

Assessment for Improving Learning: **A case of Finland**

Prof. Dr. **Maija Aksela**

Finland's Science Education Centre,

University of Helsinki, Finland

maija.aksela@helsinki.fi

Sunny greetings from Finland - "Pisa country"!





FREE! International LUMA News for teachers, researchers & educators



Subscribe to LUMA News

Finnish Education in a Nutshell

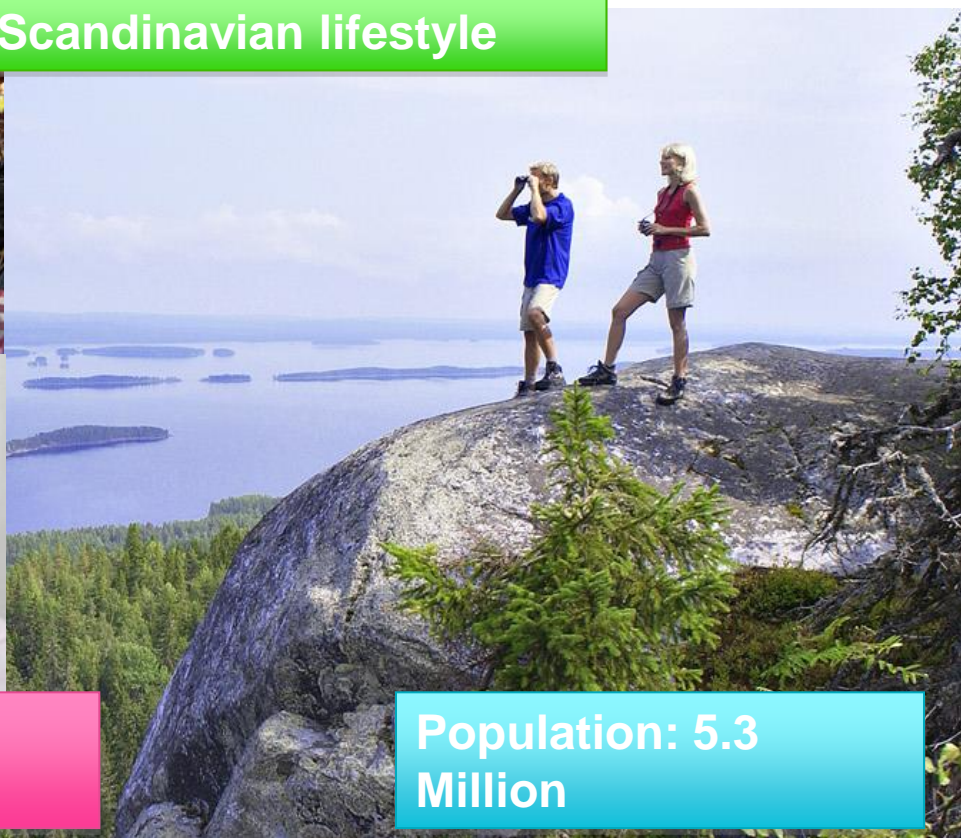
Background for Finnish PISA Success



Finland – a country of thousand lakes and islands



Scandinavian lifestyle



Officially bilingual: Finnish and Swedish

Population: 5.3 Million

See more: [This is Finland.fi](https://www.thisisfinland.fi)

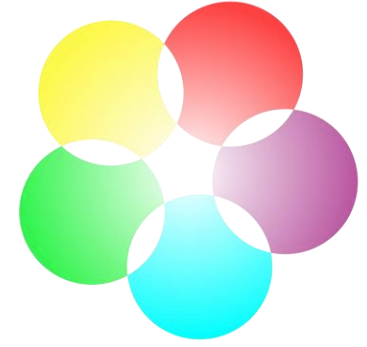


Contents of My Presentation:

- ❑ Finland's Science Education Centre, the LUMA Centre **and Improvement of Learning through Assessment**
- ❑ **News** from Finnish Assessment
- ❑ **An Example in Details** How to Improve Assessment for Learning



|



**IMPROVING LEARNING THROUGH
Finland's Science Education
Centre, the LUMA Centre
for math, science and technology education
since 2003**

LU stands for 'luonnontieteet', natural science in Finnish, and **MA** for mathematics.



A MOTTO: A STUDENT IN A HEART



EMOTION AND COGNITION HAND IN HAND



Inspiring learning and teaching for lifelong learning



- Main objectives are to
 - promote interest and teaching of biology, chemistry, geography, mathematics, physics and technology (ICT)
 - enhance interaction between schools, universities and business and industry

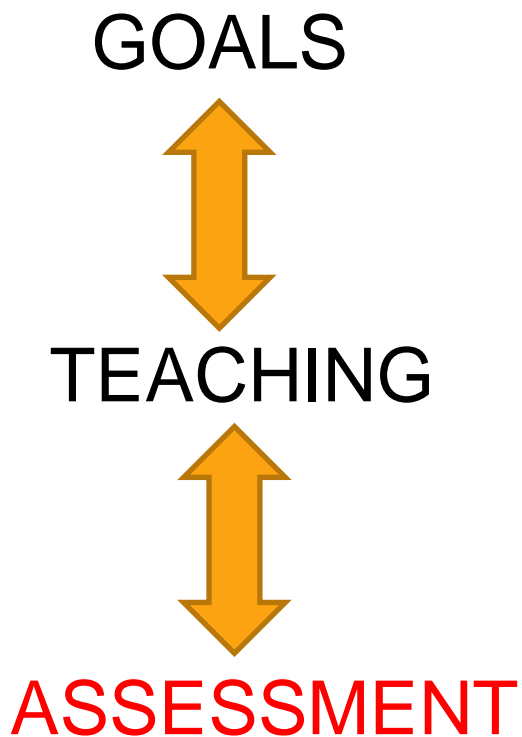
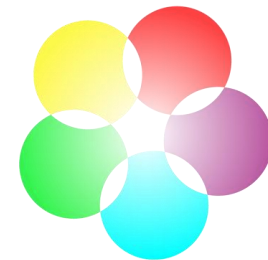


SINCE YEAR 2003



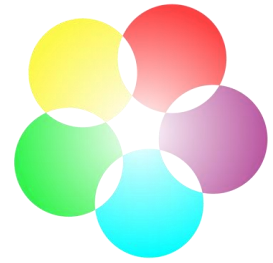


Goal-oriented learning and teaching





A KEY THEME: DIFFERENT FORMS OF ASSESSMENT



Student-centred assessment:

- Diagnostic
- Formative**
- Summative





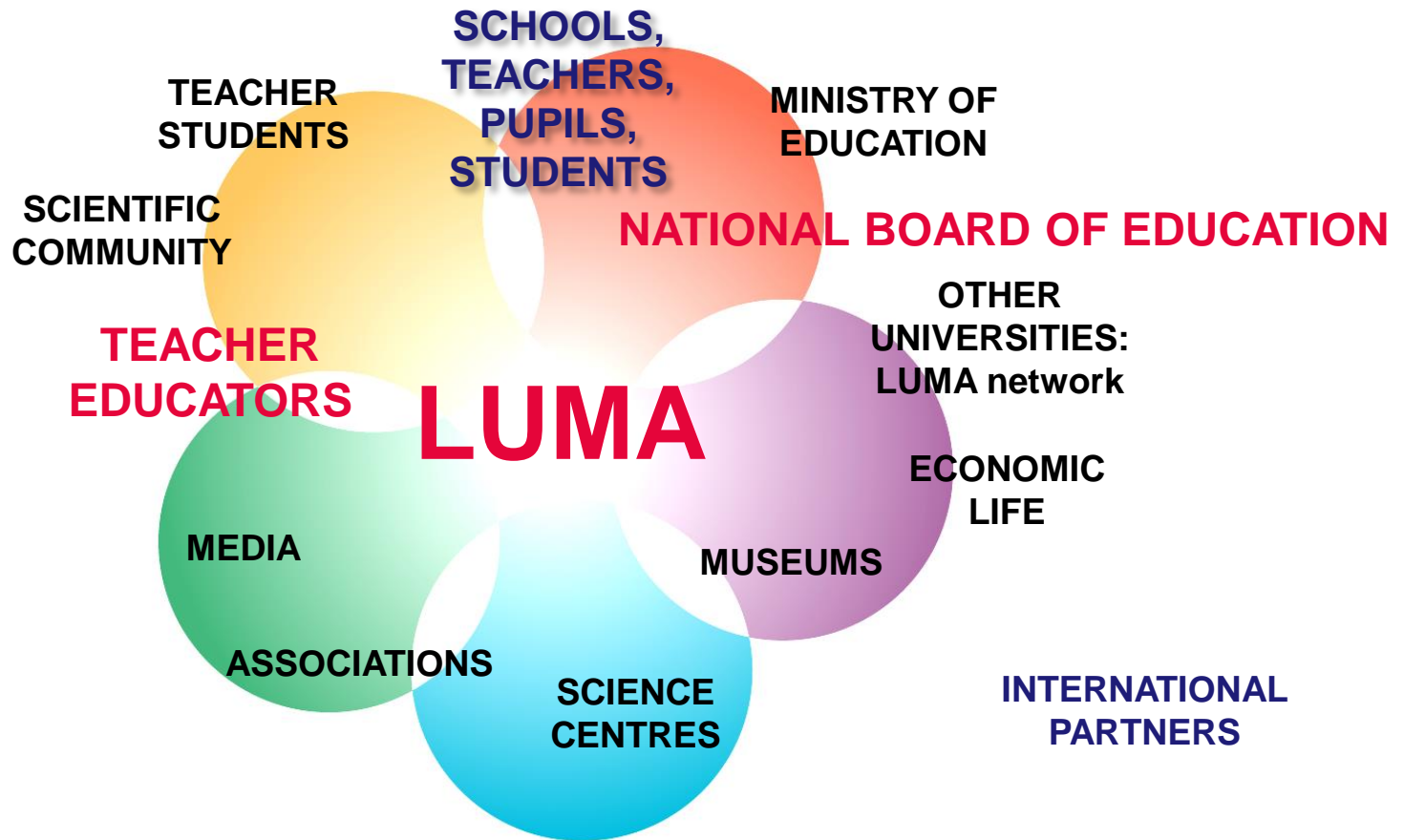
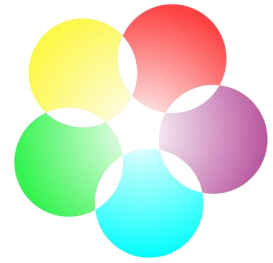
We are preparing students for future skills



“Students must become able to organise and regulate their own learning, to learn independently and in groups and to overcome difficulties in the learning process. This requires them **to be aware of their own thinking and learning strategies and methods**”. (OECD 1999)



GOOD COLLABORATION IS A KEY FOR SUCCESS





COLLABORATION WITH NATIONAL BOARD OF EDUCATION



- The National Board of Education (NBE) is responsible for: developing, monitoring, supporting and evaluating primary and secondary education
developing the national core curriculum including goals and **assessment criteria** for use in schools
- Curriculum work supports **local** pedagogic development.



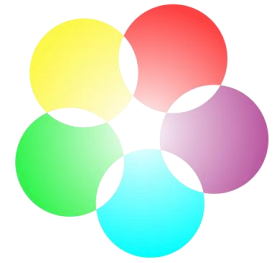
PREPARATION OF NEW NATIONAL CORE CURRICULUM GOING ON



- ❑ The renewed core curriculum will be completed by the end of 2014. New local curricula that are based on this core curriculum should be prepared by the beginning of school year **2016–2017**.
- ❑ **Collaborative working:** Each working group consists of educational officials, researchers and teachers.
- ❑ **The preparation of the curriculum is interactive.** All education providers can follow the preparation and give feedback at the different phases. They are also encouraged to involve pupils and their parents in the process.



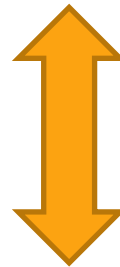
COLLABORATION WITH CURRICULUM WORK



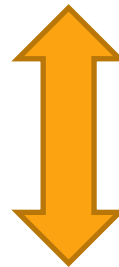
Developing new innovations **with schools and teachers**

Continuous feedback from the teacher is very important.

CURRICULUM



ASSESSMENT



PEDAGOGY

In the core curriculum pupil assessment is **divided into assessment during the course of studies and final assessment.**



SELF-ASSESSMENT CENTRAL IN FINNISH SCHOOLS

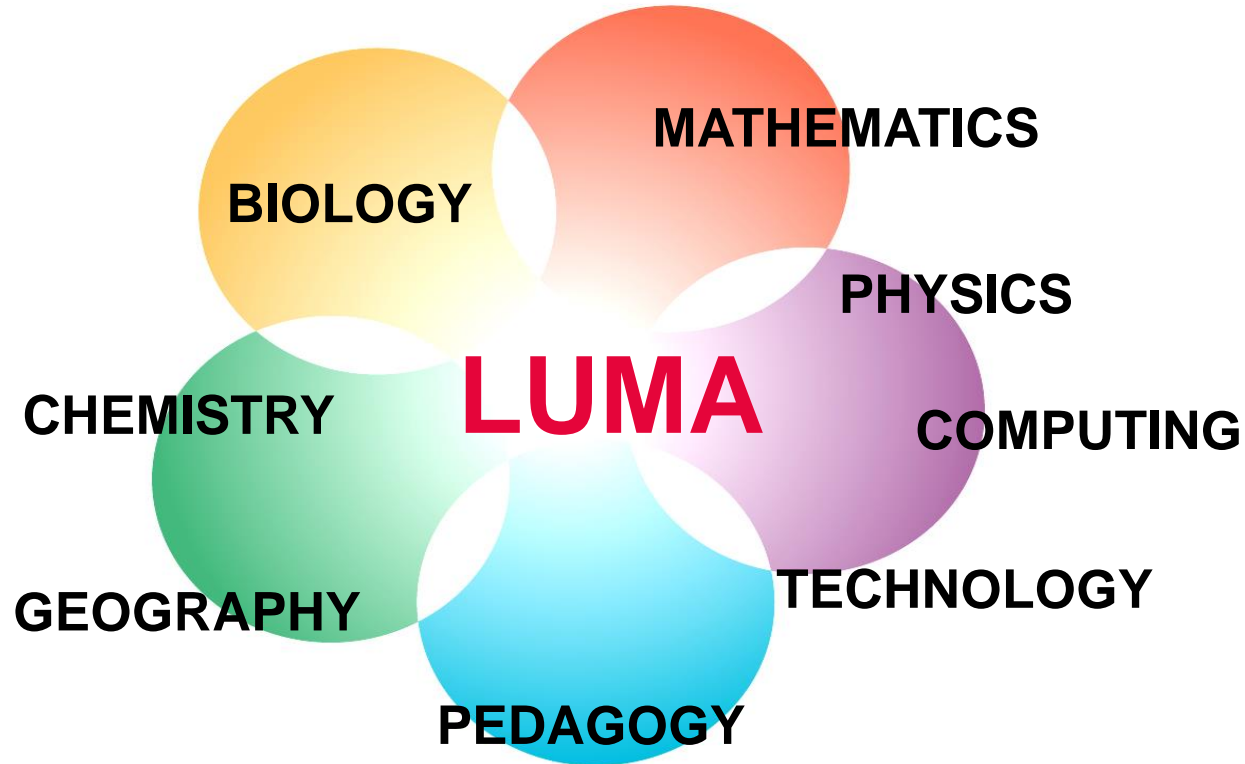
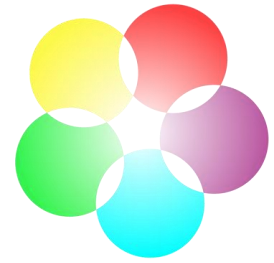


- The purpose of this is **to support the growth of self-knowledge and study skills and to help the pupil to learn to be aware** of her or his progress and learning process.

(NBA,2013)



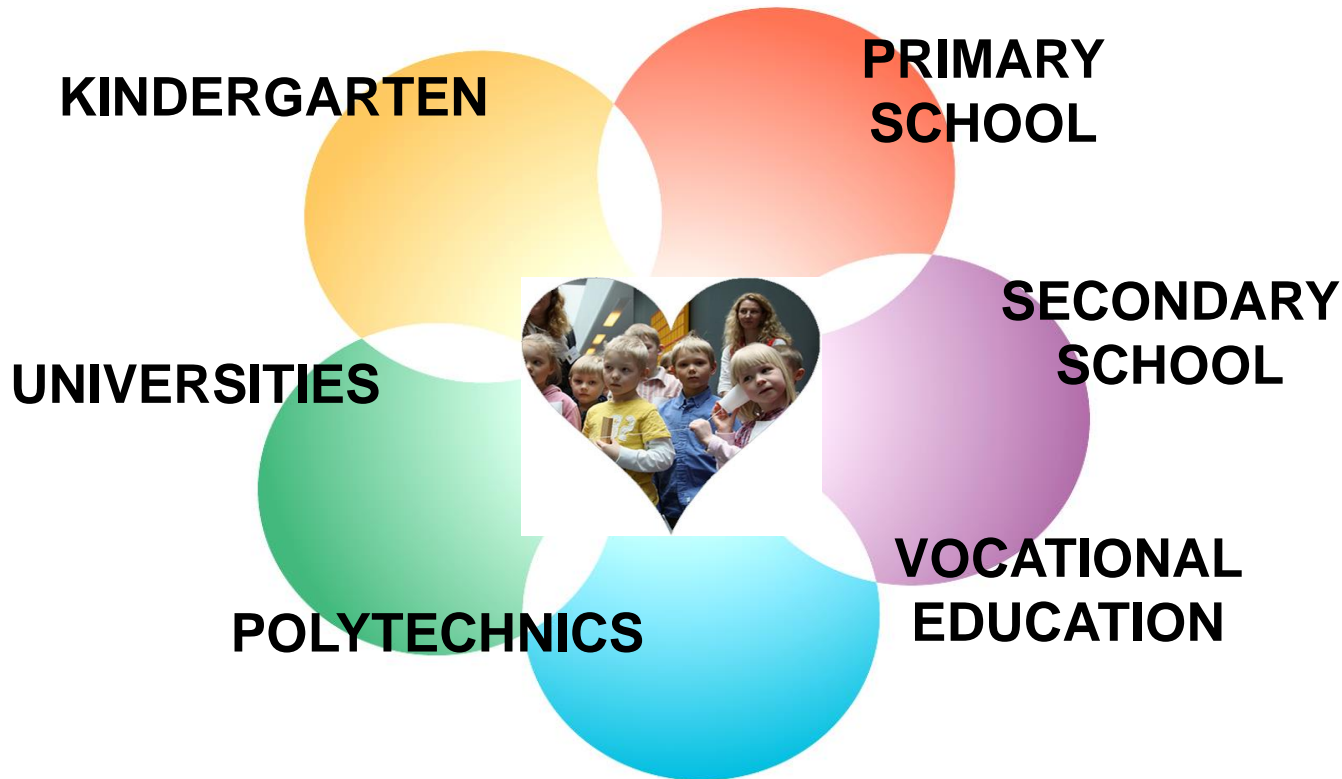
MATH, SCIENCE AND TECHNOLOGY EDUCATION



In addition, multidisciplinary topics: e.g. **Education for Sustainable Development**



SCIENCE FOR ALL: Supporting Assessment at all levels



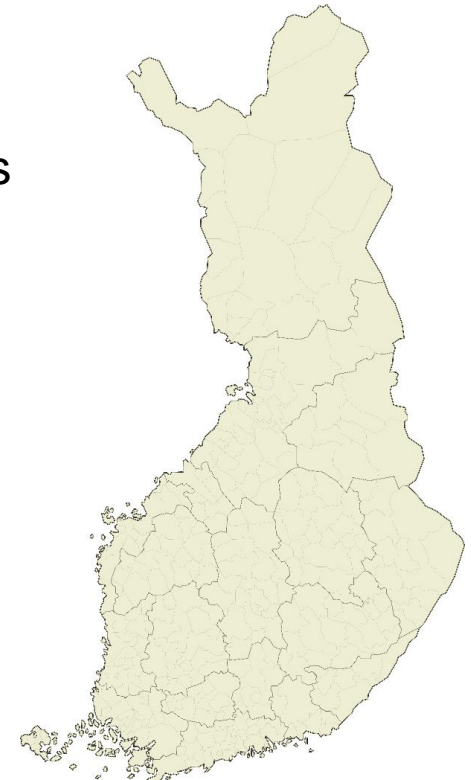
In addition, different activities with e.g. parents, e.g. Science Days



National LUMA network of LUMA centres since 2010



- Finlands' Science Education Centre, LUMA centre in Helsinki
 - coordinates the LUMA network of 10 centres
- other LUMA centres in
 - Espoo
 - Joensuu
 - Jyväskylä
 - Kokkola
 - Lappeenranta
 - Oulu
 - Tampere
 - Turku

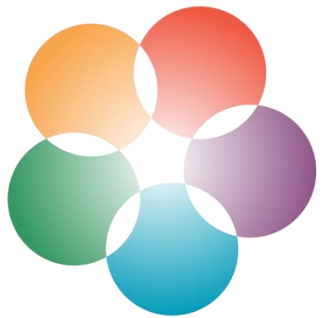


A national strategy and a steering group for collaboration.



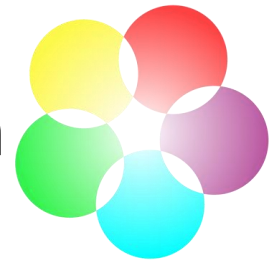
Opportunities for Improving Learning: LUMA activities for kids and young people

- Science days for children and families
- **Four modern free learning environments** at university campus: science classes in chemistry (Gadolin), physics (F2k), mathematics (Origo) and computing science (Linkki)
- Science clubs
- Science webmagazines
 - One for children
 - Three for young people
- Science camps (15-20 camps every year)



Science with joy of learning and achievement

Little Jippo clubs for children aged 3–6



Emotion
and
cognition

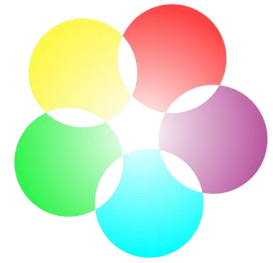
Encourage
for
questions:
**why and
how?**



The developed model **combines** science, technology, art, and emotions through stories, inquiry, role-playing, and music.



Math clubs for children

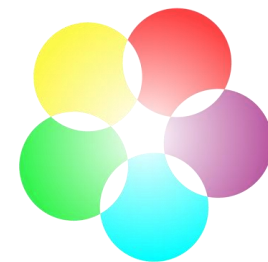


The most important goal is to give **positive experiences within mathematics**





Jippo science day for children aged 7–12



Different tasks with parents



15-20 **camp**s each year





National webmagazine Jippo for children & parents



Hands-on activities,
videos, stories...

Jippo - Lasten luonnontiedeverkkolehti



Etusivu

Tutkimustupa

Jipon pätkinät

Kysy Jipolta

Jippolan Sanomat

Tiesitkö?

Pikku-Jipot

Lemmikkikorneri

Meidän luokka

Tutki ja ihmettele: Sokerisateenkaari

Tutkimustupa

Pistä sateenkaari lasiin!

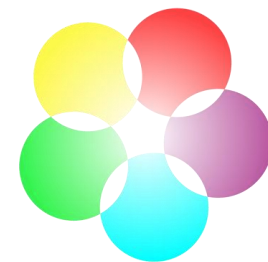


Tarvitset:

- läpinäkyvän, ohuen lasin
- neljä läpinäkyvää lasia
- mitta-astian
- elintarvikvärejä (esim. ketlainen, sininen, punainen)
- sokeria



National webmagazine Luova for youth



KYSY TUTKIJALTA

OPISKELIJAEELÄMÄÄ

Opiskelijablogit
Opiskelijahaastattelut
Vinkkejä ja linkkejä

TIEDEJUTUT JA UUTISET

Globaalit haasteet
Ihmeellinen elämä
Laboratoriossa tutkittua
Maan uumenista avaruuteen
Mahtava matematiikka
Teknologian mahdollisuudet

AKTIVITEITIT

Kokeile kotona
Luova pulma
Tiedekilpailut
Tiedetapahtumat

Kemia voisi olla aika siisti homma!

📖 [Opiskelijaelämää / Opiskelijahaastattelut](#) - 16.01.2013

Neljännän vuoden kemian opiskelija Teemu Myllymäki halusi alun perin opiskella lääketiedettä, mutta kiehtova kemia ja sen monet mahdollisuudet veivät nuoren miehen mukanaan jo ensimmäisenä opiskeluvuonna Kumpulan tiedekampuksella.



Teemu Myllymäki. Kuva: Sakari Tolppanen.

Alun perin Lahdesta kotoisin oleva matemaattis-luonnontieteellisen tiedekunnan opiskelija **Teemu Myllymäki**,

LUOVAN TWITTER 

Opiskelijat suunnittelivat SpaceApps-kilpailussa Marsiin kasvihuoneen, jotta edes perillä saisi tuotetta purtavaa.
<http://t.co/Oz9E0prrXT>

Lukiolainen! Luovan nimikkoleirillä 5.-9.8. luvassa tutkimuksia oikeissa yliopistolaboratorioissa. Ilmoittaudu nyt!
<http://t.co/4Dk1yc6To0>


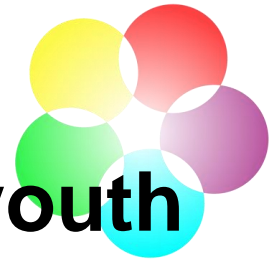
Osataan Helsingin yliopistossakin Harlem Shake: <https://t.co/Ubg5T0ryV4>

LUOVAN GALLUP

Kuinka pääasiassa suojaat itsesi auringon UV-säteilyltä?



FREE! International webmagazine MyScience for youth



My Science

FRONTPAGE

THEMES

- Digital Communication
- Earth, Water & Energy
- Math & Science

MY CAMP

- Blogs
- News
- Profiles

EVENTS

- EUCYS
- ScienceSLAM

ACTIVITIES


- Try This at Home

About MyScience

MILLENNIUM YOUTH CAMP / NEWS - JUN 11, 2013

Research reality meets Millennium Youth Campers

On Tuesday, Millennium Youth Campers explored research in industrial and academic environments and got their hands on some real life experiments.



The itinerary of the day was filled with exciting visits to companies and institutes where current research is done and new technologies are developed.

ON TWITTER

"Be curious! The world is full of wonders...Connect! It's more fun to work together." MY Camp blog by Ilkka Pollari: <http://t.co/ZO8s61b9WY>

MYC blog by Dr. Wartiowaara: "The Camp sounds exactly what I would have liked to have years ago." <http://t.co/Zo0egUhrAe>

Maths and doing research is fun!" Millennium Youth Camp blog by Camilla Hollanti from Aalto University: <http://t.co/K1IugDLuO4>



Peer-reviewed journal EJYSE for young researchers aged 14–21



FRONTPAGE

- About EJYSE
- Submissions
- Current issue

**European Journal
for Young Scientists and Engineers**

Current issue of EJYSE

Special Issue for the contestants of European Union Contest For Young Scientists 2011

Published online November 2012

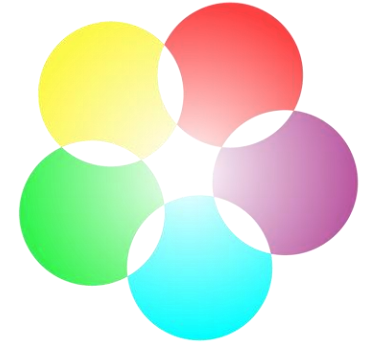
Comparison of three Finnish berries as sensitizers in a dye-sensitized solar cell
by Jarkko Etula

n Cam: The development of a camming device for climbing
by Pius Theiler

Antileaks: A device for detection and discontinuation of leakages in domestic water supply systems
by Gal Oren and Nerya Stroh

**HELSINKI
EUCYS 2011**

© Finland's Science Education Centre LUMA, Faculty of Science, University of Helsinki
ISSN 1799-9634 (print) & 1799-9642 (online)



Activities and services for teachers

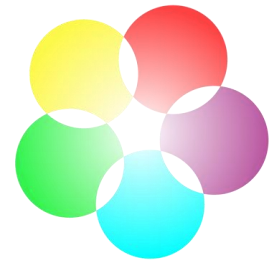
**to support them in their
everyday work and lifelong learning**




National webmagazine

LUMA Sanomat:


Assessment is one of key topics






LUMA Sanomat


Luonnontieteiden, matematiikan, tietotekniikan ja teknologian opetuksen kansallinen verkkolehti




Toukokuun avaus:
Kuinka opettaa paremmin?



Kuukauden kohokohta



Nuoret ympäri maailman
uskovat luonnontieteiden ja teknologian mahdollisuuksiin



Utta: LUMA-rahasto
palkitsee vuoden LUMA-toimijoita

Etusivu »

Hae juttuja, tapahtumia, ...

Hakusanat tähän

Jutut »


Tapahtumakalenteri »

Opettajien täydennyskoulutukset »

Lasten ja nuorten kerhot, klubit, leirit ym. »

Materiaalit »

Videot »




Iloa LUMasta kesälläkin

Julkaistu 20.06.2013

Vaikka lukuvuoden koulutyö oli jo päättynyt, **ISSE-symposiumin** illallisella 11.6. iloitiin LUMA:sta, kun vuorossa oli vuoden 2012 LUMA-koulujen ja LinssiLUMA-kilpailun voittajan palkinta.

[Lue lisää](#)



Luonnontieteistä kisattiin Linnakallion kauniissa maalaismiljöössä

Julkaistu 19.06.2013

Alavieskassa Linnakallion maastossa peruskoulun viides- ja kuudesluokkalaisten kävivät jännittävän matemaattis-luonnontieteellisen MALU-kisan loppukilpailun toukokuussa. Esikarsinnat järjestettiin maaliskuussa.


Ilmoittautuminen käynnissä

- 29.7.-9.8.2013 Toiminnallinen kesäkurssi lukioikäisille matematiikan perusteista ja sovelluksista, Tampere
- 20.9.2013 alkaen Eriyttäminen LUMA-aineiden opetuksessa -täydennyskoulutus, Helsinki

Nyt ajankohtaista

- 30.9. mennessä käsikirjoitukset LUMAT-lehden joulukuun numeroon

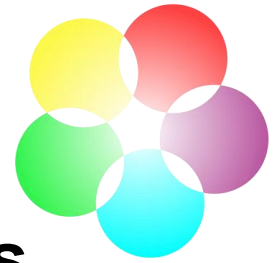
Tweets [Follow](#)

 **LUMA Sanomat** 19 Jun
@LUMAsanomat

Mukavaa kesää ja Juhannustal!



Peer-reviewed **international journal** **LUMAT** for publishing research findings & best practices



SUOMEKSI | PA SVENSKA

LUMAT

LUMAT: Research and Practice in Math, Science and Technology Education

The journal provides Finnish and international researchers and developers of math, science and technology education, and teachers from early education to universities with the possibility to publish their research and good practices. Research articles are peer-reviewed.

Languages of publication are Finnish, Swedish, and English. The abstracts of all articles will be published in all three languages.

The minimum of two issues will be published annually, including special issues dedicated to predetermined themes. The journal is available online free of charge. Printed issues can be later subscribed from Unigrafia's print-on-demand service.

Articles are published under Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND 3.0) copyright license.

[Publication schedule](#)

LUMAT

Information on the journal


Issues

Manuscript for publication

Contact information

Twitter Seuraa

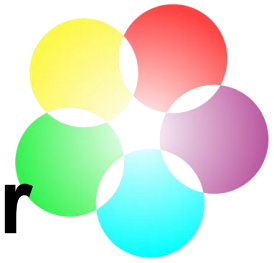
19. kesäkuuta

 **LUMAT**
@LUMATnow

Call for papers: NFSUN 2014, Helsinki, Finland, 4th - 6th June 2014
helsinki.fi/luma/nfsun201



40-50 **in-service training** courses and events per year

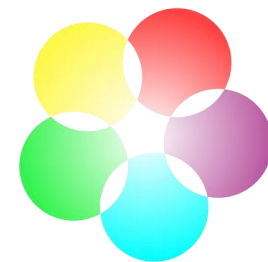


How to support different learners e.g. gifted and talented students, and low-achievers?





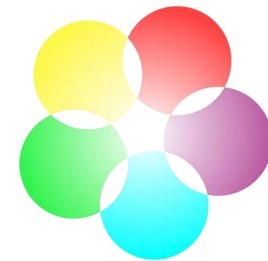
Research and development: Opportunity to visit authentic science labs at campus



New
materials



ChemistryLab
Gadolin



Example:

ChemistryLab Gadolin

Kemma Chemistry Centre

Department of Chemistry

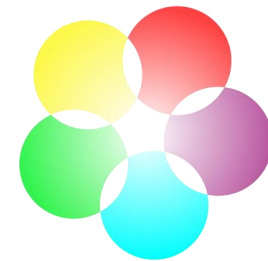
University of Helsinki

Finland

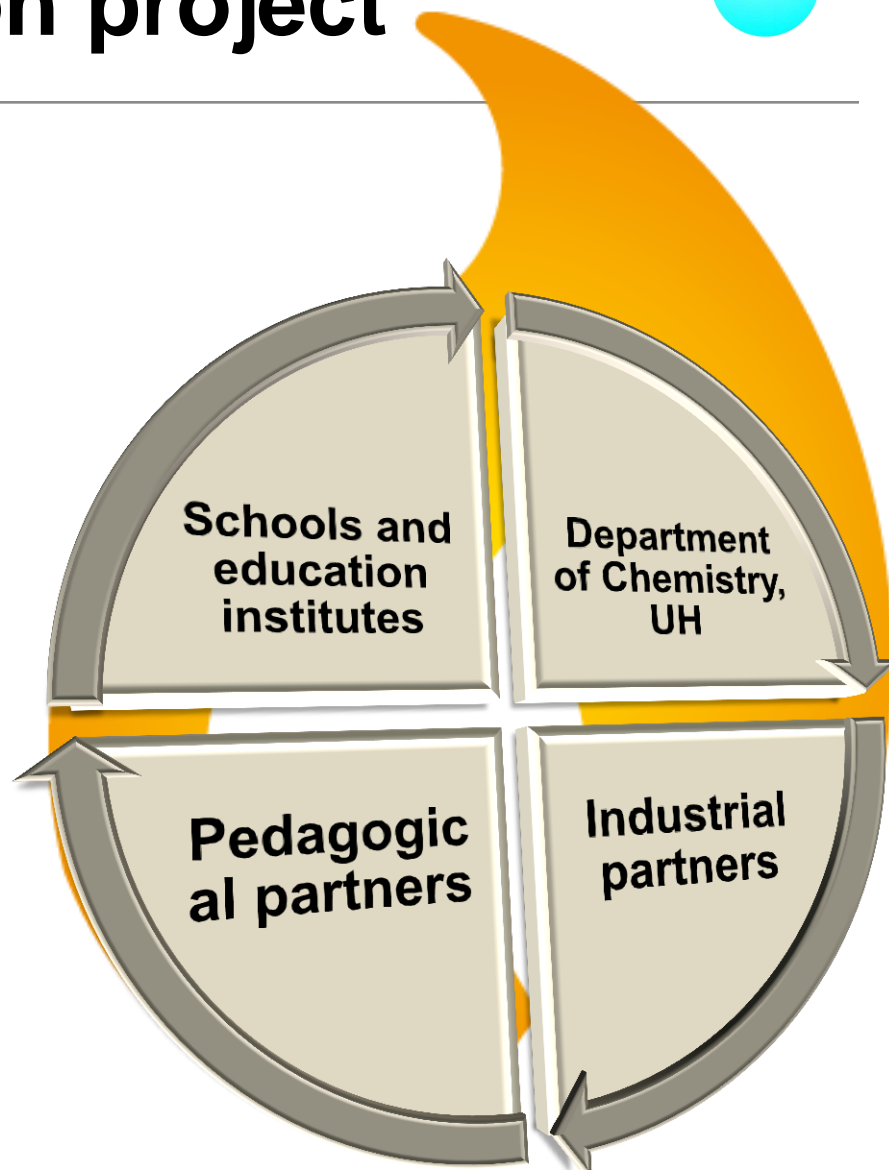


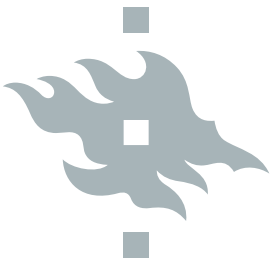


Gadolin is a collaboration project



- ChemistryLab Gadolin was founded in 2008.
- **21 partners**
- It is **free of charge** for schools.





HELSINGIN YLIOPISTO

Kemian laitos &
Farmasian tiedekunta



OPETUSHALLITUS
UTBILDNINGSTYRELSEN



Helsingin kaupunki
Opetusvirasto

MAAIL



KEMIANTEOLLISUUS RY



SUOMEN BIOTEOLLISUUS
FINNISH BIOINDUSTRIES



Metrohm
Nordic



Vernier
Suomi

Thermo
SCIENTIFIC



SUOMEN KEMIAN SEURA

Kemiska Sällskapet i Finland - Association of Finnish Chemical Societies

NESTE OIL

BASF
The Chemical Company



kemira

A Member of
The Linde Group

AGA



BOREALIS

PLD
FINLAND

VWR

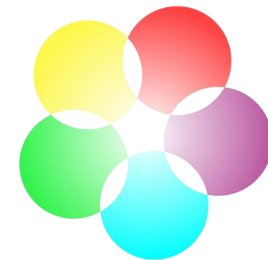
IS-VET

3M

BRUKER



Goals



- To support chemistry teaching and learning.
- To rise the youth's interest in natural sciences.
- To support the potential future professionals, i.e. to introduce career possibilities in the field of chemistry.
- **To bring out the up-to-date information on the versatile applications of chemistry, and its important status in industry and in the society.**
- To promote the positive image of chemistry.
- To support the goals of schools, university departments of chemistry, enterprises and other partners.



Visits to ChemistryLab Gadolin

- Over **4000** visitors from schools / year
- **Visits include** (1-8 hours / visit)
 - Introduction of ChemistryLab Gadolin, The Department of Chemistry, The UH and The Campus
 - Laboratory work
 - Molecular modelling
 - Visits to research groups



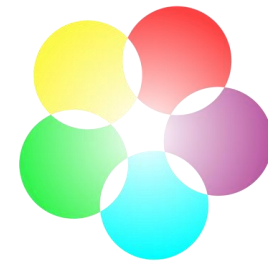


Encouraging experiences through new educational innovations!





Meeting scientists



Gadolin offers student groups the **opportunity to meet scientists** at the Department of Chemistry, the University of Helsinki and to **discuss** with them about chemistry and visit their research laboratories.



Collaborating with chemical industry



A Member of
The Linde Group | AGA

Ilmaa ja heliumia

Kemianluokka Gadolin
Kuukauden työ Tammikuu 2010

Kemianluokka
Gadolin



NESTE OIL

Muovien tunnistus FT-IR-laitteella

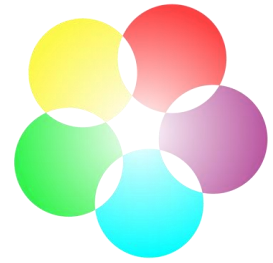
Toukokuun 2010 kuukaudentyö
Kemianluokka Gadolin

Kemianluokka
Gadolin

www.brukeroptics.com



Using design research for developing new educational innovations

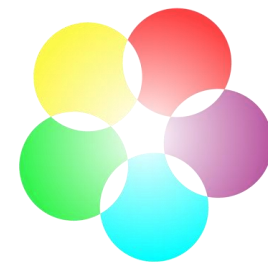


- ChemistryLab Gadolin also is a research laboratory for chemistry learning and teaching
- It is collaborating with [the Unit of Chemistry Teacher Education](#) in the Department of Chemistry
- Activities are developed through design research
- M.Sc. thesis and other publications

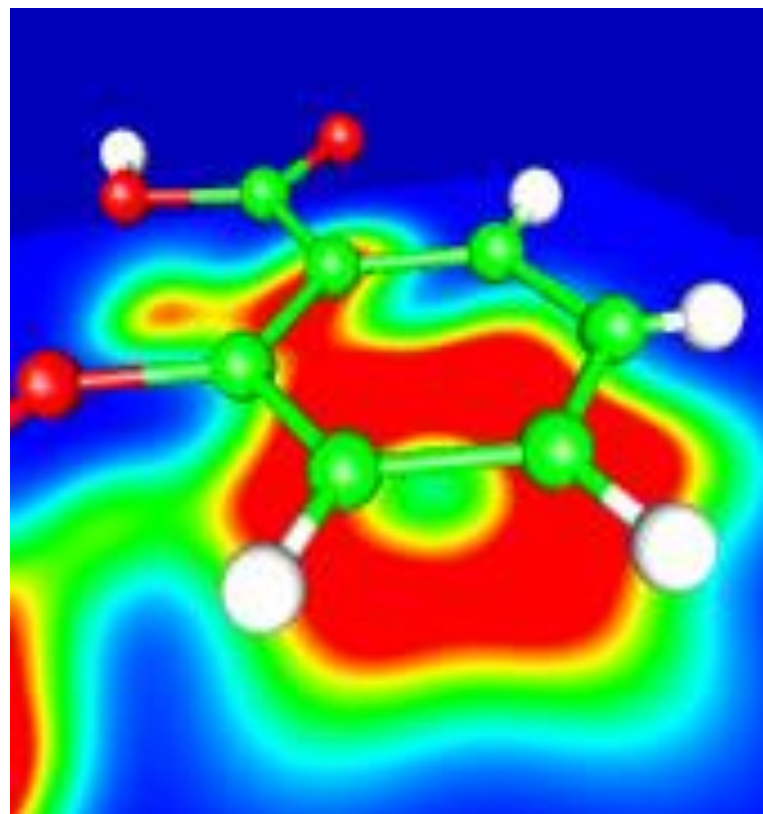


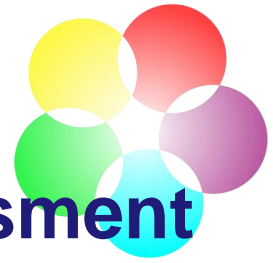


II News from Finnish Assessment



□ The tests of national A-levels exams ([the Matriculation Exam](#)) of the Finnish upper secondary schools will be **gradually digitalized** in the years 2016-19.





III An Example in Details How to Improve Learning through Assessment

- How to Support Students' Higher-Order Thinking towards Meaningful Learning? ([Aksela, 2005](#))



- An analysis of Finnish chemistry matriculation examination questions according to cognitive complexity ([Tikkanen & Aksela, 2012](#)) **using Refined Bloom's Taxonomy** (Krathwohl & Anderson, 2001)



- Design of Tasks and Materials for Using Higher-Order Thinking Skills Towards Meaningful Learning



- **Pre-Service and In-Service Training for Teachers**



ROTE-LEARNING in SCIENCE EDUCATION

- ❑ Learning too often occurs only by rote-learning of factual knowledge (e.g. Entwistle & Ramsden, 1983; Gabel, 1999).
- ❑ Instead of **only focusing on what to think in chemistry, should also be focused more on how to think in chemistry.**
- ❑ To obtain meaningful chemistry learning requires more focus on student higher-order thinking skills (HOCS) and also in teacher education (Aksela, 2005).

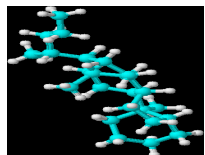
THINKING LEVELS IN CHEMISTRY

Makroskopic



Human

Mikroskopic



Symbolic

NaOH,
n=m/M

Gabel et. al 1987, Johnstone 1991, Nakhleh & Krajcik, 1991

2-DIMENSIONAL TAXONOMY: KNOWLEDGE DIMENSION

(Anderson & Krathwohl, 2001)

Table 3.3 Major types and subtypes of the knowledge dimension (Anderson & Krathwohl, 2001, page 46). Examples are drawn from chemistry by this researcher.

Major Type and Subtypes	Examples from Chemistry
Factual Knowledge 1a) Knowledge of terminology 1b) Knowledge of specific details and elements	e.g. formulas of compounds, definitions of atom, electron, molecule, chemical reaction, names of elements, biographies of chemists, dates of their innovations
Conceptual Knowledge 2a) Knowledge of classifications and categories 2b) Knowledge of principles and generalizations 2c) Knowledge of theories, models, and structures	e.g. Periodic table, atomic theory, ideas of chemical reactions
Procedural Knowledge 3a) Knowledge of subject-specific skills and algorithms 3b) Knowledge of subject-specific techniques and methods 3c) Knowledge of criteria for determining when to use appropriate procedures	e.g. Skills used in practical work and in inquiry, use of computer-based environments, scientific methods
Metacognitive Knowledge 4a) Strategic knowledge 4b) Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge 4c) Self-knowledge	e.g. Knowledge of the design of experimental work, knowledge of the cognitive demands of different tasks in chemistry, awareness of one's own strengths and weakness in chemistry knowledge

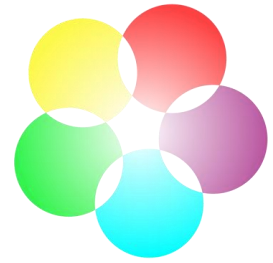
HIGHER-ORDER THINKING SKILLS (HOCS)

Table 3.2.1a Bloom's original Taxonomy (1956) compared to the revised taxonomy (Anderson & Krathwohl, 2001).

Bloom's Original Taxonomy	Level of Thinking	The Revised Taxonomy
Knowledge	lower-order	Remember
Comprehension	lower-order	Understand
Application	higher-order	Apply
Analysis	higher-order	Analyze
Synthesis	higher-order	Evaluate
Evaluation	higher-order	Create



HOCS ITEMS

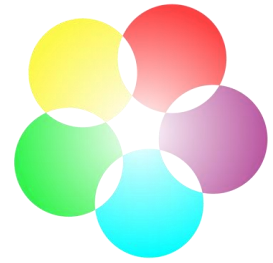


- HOCS items are **quantitative or qualitative, ill-defined/structured, or open-ended questions, mostly unfamiliar to the student**, which require for their ‘solution’ much more than just knowledge and/or application of known algorithms
- They may **require analysis, synthesis, system thinking, decision making, problem-solving capabilities**, but mostly the making of connections, and critical evaluative thinking.

(Tsaparis & Zoller, 2003, p.51)



LOCS ITEMS



❑ LOCS items are knowledge questions **that require simple recall of information or a simple application of known theory or knowledge to familiar situations and context.**

❑ They can also include the so called ‘problems’, not necessarily understood by the ‘solver’, which are already familiar to the learner through previous specific directives, or long-term practice, or both.

Questions according to cognitive complexity (Tikkanen & Aksela, 2012)



**KNOWL
EDGE**

LOWER-ORDER THINKING SKILLS (LOCS)

HIGHER-ORDER THINKING SKILLS (HOCS)

60 (23 %)

197 (77 %)

**Rememb
er**

**Understa
nd**

Apply

Analyze

Evaluate

Create

**Factual
Knowledge**

-

-

-

-

-

-

**Conceptual
knowledge**

-

33
(13 %)

-

4
(2 %)

-

17
(7 %)

**Procedural
knowledge**

-

-

27
(11 %)

85
(33 %)

40
(16 %)

51
(20%)

**Metacognitive
knowledge**

-

-

-

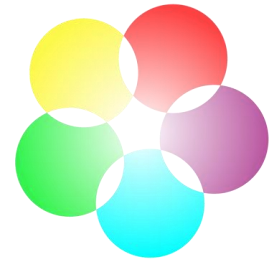
-

-

-



SUMMARY



- ❑ "A Student is in our heart! "
- ❑ The use of different kind of assessment is central for meaningful learning
- ❑ Refined Taxonomy is **a tool** for designing activities and materials for higher-order thinking skills towards meaningful learning
- ❑ **Teachers and their collaborative networking** is a key for success, also in improving assessment



FREE! International LUMA News for teachers, researchers & educators



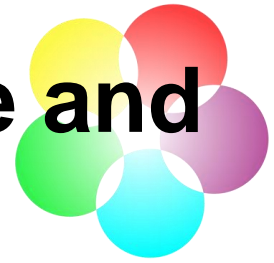
Subscribe to LUMA News

Finnish Education in a Nutshell

Background for Finnish PISA Success



LUMA: Joy of math, science and technology for all!



Thank You
for your
attention!



Keep in touch!