LUMA activity: A way to challenge the active minds of young people

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ABSTRACT

The challenges and solutions to the problems in education of natural sciences and engineering are introduced in the paper. The Luma activity gives the school teachers new methods to make the theoretical studies more interesting by showing application examples in practice. Narrowing the gap between schools and universities is a key element in the new teaching paradigm, which is believed to have a bright future in education.

1 INTRODUCTION

The modern society is dependent on talented individuals working in different fields in industry and economics. Our well-being needs constantly new innovations and ideas for business and industry to be competitive internationally. A key issue to meet this goal is to wake the interest of young people to study natural sciences and engineering. LUMA or LUMATE activity has been created for this purpose. The word LUMATE comes from the Finnish words “Luonnontieteet, matematiikka, tekniikka” and means almost the same as STEM (STEAM), “Science, Technology, Engineering, Arts, Mathematics”. Computer science and IT are essential topics here; they belong to the science and technology parts.

To attract new talented students is by no means an easy task. The youth of today have so many things to do and possibilities to choose from that mathematics, physics, chemistry engineering, etc. might not be their first choices when planning the future. High schools in Finland have currently four mandatory courses in natural sciences altogether, which is the same amount as the courses in history. The results in the matriculation examination have gone worse and worse especially in physics, while the international PISA ranking is also decreasing. An alarming example is for example that last year in the Helsinki University teacher education only two students chose physics as their major! In fact, in high schools there would be a need for several hundreds of more students to choose the large syllabus in mathematics.

The starting point of Luma activity has been to meet the above challenges. The idea is to introduce basic experimenting work in natural sciences, engineering and computer science to children from kindergartens, primary

schools and high schools, to wake their interest to study these topics. The carrying idea is to move from classical classroom teaching to practical experimenting and working together, which is fun. It is interesting to note that a similar idea is nowadays used in the curriculum of first-year university students by introducing hands-on courses, where the students do small practical projects in groups, learn how to combine topics in different areas of engineering and science, and finally understand that they later need to elaborate more on theoretical courses in order to master totally the target project goals.

The paper presents an overview of the Luma activity in Finland, specifically through Luma-centre Finland and Luma Centre Aalto. It is to be understood that this activity is somewhat selfish: we try to call the most talented highschool (and even younger) students to consider studies in natural sciences and technology. Automation is a broad discipline, which can nowadays be combined with and applied in almost any field of technology, and beyond. Therefore the Luma activity serves for attracting talented students to study automation as well.

In the paper Luma activity is first discussed, including a short introduction to Luma centre Finland and the StarT initiative. Special focus is given to topics that are of major importance in engineering education – especially in mathematics, physics, computer science, control engineering and automation. The idea of project work in education is the key concept that is suggested in all education, from kindergarten to schools and universities, even to retirement homes!

2 LUMA ACTIVITY

LUMA activity was established in Finland in 2003, when the first Luma centre was founded (Petäjistö and Putila, 2016). The idea was to narrow the gap between (high)schools and universities by offering courses, laboratory exercises, competitions etc. to school students, to be given in universities by the university teachers and other personnel. Currently there are 13 Luma centres in Finland, each one having their own organisation, facilities and operating methods in co-operation with the schools. In practice this means that the whole Finland area is covered by the Luma centres. For example, the Uusimaa district is divided between two Luma centres: Luma centre of the University of Helsinki and Luma Centre Aalto.
The activies in Luma Centre Aalto can roughly be divided into the following parts:

- Top courses for high-school students,
- Science days and exercises in LUMARTS and BIOFILIA labs,
- Visiting lecturers in different disciplines,
- Invite a researcher to visit school lesson- service,
- Short special courses in LUMARTS or BIOFILIA,
- Participation in science competitions and exhibitions for school children

The LUMARTS laboratory was built in Otaniemi and started its operation in 2014. It has about 2000 student visits every year. The laboratory has exercises in the fields of electrical engineering, mechanics, automation, chemistry, biochemistry and environmental sciences. The idea is that a teacher brings his/her students to the lab and also teaches the experiments which are done during the session. To make this possible Luma Centre Aalto organises

short courses to the teachers on different topics and experiments in the lab. For example, programming and experimenting with the Arduino units have been particularly popular lately. Especially programming and robotics are currently of strong interest among the teachers and students. It is worth mentioning that Luma activity includes also traditional lectures. For example, several international mathematicians have given interesting talks on practical applications and games in mathematics, something that is not normally seen in mathematics classes in schools and universities.

Attached to LUMARTS is BIOFILIA, which is a laboratory of Bioarts. Special courses are arranged there in this relatively new and fascinating area, where biological matter is studied and used to form new structures, even for artistic purposes (biological jewels).

The top courses are short special courses (3-5 days) on a given topic. Usually each day starts with lectures, followed by practical construction and experimental work. The students may for example construct in groups small robots containing batteries powered by solar panels. At the end there is a contest, to see which robot can travel the longest distance, when the battery has been loaded a certain fixed time. Top courses have been arranged for example in the following themes:

- Micro and nanotechnology,
- Space and satellites,
- Medical chemistry,
- Bioarts,
- Mathematics,
- Robotics.

New special courses and laboratory experiments are constantly being planned and designed.

Within Luma a new operation mode is called StarT. It is linked to the Finland 100-year celebration and to the status of National Task that the Ministry of Education and Culture granted to the Luma centre Finland for the years 2017-2020. StarT activity aims at meeting the new teaching curriculum, which was established in 2016 in all Finnish schools. It is based on event-based learning, combining different disciplines as opposed to the traditional separate learning of subjects, and waking the pupils' creativity by project work and working together. The special topics in StarT are

- Everyday mathematics,
- Well-being (e.g. health, food, exercise),
- Nature and environment,
- Programming and robotics,
- Technology surrounding us,
- Stars and space,
- "This works"- moving toy (for school classes 1. – 6.)

Start is a national working culture, where school children do projects in their schools and present the results in StarT events (StarT party and StarT gala), compare to Slush. The idea is not in competition, but adopting a really new way and culture in teaching and learning. Several industrial companies are already co-operating in StarT, and it is expected that these kinds of educational changes are going to take place widely in Finland and in other countries as well. The protector of StarT in the Finland 100-year celebration is the President of the Republic Sauli Niinistö.

3 TOWARDS UNIVERSITY STUDIES: AUTOMATION AND CONTROL ENGINEERING

In the university level the problems in education seem to be very similar globally. The young students are not so interested to study in the classical way, and the basic skills in e.g. mathematics and physics are constantly deteriorating (Zenger, 2007). That reflects immediately to the studies of control engineering and automation, which are heavily based on system theory and system thinking, which have a strong mathematical basis.

The Luma activity has several courses and exercises that introduce basic automation and control concepts to the students. A special focus is given to experiments with the Arduino kits and simple robot systems to teach the students construction work, electronics, programming and simple kinematics. For process control experiments the two experimental setups in Figs. 1 and 2 are shown (Zenger, 2016). In Fig. 1 a simple controller of PID type is used to control the liquid level in the tank. Closed loop (or open loop) control is a totally new concept to the students and to their teachers, so that the process experiment makes a pretty neat application for the physics or chemistry class. Moreover, modelling shows the need of mathematics and especially the need to combine mathematics and physics in real industrial work. That experience has turned out to be quite a convincing experiment to the young students.

The second example shown in Fig. 2 shows a lift system, which is controlled by a programmable logic controller. Programming this way is again something, which gives a glimpse of practical industrial automation to the students and to their teachers.

The new ideas and methods in teaching automation and control to the university students have been discussed extensively by Zenger (2016). Here it suffices to say that a hands-on course for the first year students is given to familiarize them to the basic topics and practical design. Later on, an extensive project work course is given, in which the students working in small groups design and construct a special application. During the course special attention is given to learning the theory and practice of project work in general. The course ends with a large gala, where the students present and demonstrate their work. The project work course is described in detail in (Oksanen, 2017)

4 CONCLUSIONS

In the paper the Luma activity has been presented, which is a key approach in waking the interest of young children for studies of natural sciences and engineering. The well-being of a nation in today's competitive world is based on educated talented people, who are capable of intelligent product design, economical thinking and ability to commercialise products. The age-old teaching methods of the youth must be renewed to make the change possible. In this respect it is not a surprise that the first scientific kindergartens have started their operation in Finland in recent years. They are followed by the Luma activity.

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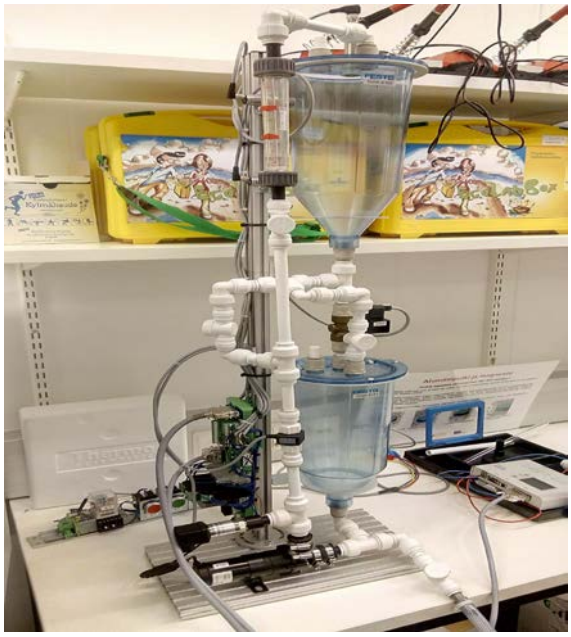

Fig. 1. A flow process system

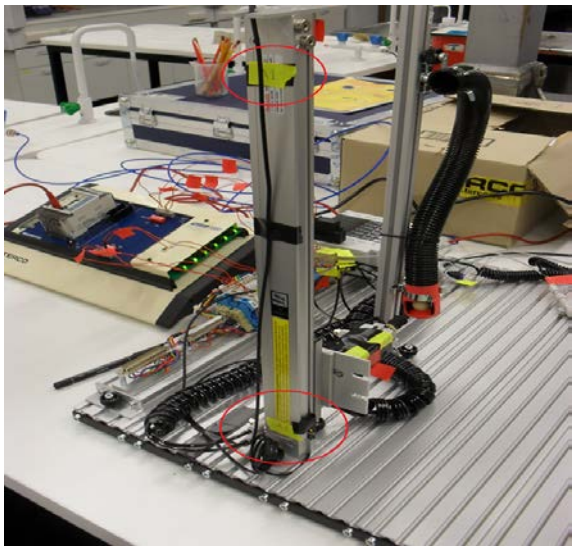

Fig. 2. A mechanical process

5 REFERENCES

Petäjistö, S., Putila, P.: STEAM activities for pupils and schools in Finland, *Proceedings of the 44th SEFI Conference*, 12-15 September 2016, Tampere, Finland.

Zenger, K.: Challenges and New Directions in Control Engineering Education, *Proceedings of the 9th Eurosim 2016 Congress*, 12-16 September, Oulu, Finland.

Zenger, K.: *Control engineering, system theory and mathematics: the teacher's challenge*, European Journal of Engineering Education, vol. 32, no. 6, pp. 687-694, 2007.

Oksanen, T.: Project-based learning in the master programme of automation and electrical engineering (in Finnish), *Proceedings of the Automation days 2017*, March 23-24, Vaasa, Finland, 2017.

www-pages: (partly in Finnish)
http://www.luma.fi/centre
http://www.luma.fi/start
http://luma.aalto.fi

Fig. 3. Special course within Luma activity

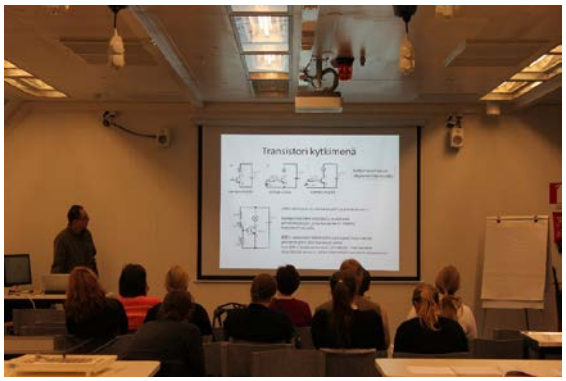

Fig. 4. A preparatory course for laboratory exercise in electronics (LUMARTS)

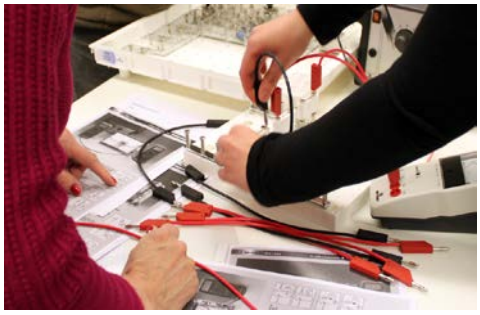

Fig. 5. Practical experimenting

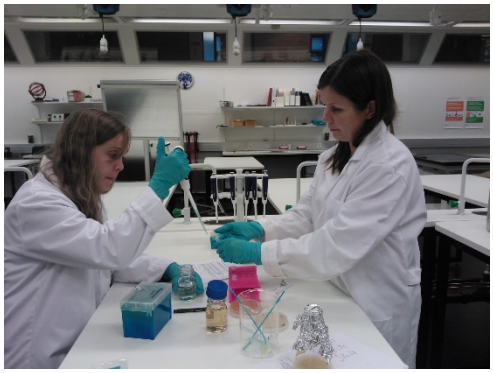

Fig. 6. Chemistry class in LUMARTS

Fig. 7. Working session in LUMARTS