LUMA Centre Finland; https://www.luma.fi/en/

International StarT LUMA programme since year 2016

AN EXAMPLE OF OUR DESIGN-BASED RESEARCH PROJECT

CO-DESIGNING SCIENCE CLUBS FOR NON-FORMAL STE(A)M LEARNING ENVIRONMENTS

-Director of the programme, Professor Maija Aksela, LUMA Science Ambassador, First director of LUMA Centre Finland (2013-2025**)**
-Project manager, doctoral researcher, education manager at LUMAlab Gadolin, Dr Outi Haatainen,
International StarT LUMA programme, LUMA Centre Finland
LUMAlab Gadolin & The Unit of Chemistry Teacher Education
Department of Chemistry, Faculty of Science, University of Helsinki, Finland

OUR RESEARCH INTERESTS IN A PILOT STUDY

- RQ1: How to co-design an inspiring science club for non-formal learning environments (after school)? (reported here)
- **RQ2: What kind of pedagogical solution for a student-centred science club can be produced as a product of co-designing?** (reported here)
- RQ3: How relevant is this kind of collaborative learning for students, student teachers and teachers learning during a science club? (later reported)

Cultural sustainability approach:
How to find novel solutions for inspiring all students in science?

LUMA CENTRE FINLAND

- for promoting high quality math, science and technology education (since year **2013**)
- **A NETWORK OF 11 UNIVERSITIES AND 13 LUMA CENTRES: Collaboration between schools, universities and society nationally and internationally**
- **First LUMA Centre at University of Helsinki in year 2003**

- **NATIONAL TASK FROM MINISTRY OF EDUCATION**
- **NATIONAL BOARD (A MEMBER OF EACH UNIVERSITY)**
- **NATIONAL LUMA ADVISORY BOARD (OVER 40 ORGANISATIONS)**
- **LUMAT SCIENCE RESEARCH FORUM: E.G. INTERNATIONAL LUMAT SYMPOSIUM AND JOURNAL LUMAT**

Research and development policy of the LUMA Centre Finland:
Design-based research as a framework
https://www.luma.fi/en/files/2019/03/LUMA_RD_policy_2018-06.pdf

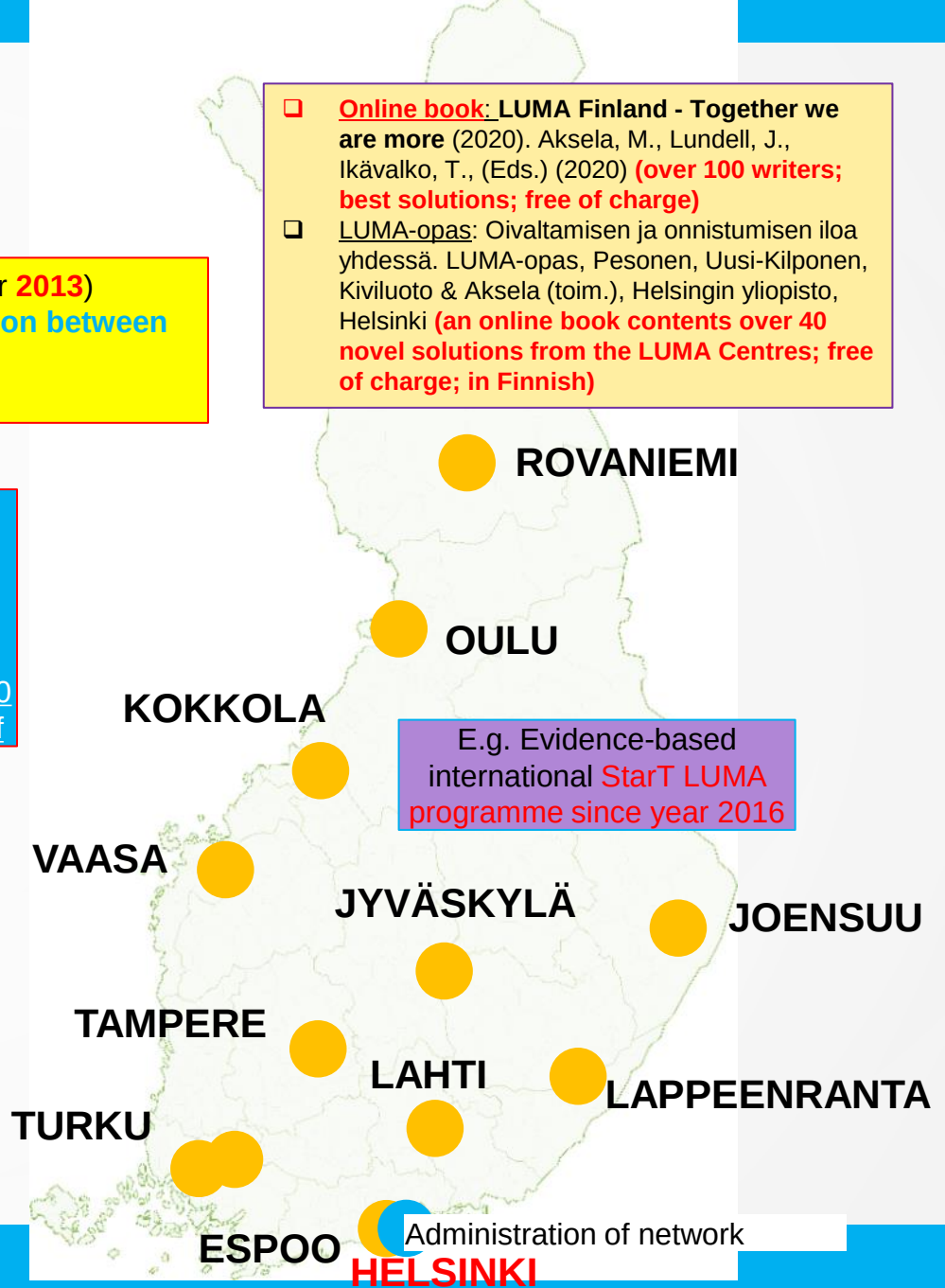
- **Online book: LUMA Finland - Together we are more** (2020). Aksela, M., Lundell, J., Ikävalko, T., (Eds.) (2020) **(over 100 writers; best solutions; free of charge)**
- LUMA-opas: Oivaltamisen ja onnistumisen iloa yhdessä. LUMA-opas, Pesonen, Uusi-Kilponen, Kiviluoto & Aksela (toim.), Helsingin yliopisto, Helsinki **(an online book contents over 40 novel solutions from the LUMA Centres; free of charge; in Finnish)**

Together we are more! (motto)

Finnish National STEM Strategy and Action Plan: Experts in natural sciences, technology and mathematics in support of society's welfare and growth

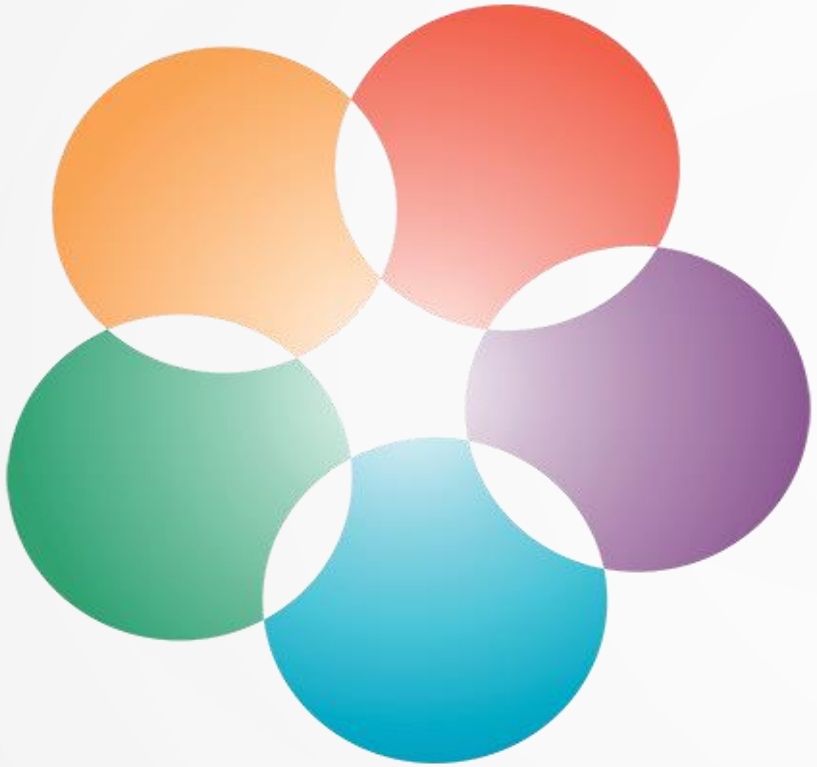
Finnish National STEM Strategy and Action Plan Teacher Education Vision (LUMA part of the vision)

17 LUMAlabs at the centres:
The oldest one LUMAlab Gadolin Hub since 2018



HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Joy of Science for all!



”LUMA flower”

The philosophy behind the LUMA logo

- **Together we are more! (motto)**
- Light in the middle is **the light in students’ – makers of future -eyes when they are engaged on science**.

LUMA is the brand for Finnish science education. It is abbreviated from “luonnontieteet, the Finnish word for natural sciences, and “matematiikka”, the Finnish word for mathematics. **A means all subjects/all sciences (STEAM approach/pedagogy).**

LUMA CENTRE COLLABORATION
SINCE **THE YEAR 2003**

LUMA Centre Finland:
An Example of Design-based Research Project

INTERNATIONAL START LUMA PROGRAMME

- **Aims to engage children, youth, teachers, and families on novel math, science and technology education (STEAM) education through collaboration and sharing**
- An innovative and supportive platform designed to enhance collaborative project-based learning
- Rooted in research and aligned with the latest core curriculum of Finland
- Organized by the LUMA Centre Finland and its cooperation partners since 2016

Research papers and theses, e.g.

Haatainen, O., & Aksela, M. (2021). Project-based learning in integrated science education: Active teachers' perceptions and practices. *LUMAT: International Journal on Math, Science and Technology Education*, *9*(1), 149–173. https://doi.org/10.31129/LUMAT.9.1.1392
(A part of her Ph.D. thesis)

"Every child and youth can be a Star through Teamwork"

In Finnish **T means in the word StarT**:
Tiede (science), Teknologia (technology), Työelämä (working life), Tulevaisuus (future), Taide (art)…

Learning through sharing

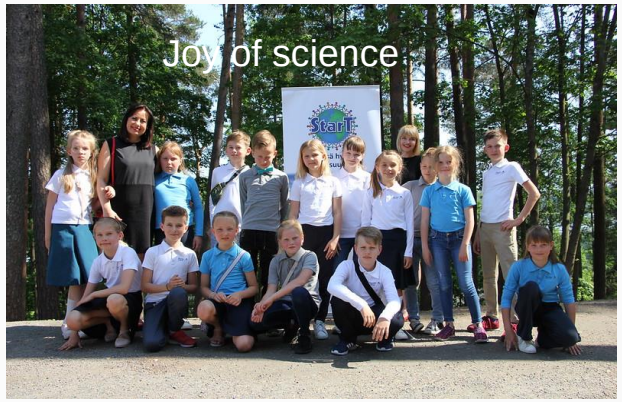
START LUMA PROGRAMME SINCE 2016

100.000 students (3 to 19 y.o.) and their teachers

3000 shared projects and practices

2500 learning communities

Over 70 countries;
MOU agreements



Research papers and theses, e.g.

Markula, A. E., & Aksela, M. (2022). The key characteristics of project-based learning: how teachers implement projects in K-12 science education. *Disciplinary and interdisciplinary science education research*, *4*, Artikkeli 4:2. https://doi.org/10.1186/s43031-021-00042-x

A material bank (awarded solutions around the world; 3 minutes **videos** etc): https://start.luma.fi/en/materials/

Virtual StarT LUMA science club for kids in English: https://start.luma.fi/en/start-programme/start-goedu-virtual-science-club/

Research-based solutions: COLLABORATIVE DESIGN-BASED RESEARCH AS A FRAMEWORK TOOL

EARLIER RESEARCH & INNOVATIONS: SCIENCE & PEDAGOGY

THEORETICAL PROBLEM ANALYSIS

EMPIRICAL PROBLEM ANALYSIS

LUMA STRATEGY AND ACTION PLAN; NATIONAL CURRICULUM ETC; **NEEDS**

CO-DESIGNING WITH DIFFERENT PARTNERS: GOALS FOR THE ACTIVITY;

A PILOT MODEL AND TESTING IT
(AN ITERATIVE DESIGN CYCLE AND DATA COLLECTION)
E.G. SCIENCE CLUBS AT SCHOOLS

THREE KIND OF RESULTS:
Solution(s), New theory & Understanding of the Process

A novel continuos learning model

Partners: scientists, engineers, teacher educators, teachers, student teachers OR companies….

Aksela, M. (2019). **Towards student-centred solutions and pedagogical innovations in science education through co-design approach within design-based research.** *LUMAT: International Journal on Math, Science and Technology Education*, *7*(3), 113–139. https://doi.org/10.31129/LUMAT.7.3.421

StarT LUMA Programme; Ph.D. thesis research part of it:

Outi Haatainen: Towards Integrated Science Education through Collaborative Project-Based Learning : Teachers' Perceptions, Experiences and Practices

M.Sc. & Ph.D. thesis

Scientific papers and publications

Solutions: PEDAGOGICAL INNOVATION(S): MODELS, MATERIALS AND ACTIVITIES

TEACHER EDUCATION

E.G. MOOCS

START LUMA 2024-25 PILOT MODEL

co-designing and co-creating novel models between universities, schools and society through collaboration with some countries

Our research project

Different models between universities and schools

Science clubs for children and families at schools through teacher and university student collaboration – learning for all

Pre-service training for student teachers as a part of a course

In-service training model for the teachers

Science ambassador model for university science students

Online course in English for teachers and pre-service teachers

Module 1: Project-based learning in STEAM education

Module 2: StarT LUMA programme (every country has a possibility to include their own materials/examples)

International StarT LUMA Science Camp in Helsinki:

For participating teachers and student teachers

Co-designing: All interested parties are welcome to join (let us know by the end of Nov 2024)

Participation: we will inform later, once we have dates and programme

Other collaboration possibilities

MOU agreements (7 countries)

StarT LUMA steering group

Joint research

Erasmus+ projects

A partner of society in Finland: Helsinki City and schools as their segregation program

Research-based solutions: COLLABORATIVE DESIGN-BASED RESEARCH AS A FRAMEWORK TOOL

EARLIER RESEARCH & INNOVATIONS: SCIENCE & PEDAGOGY

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CO-DESIGNING: THEORETICAL PROBLEM ANALYSIS THROUGH PBL MOOC

Module 1: PBL in STEAM education

- Compulsory theory part of the course with many examples
- Final assignment: planning a PBL module (science club models)
- 2 credit points (appr. 54 hours of work)
- Content agreed with each partner and can be added later for example by students

Module 2: StarT LUMA programme

- Additional content from partner countries and introduction to StarT LUMA programme
- For example, sharing the co-designed STEAM activies done in science clubs

THEORETICAL PROBLEM ANALYSIS

FORMAL, NON-FORMAL AND INFORMAL LEARNING

Table I. Differences between Formal, Non-formal and Informal Learning

Formal	Non-formal	Informal
Usually at school	At institution out of school	Everywhere
May be repressive	Usually supportive	Supportive
Structured	Structured	Unstructured
Usually prearranged	Usually prearranged	Spontaneous
Motivation is typically more extrinsic	Motivation may be extrinsic but it is typically more intrinsic	Motivation is mainly intrinsic
Compulsory	Usually voluntary	Voluntary
Teacher-led	May be guide or teacher-led	Usually learner-led
Learning is evaluated	Learning is usually not evaluated	Learning is not evaluated
Sequential	Typically non-sequential	Non-sequential

Eshach, H. (2007). Bridging In-school and Out-of-school Learning: Formal, Non-Formal, and Informal Education. *Journal of Science Education and Technology*, *16*(2), p. 174. https://doi.org/10.1007/s10956-006-9027-1

THEORETICAL PROBLEM ANALYSIS

PROJECT-BASED LEARNING

- A collaborative, student-driven, teacher-facilitated pedagogical approach that organizes learning around clearly defined projects
- Roots in constructivism theories of learning: learning is context-specific, learners are involved actively in the learning process, and they achieve their goals through social interactions and the sharing of knowledge and understanding
- Recommended for STE(A)M education and ESD

(Birdman et al., 2021; Haatainen & Aksela, 2021; Kokotsaki et al., 2016)


Picture: AI-generated

RQ1: USED MODEL FOR CO-DESIGNING

Science clubs as collaboration between the University of Helsinki, the Helsinki City and StarT programme – supporting culturally sustainable STEAM education

Pre-service teachers, university course (theory and practice at science clubs), learning through collaboration

- Lectures & MOOC on PBL
- Planning and implementing the science club
- Experimental work in LUMAlab Gadolin
- StarT LUMA webinar: presenting the club projects and learning

Primary school teachers, continuous learning during a science club

- Meetings with university teacher and students
- Reflecting and giving feedback for student teachers
- Participating in science clubs
- Voluntary: MOOC on PBL, StarT LUMA webinar

Primary school pupils, science clubs

- 3rd and 4th graders
- Six 90 min sessions once a week
- Experimental science activities
- Project as a group work

Families

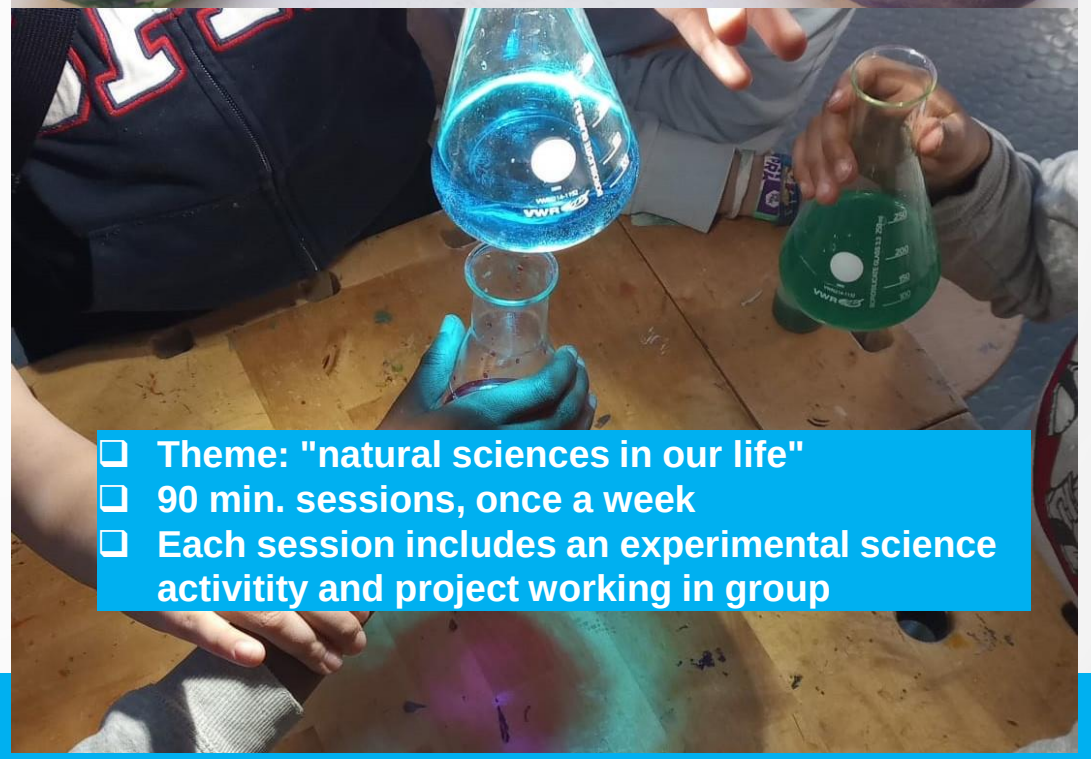
- Invited to the last club session
- Club participants present their projects and get diplomas

Listening students' questions, wishes and feedback during a science club

6 sessions; once a week

RQ2: A PEDAGOGICAL SOLUTION: CO-DESIGNED SCIENCE CLUBS FOR STE(A)M EDU

- **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”



- ❑ **Theme: "natural sciences in our life"**
- ❑ **90 min. sessions, once a week**
- ❑ **Each session includes an experimental science activitity and project working in group**

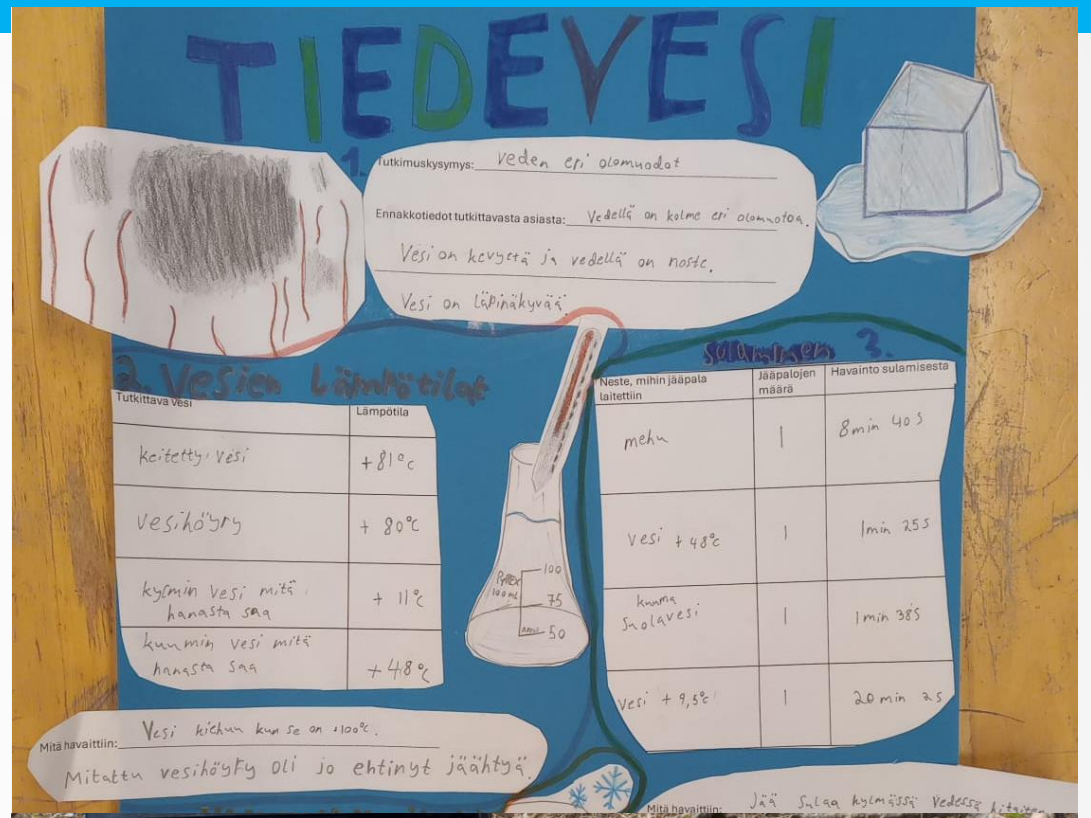
CO-DESIGNED SCIENCE CLUBS FOR STE(A)M EDU

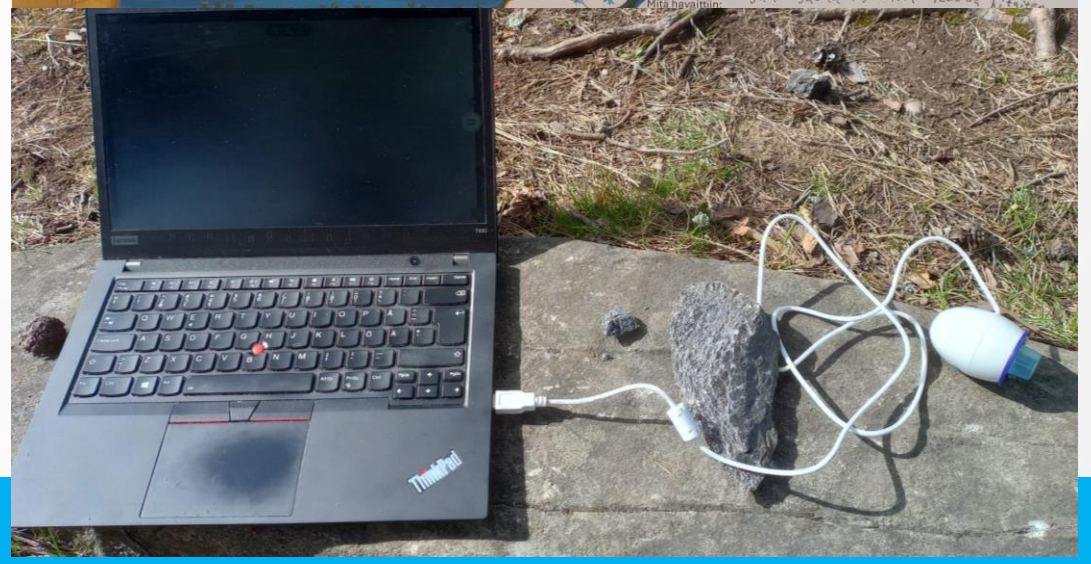
- **6th session**: a small ”science fair”

“I’m gonna show how to do sugar rainbows at home!” (club participant, 2024)

“They told me it was the best club so far!” (parent, 2024)

“Thank you! Nice that you enable our participation to see the children's projects” (parent, 2024)





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

THANK YOU!

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https://start.luma.fi/en/