

STEAM-activities for Pupils and Schools in Finland
Tampere LUMATE Centre and LUMA Centre at Aalto University

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INTRODUCTION

Finland is known for its excellent PISA rankings as well as of high level academic competence and teacher training compared with many other countries. The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students. To further support this high level of competence and lifelong education for teachers, the new LUMA Centre Finland (LUMA-keskus Suomi) was established at the end of 2013. LUMA Centre Finland functions as the umbrella organization for LUMA centres in Finnish Universities in order to strengthen and promote their collaboration on a national level [1]. The acronym LUMA stems from the Finnish words for natural sciences and mathematics. According to the joint national strategy and action plan, the new Centre will promote skills in mathematics, natural sciences and technology.

Activities provided by LUMA centres include science and technology clubs, camps, theme days and courses for children and young people. Also national in service training courses are held for teachers across Finland. STEM classrooms and laboratories are developed all over Finland in such a way that they form centres for STEM education and research. Most activities are free of charge and available for everyone regardless of their socio-economic background.

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1 LUMA CENTRE FINLAND

1.1 General

Finnish LUMA centre activities began in 2003 when the first LUMA centre was established at the University of Helsinki. LUMA Centre Finland was established ten years later in November 2013. Tampere University of Technology and Aalto University were the first technical universities to join to the LUMA network in 2011. The other centres were established later (for more information see <http://www.luma.fi/centre/>). Nowadays there are 13 LUMA centres:

1. Central Finland LUMA Centre (University of Jyväskylä)
2. LUMA Centre Aalto (Aalto University)
3. LUMA Centre Lapland (University of Lapland)
4. LUMA Centre of Central Ostrobothnia (Kokkola University Campus Chydenius)
5. LUMA Centre of Ostrobothnia (University of Vaasa)
6. LUMA Centre of Southwestern Finland (University of Turku)
7. LUMA Centre of the University of Eastern Finland
8. LUMA Centre of the University of Helsinki
9. LUMA Centre of the University of Oulu
10. LUMA Centre Päijät-Häme (Lahti University Campus)
11. LUMA Centre Saimaa (Lappeenranta University of Technology + Saimaa University of Applied Sciences)
12. LUMA Centre Åbo Akademi (Åbo Akademi University)
13. Tampere LUMATE Centre (University of Tampere and Tampere University of Technology + Tampere University of Applied Sciences)



Fig. 1. Map of LUMA centres in Finland.

The centres organize LUMA activities in their own regions, each with its own particular emphasis. The University of Helsinki coordinates the overall network. Every centre has its own part time or full time coordinator and director. Coordinators have regular web conference meetings. National LUMA Days are organized once a year. STEM research and STEM teaching innovations is increased via the national LUMA.fi online portal, LUMA newsletter and LUMA TV.

Each University finances its own LUMA centre. Some national development programs are financed by the Ministry of Education and Culture. Some centres may also get resources from the local authorities, industry and foundations. There are ongoing negotiations to acquire basic resources for every centre directly from the Ministry of Education and Culture.

Each community in Finland has been asked to nominate their own contact persons who inform schools and teachers of news, activities, opportunities and events. Usually these persons are active teachers in STEAM fields.

Some of the activities are national and some are local depending on the particular focus and available resources of each LUMA centre. In this paper we introduce some national activities that are common to all LUMA centres and some which are specific for LUMATE Centre in Tampere and LUMA-Centre at Aalto University.

1.2 National activities in all Finnish LUMA centres

LUMA Centre Finland coordinates the national program for education in the natural sciences and mathematics financed by the Ministry of Education and Culture. The pilot programs in 2014-2016 concern mathematics, natural sciences and technology. The program will continue in 2017-2019 and aims to spread the influence to more schools [2].

Over 10 years ago the Technology Industries in Finland started a technology competition, Tämä toimii! (This Works!) for schools. Since 2013 the LUMA Centre Finland has taken responsibility for organizing the competition. LUMATE Centre has coordinated the competition for the past three years. This competition is dedicated to lower secondary school pupils (from 4th to 6th grades). The competition is a project where mixed groups of four pupils design and build a moving toy at school from a given or self-collected set of materials [3]. They must also produce a project diary and marketing material for the particular toy they have created. Figure 2 shows the number of schools and participating groups between the years 2014-2016. The participation was limited to only certain cities in 2014.

The toy that was elected best in each school continues through to the next round. This takes the form of a regional competition arranged by the local LUMA centre. One toy from each of the 11 regional competitions is selected to participate in the final competition. In 2016 the final national competition is being organized by Technology Academy Finland (TAF) to coincide with the Millennium technology prize events in May.

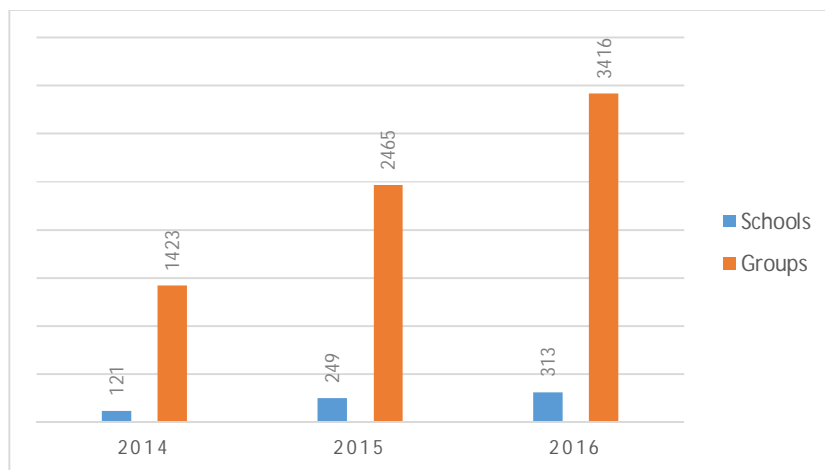


Fig. 2. Diagram of participation in the Tämä toimii! competition.

On the internet LUMA Centre Finland provides science clubs for children aged 3 to 6 years [4]. There are videos of experiments which children themselves can conduct together with their parents at home. The science behind each experiment is also explained.

LUMA Centre Finland will celebrate the 100th anniversary of Finnish independence (2017) by launching its innovative StarT initiative. This initiative will give concrete tools and practical support for implementing interdisciplinary project work in schools and hobby groups. The aim of StarT is to create a novel operating culture focusing on project work carried out by children and youth to support the Finnish National Curriculum. The most distinguished projects will be presented in regional StarT Festivals and a national StarT Gala. Through StarT, every child and youth can be a Star [5].

2 LUMATE CENTRE IN TAMPERE

2.1 General

Tampere's LUMATE Centre was the first technically oriented LUMA centre in Finland (the additional "TE" in the name comes from the word "Technology"). The centre was founded in the spring of 2011 by a collaborative effort of both Universities of Tampere, the Economic Information Office, Tampere Chamber of commerce, Tampere technological society and the federation of Finnish Technological Industries. The centre operates from the campus of Tampere University of Technology and serves the whole Pirkanmaa area and Southern Ostrobothnia (Etelä-Pohjanmaa). In the beginning of 2015 The Tampere University of applied Sciences joined the LUMATE Centre. Now LUMATE is a co-operative project of three Universities of Tampere.

LUMATE Centre works in cooperation with many other organizations. The major partner is the city of Tampere which has provided financial support every year. That support has enabled us to arrange LUMATE Centre's core activities free of charge.

2.2 Science clubs and camps

The LUMATE Centre organizes science clubs for children (1st to 8th grades). LUMATE provides different kind of clubs eg. Lego robotic clubs, electronic clubs, programming clubs and traditional science clubs. Most of these activities take place during evening hours in LUMATE's own teaching room located within the Tampere High School of Technology. LUMATE also provides afternoon science clubs in several schools in Tampere.

In addition, every two weeks LUMATE arranges an event called "Tiedepysäkki" (Science station) in it's own teaching room. On every event, the focus has been on a different subject, for example 3D-printing or games and tactics. Everyone is welcomed to participate, either on their own, or together with friends or family

During the school holidays each summer and fall LUMATE provides science camps. The camps are aimed at children from preschool age up to 8th grade. The Camps last one week (every day from 9am-3pm) and are very popular and entertaining. Each camp has a maximum of 20 children. Several camps are organized in parallel each week.

Participants are chosen randomly by a lottery and all camps and activities are provided free of charge. In 2015 there were over 500 participants in the science clubs and camps.

2.3 Science cafes and other Science events

In addition to activities for school children, LUMATE organizes monthly “Science Cafés” in the Old Library building in Tampere city center. These are public events, aimed at older students and adults. Each month a different guest speaker makes a presentation providing entertaining and stimulating insights into their own particular field of expertise. The science cafés provide a unique forum to introduce interesting STEM subjects to high school and college students and to the lay public.

LUMATE invites experts to popularize mathematics and coordinates national tours with other LUMA centers. During these tours, experts like Matt Parker visit local schools and present Science café style events. These visits have been arranged in cooperation with the Finnish British society.

LUMATE coordinates national technology competitions for school children with an interest in natural sciences, mathematics and technology.

2.4 Education and training for teachers and student counsellors

LUMATE provides various teaching resources:

The first of these is a “Bank of Experts” from which teachers can invite different professionals to give presentations in their schools. Each expert is a specialist in a particular field and their visits can be arranged to coincide with the teacher's schedule thereby enhancing the students' understanding of the subject at hand.

LUMATE also maintains a central “laboratory equipment bank”. Schools can loan special equipment to help demonstrate science phenomena in the classroom. Much of these loaned equipment is available in sufficient quantity to allow a whole class to participate in the experiments.

Both the “Equipment Bank” and the aforementioned “Expert Bank” are also provided free of charge.

On LUMATE`s webpage there is also a bank of teaching materials which includes a collection of instructions for science experiments and a variety of methods for presenting different scientific concepts and ideas to children. Teachers (and everyone else) are free to use these in their work.

3 LUMA CENTRE AT AALTO UNIVERSITY

3.1 General

LUMA Centre at Aalto University started officially at the end of 2011. Even before that there has been various activities to motivate high schools students towards the study of natural sciences and finally promote applications to the Aalto University (former Helsinki University of Technology). Lectures, courses and visits to research laboratories have been organized for several years.

In 2012 Aalto University started to build a special LUMA laboratory for schools. It was called LUMARTS because the School of Arts at Aalto University started their “Biofilia” at the same time. Biofilia is a lab space that contains equipment for DNA handling and organic materials research combined with arts activities. While the LUMA Centre is new, it is continuously developed in collaboration with active teachers from secondary and high school education. In the following few paragraphs we will introduce some of the actions currently organized by the LUMA Centre at Aalto University [7].

3.2. LUMARTS laboratory

LUMARTS Lab is a learning and teaching environment supporting and developing science, technology and arts. LUMARTS lab was designed together with Biofilia. Biofilia is a functional unit of LUMARTS for biological arts, which also aims to support the positive image of STEAM (STEM+ART) and offers unique educational alternatives for in fields of science, art and technology.

School teachers can reserve a time slot at LUMARTS and bring their pupils to make experiments there. The teacher is responsible for the group and Aalto University offers an assistant to help in performing the work in the lab. Study visits for pupils and students aged 10–20 vary from one hour to longer courses. The study opportunities include experimental laboratory work and visits to the research laboratories, including discussions with scientists about their own research.

Teachers can choose the contents and methods suitable for their own educational purposes and curricula. The basic principles of the subject at hand are studied at schools before the LUMARTS visit and continued afterwards to support meaningful learning and higher-order thinking.

The idea has been to readily provide equipment and technologies to which schools would not otherwise have access themselves. For example, very few schools have fume cupboards for student experiments in chemistry lessons or the possibility to show how automation technology works. Arduino kits are also often used in the lab. The idea of the lab is also to integrate sciences and technology and to facilitate phenomenon based learning.

LUMARTS lab started in May 2013 and in 2014 about 1200 study visits were paid to the lab. In 2015 there were already 2200 study visits. The lab is continuously developed in collaboration with school teachers.

3.3 Lectures and Courses for High School Students

LUMA Centre Aalto offers also high-quality lectures and courses for high school students. The lectures and courses in mathematics, chemistry, astronomy and biological arts for instance, are taught by the university's own teachers and professors.

For example Space and Satellites, Micro and Nanotechnology and Medical Chemistry have been popular courses. Science lectures are organized on average twice a month and students from several high schools take part in them.

3.4 In Service Education for Teachers

Several in service education afternoons have been organized in LUMARTS for teachers. In the first years the purpose has been to teach them to use the lab and introduce the equipment and experiments. Teachers have also shared experience and information from their own fields.

The themes have varied from gene technology to origami, programming with Arduinos to colours appearing in Nature. Teachers come after school hours and they can complete part of their formal yearly education by participating in our courses.

4 SUMMARY

All universities in Finland would like to have more high motivated and interested students in natural sciences and mathematics. This is the reason why they have joined LUMA Centre Finland that was established three years ago. The centre is still quite new and the action is continuously developing depending on the resources. So far it has been successful for example in carrying out the development program LUMA

Suomi, "Tämä toimii!" competition in whole Finland and the tours of foreign experts around Finland. Also the regular meetings of coordinators via web conferences and yearly national seminars has been useful to share good practice and support for the real factors/makers.

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