

# Social Robotics in Education: State-of-the-Art and Directions

T. Pachidis, E. Vrochidou, V. G. Kaburlasos, S. Kostova, M. Bonković  
and V. Papić

Human-Machines Interaction Lab, EMaTTech, Kavala, Greece

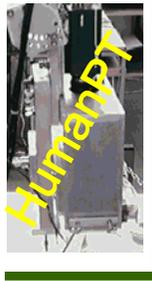
Institute of System Engineering and Robotics, Bulgarian Academy of  
Science, Bulgaria

University of Split, Split, Croatia



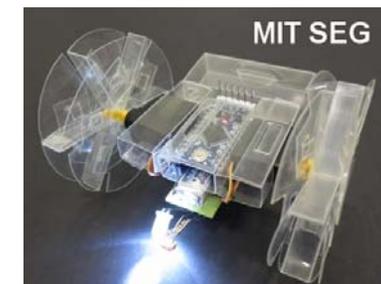
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# Commercial Robotic Platforms in Education

- They can be divided into:
  - Brick-based robot assembly kits
    - Lego Mindstorms, VEX IQ, etc
  - Minimal mobile robot design
    - Arduino Starter Kit, Bee-Bot, etc
  - Programmable robot manipulators
    - Servorobotics RA-02, Lynx AL5x, etc
  - Open-source mobile platforms designed from commercial off-the-shelf components
    - MIT SEG, Harvard Kilobot, etc





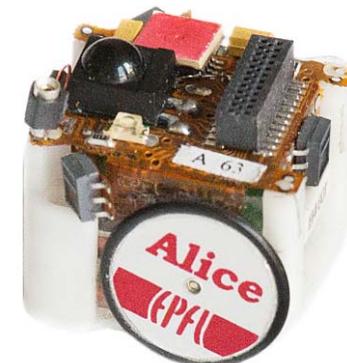
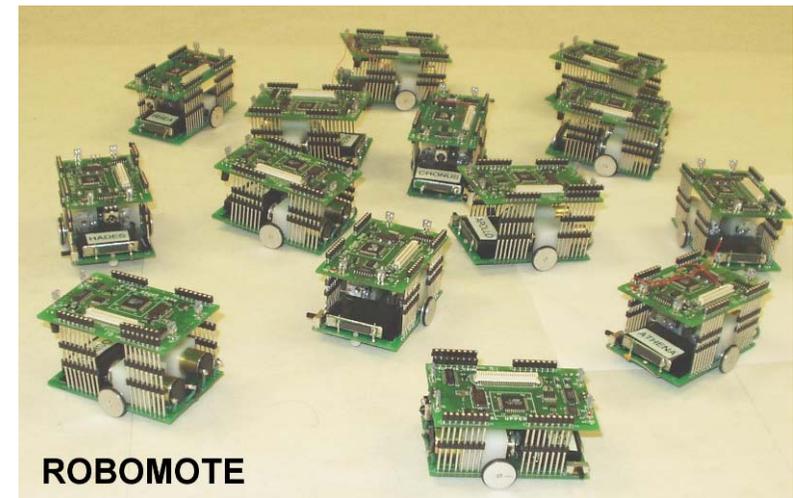
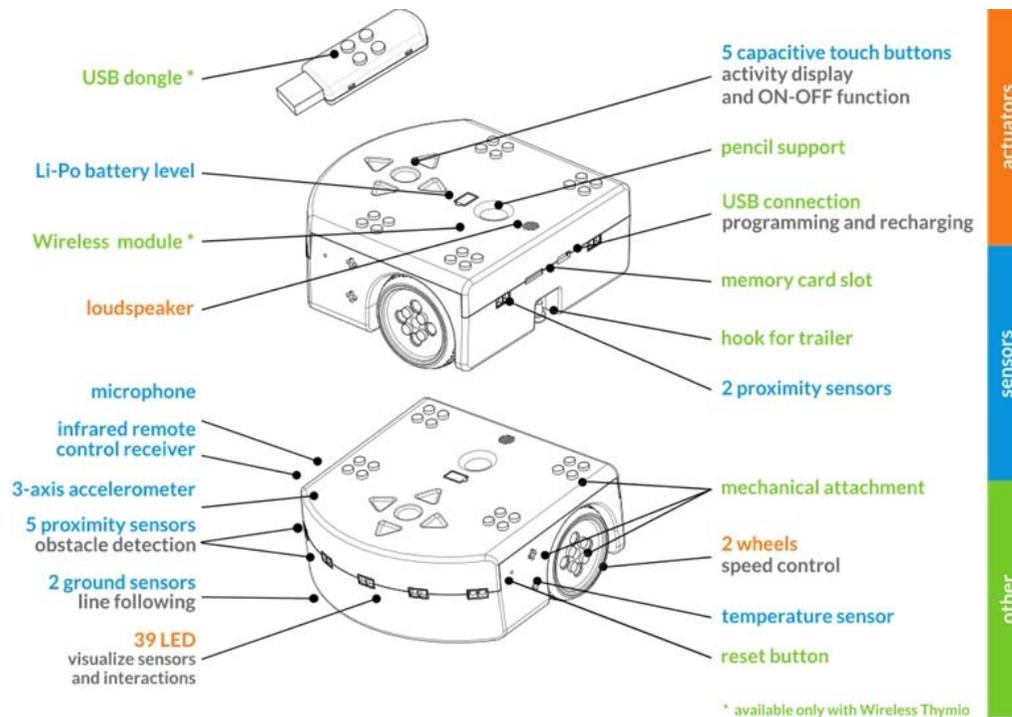
# Commercial Robotic Platforms in Education

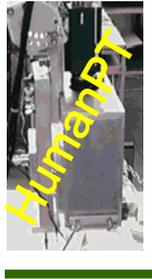
↪ Fully-assembled commercial mobile robots

➤ Thymio, iRobot Create, etc

↪ Open-source miniaturized swarm robots

➤ Robomote, Alice, etc





# Commercial Robotic Platforms Selected

## ➤ Criteria:

- ↪ Most recent reports, only in the past two years of the bibliography, regarding educational experimental researches that utilize these robots.
- ↪ Age to which these robots are addressed, so as to cover all the range of all K-12 education and university.

## ➤ Robotic platforms selected:

350 \$ **Lego Mindstorms EV3**

**Vex IQ Kits** 440 \$

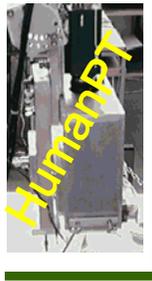
9000 \$ **NAO Humanoid Robot**

**JD Humanoid - EZ-Robot** 430 \$

123 \$ **Bee-Bot**

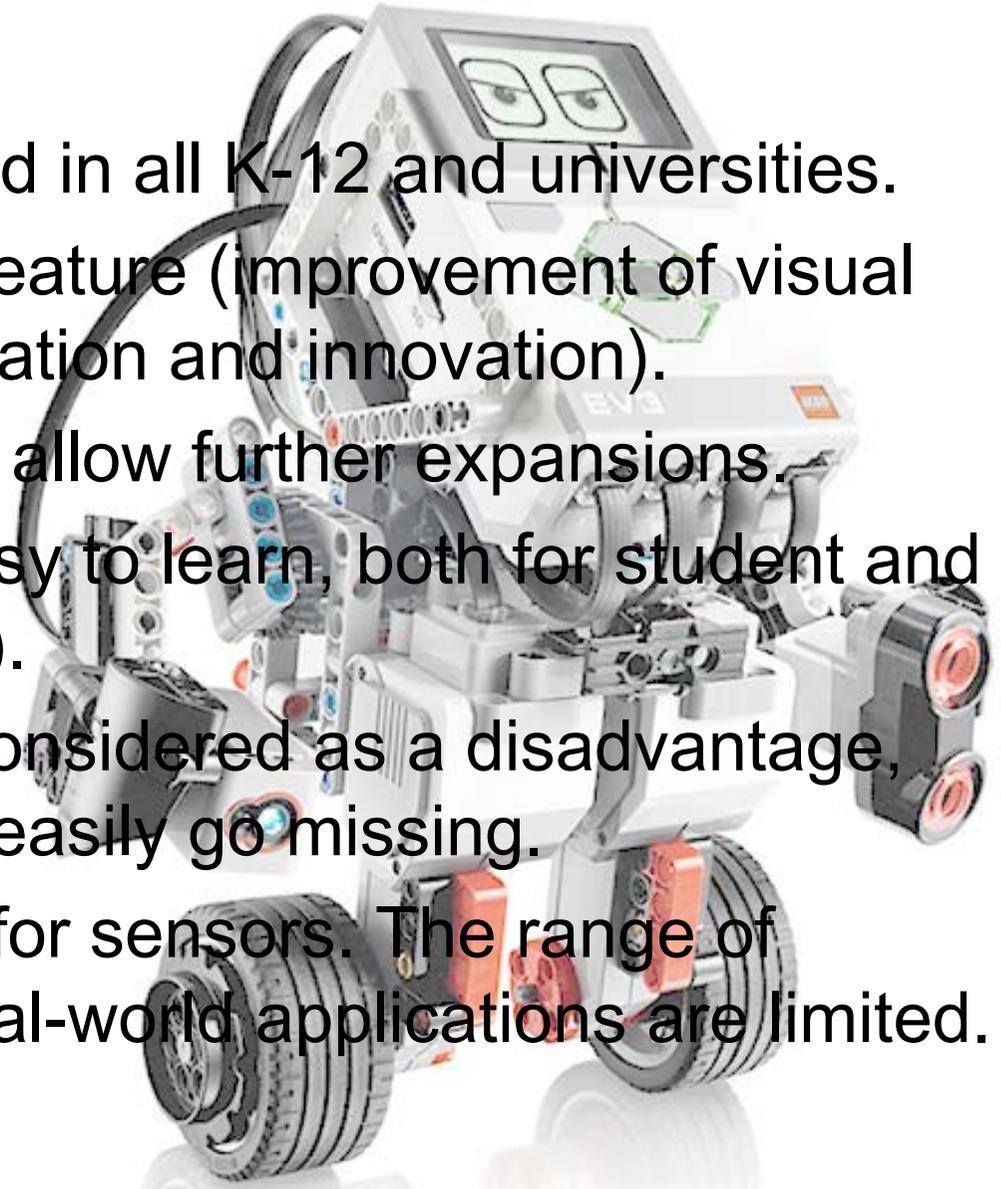
**Thymio** 193 \$

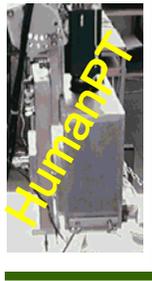
650 \$ **Romibo**



# Advantages and Drawbacks of Selected Robotic Platforms

- **Lego kits:** [https://youtu.be/uz11s\\_JJayM](https://youtu.be/uz11s_JJayM)
  - ↪ The most commonly used in all K-12 and universities.
  - ↪ Assembly is their basic feature (improvement of visual spatial skills, experimentation and innovation).
  - ↪ Variety of sensors. They allow further expansions.
  - ↪ Lego programming is easy to learn, both for student and teachers (EV 3 software).
  - ↪ But, modular design is considered as a disadvantage, since brick components easily go missing.
  - ↪ There are limited inputs for sensors. The range of potential learning and real-world applications are limited.

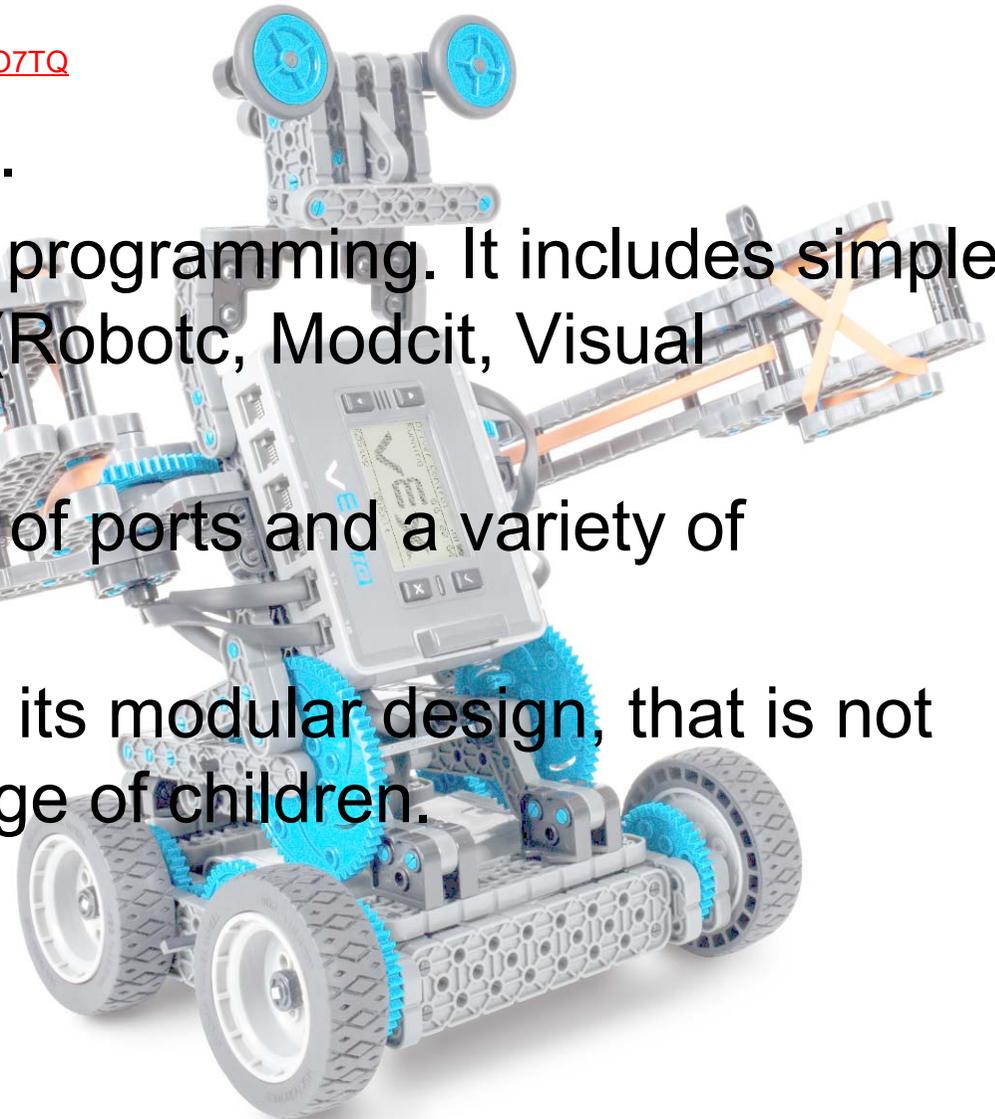
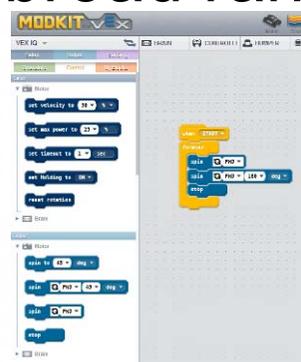
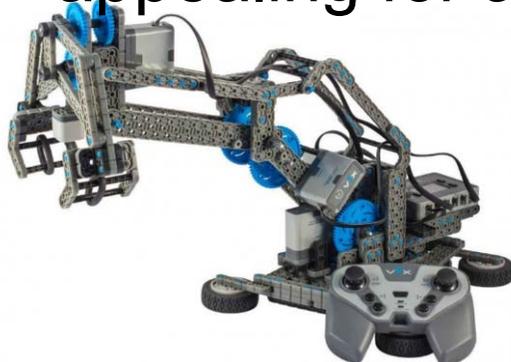


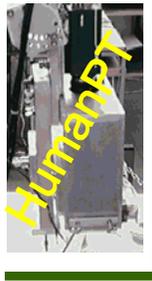


# Advantages and Drawbacks of Selected Robotic Platforms

## ➤ Vex IQ: <https://www.youtube.com/watch?v=9VaV5RO7TQ>

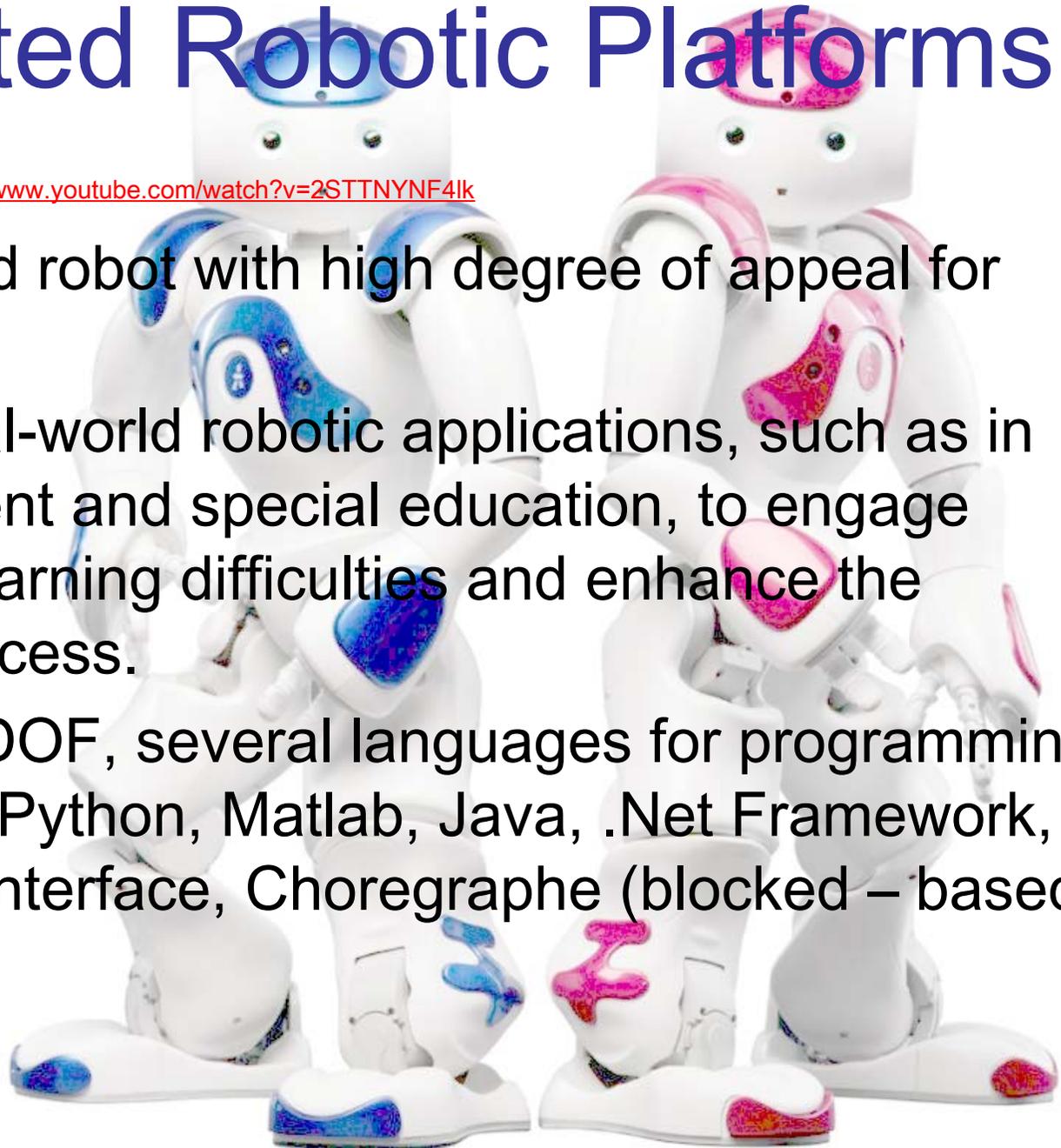
- Modular robotics platform.
- It permits traditional-style programming. It includes simple programming languages (Robotc, Modcic, Visual programming).
- It has a sufficient number of ports and a variety of sensors.
- One of Vex's' drawback is its modular design, that is not appealing for a broad range of children.

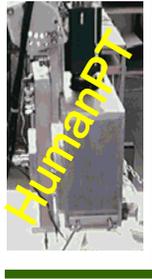




# Advantages and Drawbacks of Selected Robotic Platforms

- **NAO Robot:** <https://www.youtube.com/watch?v=2STTNYNF4Ik>
  - ↪ It is a humanoid robot with high degree of appeal for children.
  - ↪ It is used in real-world robotic applications, such as in special treatment and special education, to engage children with learning difficulties and enhance the therapeutic process.
  - ↪ It provides 25 DOF, several languages for programming, including C++, Python, Matlab, Java, .Net Framework, and a graphic interface, Choregraphe (blocked – based programming).

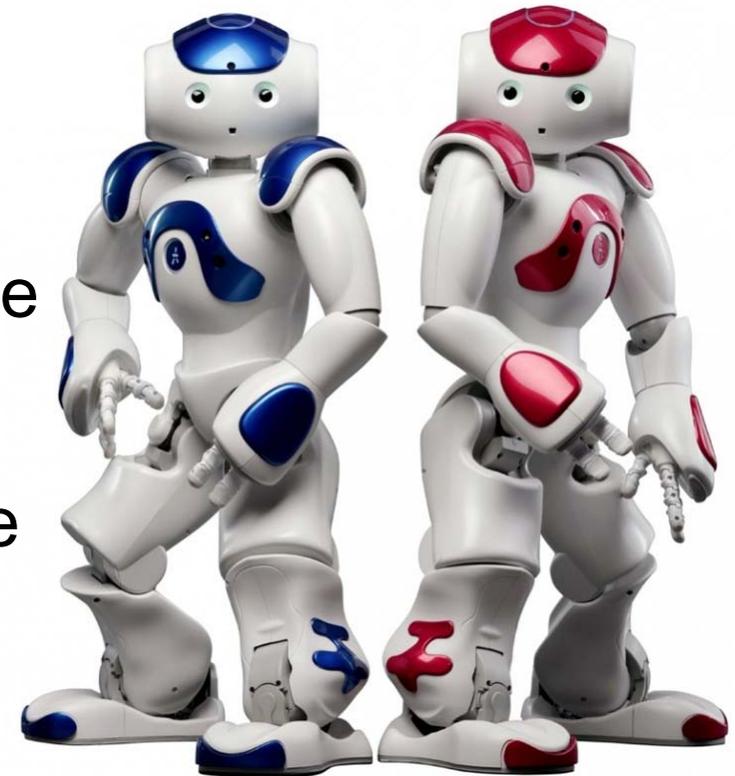


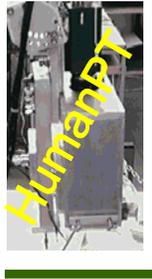


# Advantages and Drawbacks of Selected Robotic Platforms

## ➤ NAO Robot (cont.):

- ↪ However, programming is demanding and thus, it is intimidating for teachers and students.
- ↪ Moreover, its price is not affordable for many educators, and even if purchased as educational robot in the classroom, it would be on finite numbers, one or two in the same classroom.
- ↪ For this reason, NAO is more appropriate in University level and research, rather than in typical K-12 education.





# Advantages and Drawbacks of Selected Robotic Platforms

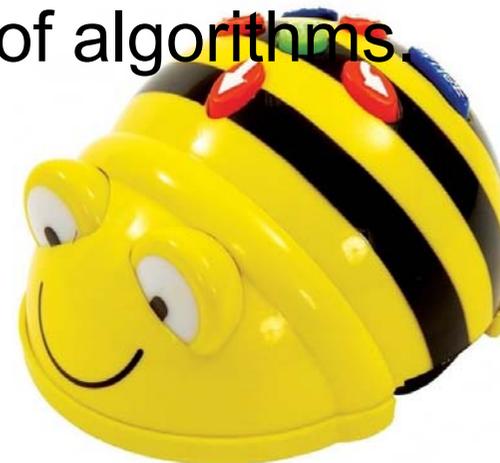
- JD Humanoid from EZ-Robot: <https://www.youtube.com/watch?v=YYSq79e5k8o>
  - ↪ Versality of a platform.
  - ↪ Emotional connection with the user due to its appearance.
  - ↪ 16 degrees-of-freedom (DOF).
  - ↪ A wide-range of learning opportunities.
  - ↪ It can be used from all ages to create real-world applications through a friendly programming interface.
  - ↪ Additionally, it allows children to elevate their programming skills since it can be programmed starting with EZ-builder software, Robo-Scratch, to C++, C# and Visual Basic.

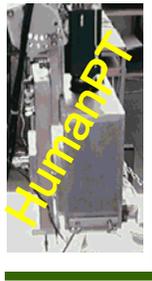


# Advantages and Drawbacks of Selected Robotic Platforms

## ➤ Bee – Bot: <https://www.youtube.com/watch?v=52ZuenJIFyE>

- Designed for use only by young children.
- It is easy to operate.
- Friendly in programming using the buttons on its back.
- Appealing appearance and affordable.
- It is used in teaching sequencing and control, positional and directional language, program sequences and repetitions, and understanding of algorithms.





# Advantages and Drawbacks of Selected Robotic Platforms

## ➤ Romibo: <https://www.youtube.com/watch?v=njQ6BCVf4YI>

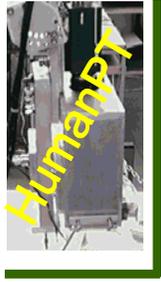
- ↪ It is a remotely controlled, socially assistive robot, with mobility, speech, gesture and face tracking.
- ↪ It is used to train social and academic skills, but usually utilized in special treatment.
- ↪ It refers to younger children.



## ➤ Thymio: <https://www.youtube.com/watch?v=RTi7DjqlGO8>

- ↪ It is a small robot which allows children to learn a robot's language.
- ↪ It is affordable, very easy to program and allows numerous experiments.
- ↪ It refers to younger children.





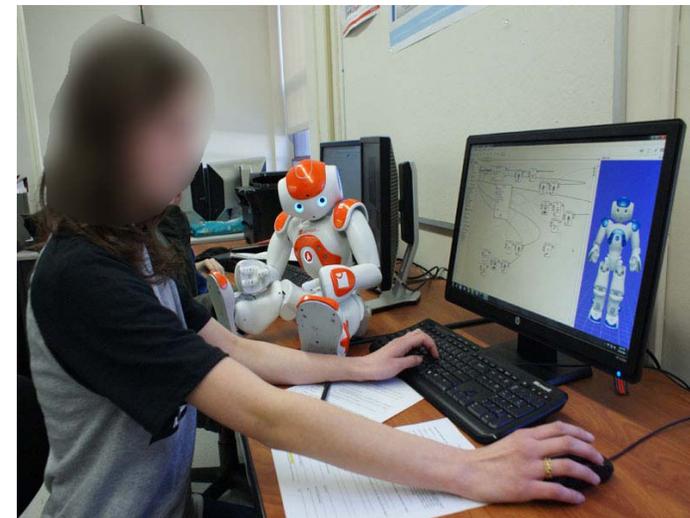
# Analysis and Evaluation of Commercial Robots in Education

- Necessary to investigate the influence of robotics on children's cognition, language, interaction, social and moral development.
  - ↪ Educational theorists → robotic activities may improve classroom teaching.
  - ↪ Limited empirical evidence.
  - ↪ Reported outcomes on the use of robots in education:
    - are rather descriptive (reports of educators),
    - are involving a small sample of participants,
    - are not integrated into official classroom activities,
    - in most applications, a robot is considered as an end or a passive tool.



# Analysis and Evaluation of Commercial Robots in Education

- The range of possible applications in education:
  - ↪ is rather limited,
  - ↪ focus mainly in enhancing development and programming skills,
  - ↪ do not engage more people (wider range of activities),
  - ↪ do not connect more disciplines and interest areas.





# Analysis and Evaluation of Commercial Robots in Education

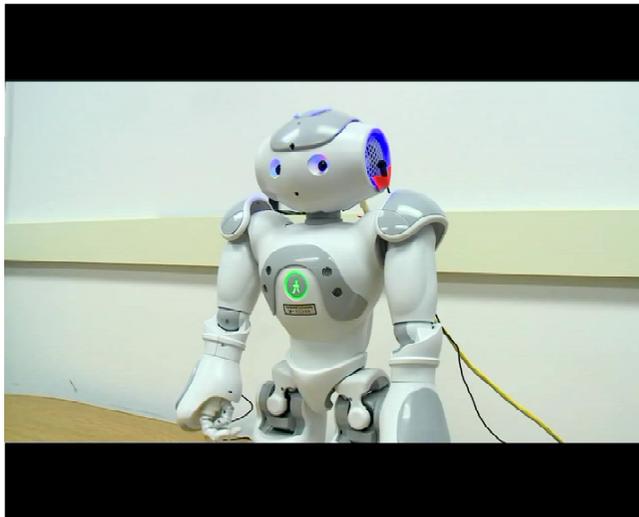
- Research studies concern also the perception of parents, children and teachers on the use of educational robotics.
  - ↪ Parents feel less confident playing with or teaching their children by using robotics.
  - ↪ Lack of technological skills by the users.

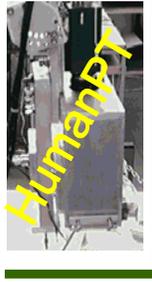




# Analysis and Evaluation of Commercial Robots in Education

- Other studies show that the use of robotics in education has a positive impact:
  - ↪ Robots encourage interactive learning and make children more engaged with learning activities.
  - ↪ Robots can potentially help children to develop various academic skills.
  - ↪ They are effective in language skill development.





# Challenges and Potential Future Directions

## ➤ Detected problems:

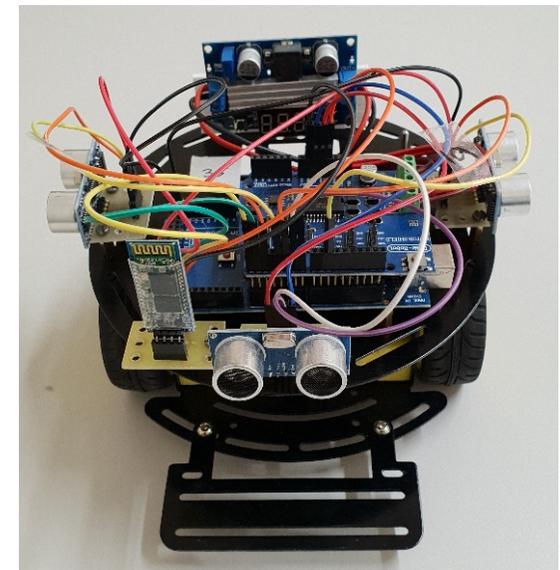
↪ Around 15% of the general population has learning difficulties.

↪ Scarce of commercially available robot platforms for education (Lego, NAO).

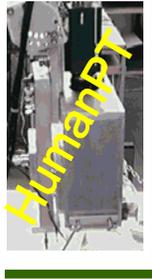
➤ Need for custom robot design.

↪ Lack of skillful teachers.

↪ Lack of the correct guidance and ambiguity in the role of teachers.

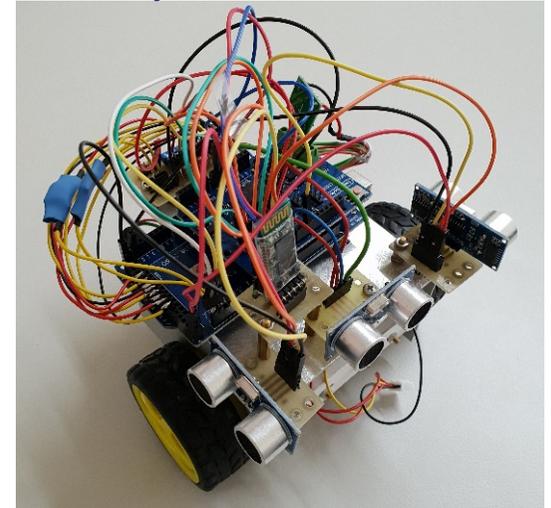


PTR1: A hand made, low cost, robot for programming and to study robotic behaviors.



# Challenges and Potential Future Directions

PTR2: A hand made, very low cost, robot



## ➤ Future research:

### ➤ More effective design of robots:

#### ➤ Hardware

- Low cost (1 robot / student)

- Advanced design (curricula, intelligence)

- Usability (simple, easy to explain design)

#### ➤ Software

- Effective software design for education

- Commercial robots need to support several development environments



# Challenges and Potential Future Directions

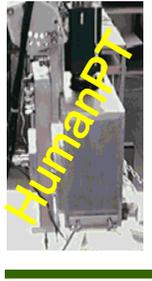
- ↪ The effective use in schools of the available robotics technology.
- ↪ The demonstration of the benefits of each approach of robotics use in education.
- ↪ The development of affordable technologies for enhancing the learning process.
- ↪ The investment in well-trained educators, comfortable with robots and programming.





# Challenges and Potential Future Directions

- ↪ The development of innovative teaching strategies and methodologies:
  - well defined curricula
  - learning material, transferable
  - creating game-like learning environments
- ↪ The design of complex activities for a robot to perform. It is required:
  - to study the difficulties in learning procedure
  - to ensure robot adequate level of intelligence
  - to increase intelligence of social robots (assistants or teachers in education)



# Challenges and Potential Future Directions

- ↪ procedures to handle numerical and not – numerical data in social robot applications.
- ↪ actions to combine social robots with ICT:
  - supporting education in difficult geographical areas (i.e. Balkan countries → mountainous ranges, inhabited islands)
  - giving cost effective educational opportunities delivered locally (internet).



# Conclusions

- Literature review of seven commercial robots currently in education according to the most recent reports in bibliography (experimental researches, age)
- Analysis and evaluation of the effectiveness of commercial robots in education according to (1) design specifications and (2) to their reported results on educational applications in the last two years.
- Presentation of challenges and potential future directions.



# Thank you for your attention !!!



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