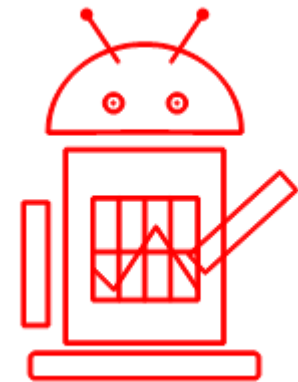


EDUCATIONAL ROBOTS IN EDUCATION

Eugenia Smyrnova-Trybulska

University of Silesia, Poland



Introduction

The need to prepare students with **twenty-first-century skills through STEM-related** teaching is strong, especially at the elementary level.

However, most teacher education preparation programs do not focus on STEM education (Schmidt, Fulton 2016) .

The global urgency to improve **STEM** education may be driven by environmental and social impacts of the twenty-first century which in turn jeopardizes global security and economic stability (Kelley & Knowles 2016).

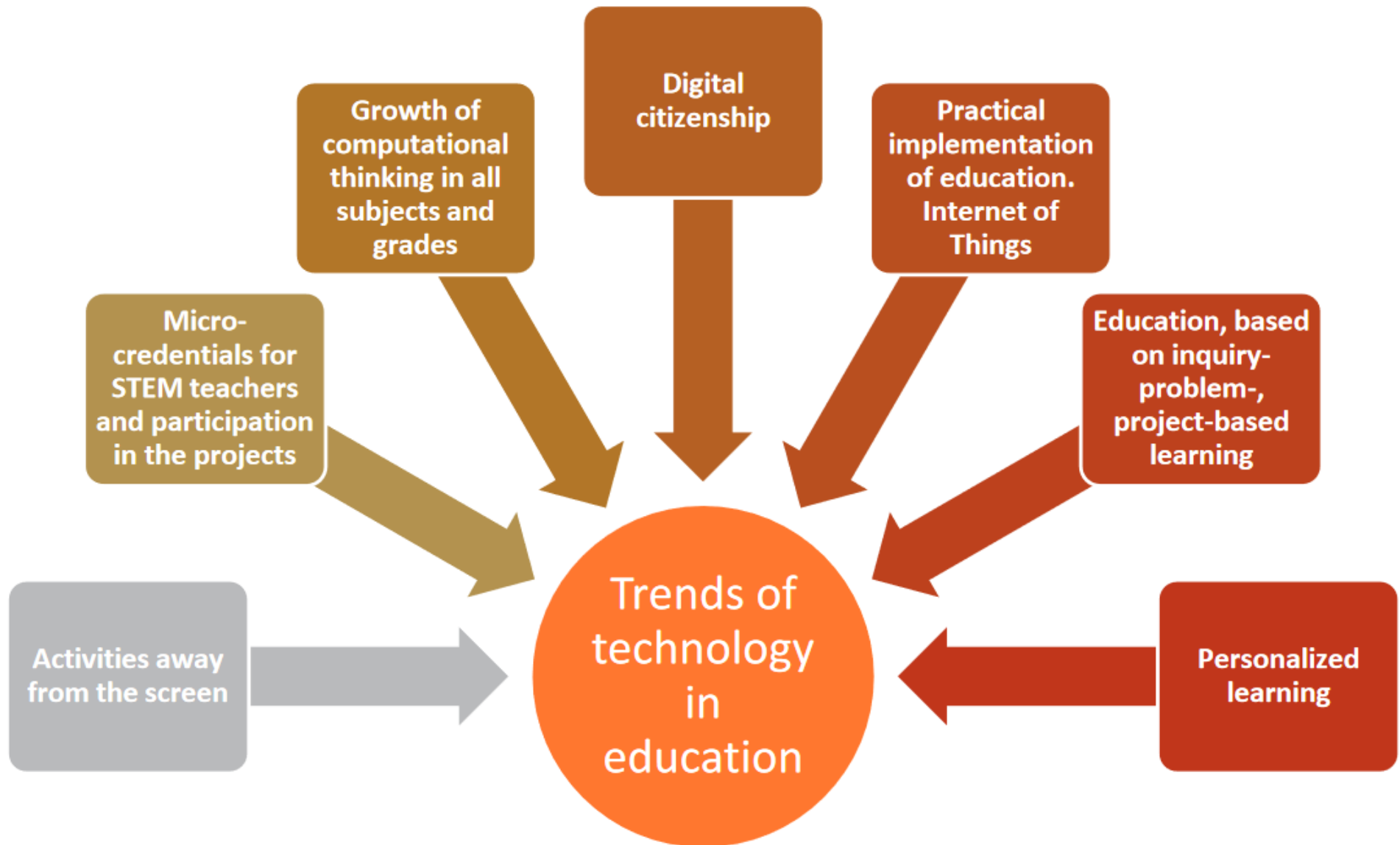
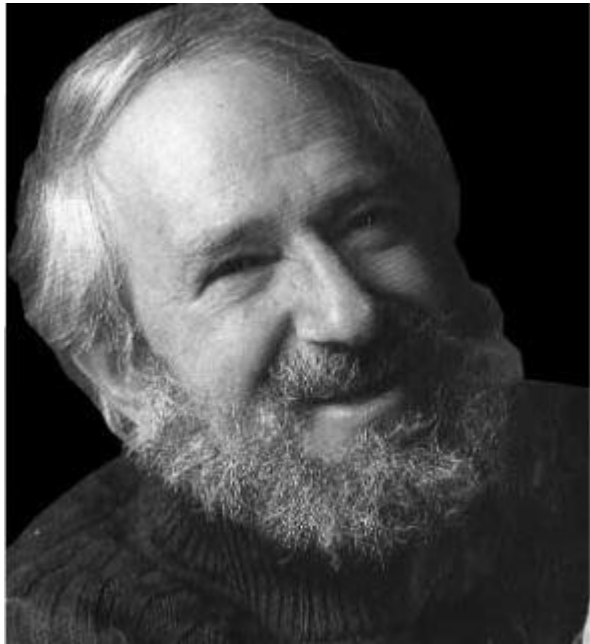


Figure 1. Trends of technology in education.

Source: Authors' own work based on Mo Qureshi (2019)

Doing is a good way to learn

Doing is a good way to learn,
but we learn best of all by the special kind of doing
that consists of **constructing something
outside of ourselves:**



- a child building a tower,
- writing a story,
- constructing a working robotic device or
- making a video game.

<http://www.microworlds.com/company/philosophy.pdf>

Papert, 1999

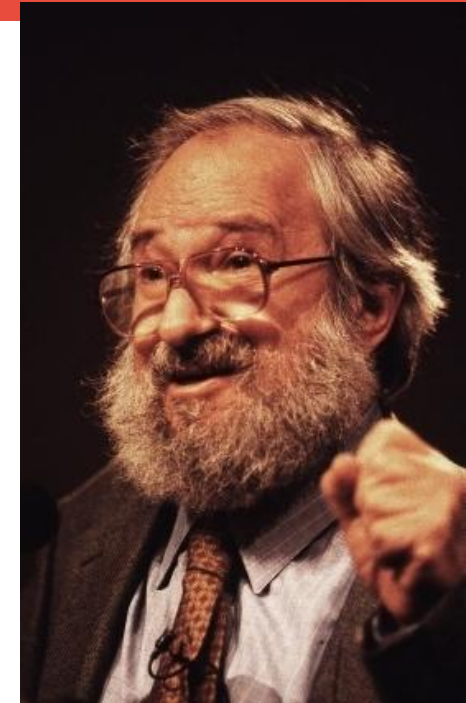
MINDSTORMS

CHILDREN, COMPUTERS,
AND POWERFUL IDEAS

SEYMOUR PAPERT



[https://en.wikipedia.org/wiki/Mindstorms_\(book\)](https://en.wikipedia.org/wiki/Mindstorms_(book))



<https://www.weturtle.org/dettaglio-articolo/19/seymour-papert-breve-biografia.html>

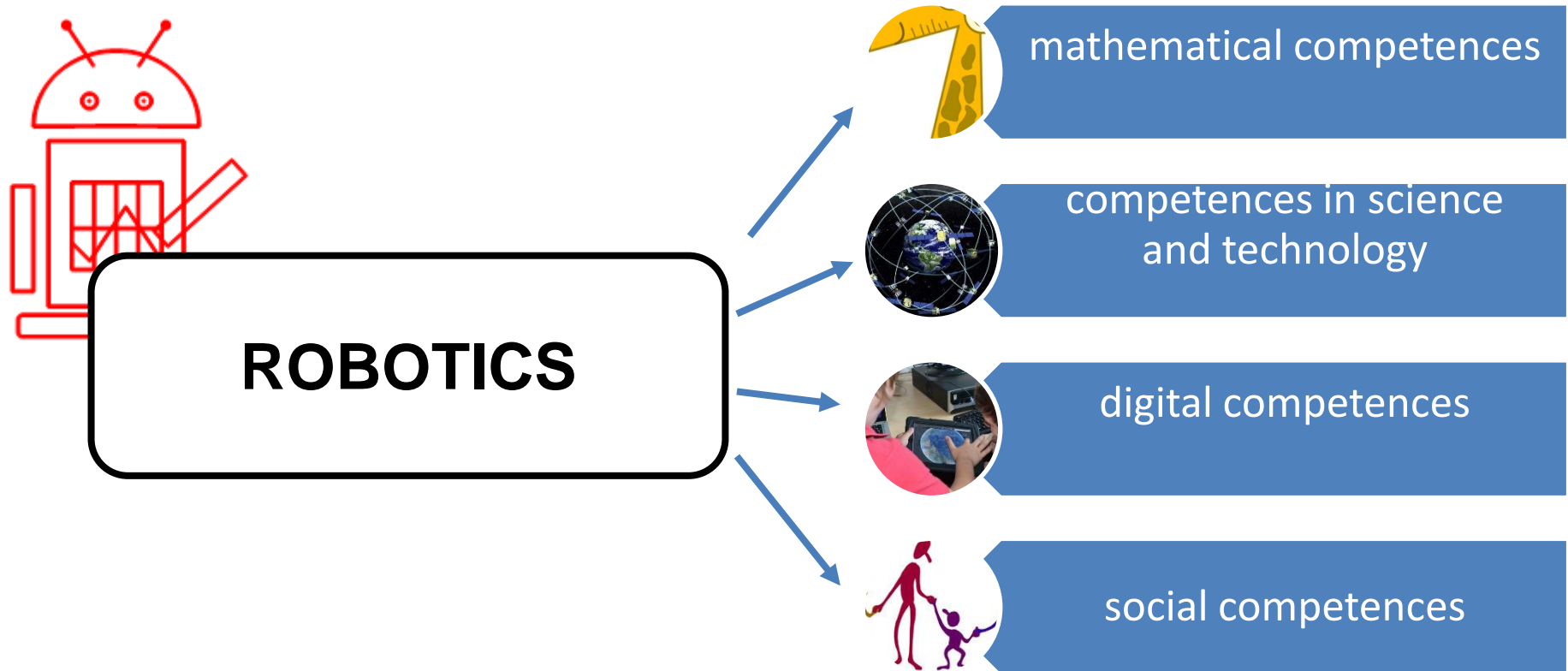
Mindstorms: Children, Computers, and Powerful Ideas is a book by computer scientist Seymour Papert, in which he argues for the benefits of teaching computer literacy in primary and secondary education. It was published by Basic Books in 1980, and republished in a new edition by Basic Books in 1993.

The Lego Mindstorms programmable construction set system is named after the book.

In 2017, thanks to Papert's family the book was made freely available online.

Papert describes the Turtle as an "object-to-think-with" and discusses many code examples of Turtle Graphics. ([https://en.wikipedia.org/wiki/Mindstorms_\(book\)](https://en.wikipedia.org/wiki/Mindstorms_(book)))

Robotics and training on key competences



Competences are understood to mean a combination of knowledge, skills and attitudes appropriate to the situation (Key Competences for Lifelong Learning - A European Reference Framework)

Robotics and training on key competences

The ability to develop and apply mathematical thinking:

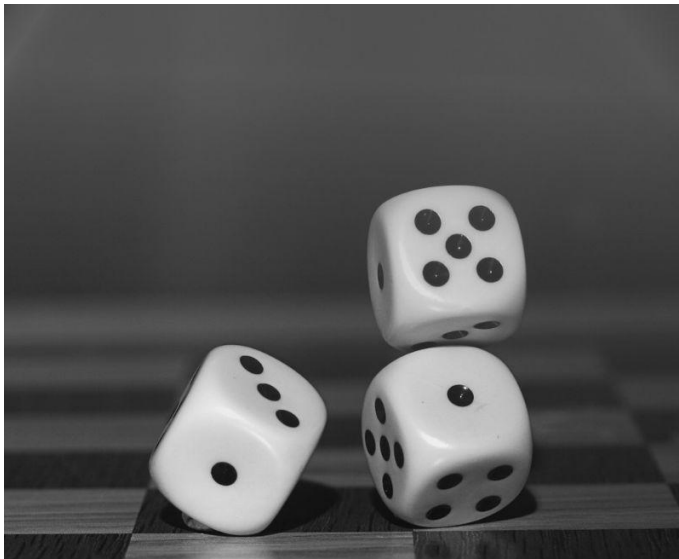
- in order to solve a range of problems
- in everyday situations.



mathematical competences

Process and activity as well as knowledge.

Robotics and training on key competences

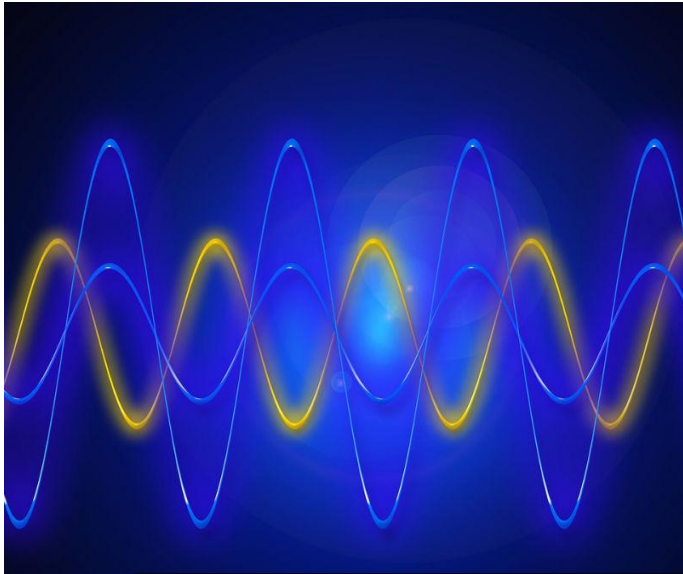


**mathematical
competences**

The ability and willingness:

- **to use mathematical modes of thought:**
 - ✓ logical thinking,
 - ✓ spatial (3D) thinking;
- **to use mathematical modes of presentation:**
 - ✓ formulas,
 - ✓ models, constructs,
 - ✓ graphs, charts.

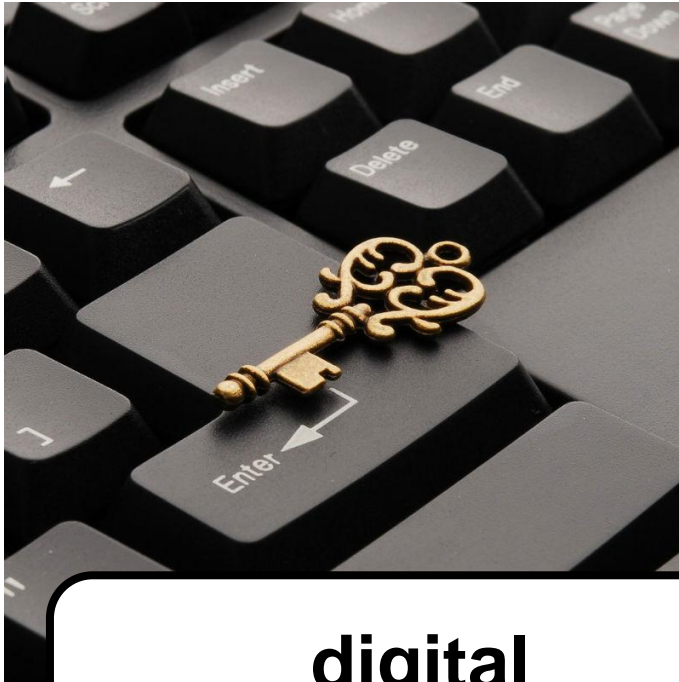
Robotics and training on key competences



**competences
in science
and technology**

- attitude of critical appreciation and curiosity;
- interest in ethical issues;
- respect for both safety and sustainability, in particular as regards scientific and technological progress.

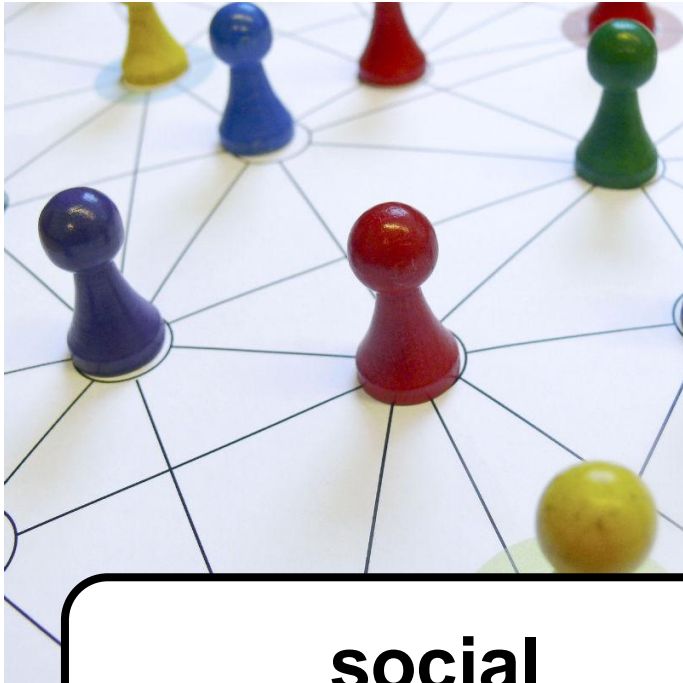
Robotics and training on key competences



**digital
competences**

- confident and critical use of Information Society Technology
- for work and communication
- to support:
 - ✓ critical thinking
 - ✓ creativity
 - ✓ innovation

Robotics and training on key competences



**social
competences**

The ability to:

- communicate constructively in various environments
- express and understand different viewpoints
- negotiate (creating the atmosphere of trust)

In elementary school in Poland you can use robots during:

ELEMENTARY SCHOOL



- **design and technology classes** – models of some machines and vehicles,
- **computer classes** – elements of visual programming – controlling a robot,
- **science classes** – perception: senses vs sensors, construction of simple electric circuits.

The Council for the Informatization of Education at the Ministry of National Education (Poland)

The most important skills acquired by a student in the course of **general education in elementary school** should be:

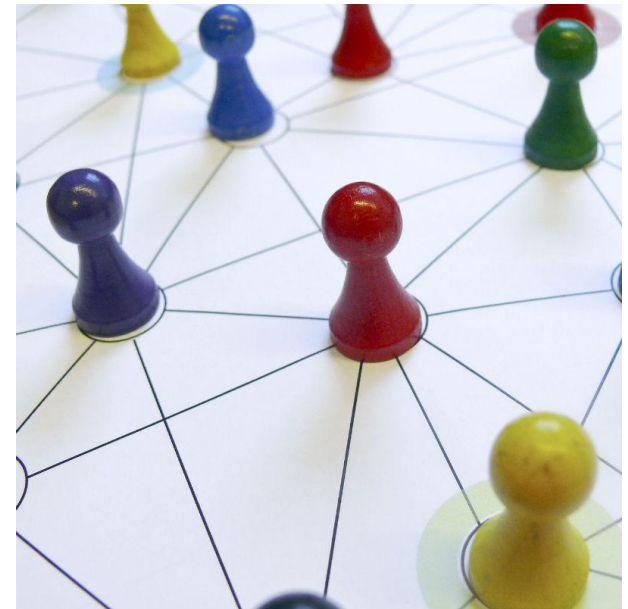
- the ability to solve problems creatively
- with using various methods derived from computer science.



The Council for the Informatization of Education at the Ministry of National Education (Poland)

The Council states:

- **robotics** and visual programming of robots as a student activity is **highly recommended** in the educational process, at the stage of primary school;
- **nature of teamwork** during the implementation of projects in robotics is significant.



Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-1 (Elementary School Activity)
presentation of activities of robots
already built (robot's interaction
with the environment)



- Design and technology classes: possible
- Computer classes: possible
- Science classes: possible

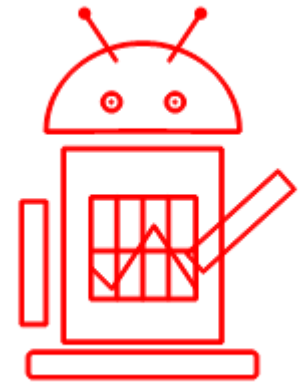


Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-2

building robots according to the plan (following examples)



- Design and technology classes:
- Computer classes:
- Science classes:

possible

possible – simple models

almost impossible – lack of time,
different learning content

Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-3

building robots according to one's wishes (freebuild)

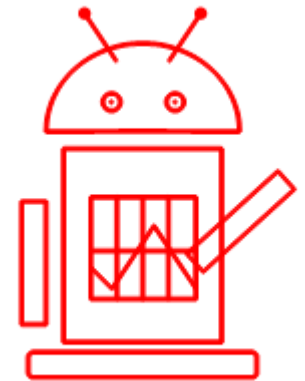
- Design and technology classes: possible and recommended
- Computer classes: more difficult (lack of time for the test phase and design modifications, different teaching content)
- Science classes: almost impossible – lack of time, different learning content



Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-4 modifications of the robots (design changes)



- Design and technology classes:
- Computer classes:
- Science classes:

possible and recommended
possible – simple modifications
almost impossible – lack of time,
different learning content

Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-5

modifications of the robots – using other sensors (e.g. mobile robots)



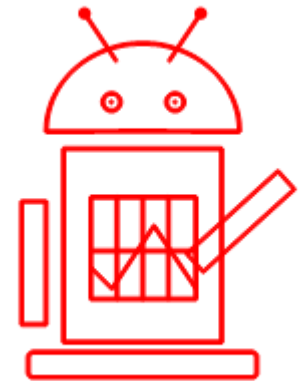
- Design and technology classes: possible and recommended
- Computer classes: possible and recommended
- Science classes: almost impossible – lack of time, different learning content

Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

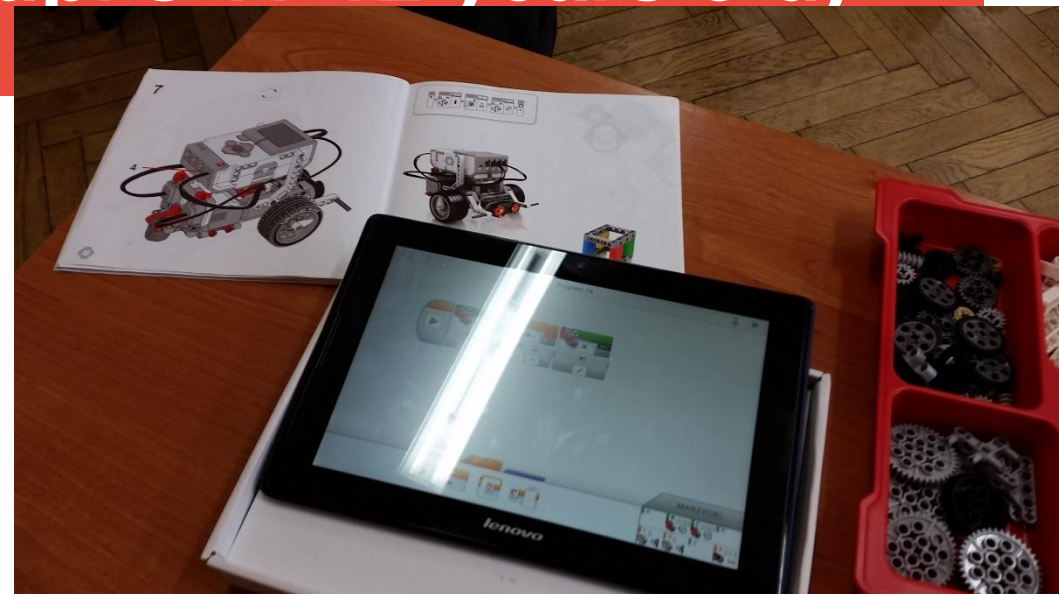
ESA-6

creation and testing of a simple input-output systems (sensor-display, sensor-motor)



- Design and technology classes: possible and recommended
- Computer classes: possible and recommended
- Science classes: possible and recommended

.Robots on the classes in Primary School 2 Bielsko-Biała (6 class, pupils 11-12 years old)

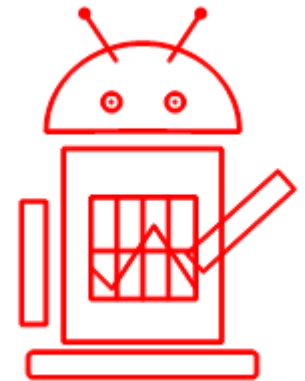


Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-7

programming simple input-output systems (sensor-display, sensor-motor)



- Design and technology classes: possible, although it is not the main objective of the course
- Computer classes: possible and recommended
- Science classes: possible, although it is not the main objective of the course

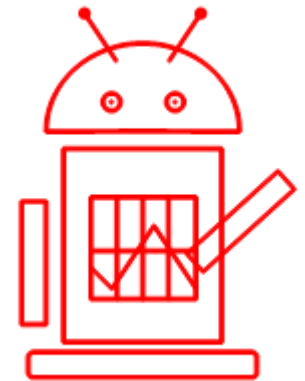
Evaluation of the possibility of implementation of selected activities while working with robots

Activity (action) in class:

ESA-8

programming a robot already built

- Design and technology classes: possible
- Computer classes: possible and recommended
- Science classes: practically impossible – lack of time, different learning content



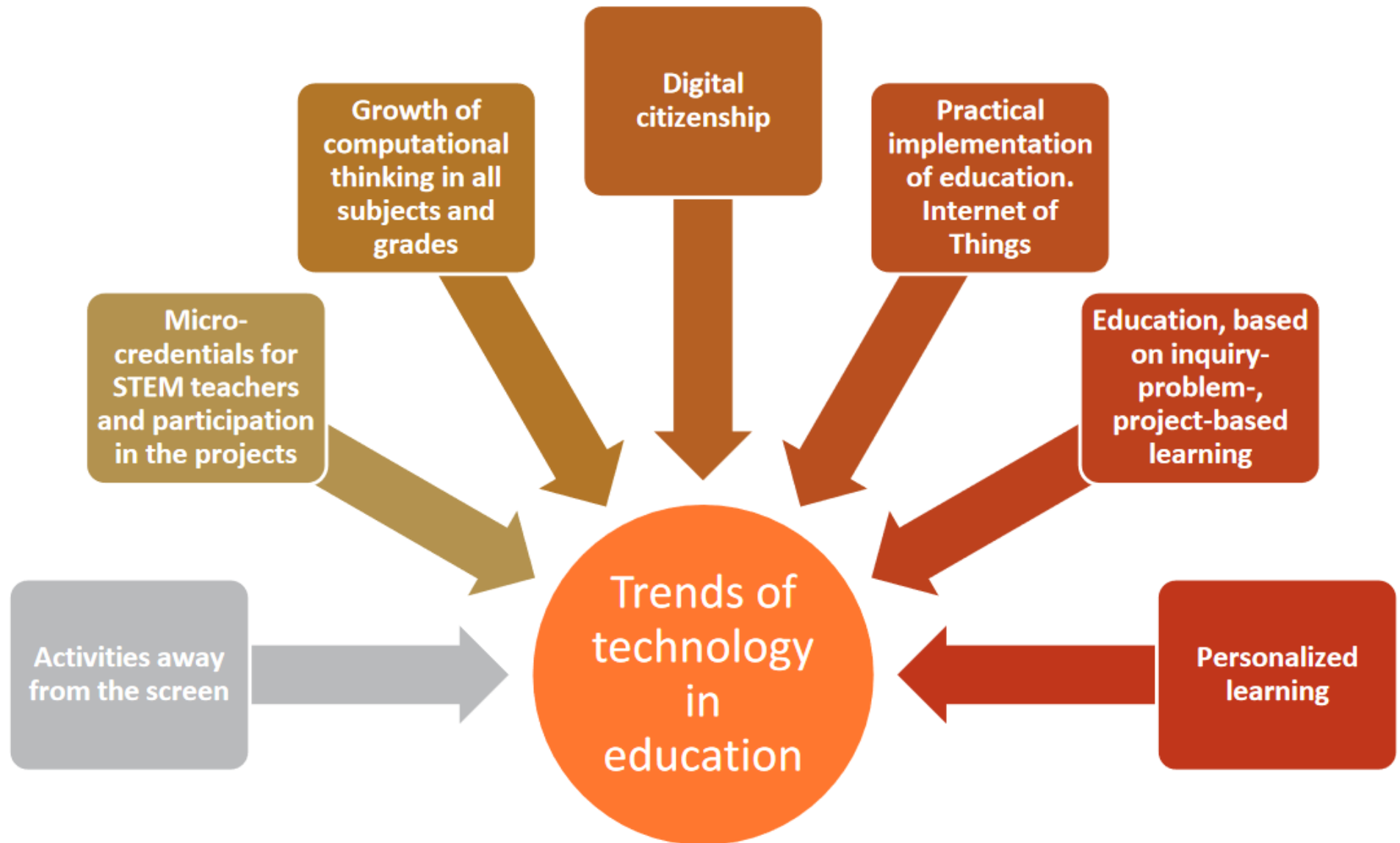


Figure 1. Trends of technology in education.

Source: Authors' own work based on Mo Qureshi (2019)

Table 1

An overview of robots for use in education

Name of the set	Expanda- bility	Dedicated software	Level of advancement	Company producer Website
LoFi Robot	Big	NO	Intermediate	LOFI Sp. z o.o. https://www.lofirobot.com/
Makeblock Mbot	Average	YES	Intermediate	Makeblock Co., Ltd https://www.makeblock.com/
Ozobot	Small	YES	Beginner	EduSense Sp. z o.o. http://www.ozobot.pl/
Lego Mindstorm	Big	YES	Full	Lego Group https://www.lego.com/pl-pl/mindstorms
Dash and Dot	Small	YES	Beginner	Wonder Polska Sp. z o.o. Sp. k. http://makewonder.pl/
Photon	Small	YES	Full	Photon Entertainment sp. z o.o. https://photonrobot.com/pl/

Source: Authors' own work

Table 2 An overview of robots for use in education:

L. p.:	Name of the set:	Expanda- bility	Dedicated software EN/PL	Level of advancement	Company producer Website
1	Lego Mindstorm	Average	YES	Full	Lego Group https://www.lego.com/pl-pl/mindstorms
2	Jimu robots	Average	Yes	Full	UBTRobot https://ubtrobot.com jimurobot.pl
3	Photon home edition	No	Yes	Simple	Photon Entertainment sp. z o.o. Poland https://sklep.photon.education/collections/for-home
4	Abilix Krypton	Intermediate	Yes	Full	Solectric GmbH Polska https://abilix.pl/en/products/
5	Makeblock	Full	Yes	Full	MakeBlock https://education.makeblock.com/
6	Edison V2.0	Beginner	Yes	Simple	NicroBric https://neorobot.pl/pl/Edison-robot-edukacyjny.html
7 27	Lofi	Average	Yes	Intermediate	LOFI Sp. z o.o. Poland https://www.lofirobot.com/

"Engineer" - "genium" (genius), "inventor, discoverer"

When using the term "**engineering approach in teaching**", one can indirectly refer to the possible Latin origin of the word "engineer":

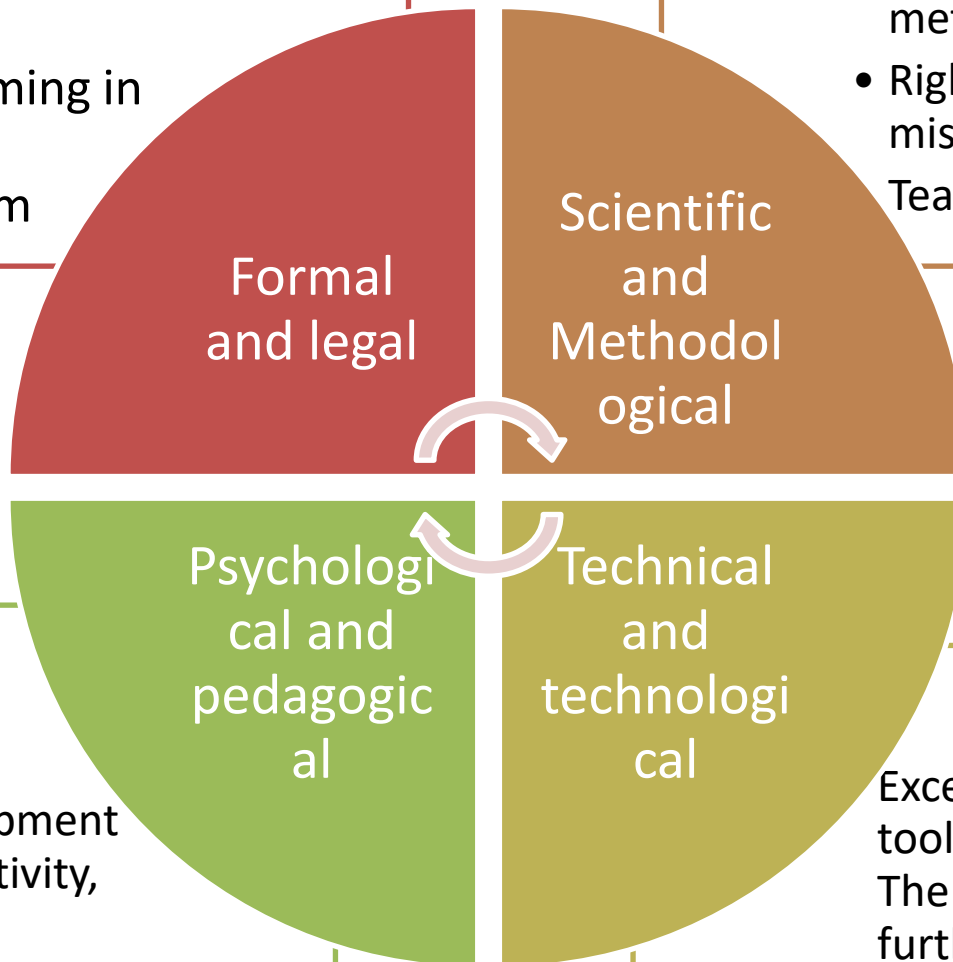
from "**ingenium**" (**reason, brain**), which in the word-formation sense is close to "**genium**" (genius), "**inventor, discoverer**".

Thus, they indicate that the **engineering approach** in teaching may in itself constitute an incentive to learn and acquire **new qualifications**.

.Determinants of the engineering approach in education:

- Key competences Robotics, programming in the core curriculum

- Agile Scrum methodology
- Right to mistake
- Teamwork



- The development of creativity,
- critical thinking

Excellent ICT (ICT) tools for learning;
The need for further development of ICT

STUDENT: CREATIVE THINKER
Superior goal education

.Nadrzędny cel edukacji

“In today's society it is less about what and how much a person knows, but about whether he thinks **creatively** or is able to find **new solutions in new situations.**”

Creative thinking requires engaging others. ”

Mitchel Resnick MIT, USA

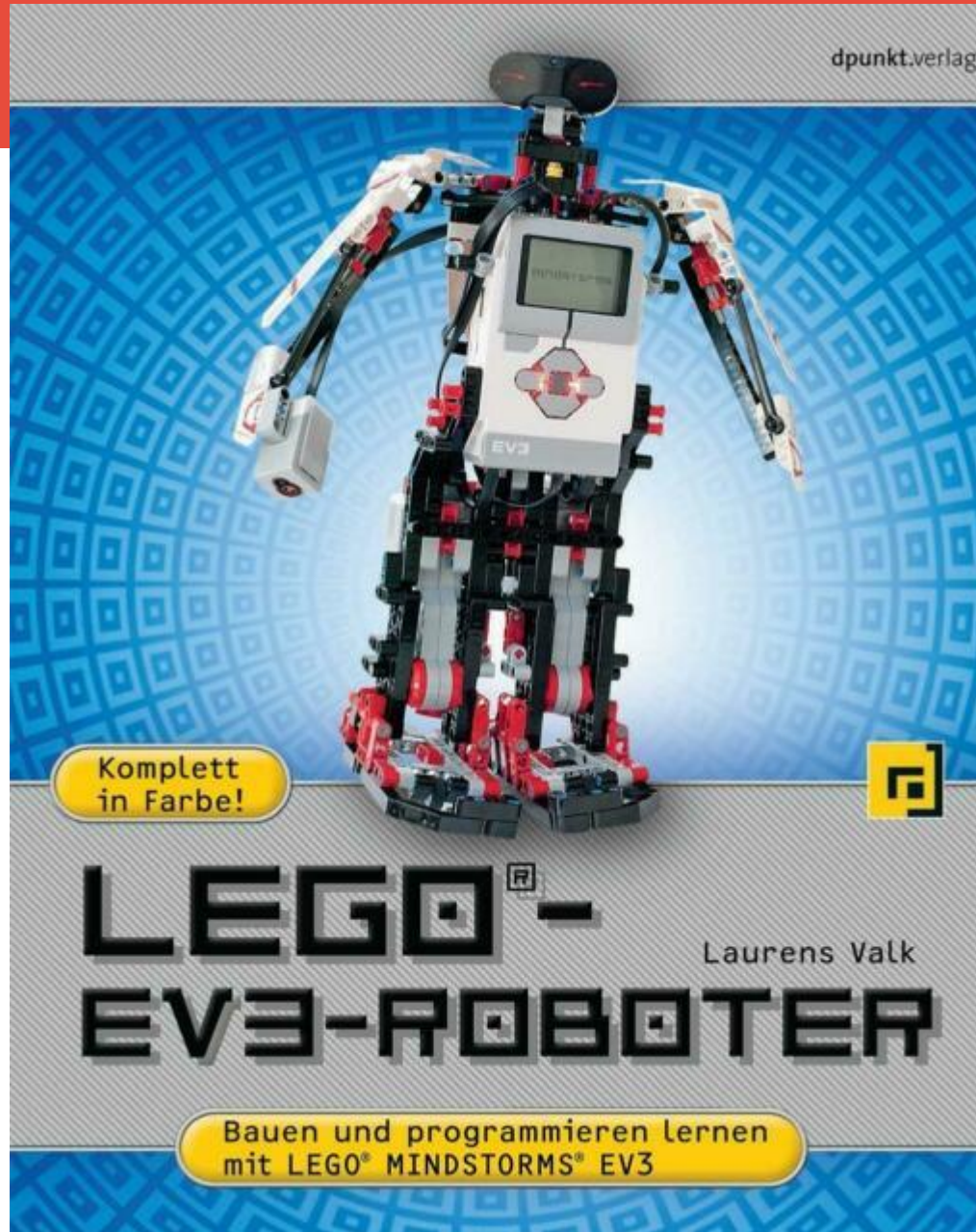
foto:

<http://web.media.mit.edu/~mres/mres-photos.html>



Symbol	Feature	Importance in the teaching process
CPI-01	Expression of goals	From the beginning of the class, the student knows what the expected end product is
CPI-02	Freedom to access information sources	The Internet as a source of inspiration: transfer of ideas, not ready-made solutions
CPI-03	A variety of possible solutions	There is more than one correct solution to the problem posed
CPI-04	Opened for pylori bugs / mistakes	Mistakes and understanding its causes as a signpost leading to the goal
CPI-05	Responsiveness - quick response to changes in conditions	The teacher is the organizer of the activities , but has to react quickly to changes in the plan suggested by the students
CPI-06	Teamwork / collaboration	The best results are achieved when working in teams of 2 or 3 students
CPI-07	Product use	The team's work ends with documenting the stages of creating a robot (photos or 3D instructions), which may be used by others in the future

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Komplett
in Farbe!



LEGO® - EV3-ROBOTER

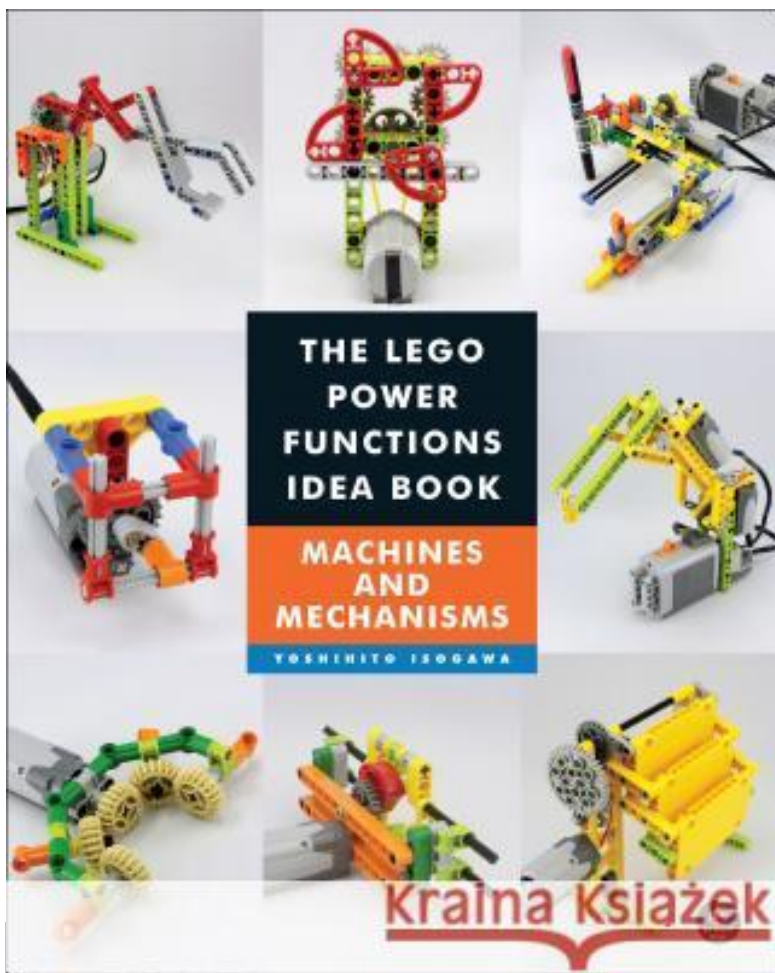
Laurens Valk

Bauen und programmieren lernen
mit LEGO® MINDSTORMS® EV3

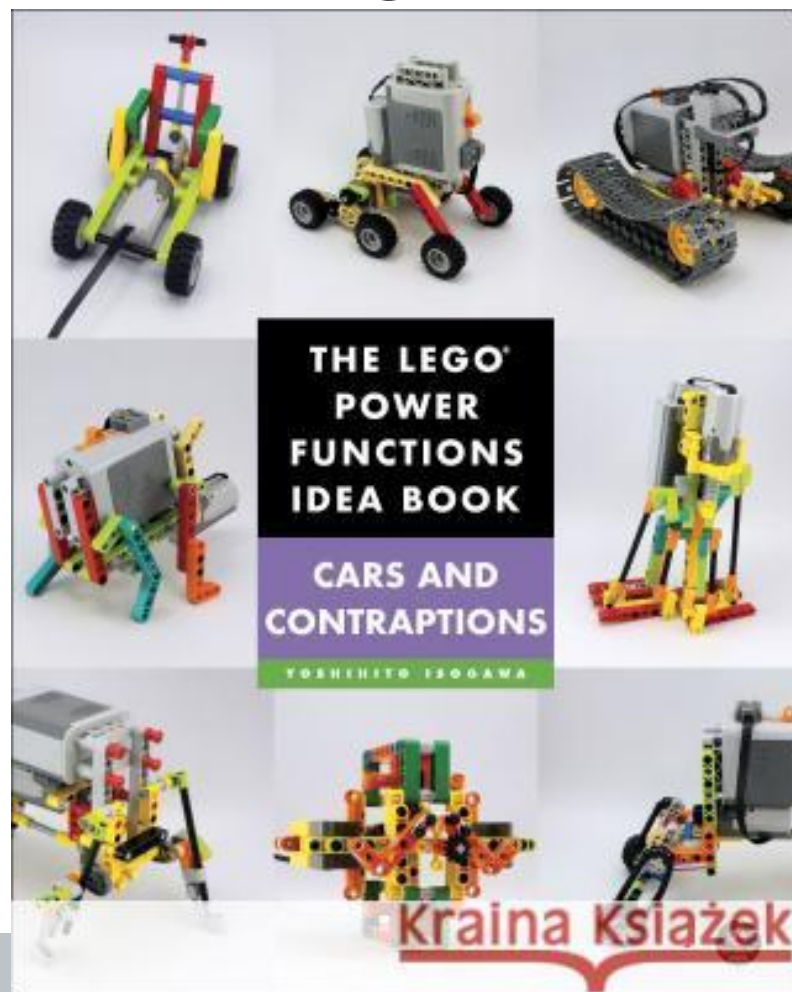
The Lego Power Functions Idea Book, Vol. 1: Machines and Mechanisms

Functions Idea Book, Vol. 2: Cars and Contraptions

Yoshihito Isogawa

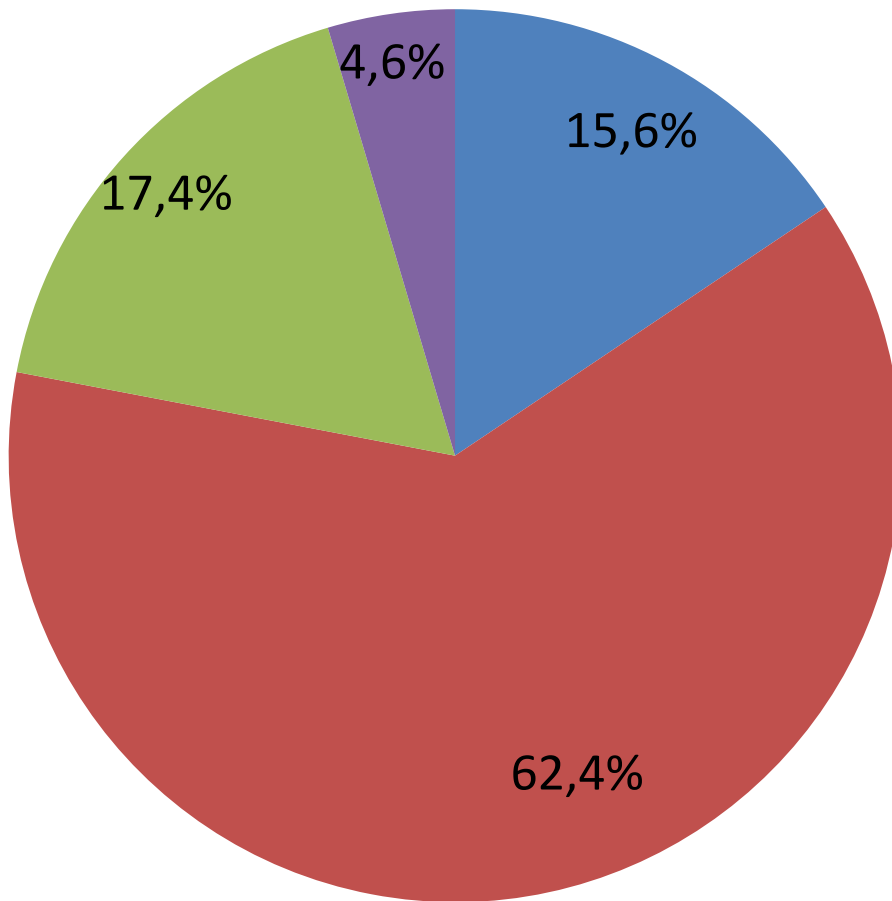


Yoshihito Isogawa



Do you think it is possible to teach students robotics in class at school or is it a more of out-of-school education process?

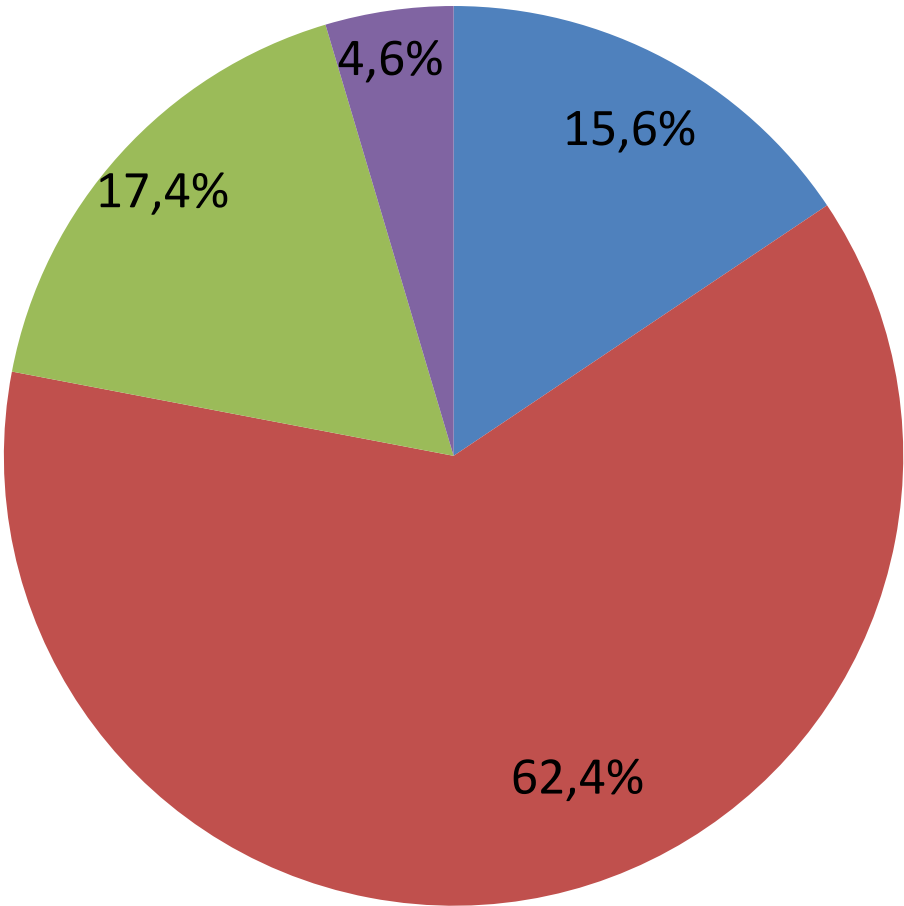
POLAND



- Robotics can be taught in the classroom, as a mandatory part of the curriculum
- You can implement robotics classes in school if the school provides appropriate conditions and equipment
- You can implement robotics classes in selected schools or for selected students
- It is rather a process of school education, including some students

Do you think it is possible to teach students robotics in class at school or is it a more of out-of-school education process?

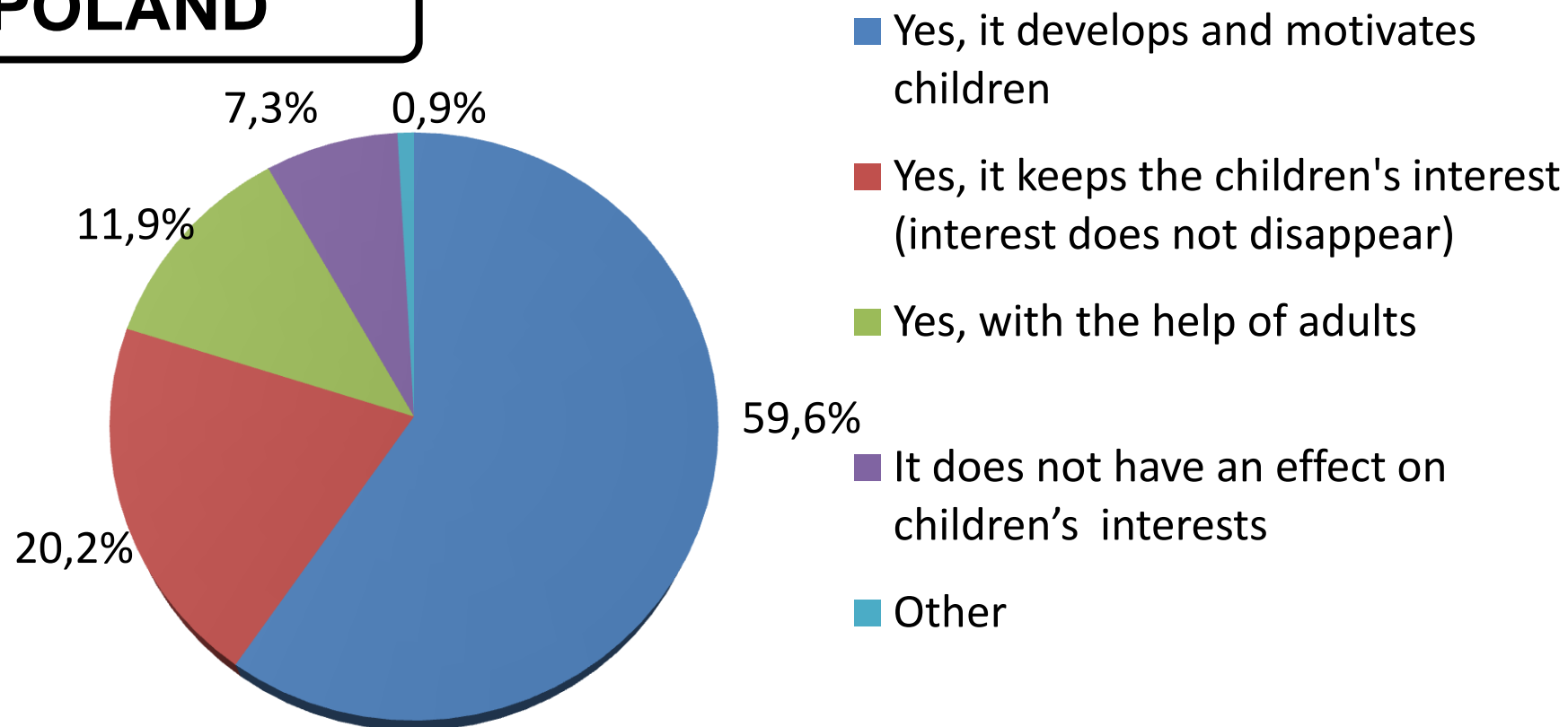
POLAND



- Robotics can be taught in the classroom, as a mandatory part of the curriculum
- You can implement robotics classes in school if the school provides appropriate conditions and equipment
- You can implement robotics classes in selected schools or for selected students
- It is rather a process of school education, including some students

Do you think that it is interesting for children to create a robot by themselves?

POLAND



The study was carried out to determine the needs of modern education to introduce the basics of robotics in the educational process of elementary school.

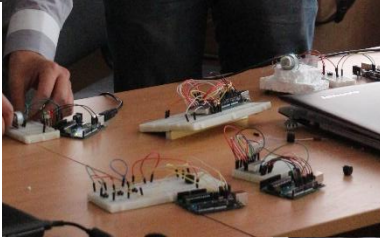


Creating of the algorithmic thinking and coding and use
Scratch on the classes in Elementary School 2 Bielsko-Biała

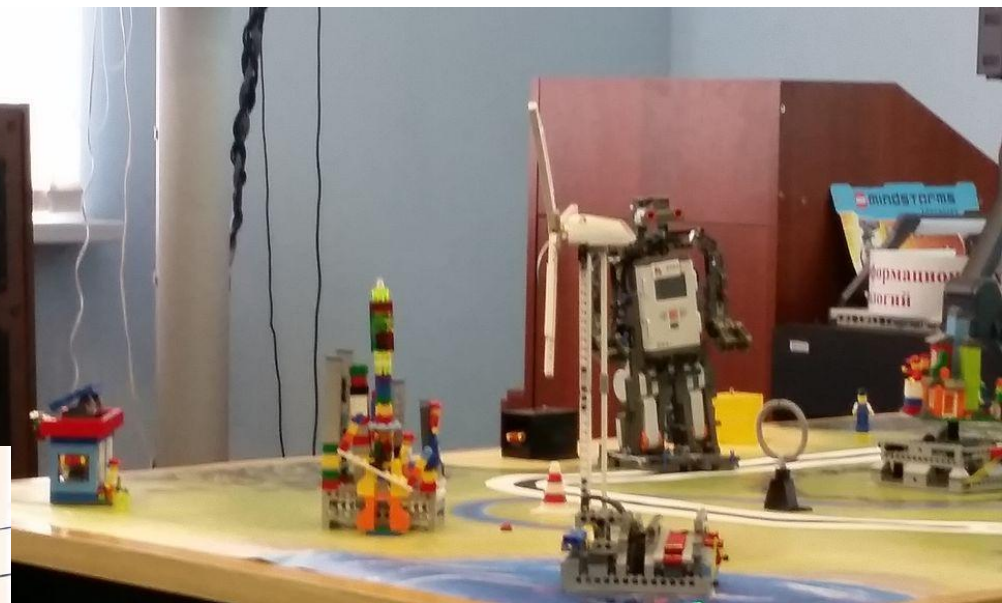




Robots Lego Education on the classes in Primary School 2 Bielsko-Biała



.HSPU, SPB,
Russia. 2016



Robots on the classes in school in SPB, R

.HSPU, SPB, Russia, 2016



Robots on the classes in school in SPB, RU

.Silesian Festival of Science 12-14/01/2019



.Silesian Festival of Science 12-14/01/2019



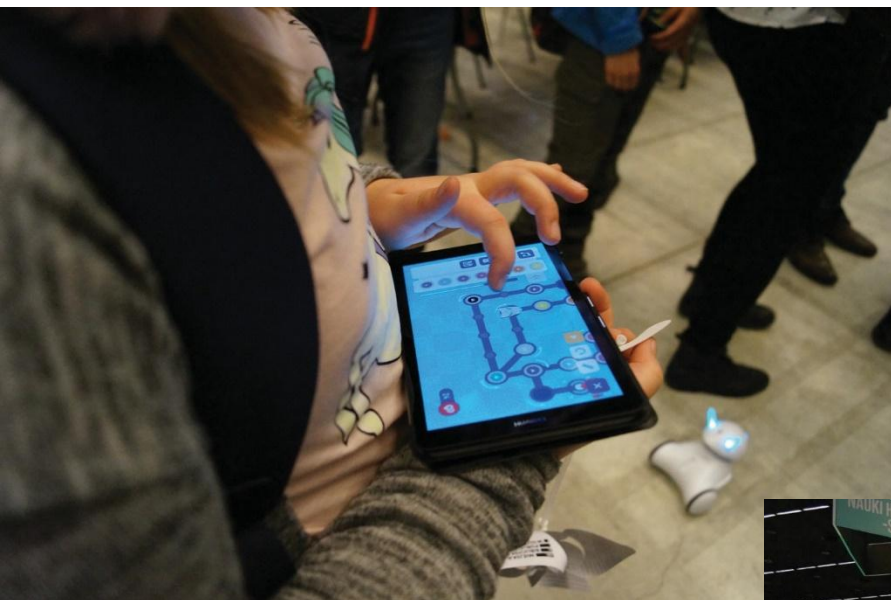
.Silesian Festival of Science 12-14/01/2019



.Silesian Festival of Science 12-14/01/2019



.Warsztaty z robotami Photon na FŚN 2019



[20]

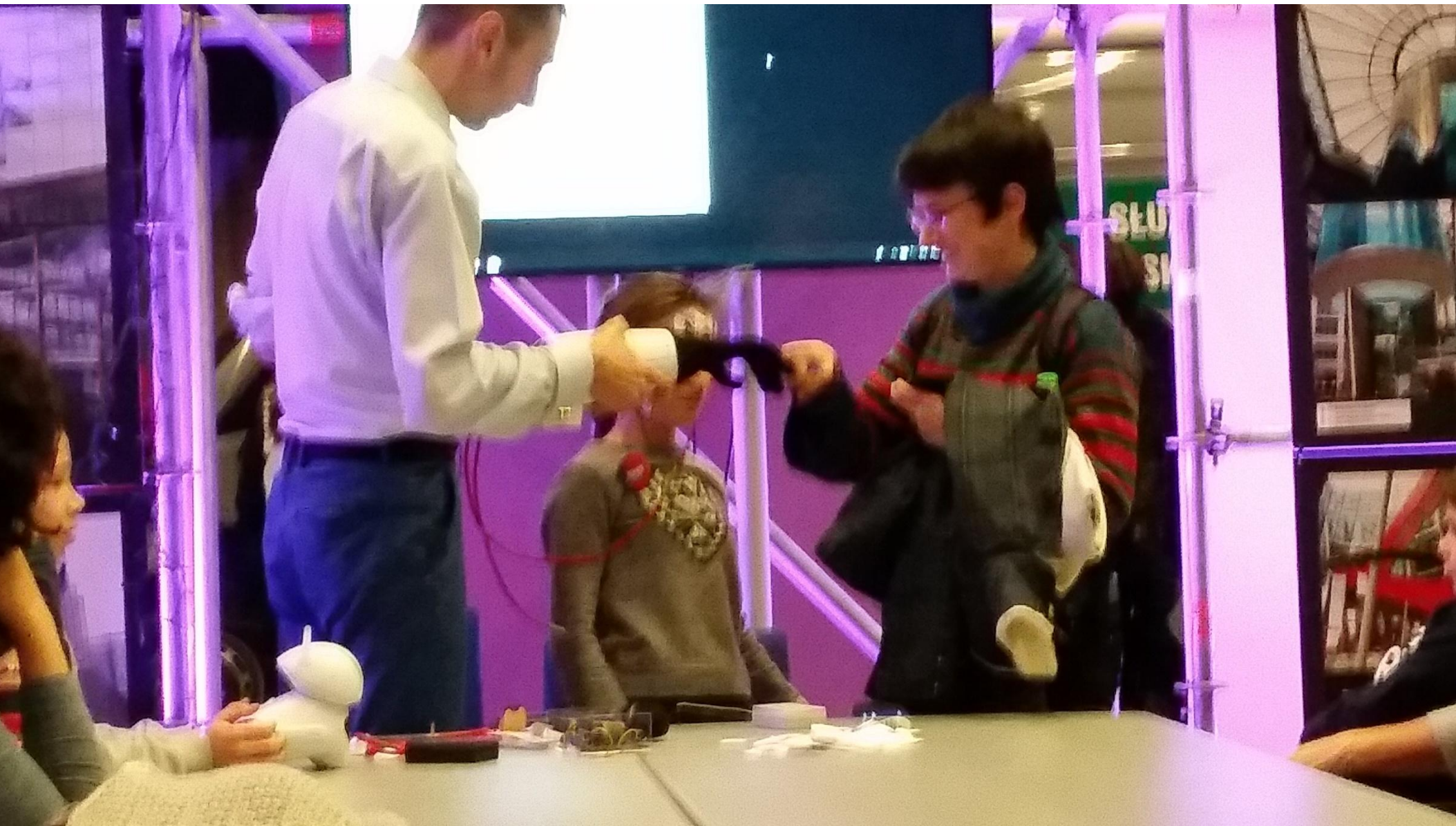
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.Silesian Festival of Science 12-14/01/2019



.Silesian Festival of Science 12-14/01/2019



.LEGO Education SETs

LEGO DUPLO Education STEAM Park

LEGO DUPLO - Creative set

LEGO DUPLO Build Emotions

LEGO System Community - Starter Kit

LEGO System - Creative Set

.CONCLUSION

The results of survey conducted in Poland among in-service teachers and prospective teachers show that more than 50% respondents understand the important role of the STEM education and the necessity to introduce it the elementary level of education by workshops and other activities.

These classes and other STEM education activities could provide successful development of twenty-first-century skills, in particularly key competences.

Simultaneously, still open is the question concerning the comprehensive STEM education of prospective teachers pursuing pedagogical programmes, in particular in the specialization of early education

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**Thank you
for your attention!**

Eugenia Smyrnova-Trybulska
University of Silesia, Poland