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Co-designing Science Clubs for Non-formal STEAM Education

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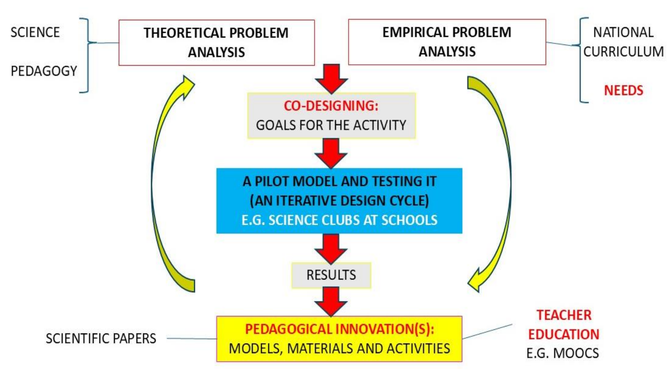
There is a growing need to find novel pedagogical solutions to better engage all students in science education and to promote inspiring teacher education (Ministry of Education and Culture, 2023). Various types of non-formal learning environments have previously been developed within the LUMA Centre Finland (Aksela, Lundell & Ikävalko, 2020). The main aim of this project is to promote culturally sustainable STE(A)M education. Could after-school student-centred science clubs serve as inspiring non-formal learning environments for all students?

Research questions:
(RQ1) How can we co-design relevant, student-centred science clubs for non-formal learning environments (after school)?
(RQ2) What kinds of pedagogical solutions can be developed through the co-design process involving student teachers and in-service teachers?

In this paper, we present **preliminary results** from our pilot study, conducted using educational design-based research (e.g., Aksela, 2019). The project is part of the international StarT LUMA programme by LUMA Centre Finland. It was carried out as a collaboration between LUMAlab Gadolin (part of LUMA Centre Finland), a pre-service teacher education course at the Unit of Chemistry Teacher Education, University of Helsinki, and primary schools in Helsinki, starting in 2024.

DESIGN-BASED RESEARCH

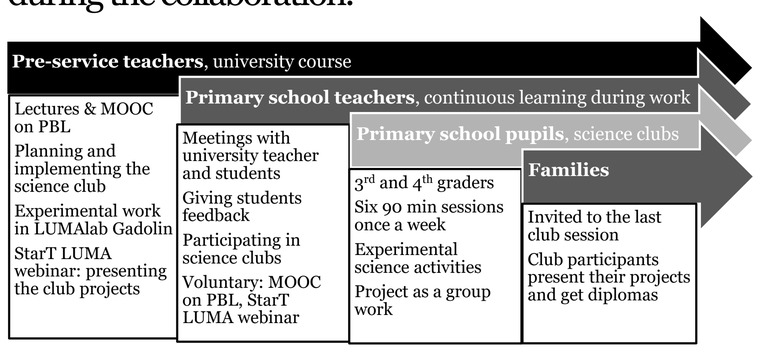
Educational design-based research (Aksela, 2019; see figure) served as the framework for co-designing the science clubs. This approach has been utilized by LUMA Centre Finland for several years, enabling the development of relevant pedagogical solutions, novel theories in context and insights into the co-design process.



The clubs were co-designed as part of a pre-service teacher education course where organizing science clubs in schools served as a practical component of the course "Everyday Chemistry" (1st year, 5 ECTS), which integrates sustainability and project-based learning (PBL).

RQ1: Co-designing a science club

The co-design process during the course involved several stages (see Figure below). First, student teachers engaged in theoretical problem analysis through a MOOC (1 ECTS) on PBL as an introduction to the topic (e.g., Haatainen & Aksela, 2021). This MOOC was also offered as a continuous learning opportunity for collaboration schools and teachers during the collaboration.



After this, the co-design of the after-school science clubs with primary school teachers began with an online meeting (in Feb-March). The clubs were held in the collaboration school once a week for a six-week period (March-May). University students gained experience as instructors, while teachers acted as mentors and co-learners, gaining new ideas for implementing PBL and hands-on experiments in STE(A)M education.

To reflect, student teachers and teachers had a chance to share their experience and learn at the StarT LUMA webinar , exchanging insights with international colleagues.

RQ2: A Pedagogical solution: A science club model

A six-session student-centred science club model for co-designed and co-created during a project between student teachers and school teachers. The clubs are for children aged 9-11 and have a theme "Natural Sciences in Our Life".

Content of the club sessions:

- **1st session:** Introductions and writing rules together, discussing natural sciences in our lives and interesting topics
- **2nd session:** Groups choose their own project-question and plan their project
- **3rd and 4th sessions:** Project related inquiry, experiments and discussions
- **5th session:** Planning the final session together and making project presentation
- **6th session:** a small ”science fair”. The participants presented their projects in person, with posters and videos as a support.

PRELIMINARY CONCLUSIONS

- Co-designing science clubs for non-formal learning environments between student teachers and in-service teachers can be fruitful.
- A PBL (Project-Based Learning) MOOC could support the co-design process for student teachers by providing access to previous research and practical examples. However, the use of English as the language of instruction was challenging for some students.
- Relevant, student-centred solutions for science clubs could be successfully co-designed. We developed a student-centred science club model consisting of six sessions. The final session, which included families in a small science fair, was seen as an inspiring and engaging element.
- Nevertheless, further research is needed. Additional cycles of design-based research are required to deepen our understanding and refine the model

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