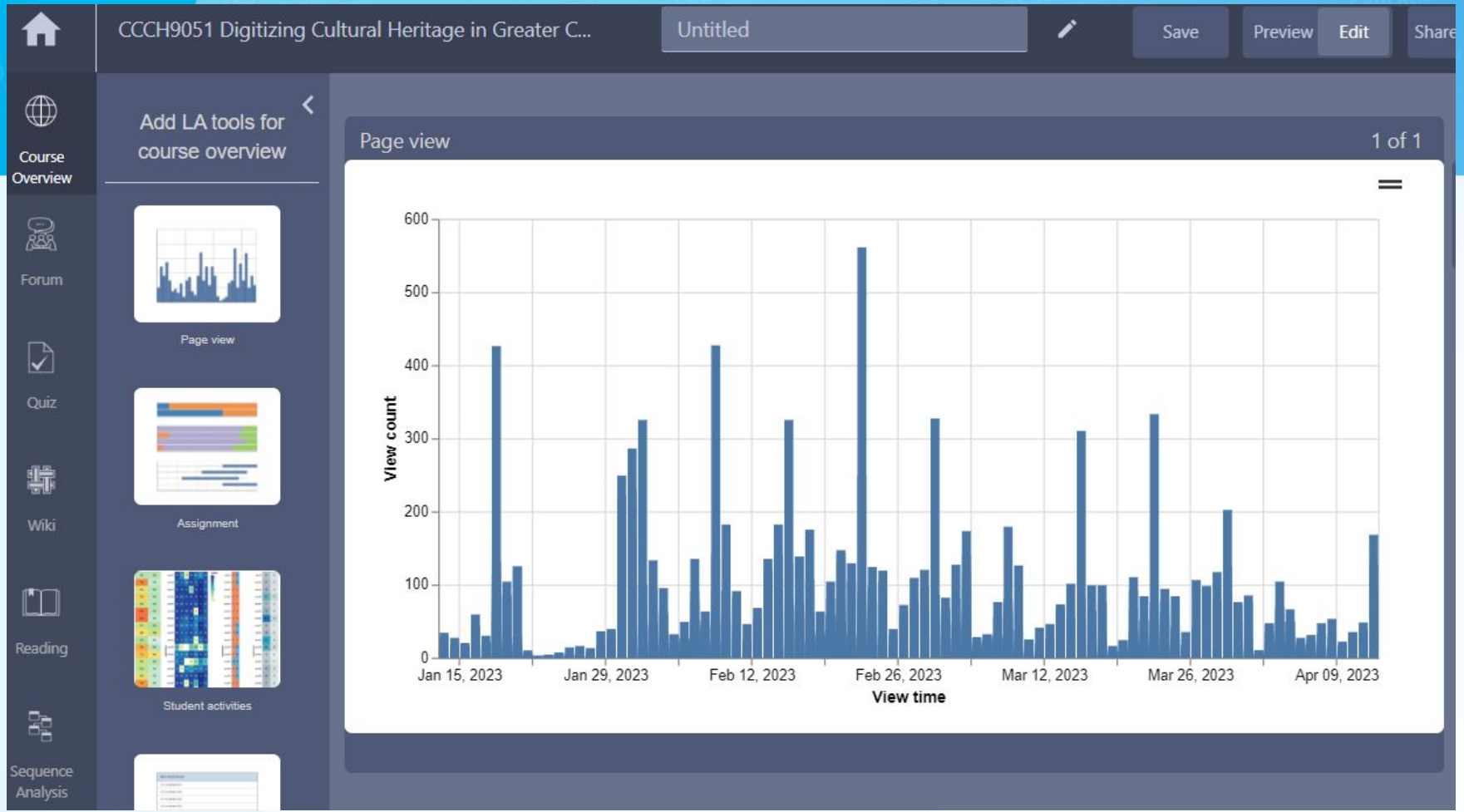
EDU Moodle
English (en)
https://moodle3.edu.hku.hk/course/view.php?id=804
CCCH9051_2A_2022
Participants
Badges
Competencies
Grades
General
Feedback on assignments
Group Project
Preparation on 2nd VR story
Assignment: 1st VR Story (Class A/B/C/D/E) due 23:59 Mar 4 (HKT)
Assignment: 1st VR
CCCH9051 Digitizing Cultural Heritage in Greater China [Section 2A, 2022]
Home / My courses / CCCH9051_2A_2022
General
Welcome to CCCH9051!
Lecture Time: Wednesday 16:30 - 18:20 (HKT) (Face to Face)
Lecture Venue: CYCP1
Course Coordinator: Dr. Xiao Hu (xiaoxhu@hku.hk)
Teaching Assistant: Mr. Jeremy Ng (jntd@connect.hku.hk)
Please fill in this tutorial timeslot registration form as soon as possible.
https://bit.ly/CCCH9051_2023_tut_reg
We are NOT using the HKU Portal's Tutorial Sign-up System. Thank you!
Visual Learning Analytics
Learning Analytics
Quickmail
Compose Course Message
View Drafts
View Scheduled
View Sent Messages
My Signatures
Alternate Emails
Configuration


CCCH9051 Digitizing Cultural Heritage in Greater C...
Untitled
Save
Preview
Edit
Share
Course Overview
Forum
Quiz
Wiki
Reading
Sequence Analysis
Add LA tools for course overview
Page view
Assignment
Student activities
Page view
1 of 1
View count
600
500
400
300
200
100
0
Jan 15, 2023
Jan 29, 2023
Feb 12, 2023
Feb 26, 2023
Mar 12, 2023
Mar 26, 2023
Apr 09, 2023
View time


CCCH9051 Digitizing Cultural Heritage in Greater C...
Untitled
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Preview
Edit
Share to stud
Course Overview
Forum
Quiz
Wiki
Reading
Sequence Analysis
Add LA tools for forum
Forum general analysis
Calculation table
Forum behavior analysis
Frequency
Interaction
Forum content analysis
Frequency
12 of 13
week
01/13-01/14
01/15-01/21
01/22-01/28
01/29-02/04
02/05-02/11
02/12-02/18
02/19-02/25
02/26-03/04
03/05-03/11
03/12-03/18
03/19-03/25
03/26-04/01
04/02-04/08
04/09-04/13
User -.st136-afcdbc had 4 replies on Week 03/19-03/25
0
4

CCCH9051 Digitizing Cultural Heritage in Greater C...

Untitled

Save | Preview | Edit | Share to students

Course Overview

Forum

Quiz

Wiki

Reading

Sequence Analysis

Forum general analysis

Calculation table

Forum behavior analysis

Frequency

Interaction

Forum content analysis

Hashtag

Hashtag 7 of 8

Keyword 8 of 8

01/13-01/14	01/15-01/21	01/22-01/28	01/29-02/04	02/05-02/11	02/12-02/18	02/19-02/25	02/26-03/04	03/05-03/11	03/12-03/18	03/19-03/25
contact	class	collecting	chinese	cultural	citizen	amp	e5	grave	hk	admin
cultural	first	experiments	cultural	friends	friends	e5	gov	heritage	hku	collection
form	hk	know	heritage	heritage	hong	e6	hk	hk	https	exhibits
heritage	hku	myself	introducing	learn	kong	gov	hong	https	items	https
hk	https	neuroscience	people	media	media	hk	html	net	net	items
hku	jan	nice	promote	people	other	hong	https	omeka	omeka	net
https	lectures	others	relevant	promote	promote	html	kong	task	task	omeka
lecture	reasons	team	social	relevant	relevant	https	net	tut	tut	task
questions	tutorial	tiffany	student	social	social	kong	omeka	week	tutorial	tutorial
tutorial	tutorials	working	value	student	student	org	org	wikipedia	week	week

How these LA visuals inform LD?

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Outline

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- LA, LD and the Connections
- LA Projects
  - Collaborative learning analytics: Wikiglass
  - Maker learning analytics: LAVR/CLEVR
- IDEALS - Towards Successful Integration of LA & LD
  - An Example
- **Future Opportunities and Challenges**

Opportunities

- LA substantializes LD
  - make LD less abstract
- LA evidences effects of LD
  - make LD convincing for uptake
  - provide rationale for change
- LD provides theoretical grounding for LA
- LD provides guidance for LA applications

- So far, few empirical studies evaluating impact of LDs

Challenges

LDs not well used

- Learning curve
  - hard to change habits
- Time as a barrier

Understand our teachers

- Analytics questions
- Need analysis

THANK YOU! Q/A

http://ccmir.cite.hku.hk

https://www.researchgate.net/lab/CCMIR-Xiao-Hu

Feel free to contact me at
xiaoxhu@hku.hk
for more discussion.