Report on the Implementation of the National Task 2021–2024 in the LUMA Centre Finland Network

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Content

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Summary

The Ministry of Education and Culture, Finland granted LUMA Centre Finland a second consecutive national task for the years 2021–2024. The primary goal of the funding was to ensure a high level of competence in mathematics, science, and technology, as well as to ensure enough STEM-related experts in Finland. During the four-year period, approximately 391,800 individuals participated in the activities. For comparison, during the previous mandate period (2017–2020), the total number of participants was 245,200. These figures do not include individuals reached through communications. This report presents the outcomes of the operational period through the network's self-defined sub-goals, with a particular emphasis on new community-based models of operation.

The implementation of the national task was planned collaboratively. Key objectives included strengthening continuous professional development for teachers, enhancing university collaboration and network forums, and expanding LUMA activities for children, youth, and families during their free time. Progress toward these goals was assessed annually through self-evaluation, peer-evaluation, and monitoring of the Board of LUMA Centre Finland. The goals were also reviewed at development days held at the end of the year, during which necessary adjustments, especially to sub-goals, were made.

Supporting teachers' continuous learning was one of the most important objectives, and several new models were developed to achieve this. Around 140 teachers and instructors participated in the *LUMA Developers* program, co-creating new teaching models and materials. *LUMA Weeks*, continuing education courses, and online modules expanded teachers' expertise, while study visits and school outreach by LUMA Centres strengthened science education in practice. On average, continuing education was provided to approximately 4,600 education professionals annually.

University collaboration was actively developed. LUMA Centre Finland contributed to the creation and monitoring of the Finnish National STEM Strategy and it's Action Plan. Internal and external communication about LUMA activities within universities improved, and cooperation was strengthened with international science education networks such as Science on Stage and the EU STEM Coalition.

LUMA activities for children, youth, and families during their free time were expanded in various forms. Clubs, camps, and science events reached a total of 13,600 children and young people over the four-year period. New target groups were reached through partnerships with libraries, scouting organizations, and youth services. Remote science clubs and multilingual workshops enabled broader participation of children and families in geographically and socioeconomically diverse situations.

Communication within the Centre and for outreach purposes was developed over the four-year time interval, both strategically and in practice. The impact of social media increased, particularly on Facebook and Instagram, and both the subscriber base and open rate of the LUMA newsletter rose substantially. Communication content was diversified through blog series and online publications. The 2024 Science on Stage festival brought significant international visibility to Finnish LUMA activities, gathering 750 education professionals from over 35 countries.

The national task period significantly advanced LUMA activities: high-quality continuing education for teachers was delivered, university collaboration was strengthened and stabilized, and informal science education became more diverse.

Co-designed Implementation

The planning of the national task's implementation began in January 2021 with online development workshop. Based on the discussions held during these sessions, five planning groups were formed, each focusing on a specific area: 1) Teacher Education and Continuous Learning, 2) Non-formal and Informal Science Education, 3) Curriculum Support, 4) Operational Culture, Evaluation, and Funding, 5) Communication and Materials. These groups met several times during spring 2021 to assess the current state of their respective focus areas and to define priorities for future work.

To support the main objective of the national task, three key themes were identified to guide the operational plans of the LUMA Centres throughout the period. The goals were intentionally formulated to be both challenging and directive, especially targeting areas not yet addressed in existing plans.

The three objectives of the national task were:

1. Support for Formal Education: Strengthen and expand teachers' continuous professional development.
2. Research and Teacher Education: Enhance inter-university collaboration and develop network forums, including partnerships beyond the network.
3. Informal Learning Activities: Increase the reach and impact of LUMA activities for children, youth, and families during their free time.

Progress toward these goals was evaluated annually using a self-assessment matrix and peer discussions. In addition, the director and administrative team met annually with representatives from each LUMA Centre to review centre-specific activities. The board reviewed and approved the annual evaluation plans and results. The goals were also revisited each year during the network's end-of-year development days, and adjustments, particularly to sub-goals, were made as needed based on progress.

A central mission of LUMA Centre Finland is to develop pedagogical innovations for STEM education based on scientific research. The planning of the national task was grounded in research-based development, specifically design-based research (DBR), which produces both new theoretical knowledge and practical solutions such as learning environments, operational concepts, pedagogical approaches, and educational materials. Solutions developed during the period were published on LUMA Centres' websites and material repositories as instructional guides, on the luma.fi site as news items, and in various scientific journals. On average, 130 research publications were produced annually (compared to 50 per year during 2017–2020). Publications from the 2021–2024 period have been collected on the luma.fi website.

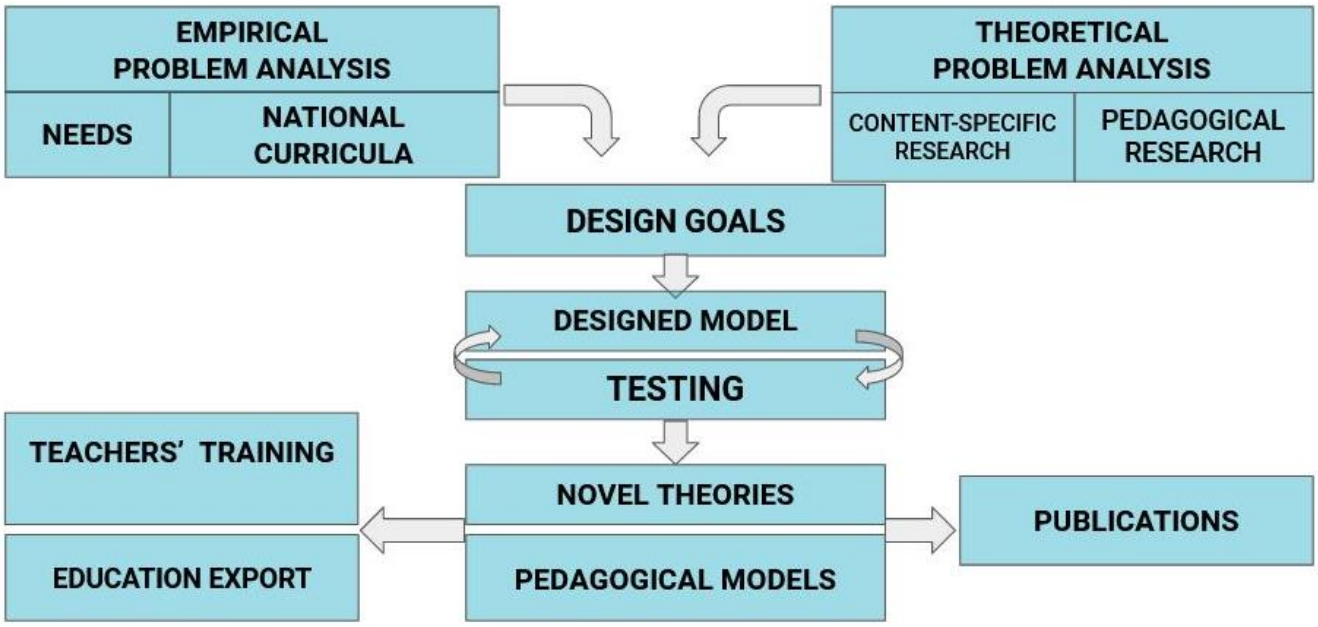


Figure 1. Design-based research model.

Funding

The Board of LUMA Centre Finland decided annually on the allocation of the national task funding. The funding was distributed equally among the 13 LUMA Centres, with designated portions allocated to network administration and to support activities in Swedish and Sámi languages.

It is important to note that a significant portion of the activities was funded through sources other than the national task from the Ministry of Education and Culture, Finland. These additional sources included, for example, grants from foundations, corporate sponsorships, and support from universities. The activities and participant numbers presented in this report would not have been possible without this complementary funding. Local supplementary funding enabled the LUMA Centres to implement regionally prioritized initiatives.

Each LUMA Centre contributed to the implementation of the national mandate's goals based on its own resources, expertise, and strategic objectives.

Key Figures from Period 2021–2024

Activities supporting the high-quality implementation of curricula reached a total of 378,091 children, students, or teachers during the national mandate period 2021–2024.

- 133,704 children, youth, or teachers participated in workshops or events held during the school day.
- 135,808 children or youth visited LUMA Labs in LUMA Centres on study visits.
- 2,383 young people took part in LUMA university courses or online courses.
- 457 students completed their work experience (TET) placements.
- 28,148 teachers or students participated in science competitions.
- 28,281 instances of borrowing teaching tools or materials.
- 30,988 children, youth, and teachers were reached through school and daycare visits.
- 18,322 teachers participated in continuing professional development.

Informal learning activities reached 13,618 children and young people during the period of 2021–2024.

- 8,700 children or youth participated in clubs and virtual clubs.
- 2,221 children or youth attended camps and virtual camps.
- 2,697 children took part in science birthday parties.

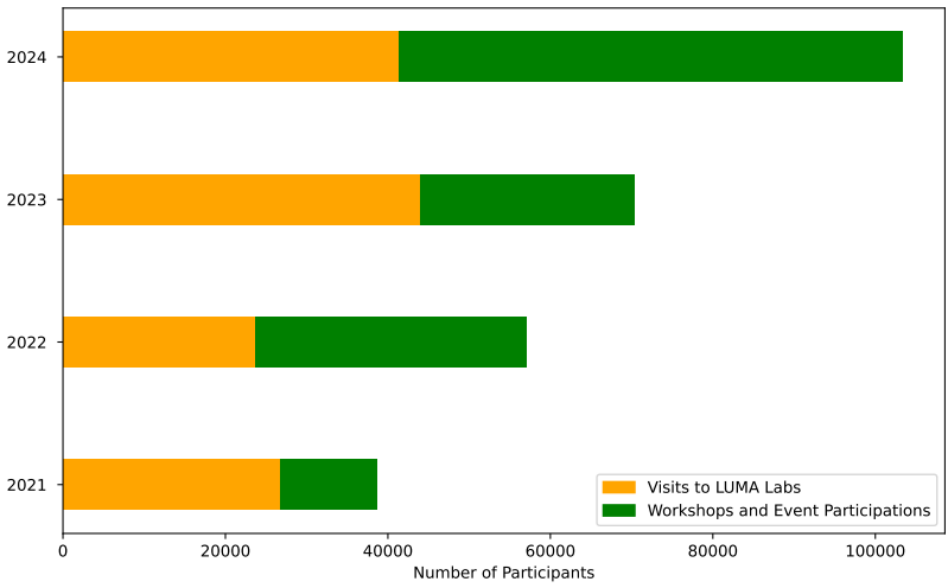


Figure 2. Yearly participation comparison.

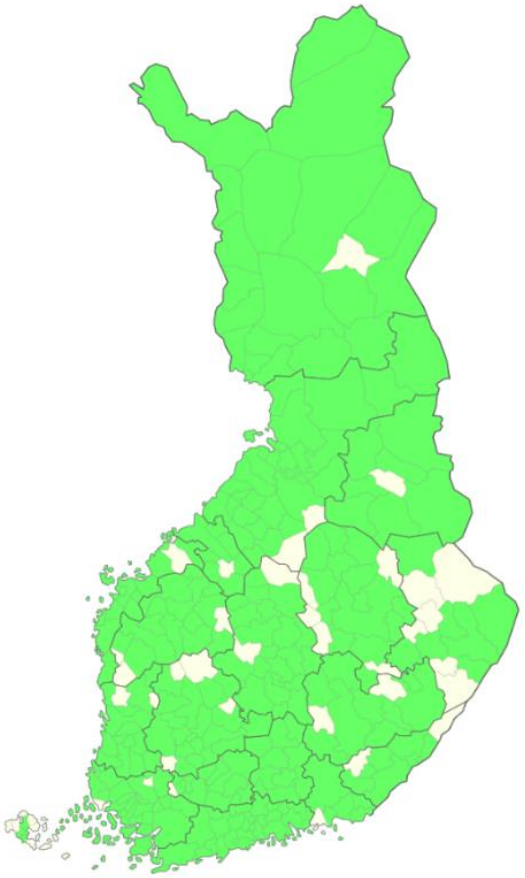
Accessible LUMA Activities

The motto of the national mandate period was "*Joka kolkkaan ja niemeen*" which translates into "*To every corner and cape*". The goal of LUMA activities was to ensure accessibility for every child, young person, and teacher in Finland, regardless of geographical location or social and economic background. This goal was pursued primarily in two ways:

1. By offering remote participation opportunities and online materials.
2. By organizing outreach tours to municipalities, schools, and early childhood education units located farther from universities. These efforts were supported by dedicated additional funding.

With an additional €2,500 in centre-specific funding granted by the LUMA Centre Finland Board, the following types of activities were carried out during 2023–2024:

- Outreach tours to remote schools: These included various workshops, study visits, and tailored teacher training sessions delivered directly in schools and daycare facilities.
- Travel cost reimbursements for educational institutions located far from LUMA Centres to enable participation in study visits.
- Bus transportation for schools to attend LUMA-themed events.
- Travel expenses for LUMA educators to enable them to organize activities at children's and youth events across Finland.
- Design and piloting of new remote workshops.
- Procurement of loanable materials to support LUMA activities in schools' own facilities.



Thanks to these measures, thousands of children and young people in remote areas, previously underrepresented due to long distances, were able to participate in LUMA activities. During the national task period, LUMA activities reached a total of 85% of all municipalities in Finland.

Objective 1: Strengthening and Expanding Teachers' Continuous Professional Development

This goal was considered highly important during the national task period, as it is closely linked to many of the network's core activities, such as research, teacher education, and study visit programs. During the period, various remote learning models were developed and tested, as geographical accessibility and equity were key overarching objectives for the network. Based on positive experiences, remote activities will continue to be developed and implemented in the future.

Different models of continuing education were developed across Finland. For example, the *LUMA Club* organized by the Central Finland LUMA Centre brought together subject teachers in the region to learn about current research in science and education. The *ESERO Finland* collaboration provided teachers and students with new content and perspectives. At the 2023 *Metsävisa* final held at Aalto University, dozens of teachers participated in training sessions on the same themes while their students competed in the event.

As part of this goal, the following annual activities were carried out to support curriculum implementation: annual *LUMA Weeks* for schools and early childhood education units, study visits to LUMA Centres and LUMA Labs, school and daycare visits by LUMA Centres, development of new teaching materials, loan services for teaching tools, continuing education and online courses, the international *Teachers' Climate Change Forum*, participation in annual *Educa* fair and other educational events and direct interaction with teachers. In addition to these, the network focused on new initiatives through the following sub-goals.

1.1. LUMA Developers

Since autumn 2021, LUMA Centre Finland brought together approximately Finnish 140 teachers interested in developing their own STEM education. The so called LUMA Developers initiative included both schools and early childhood education units. In collaboration with experts from the LUMA network, these learning communities co-developed new practices and materials that supported curriculum-based teaching in STEM subjects. New LUMA Developers were selected annually through an open call.

The main goal of the initiative was to enhance collaboration between schools and universities and create co-design culture in the communities. This cooperation supported curriculum implementation, promoted teachers' continuous professional development, and inspired children and young people to engage with STEM subjects. Schools and early childhood education units piloted the jointly developed projects, which were further refined based on feedback.

LUMA Developers met regularly at *LUMA Development Days*, where groups presented the progress and outcomes of their work. During the national annual *LUMA Days*, the models developed by the groups were shared with a broader audience. The work was organized into thematic groups, with topics chosen based on the interests and needs of the participating schools and early childhood education units.

Thematic groups included:

- **Collaboration with Higher Education, Researchers, and Companies** This group developed collaboration models between universities, researchers, and companies, particularly targeting upper secondary and lower secondary schools. The collaboration led to the creation of interdisciplinary and advanced courses as well as study visits.
- **Nature as a Learning Environment** This group designed and implemented projects that used nearby natural environments, especially forests and bodies of water, as learning spaces. The group included learning communities ranging from early childhood education units to upper secondary schools.
- **Models Supporting Community and Project-Based Learning** This group developed three different models to support a sense of community: 1) Inter-institutional model, where collaboration between different educational levels was implemented through shared science clubs. 2) Intra-school model, which supported cooperation between lower and upper primary school classes and created a sustainable model for everyday school life. 3) Intra-city model, where a LUMA activity plan was used to enhance collaboration between educational institutions within a city.
- **Technology Education, Programming, and Mathematics** This group developed materials and teaching practices that support technology education, programming, and mathematics.

1.2. Sharing of Materials

During the national task period, educational materials were shared both among learning communities and between LUMA Centres. The main goal was to enhance communication and ensure that the developed learning materials and training opportunities reached a broad audience. A wide range of materials and training resources were produced during the period, including **mainly in Finnish**:

- LUMA Guide LUMA-opas – Oivaltamisen ja onnistumisen iloa yhdessä
- Escape Room Game on Energy Energia-aiheinen pakohuonepeli, by Skolresurs
- Global Heroes Board Game Globaalit sankarit -lautapeli, by LUMA Centre of Ostrobothnia
- Riikkinen and Oukka Investigate – a children's book series developed in collaboration with publisher Gaudeamus Riikkinen ja Oukka tutkivat – lastenkirjasarja kirjakustantamo Gaudeamuksen kanssa, by University of Helsinki Science Education
- Fraction Mystery for mathematics education Murtolukumysteeri peruskoulun matematiikan opetukseen
- Arduino Kit for lower and upper secondary schools Arduino-paketti yläkouluun ja lukioon
- Introduction to Astronomy Tähtitieteen lyhyt oppimäärä luokanopettajille – osana aineenopettajan maisterintutkielmaa tehty materiaali auttaa tähtitieteestä tietämättömiäkin opettajia lisäämään sitä opetukseensa
- Try at Home website Aalto-yliopisto Juniorin Kokeile kotona -nettisivu, by Aalto University Junior
- Science Café lecture series recordings and learning tasks Tiedekahvila -luentosarjan tallenteet ja oppimistehtävät, by Tampere University Juniversity
- Baltic Sea Rescue Operation escape room game *"Itämeren pelastusoperaatio -pakohuonepeli"* by LUMA Centre of Central Ostrobothnia

LUMA Centre Finland also produced several online courses during the national task period with funding from the Finnish National Agency for Education. Popular courses included, for example, the *LUMATIKKA+*

online training and *The Wonder of LUMA: Nature as a Learning Environment* (in Finnish). The latter attracted particular international interest. Over the four-year period, LUMA Centre Finland developed a total of 39 online courses, co-created in collaboration with various LUMA Centres.

In addition to material production and training, teacher groups actively visited LUMA Centres throughout the period. For example, collaborations with cities and the Finnish Association of Teachers of Mathematics, Physics, Chemistry and Informatics (MAOL) helped bring the developed materials into practical use. In Ostrobothnia, the *LUMASTER Challenge* and festivals in 2023 and 2024 encouraged educators and teachers to implement project-based learning in their communities. At the *LUMASTER Festivals*, educators and teachers had the opportunity to share their ideas and experiences with one another.

1.3. Study Visits as Part of Teachers' Continuous Professional Development

Hands-on study visits are one of the core science education activities of LUMA Centre Finland. These visits are organized as part of the school day, supporting both classroom teaching and national curricula. On average, 34,000 students and teachers visited LUMA Labs annually during the national task period (compared to 20,000 per year in 2017–2020). These visits provide tens of thousands of children and young people with memorable experiences and learning opportunities in STEM subjects, while also allowing teachers to update their own knowledge on the topic of the visit. Teachers are encouraged to define learning objectives for both themselves and their student groups. Study visits also play a key role in disseminating new teaching materials and methods, serve as environments for research and teacher education, and offer opportunities to introduce children and youth to STEM fields, universities, and industry. New LUMA Labs were also established at universities during the four-year period. Notable examples include Polku (Lappeenranta) by Junior University and KOKKO (Kokkola) by the LUMA Centre of Central Ostrobothnia, both opened in 2021.

During the national task period, several new models for study visits were developed and piloted, including:

- Finnish-speaking upper secondary students participated in Swedish-language study visits organized by Skolresurs. These groups included both immersion classes and regular Finnish-speaking classes. Skolresurs also took part in a STEAM Turku pilot, where LUMA educators delivered Swedish-language STEM workshops to lower secondary students studying Swedish as their A-language.
- Remote workshops and study visits were conducted simultaneously for multiple classrooms. Group-specific remote visits, online lectures, hybrid science sessions, and virtual researcher visits also gained popularity.
- Outreach study visits to schools: For example, Aalto University Junior organized Technology Sessions, Swedish-language Technology Sessions, and Robotics Sessions in schools across the Uusimaa region. Aalto University Junior also maintained a service where Aalto researchers visited school classrooms.
- The Central Finland LUMA Centre participated in organizing a joint LUMA track for upper secondary schools in the region's remote areas. This initiative supported students' interest in STEM through university-level education and science camp meetings.

- University of Helsinki Science Education organized an annual event called *The Amazing Race of Science*, aimed at upper secondary students. The event offered students the chance to explore the Faculty of Science and its departments through a playful competition. Participants toured the campus in small groups, completing tasks at various checkpoints and gaining a comprehensive understanding of study opportunities and research at the faculty.

1.4. Low-Threshold Engagement for Teachers

During the national task period, the network organized numerous low-threshold opportunities for teachers to engage with LUMA activities. Examples include the annually held *LUMA Weeks* and open house events, such as *LUMA Coffee* events, which were arranged across Finland. In addition, LUMA Centres hosted school year opening events, and Aalto University Junior organized teacher afternoons and open house events for the public.

LUMA Weeks have been celebrated in Finland since 2004. Their aim is to spark interest in STEM subjects through various activities and to raise awareness of the importance of STEM in society. During *LUMA Weeks*, LUMA Centres have organized regional events, workshops, remote workshops and lectures, continuing education sessions, and networking opportunities for teachers. They have also shared instructions for simple experiments that can be done at home or in school, and highlighted schools' own social media posts through their channels.

In Vaasa, an energy education pathway (in Finnish) was developed for teachers at all educational levels from early childhood to higher education. This pathway allows teachers and students to explore themes such as energy efficiency and renewable energy through diverse workshops and hands-on projects. To support the development of the energy pathway, the City of Vaasa established a working group in which a representative from the LUMA Centre of Ostrobothnia participates. This collaboration enhances dialogue among energy education stakeholders, strengthens teachers' expertise, and provides them with tools to integrate energy topics into their teaching.

Figure 3. The people behind the popular LUMATIKKA+.

1.5. Elevating Mathematics Education – Learning at All Levels

During the national task period 2021–2024, the LUMA Centre Finland network has implemented a wide range of initiatives to promote mathematics teaching and learning across all levels of education, with the goal of increasing enthusiasm and competence throughout Finland. Over one hundred different sets of materials, courses, and practices have been developed (read more in Finnish at luma.fi). Materials produced by the theme group on mathematics, programming, and technology education within the development community have been especially popular. These materials have been downloaded well over 10,000 times during the task period.

Network members have participated in mathematics-themed events and campaigns such as *Mahtavaa matematiikkaa* (Magnificent Mathematics, in English) and EU Code Week. The network has also organized its own events, such as the annual *LUMA Days*, which have provided in-person mathematics training for teachers. *Aalto University Junior's themed weeks on Programming with Scratch* have engaged 7,500 students and their teachers across Finland, while the *Geometry with Origami weeks* attracted 12,000 participants.

LUMA Labs have offered mathematics workshops for learners of various ages, supporting teachers in delivering these topics. In early childhood education, children have explored ScratchJr programming, robotics adventures, and the mathematics of snowflakes. For comprehensive school students, programming has been taught using LEGO robots, micro:bits, and Sphero balls, along with mathematics workshops on topics such as time travel, statistical indicators, the mathematics of nature, and fractions using building blocks. Upper secondary students have received instruction in Python programming, encryption, artificial intelligence, applications of derivatives, and the use of origami folding in engineering.

Additionally, continuing education has been provided, particularly through project funding. The highly popular LUMATIKKA and LUMATIKKA+ continuing education programs have brought together mathematics educators from different levels, offering both theoretical expert support for mathematics teaching and collegial idea-sharing with directly applicable materials. Training has been delivered both online and in person. Instructors have also received support for after-school club activities through a popular remote club, which included mathematics-related topics. After the project funding ends in summer 2025, the learning materials produced will be available to all teachers and teacher educators on the DigiCampus platform.

On June 7, 2022, the LUMAT-B journal published a special issue titled *The LUMATIKKA Program and Mathematics Education*, edited by program coordinators Alisa Uusi-Kilponen, Eveliina Hietakymi, and Susanna Toikka. The aim of the issue was to highlight effective practices and content from the LUMATIKKA program that inspire enthusiasm for mathematics, as well as to broaden understanding of the program's impact on Finnish teacher education. The ten-article collection covers the following themes: Introduction to the LUMATIKKA Program that Inspires Enthusiasm for Mathematics, Learning Mathematics through Play in Early Childhood and Pre-primary Education, Do You Speak Math? Language Use and Insights in Lower Grade Mathematics, Boosting Meaningful Mathematics Teaching in Upper Grades and Upper Secondary Education, and Math Glasses On! Inspiring Learning Throughout the Educational Path.

Objective 2. Strengthening University Collaboration, Developing Network Forums and External Cooperation

This objective included, among other things, the following annual events and operational models: university-level teacher education and research, the *LUMAT Research Forum*, the *LUMAT Journal*, the annual *LUMA Days*, and collaboration between LUMA Centres and other stakeholders. During the 2021–2024 national task period, LUMA Centre Finland engaged in close cooperation with other networks such as ESERO Finland and the STEAM networks (Oulu and Turku), as well as internationally with networks like IDoS, Science on Stage, and the EU STEM Coalition. Through the EU STEM Coalition, LUMA Centre Finland participated in active dialogue with the European Commission, contributing to the groundwork for the development of the European STEM strategy. In addition, the network maintained active collaboration with students and universities of applied sciences. The network also focused on new initiatives through the following sub-goals.

2.1. Sharing Effective Models of Teacher Education Collaboration and Research

Although LUMA Centres have had varying levels of resources to participate in teacher education or research at their respective universities, many centres made significant progress during the national task period in establishing their activities as part of teacher education and research. For example, LUMA workshops organized for primary teacher students, as well as courses and study visits carried out in collaboration with STEM teacher education, have been popular. More detailed models of teacher education can be found, for instance, in the book describing the activities of LUMAlab Gadolin.

At many universities, practices were also established during the period that enabled better involvement of thesis students and doctoral researchers in LUMA activities. One example is the LUMA Science Helsinki research group, which began its work at the University of Helsinki in 2021. At the heart of this initiative was a model in which the coordinators of the University of Helsinki Science Education LUMA Labs conducted their doctoral research related to the activities of the science classrooms.

At the LUMA Centre of Central Ostrobothnia, a new operational model was introduced in 2023, in which university researchers are involved in science education activities already at the research funding application stage. A section on knowledge dissemination is included in the applications during the preparation phase, and a ready-made template has been created for project steering group agendas to include items related to science communication. This is a new collaborative model for making research knowledge accessible to teachers and the public. The target audience for communication is selected based on the goals of the project. For example, a researcher might visit an upper secondary school to present their research. The model is also applied in collaboration with the local business sector. LUMA educators have also participated in events aimed at businesses to present LUMA activities, rather than limiting event collaboration solely to those targeting children and youth.

The national task period strengthened the sense of community and knowledge sharing among LUMA Centres. The LUMA network successfully carried out several joint projects and events. For example, themed meetings on current topics brought together LUMA educators interested in the same themes to learn from one another and share best practices. Many LUMA Centres maintained close contact throughout the period and jointly applied for, and received, funding for collaborative projects. One such example is the joint project Tekoälytaiturit (“AI Experts”) carried out by Aalto University Junior and Tampere University Juniversity.

LUMAT Science Research Forum

The LUMAT Science Research Forum has supported LUMA activities during the national task period both nationally and internationally through four main formats: 1) National online research seminars 2) International online research symposiums 3) Summer schools, and 4) The scientific journal LUMAT. The forum was founded and is led by Professor Maija Aksela. Between 2021 and 2024, the research seminar was organized 2–4 times annually, featuring both Finnish and international researchers or future researchers in the field. Special issues of LUMAT Journal have been published based on the annually held international research symposium.

LUMAT Journal has established itself as a significant publication channel for science education research both in Finland and internationally. Founded in 2012, the journal published several special issues during the 2021–2024 period, covering timely scientific themes related to LUMA activities, such as mathematics education, the role of technology in teaching, and sustainable development. In 2023, LUMAT expanded its general issue from a national to a Nordic focus, increasing its international visibility.

The journal’s editor-in-chief has been Docent Johannes Pernaa, an expert in chemistry education at the University of Helsinki. The editorial board consists of approximately 25 respected researchers from around the world. In 2023, LUMAT’s H-index rose to eight, reinforcing its position as the leading science education journal in the Nordic countries. In 2024, the journal maintained its status as the most influential publication in the region. Articles were read and downloaded tens of thousands of times, not only from the LUMAT website but also through international databases such as Scopus, DOAJ, and ERIC.

Alongside LUMAT Journal, LUMAT-B operates as a companion publication, publishing conference proceedings and general issues. For example, in 2023 it published a collection of articles from the *European Conference on Chemical Safety in Science Education*, and in 2024 its international collaboration expanded with the publication of proceedings from the *29th International Mathematical Views Conference*.

As part of LUMAT's activities, research seminars and symposia were also organized on topics such as mathematics education, digital skills, sustainable development, and other current themes. The LUMAT Research Symposium was held for the 14th time in 2024, with the theme *New Trends in Math and Computing Science Education*.

Science on Stage Festival 2024

For the first time, Finland hosted the international flagship event Science on Stage Festival from 12 to 15 August 2024, led by LUMA Centre Finland. The event took place at the facilities of Turku University of Applied Sciences. The Science on Stage festivals are the largest events in Europe dedicated to teachers of STEM subjects. The festival brings together hundreds of teachers from over 35 countries to share ideas, learn new things, and network with their peers.

The theme of the 2024 festival was *Sustainability in STEM Education.* In conjunction with the festival, the national LUMA Days were held. The event featured workshops, presentations, and a large exhibition fair where teachers showcased the pedagogical innovations they had developed. Approximately 750 STEM education experts participated in person. The festival offered Finnish teachers a unique opportunity to explore the ideas of their European colleagues and to strengthen science education networks both nationally and internationally. The event gained wide international visibility, with over 150 articles published about it around the world. In 2024, the event website attracted more than 25,000 visitors.

StarT Programme

StarT, launched in 2016, is a program coordinated by LUMA Centre Finland with the aim of supporting an interdisciplinary and collaborative learning culture where everyone learns from one another. The program has attracted participants from nearly 70 countries and was awarded the Global Best Awards 2018 as the best initiative in Europe for connecting education and working life.

The goal is to support the objectives of national curricula, such as transversal competencies, inquiry-based and integrative learning, the use of diverse learning environments, and the implementation of multidisciplinary learning modules. The program especially aims to foster children's and young people's joy of discovery and learning across subject boundaries. In the projects, participants not only learn subject content but also teamwork, research skills, and creative approaches. The topics are linked to everyday phenomena, which helps highlight the relevance of science and lays the foundation for interest in STEM subjects.

Through research connected to the program, new relevant solutions have been sought for interdisciplinary and collaborative STEM education. In spring 2024, new types of science clubs were developed and tested

through international collaboration. These clubs served as learning environments not only for primary school pupils but also for families, teachers, and teacher trainees. Ideas and practices from program participants can be explored in the StarT material bank. In addition, a free English-language online course has been developed as part of the program to support the implementation of collaborative project-based learning.

2.2. Strengthening Internal University Engagement with LUMA Strategy and Activities

During the national task period, the Ministry of Education and Culture, Finland developed and published the Finnish National STEM Strategy and Action Plan, which outlines the current state of STEM competence and activities in Finland, as well as the national challenges related to them. The strategy was published in 2021. In spring 2022, the Ministry appointed a steering group and a working committee to draft an action plan for the STEM Strategy, with LUMA Centre Finland represented in both groups.

The action plan includes 31 concrete measures, of which LUMA Centre Finland has been designated as the responsible party for eight. In addition, the LUMA Centre Finland network participates in other measures in cooperation with higher education institutions, science centers, and other relevant actors. The LUMA network is committed to implementing the action plan to achieve the strategy's goals by 2030.

LUMA Centre Finland has actively communicated about the National STEM Strategy and its Action Plan. One of the measures includes the LUMA Centre Finland Advisory Board monitoring the implementation of the strategy and reporting annually to the Ministry. During the national task period, this monitoring was conducted twice, and the results were shared not only with the Ministry but also with other stakeholders. In December 2024, as the national task period came to an end, a seminar day was held to present a prioritization model for the National STEM Strategy and it's Action Plan, developed by the national LUMA Advisory Board based on monitoring and evaluation data. The model highlights the following key development areas for the near future:

- Ensuring the continuation of research-based teacher education programs.
- Ensuring teachers' access to in-service trainings.
- Strengthening the resourcing of LUMA Centres so they can support education providers in developing STEM teaching and teacher competence, as well as extracurricular STEM activities.
- Enhancing STEM competence and increasing the joy of learning through accessible and equitable extracurricular activities in collaboration with schools, science centres, and other actors.
- Investing in Finnish innovation capacity by providing long-term funding for science activities and teacher training.

These development priorities were communicated to the Ministry of Education and Culture, Finland in early 2025 as perspectives for shaping the goals of the new national task period.

One of the key objectives during the national task period has been to embed LUMA activities into the existing structures and practices of universities, including teaching, research, and societal engagement. Efforts have focused on integrating science education into university strategies and action plans, ensuring that LUMA becomes a natural part of institutional operations. Several universities have taken concrete

steps in this direction by establishing permanent positions for LUMA Centre staff and aligning LUMA initiatives with broader educational and research goals. As a result of these strategic efforts, many LUMA Centres have seen a strengthening of university-specific resources, enabling more sustainable and impactful collaboration within the academic community.

Objective 3. Expanding the Reach and Impact of Informal STEM Education for Children, Youth, and Families

This objective included a wide range of annual network activities such as science and technology clubs, science-themed birthday parties, summer camps, youth courses, university introduction courses, public science events, workshops at third-party events, social media campaigns (e.g., on TikTok), and online materials supporting informal learning. The aim was to increase the accessibility and impact of LUMA activities for all target groups. Informal activities such as summer camps and science clubs reached approximately 3,400 children and young people annually. The network also focused on developing these activities through the following sub-goals.

3.1. Sharing Concepts and Expertise Within the Network

The network shared ready-made activity instructions and club visit models via platforms such as Microsoft Teams. Science club collaboration culminated in an online after-school science club held in autumn 2024. The main goal of the online club was to provide accessible and inspiring after-school STEM activities for children in grades 1 and 2. At the same time, the club served as a new form of lifelong learning for municipal after-school program instructors.

During the online club, children were virtually introduced to different parts of Finland. Club broadcasts were hosted in turn from Jyväskylä, Rovaniemi, Turku, Helsinki, Lappeenranta, Vaasa, and Joensuu. Some sessions were bilingual, making participation possible for language immersion groups and Swedish-speaking clubs. The first pilot was held on Tuesday afternoons, and each session was recorded to allow participation at other times as well. The recordings proved highly popular and were supplemented with written instructions and materials lists for instructors. In total, 114 Finnish after-school clubs registered for the online science club, involving 1,743 children and 259 after-school instructors.

3.2. Reaching New Audiences

During the national task period, significant progress was made in expanding informal STEM education. Key developments included:

- Science education in collaboration with new partners: Informal activities for children and youth were organized in cooperation with libraries, youth services, the Scouts, and the Mannerheim League for Child Welfare. Libraries hosted workshops where children conducted hands-on experiments. For example, in a workshop by the LUMA Centre Päijänne Tavastia, the library curated related reading materials for children and youth, such as Harry Potter, and paired them with themed science activities. During the COVID-19 pandemic, libraries in Lahti distributed small science kits to borrowers, accompanied by remote science sessions.
- Participation in family events organized by others: LUMA Centres contributed with workshops to events such as those co-organized by Aalto University Junior and Keravan Energia, and to the Aalto-laakso program at the Kimara Scout Camp by the Scouts of the Helsinki Metropolitan Area. Aalto University Junior also collaborated closely with venues like Oodi Library, Cultural Centre Stoa, Vuotalo, and the World Village Festival.
- Expanding geographic and socioeconomic reach: For example, online science clubs enabled entire families to participate in LUMA activities. Aalto University Junior organized multilingual workshops at various events in collaboration with interpreting students from Diaconia University of Applied Sciences (DIAK). In spring 2023, Aalto University Junior also held remote workshops for children in Ukraine.
- Thematic Weeks by Aalto University Junior, which reached tens of thousands of children and youth from 240 municipalities through online activities.
- The Kitchen Chemistry online course, developed with the participation of the Central Finland LUMA Centre, was used by the general public, teacher education programs, and especially upper secondary students during thematic weeks to explore experimental home chemistry.
- Events for children of international staff and the popular Take Your Child to Work Day, organized at several universities.

Because the national task period coincided with the COVID-19 pandemic, at-home science activities became especially popular. On the LUMA network's social media channels, "Try This at Home" style instructions and videos gained wide popularity. These were shared on platforms such as TikTok, Instagram, Facebook, and YouTube.

Informal learning activities also included adults. The LUMA Centre of Southwestern Finland developed a popular science club for adults, which attracted participants from a wide range of professions, including teachers.

Communication

The communication efforts of LUMA Centre Finland have developed significantly over the four-year period, both strategically and in practical implementation. The communications team, established in 2021, has solidified its role through regular meetings and training sessions. Internal communication has been enhanced, for example, through more active use of Microsoft Teams. The accessibility and search engine visibility of the website have been continuously improved, and the number of LUMA News publications has

increased year by year, reaching 61 publications in 2024 in three different languages.

Social media followings have grown steadily, with particularly strong increases in reach on Instagram and Facebook. In 2024, Facebook reached 56,000 users and Instagram 11,000, demonstrating the expanding impact of LUMA communications. The subscriber base of the LUMA newsletter also grew, and its open rate increased significantly over the four-year period. Communication content has been diversified through blog series, such as "*Joka kolkkaan ja niemeen – Till hela landet*" (To Every Corner and Cape, in English) launched during the anniversary year 2023, and "*Valtakunnalliset innostavat LUMA-mallit*" (Inspiring National LUMA Models, in English) in 2024. On social media, topics that gained particular attention included continuing education, school collaboration, and major events such as Science on Stage and LUMA Days.

Overall, the communication of LUMA Centre Finland has evolved into a multi-channel, audience-responsive, and widely reaching entity. It is grounded in the growth of the broader LUMA community and the increasing recognition of LUMA activities.

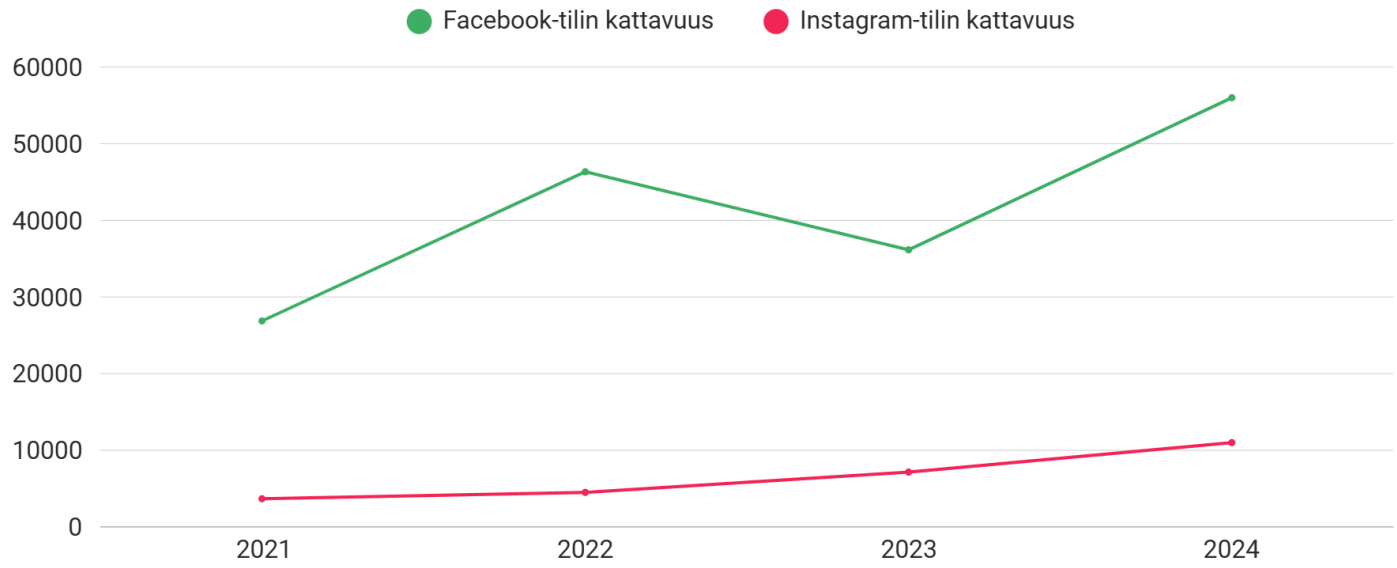


Figure 4. Growth in the reach of LUMA Centre Finland's social media accounts, 2021–2024. The reach on Facebook is shown in green, and the reach on Instagram is shown in red.

Increasing Visibility Through Communication Partnerships

Tampere University Juniversity produced a series of Science Café lectures for Yle Areena in autumn 2023 as part of the European Researchers' Night program. The lectures attracted over 2,000 viewers on Yle Areena, after which the recordings and related learning tasks were published on Juniversity's YouTube channel. The collaboration with Yle Areena significantly increased national awareness of the Science Café concept. In addition, Aalto University Junior produced both printed and digital materials in collaboration with Helsingin Sanomat's Lasten Uutiset and Hufvudstadsbladet's HBL Junior.