EDUCATIONAL ROBOTS IN EDUCATION

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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, 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.


Papert, 1999
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.

Robotics and training on key competences

ROBOTICS

competences in science and technology

digital competences

social competences

mathematical 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.

Process and activity as well as knowledge.
Robotics and training on key 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

- 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

- confident and critical use of Information Society Technology
- for work and communication
- to support:
  - critical thinking
  - creativity
  - innovation
Robotics and training on key competences

The ability to:

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

social competences
In elementary school in Poland you can use robots during:

- **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 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: possible
- Computer classes: possible – simple models
- 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-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: **possible and recommended**
- Computer classes: possible – simple modifications
- 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-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)
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>
<thead>
<tr>
<th>Name of the set</th>
<th>Expandability</th>
<th>Dedicated software</th>
<th>Level of advancement</th>
<th>Company producer Website</th>
</tr>
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<tbody>
<tr>
<td>LoFi Robot</td>
<td>Big</td>
<td>NO</td>
<td>Intermediate</td>
<td>LOFI Sp. z o.o. <a href="https://www.lofirobot.com/">https://www.lofirobot.com/</a></td>
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<tr>
<td>Makeblock Mbot</td>
<td>Average</td>
<td>YES</td>
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<td>Makeblock Co., Ltd <a href="https://www.makeblock.com/">https://www.makeblock.com/</a></td>
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<td>Lego Mindstorm</td>
<td>Big</td>
<td>YES</td>
<td>Full</td>
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<td>Photon</td>
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<td>Photon Entertainment sp. z o.o. <a href="https://photonrobot.com/pl/">https://photonrobot.com/pl/</a></td>
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<td><a href="https://ubtrobot.com/">https://ubtrobot.com/</a> jimurobot.pl</td>
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<tr>
<td>3</td>
<td>Photon home edition</td>
<td>No</td>
<td>Yes</td>
<td>Simple</td>
<td>Photon Entertainment sp. z o.o. Poland</td>
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<td>Average</td>
<td>Yes</td>
<td>Intermediate</td>
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<td><a href="https://www.lofirobot.com/">https://www.lofirobot.com/</a></td>
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"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
- Excellent ICT (ICT) tools for learning;
- The need for further development of ICT
- Development of creativity,
- Critical thinking
- Superior goal education
- Student: Creative thinker
- Formal and legal
- Scientific and methodological
- Psychological and pedagogical
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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]
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Feature</th>
<th>Importance in the teaching process</th>
</tr>
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<tr>
<td>CPI-01</td>
<td>Expression of goals</td>
<td>From the beginning of the class, the student knows what the expected end product is</td>
</tr>
<tr>
<td>CPI-02</td>
<td>Freedom to access information sources</td>
<td>The Internet as a source of inspiration: transfer of ideas, not ready-made solutions</td>
</tr>
<tr>
<td>CPI-03</td>
<td>A variety of possible solutions</td>
<td>There is more than one correct solution to the problem posed</td>
</tr>
<tr>
<td>CPI-04</td>
<td>Opened for pylori bugs / mistakes</td>
<td>Mistakes and understanding its causes as a signpost leading to the goal</td>
</tr>
<tr>
<td>CPI-05</td>
<td>Responsiveness - quick response to changes in conditions</td>
<td>The teacher is the organizer of the activities, but has to react quickly to changes in the plan suggested by the students</td>
</tr>
<tr>
<td>CPI-06</td>
<td>Teamwork / collaboration</td>
<td>The best results are achieved when working in teams of 2 or 3 students</td>
</tr>
<tr>
<td>CPI-07</td>
<td>Product use</td>
<td>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</td>
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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**

- 62.4%: It is rather a process of school education, including some students
- 15.6%: You can implement robotics classes in school if the school provides appropriate conditions and equipment
- 17.4%: You can implement robotics classes in selected schools or for selected students
- 4.6%: Robotics can be taught in the classroom, as a mandatory part of the curriculum
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Do you think that it is interesting for children to create a robot by themselves?

![Pie chart showing survey results](chart.png)

- **59.6%** Yes, it develops and motivates children
- **20.2%** Yes, it keeps the children's interest (interest does not disappear)
- **11.9%** Yes, with the help of adults
- **7.3%** It does not have an effect on children’s interests
- **0.9%** Other

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 Dash & Dot on the classes in the Elementary School in Evora
Robots Lego Education on the classes in Primary School 2 Bielsko-Biała
Robots on the classes in the Secondary School in Kyiv
Robots on the classes in school in SPB, RU
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Silesian Festival of Science 12-14/01/2019
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Warsztaty z robotami Photon na FŚN 2019
Silesian Festival of Science 12-14/01/2019
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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
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 particular 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.
Sources

Sources

• Zuziak W.: Teaching how to code we teach through the coding [w:] Smyrnova-Trybulska E. (red.): E-learning and Intercultural Competences Development in Different Countries, Studio NOA for University of Silesia, Katowice - Cieszyn, 2014.


Thank you for your attention!

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