



Evaluation of a Digital Learning Module about Positron Emission Tomography

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Sparkle talk, IMPRESS Symposium, 30th June 2023

Motivation

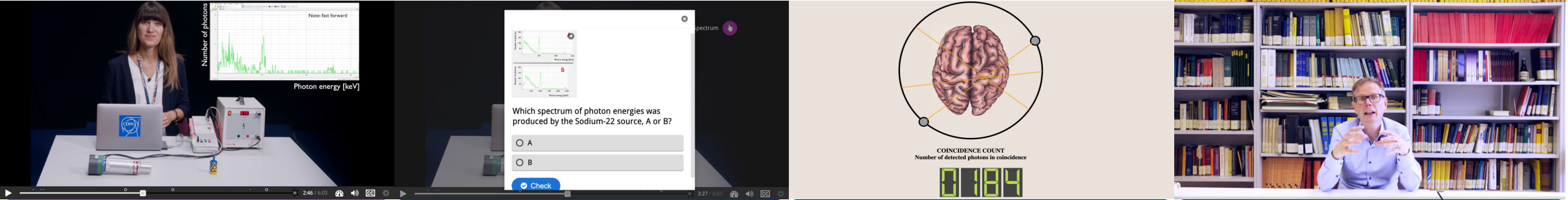
- ❖ S'Cool LAB (*now Science Gateway labs*): Out-of-school science learning lab, hands-on experiments
- ❖ Covid-19: Need for virtual alternatives

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➔ “Digital Positron-Emission-Tomography Learning Module” (“PET DLM”)

- ❖ Usage: ≥ 16 y.o., mainly in classroom (1-2 school hours) as elaboration to the curriculum
- ❖ Series of:



Experiment videos

Quizzes

Interactive screen experiments

Expert interviews

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- ❖ 2023: still relevant!
 - authentic opportunities to foster students’ interest still needed
 - possibility to visit CERN or similar centers limited to “privileged” schools

PhD Project Phases

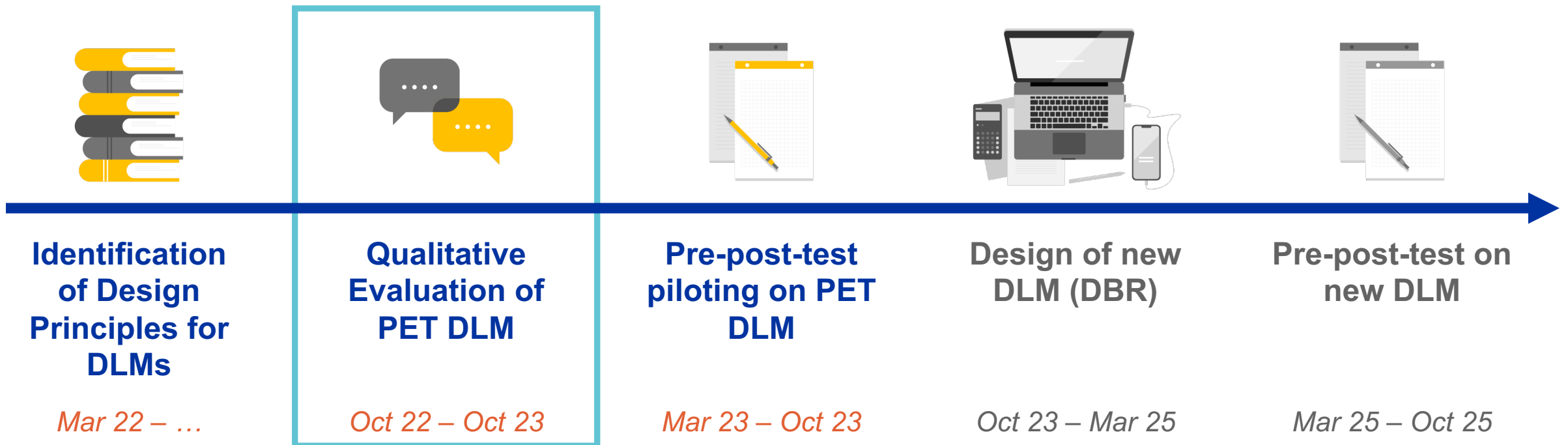
Evaluation of PET DLM: part of a 4-year **Design-based Research (DBR)** PhD project

Overall aim: *identify and evaluate a **theory-driven and evidence-based set of design principles** for the design of future DLMs or similar digital learning environments*

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Identification of Design Principles

Goal of literature review: Identify Design Principles for (digital) learning that

- support **cognitive processes** (e.g., reduce extraneous cognitive load)
- foster students' **affective variables** (e.g., trigger situational interest) *(Wang & Reeves, 2007)*



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Theoretical and empirical studies

Cognitive Theory of Multimedia Learning *(Mayer, 2005)*

Cognitive-Affective Theory of Learning with Multimedia *(Moreno, 2006)*

Variation Theory of Learning *(Marton & Booth, 2013)*

Predict-Observe-Explain *(White & Gunstone, 1992)*

Results from studies on interesting content/context/activities

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Hierarchy
of design
principles

Content/context/activities

Structure

Presentation



Qualitative Evaluation of PET DLM

- ❖ **Participants:** high-school students (16-18 y.o.) from various countries
- ❖ **Instruments:** semi-structured interview protocol
- ❖ **Interview questions: (sometimes competing) Design Principles vs. outcomes**



Qualitative Evaluation of PET DLM

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 - ❖ “Use authentic contexts” (van Vorst et al., 2014) → Triggered situational interest
- } “What did you think about the additional information about the Compton effect?”



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- ❖ **Procedure:** Zoom interview, student shares screen and uses the DLM (audio/video recorded)
 - ❖ **Analysis:** Qualitative Content Analysis (Kuckartz, 2019)
 - ❖ **Current status:** piloting finished, recruiting participants for main study... results soon!



Coming soon... Design of new DLM

❖ Content: Radiation and its interaction with matter

1. Students are interested (*Häußler, Hoffman, et al., 1998*)
2. Omnipresent in our daily life (medical, industrial, energy, and entertainment sectors)
3. Many reported misconceptions
4. Experiments usually not available in schools



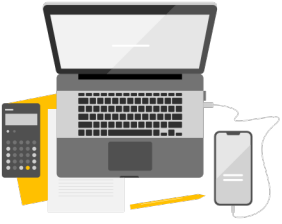
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❖ Context: Space and space travel

1. Students are interested (*OECD, 2016; Holstermann & Bögeholz, 2007; Zochling et al., 2022*)
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❖ Current status:

- brainstorming experiment demonstration & interactive screen experiment ideas
- drafting key ideas



Literature

1. Häußler, P., Lehrke, M., & Hoffmann, L. (1998). *Die IPN-Interessenstudie Physik*. Kiel: IPN.
2. Holstermann, N., & Bögeholz, S. (2007). Interesse von Jungen und Mädchen an naturwissenschaftlichen Themen am Ende der Sekundarstufe I [Gender-specific interests of adolescent learners in science topics]. *Zeitschrift für Didaktik der Naturwissenschaften*, 13, 71-86.
3. Kuckartz, U. (2019). Qualitative text analysis: A systematic approach. *Compendium for early career researchers in mathematics education*, 181-197.
4. Marton, F., & Booth, S. (2013). *Learning and awareness*. Routledge.
5. Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 31e48). Cambridge: Cambridge University Press.
6. Moreno, R. (2006). Does the modality principle hold for different media? A test of the method-affects-learning hypothesis. *Journal of Computer Assisted Learning*, 22(3), 149-158.
7. OECD. (2016). *PISA 2015 Results (Volume I): Excellence and Equity in Education*. Paris: OECD Publishing
8. Wang, S. K., & Yang, C. (2005). The interface design and the usability testing of a fossilization web-based learning environment. *Journal of Science Education and Technology*, 14, 305-313.
9. White, R., & Gunstone, R. (2014). *Probing understanding*. Routledge.
10. Zochling, S., Hopf, M., Woithe, J., & Schmeling, S. (2022). Students' interest in particle physics: conceptualisation, instrument development, and evaluation using Rasch theory and analysis. *International Journal of Science Education*