Human-Centered Learning Technologies and the Learning Experience

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GenieLearn

Current Project: https://genielearn.uc3m.es/

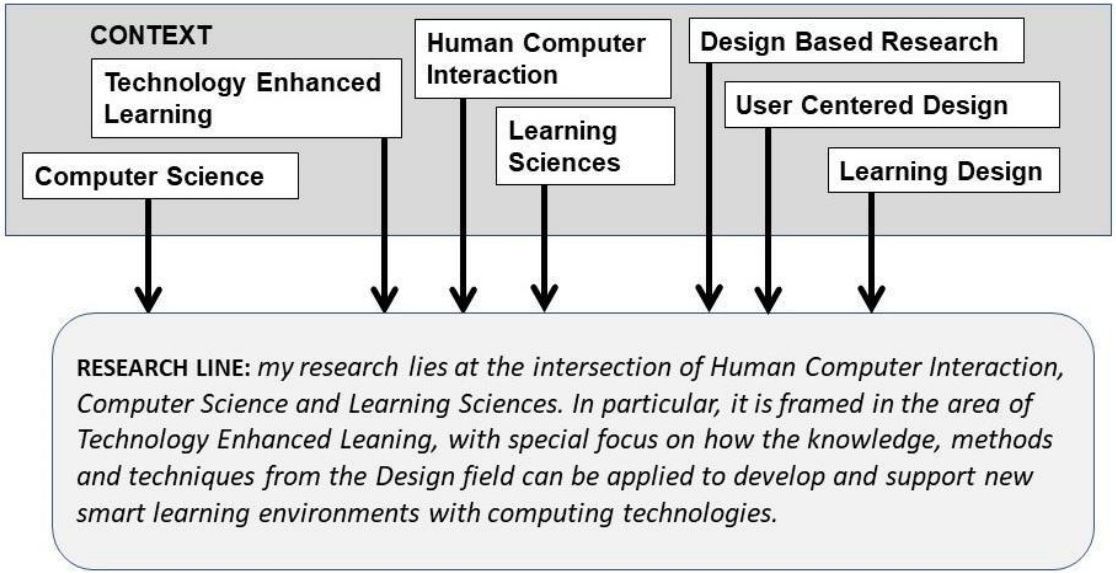
Human Centered Learning Technologies

- **Focus of Presentation:** Enhancing the Learning Experience through the Design and Analytics of Learning Technologies
- **Researcher Perspective:** Insights from personal research experience
- **Key Areas for Improvement:** Highlighting often overlooked aspects in learning technologies
- **Design Methods/Techniques**: Practical approaches for learning and education contexts

Image generated by ChatGPT

Learning Technologies

Technology Enhanced Learning (TEL), also known as Learning Technologies or E-Learning, is an intrinsically interdisciplinary field comprising research topics that concern engineering, computer science and social sciences.



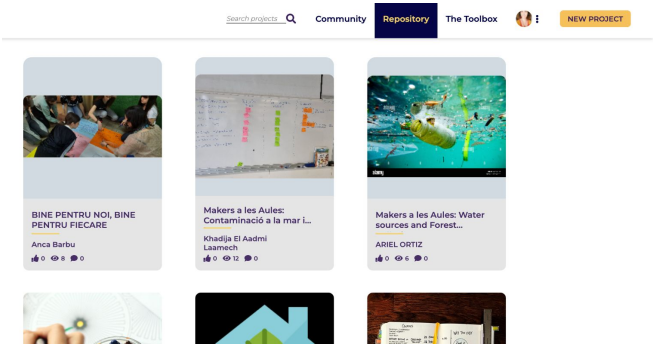
Human Centered Learning Technologies

Addressing Human Factors in Learning Technologies Design

- **Human-Centered Approach:** Essential to consider human factors and the complexity of learning in design (Cohen et al., 2020; Shum et al., 2019; Ahn et al., 2019; Gilies et al., 2016 Goodyear, 2015;).

- **Role of Artefacts:** Learning mediated by artefacts, such as learning technologies (e.g., authoring tools) and computational representations of teachers' designs (Asensio-Perez et al., 2017).

Human-Centred Learning Technologies



ILDE+ DTIPS

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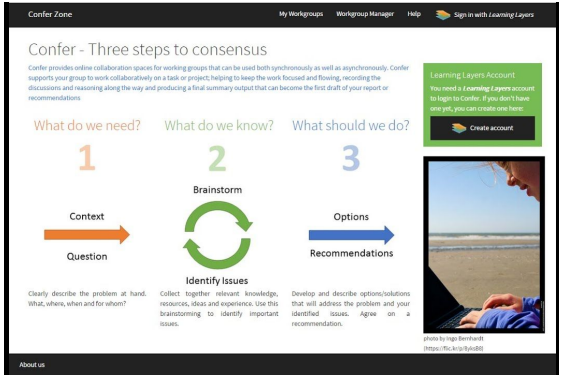

Confer tool

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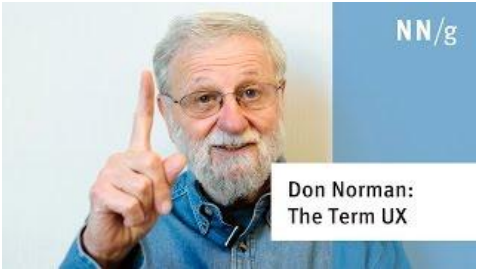
User Experience (UX) → Learning Experience (LX)

HCI > User Experience (UX) (Don Norman & Jakob Nielsen)

- UX encompasses all aspects of a user's interaction with a product, system, or service.
- Involves behaviors, attitudes, and emotions related to use.
- Includes practical, experiential, affective, meaningful, and valuable elements of human-computer interaction.



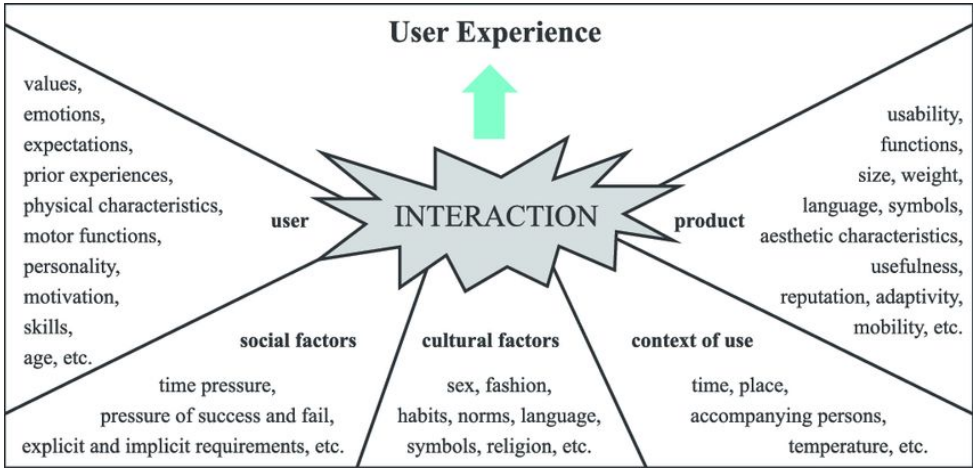


Image source: Arhippainen and Täht (2003) user experience factors

User Experience Honeycomb - Peter Morville

User Experience (UX) → Learning Experience (LX)

Design Challenge: Learning technologies need alignment with HCI (Buckingham Shum, S. et al, 2024) and learning sciences (Kolb, 2014) for a successful Learning eXperience.

Human-Centered Approach (HCI):

- Beyond usability and performance
- Addresses educational, physical, psychological, and ethical needs

Key Focus Areas:

- Authentic educational needs: pedagogical alignment, context, meaningful interaction
- Physical/psychological needs: ergonomics, BPNs, well-being
- Ethical principles: human values, sustainability

Methods:

- Human-centered Design
- Data/Learning analytics

Authentic Educational Needs

- **Situated Learning Theory**: Learning is unintentional and embedded in authentic activity, context, and culture (Lave & Wenger, 1991)
- **Activity Theory**: Knowledge is acquired through meaningful actions, like collaborative dialogue and social interaction (Vygotsky, 1978)
- **Contextual Learning**: Context is dynamically constructed by learners through their interactions with the environment, not just a fixed setting (Sharples et al., 2005)

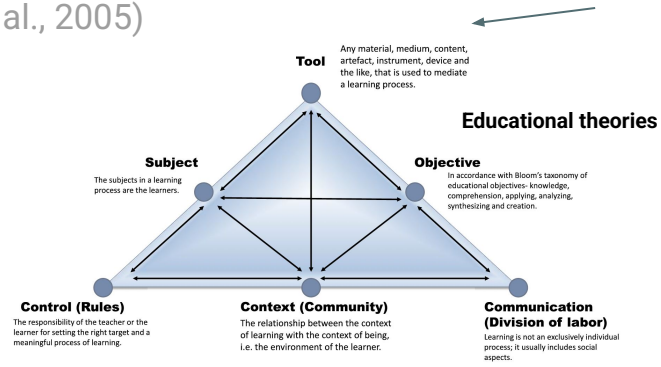


Fig. 1. The framework of activity theory for mobile learning.

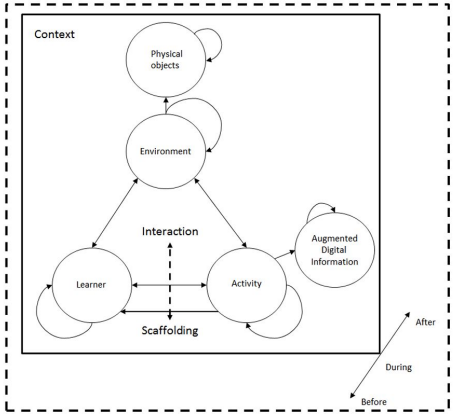
Adapted framework from Engeström (1999) for m-learning → REF: Chung, C. J., Hwang, G. J., & Lai, C. L. (2019).

Context of use: Meaningful interactions

As Woo & Reeves (2007) state: *"Interaction in learning is a necessary and fundamental process for knowledge acquisition and the development of both cognitive and physical skills."* Woo, Y., & Reeves, T. C. (2007). Meaningful interaction in web-based learning: A social constructivist interpretation. The Internet and Higher Education, 10(1), 15-25.

Some of my contributions in this regard are:

- Enriched learning scenarios: context-aware, location-based and across spaces
- Modelling the necessary emergent properties to design and analyse learning (e.g. assessment) activities
- Computational representations (e.g. extension of IMS QTI)



M-assessment system monitoring and assessing interactions

- **Santos, P.**, Cook, J., & Hernández-Leo, D. (2015). M-AssIST: Interaction and scaffolding matters in authentic assessment. Journal of Educational Technology & Society, 18(2), 33-45. (Q1)
- **Santos, P.**, Hernández-Leo, D., Blat, J., (2014) To be or not to be in situ outdoors, and other implications for the design and implementation, in geolocated mobile learning, Pervasive and Mobile Computing, 14(Oct.2014), 17-30. (Q1)
- **Santos, P.**, Hernández-Leo, D., Pérez-Sanagustín, M., & Blat, J. (2012). Modeling the Computing Based Testing domain extending IMS QTI: Framework, models and exemplary implementations. Computers in Human Behavior, 28(5), 1648-1662. (Q1)
- **Santos, P.**, Balestrini, M., Righi, V., Blat, J., & Hernández-Leo, D. (2013). Not interested in ICT? A case study to explore how a meaningful m-learning activity fosters engagement among older users. In Scaling up Learning for Sustained Impact: 8th European Conference, on Technology Enhanced Learning, EC-TEL 2013, Paphos, Cyprus, September 17-21, 2013. Proceedings 8 (pp. 328-342). Springer Berlin Heidelberg.
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Pedagogical practices, methodologies & Learning Design

Diverse pedagogical approaches and methodologies: Assessment, Collaborative Learning, Situated Learning, Hands-on learning, M-learning, Gamification…

Learning skills/competences: Computational thinking, Self-regulation skills, …

Learning Design: Teachers/Learners as designers

ILDE + Makers in the classroom: a platform to create/share Learning designs

- Velamazán, M., **Santos, P**., Hernández-Leo, D., & Amarasinghe, I. (2022). Student preferences and behaviour in anonymous collaborative learning. In Proceedings of the 15th International Conference on Computer-Supported Collaborative Learning-CSCL 2022, pp. 419-422. International Society of the Learning Sciences.
- Martínez Moreno, J., **Santos, P**., & Hernandez-Leo, D. (2021, October). Maker Education in Primary Education: Changes in Students' Maker-Mindset and Gender Differences. In Ninth International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'21) (pp. 120-125). (Best paper award)
- Cook, J., Mor, Y., & **Santos, P.** (2020). Three cases of hybridity in learning spaces: Towards a design for a Zone of Possibility. British Journal of Educational Technology, 51(4), 1155-1167. (Q1)
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Psychological and Physical needs

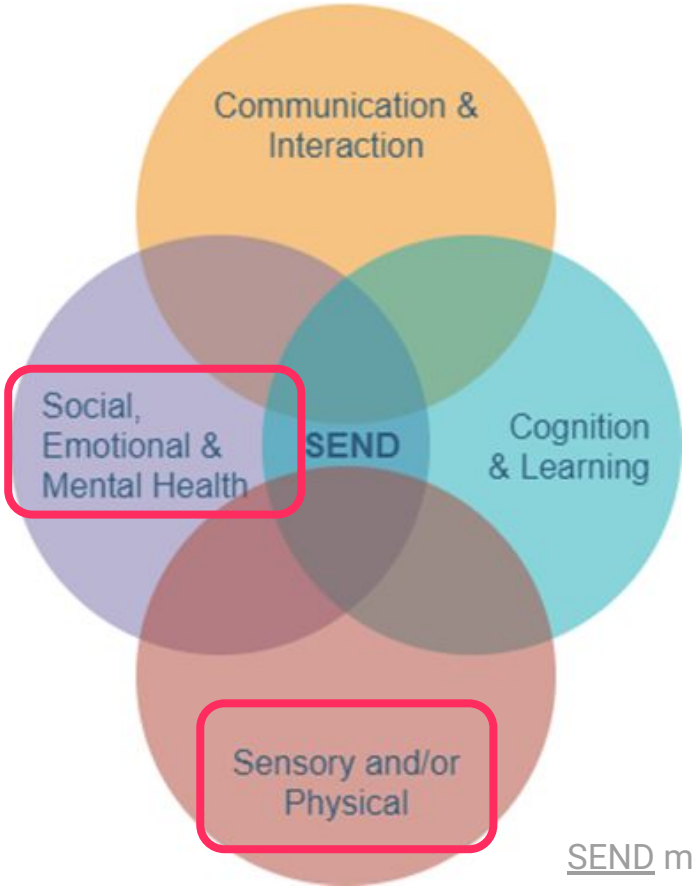
Learning as a socio-cognitive process (mental information processing)
Examples: Cognitive walkthrough

Communication/Interaction >> Usability
Examples: System usability Scale (SUS): LINK

But these two are less explored/considered:

Physical needs >> **Ergonomics**

Psychological needs >> Basic Psychological Needs (BPNs), Digital wellbeing



SEND model

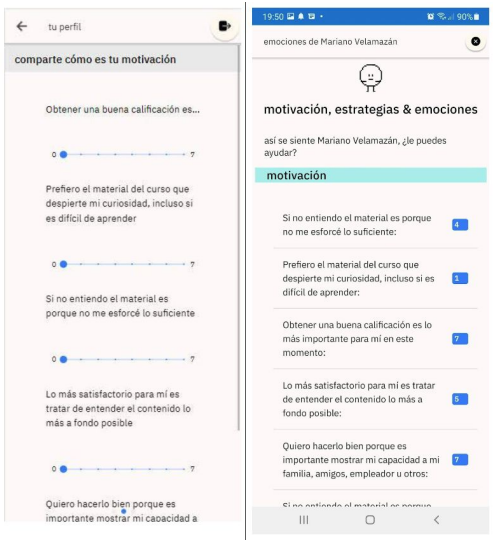
Psychological needs

Based in the Self-Determination Theory (SDT), explore how teachers/students perceptions of technology use affect the fulfillment of their basic psychological needs (Autonomy, Competence, and Relatedness), ultimately impacting their well-being.

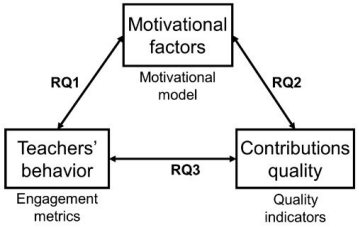
To address the impact of educational technologies on well-being, there is a need for framing the use of the well-being concept in TEL in such a way that researchers and technologists can take it into account while designing and evaluating educational technologies

Identification and understanding of factors that promote sustained motivation and wellbeing in the use of learning technologies

Supporting self/socio-emotional regulation in Smart Learning Environments



Mobile app prototype to support students' socio-emotional challenges



A study of motivations, behavior, and contributions' quality in Online Communities of teachers

- El Aadmi-Laamech, K., **Santos, P.**, & Hernández-Leo, D. (2025). Impact of Basic Psychological Needs Fulfillment on Teachers' Well-Being in Online Communities: Designing for Well-Being. Computers in Human Behavior Reports, 100706. (Q1)
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Ergonomics /Physical needs

Cognition
- Perceiving
- Reasoning
- Learning
- Evaluating
- Remembering

How well the use of a product matches the cognitive capabilities of users?

- Focuses on aligning product use with users' cognitive abilities.
- Involves perception, memory, reasoning, and motor response in human-system interactions.
- Aims to balance human well-being with system performance.

Ergonomics beyond cognition - it also has into consideration the device form and position in relation to the human body → ***How are people physically engaging with the devices?***

https://tangible.media.mit.edu/project/tangible-bits/

References:
https://www.usabilitybok.org/cognitive-task-analysis
MIT - Cognitive Task Analysis: https://web.mit.edu/16.459/www/CTA2.pdf

Interesting reading: Luck, R. (2018). Inclusive design and making in practice: Bringing bodily experience into closer contact with making. *Design Studies*, *54*, 96-119.

Human-Centered Design Methods

Using Human-Centered Design Techniques to understand the users' needs (e.g. students, teachers, lifelong learners)

Consider different educational settings (formal, informal, workplace learning)

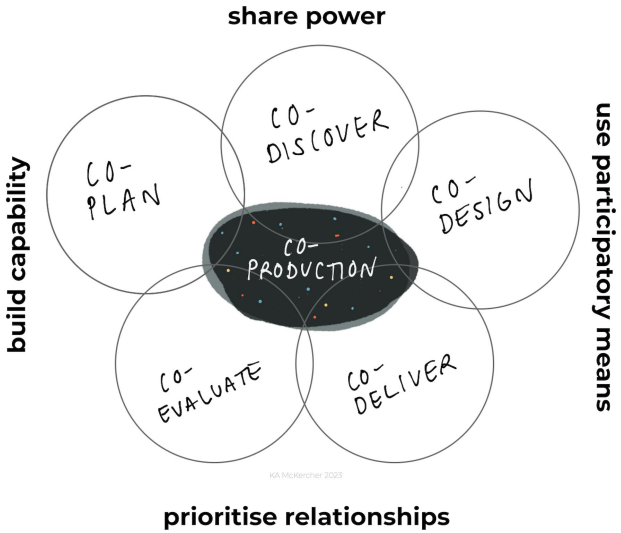
"*Learning involves complex, often longitudinal, socio-cognitive processes that can be hard to track and assess*" (Buckingham et al., 2024)

Requires:

- Long studies: RPP (Research-Practice Partnership)
- Examples a 4 year Participatory Design process (Campos et al. (2023))

Co-design vs Participatory design

Co-design promotes equality in the program or research design process, while participatory design approaches ensure active stakeholder involvement in shaping the research or program outcomes.



McKercher, K. A. (2020). Beyond sticky notes. Doing co-design for Real: Mindsets, Methods, and Movements, 1st Edn.

Read: *Ahn, J., Campos, F., Hays, M., & DiGiacomo, D. (2019). Designing in Context: Reaching beyond Usability in Learning Analytics Dashboard Design. Journal of Learning Analytics, 6(2), 70-85.*

Human-Centered Design Methods

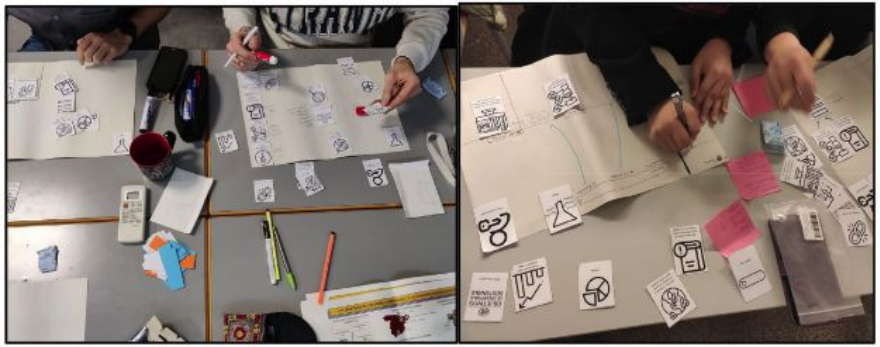
-Using Human-Centred Design Techniques to understand the users' needs (e.g. learners, teachers)

- Design Thinking, Value Sensitive Design, Responsible Design Process

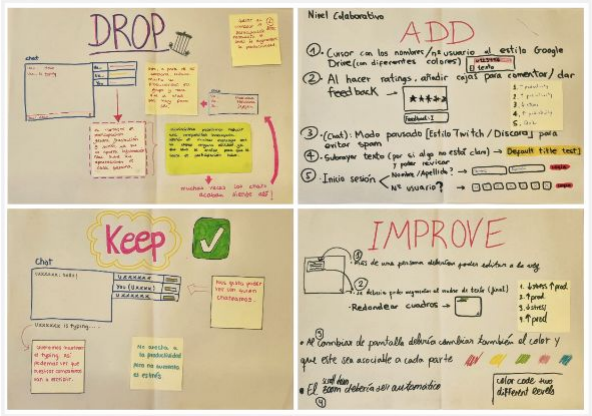
-Real educational settings (formal, informal, workplace learning)

Exemplary contributions applying:

- Sketches
- Paper prototyping
- Storyboard
- Card sorting
- Wireframes
- Wizard of Oz
- …



Card-sorting task with teachers



Paper prototypes as a mechanism of co-design with students

-**Santos, P.**, El Aadmi, K., Calvera-Isabal, M., & Rodríguez, A. (2025). Fostering students' motivation and self-efficacy in science, technology, engineering, and design through design thinking and making in project-based learning: a gender-perspective study in primary education. International Journal of Technology and Design Education, 1-27. (Q2)

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Human-Centered Design Methods

User-Centered Design Considerations:

- **Meaningful interaction:** Is it the most effective way to interact?
- **Optimal interaction styles:** Are different human senses considered in the design?
- **Support for diversity**: Addressing special needs and learning diversity (Universal Design for Learning: https://udlguidelines.cast.org/)

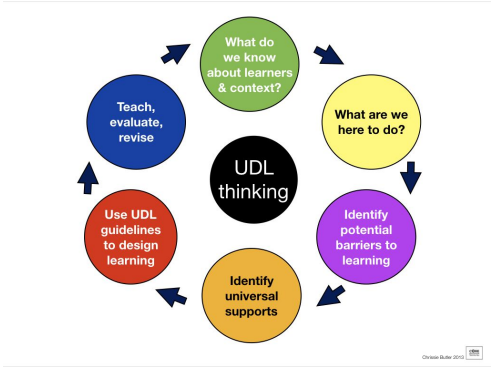


Image from: Take a Universal Design for Learning (UDL) approach

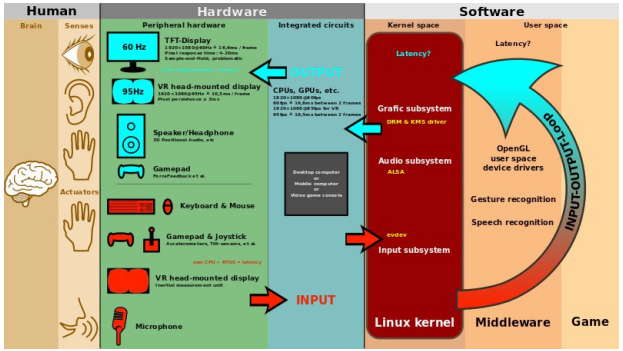


Image source: Lumen

! See that not all human senses are considered in this image

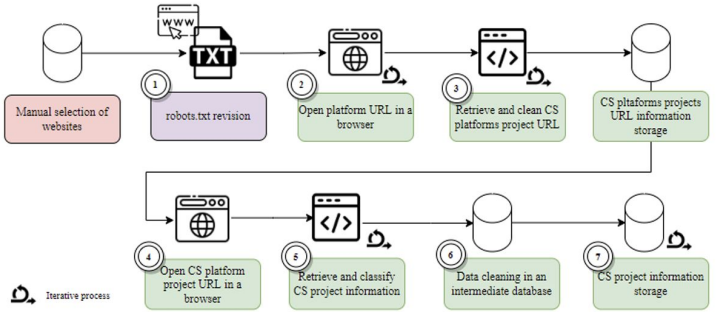
Image from:https://udlguidelines.cast.org/

Use of Analytical computational methods to develop 'Smart learning technologies'

Application of analytical computational methods for capturing and processing data with educational purposes, integration of AI technologies

Computational analysis of network/social/participation to understand users' behavior

Design of Learning Analytics by applying a Human-centred approach (HCLA)



Building an algorithm to extract and analyze Citizen Science Data with educational purposes

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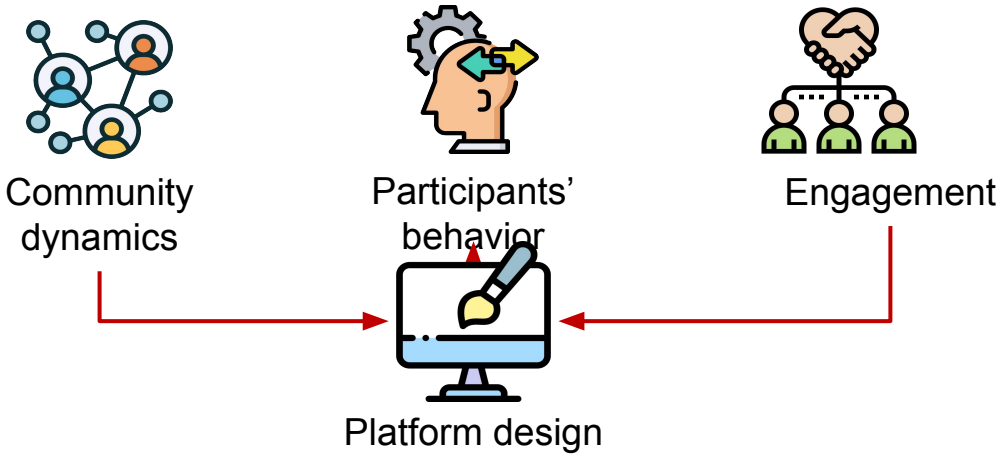
Data Analytics Approach

- Data analytics to facilitate data-informed design decisions
- Application of data analytic computational methods for capturing and processing data with educational purposes

-Computational analysis of network/social/participation to understand users' behavior



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Ethical Design Process

From Open Science and Open Data to Ethics and Trustworthy Learning Analytics

Ethics perspectives in educational technology research, relevant when collecting and sharing data and also in the design and development of technologies, especially when they are based on data analytics or artificial intelligence techniques

Aspects related to the capacity of educational software systems to support human agency and preserve human well-being and sustainability

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Human-Centred Design of Learning Analytics

Guest Editors

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Link to the call

"HCLA researchers and practitioners are adopting and adapting HCI theories/methods to meet the challenge of meaningfully engaging educational stakeholders in the LA design process, evaluating systems in use and researching the sociotechnical factors influencing LA successes and failures."

HCLA special issue in BJET

Topic questions:

- Can design processes from other disciplines, such as HCI, Co-Design and Participatory design, be unproblematically adopted for HCLA, or do they require adaptation?
- What are the obstacles to the adoption of HCLA design processes?
- How can the voice of students be taken more into account, besides the dominant thread of involving teachers? (a gap identified in the 2019 JLA special issue)
- What are the lessons learnt from mid-to-long term HCLA studies and how do they inform the aforementioned topic of adoption?
- To what extent can the design tools used in other areas be adopted or adapted for the purpose of LA design?
- Human-AI complementarity.

Conclusions

- Human-centered approaches in learning technologies are essential to shaping future educational experiences
- By addressing authentic educational needs, prioritizing psychological and physical well-being, and integrating ethical design principles, we can foster more meaningful and inclusive Learning Experiences (LX)
- The intersection of Human-Computer Interaction (HCI), Learning Sciences and Data Science creates opportunities for innovative and adaptive learning environments
- As we move forward, it is crucial to embrace holistic, user-centered design to ensure that educational technologies continue to enhance and support diverse learning journeys

Don Norman, has recently argued for the urgent need to move to humanity-centred design, encompassing a longer-term, ecosystems design mindset → focus on people's needs not as individuals but as societies with complex, deep-rooted problems

Image generated with DALL·E

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Questions?

Thank you for your attention!

Human-Centered Learning Technologies and the Learning Experience

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