Towards a new learning model: the pedagogical value of STEM & Robotics integration in education

keynote speech at 1st Pan-Cypriot Conference: STEM & Robotics in Education, Limassol, March 10, 2018

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Interest in STEM Education is growing up...
EDUMOTIVA: focus on...

• Educational Robotics, 3D printing, DIY electronics, Creative programming tools
• Development of 21\textsuperscript{st} century skills
• Playful and project-based learning practices
• Innovative teaching practices.
Training people from kindergarten to adult learners...
European Robotics Week National Coordinator in Greece
EDUROBOTICS 2016
25 November 2016 | Athens, Greece

http://edurobotics2016.edumotiva.eu

ROBOESL conference
"Robotics-based learning interventions for preventing school failure and early school leaving"

26.11.2016
Athens, Greece

http://roboesl.eu/conference
ROBOESL Exhibition in Athens 2016

http://roboesl.eu/conference/
Our EU-funded running projects...

**Research Projects**
INBOTS (H2020 | 2018-2020) [http://inbots.eu](http://inbots.eu)
eCraft2Learn (H2020 | 2016-2018) [https://project.ecraft2learn.eu](https://project.ecraft2learn.eu)

**Learning technologies - applied research**
WEMAKERS (Erasmus+ | 2017-2020)
HOLOMAKERS (Erasmus+ | 2017-2020) [https://holomakers.eu](https://holomakers.eu)
MAKEITREAL (Erasmus+ | 2016-2018) [http://makeitreal.info](http://makeitreal.info)
CONSTRUIT! project (Erasmus+ | 2014-2017) [www.construit.org](http://www.construit.org)
ROBOESL project (Erasmus+ | 2015-2017) [www.roboesl.eu](http://www.roboesl.eu)

**Well being – Social Inclusion – Intercultural exchange**
HEALTHEDU (Erasmus+ | 2016-2018) [http://healthedu.emundus.eu](http://healthedu.emundus.eu)
STEM & robotics in education

Shifting Focus…

pedagogy

technology
there’s nothing so practical as good theory

Piaget’s Constructivism, Papert’s constructionism
The TERECoP model

TERECoP 2006-2009

“Teacher Education in Robotics-enhanced Constructivist Pedagogical Methods»

www.terecop.eu
The TERECoP learning methodology...

Engagement
Exploration
Investigation
Creation
Evaluation
TERECoP training methodology for teachers...

“teachers teach as they are taught, not as they are told to teach”!
RoboESL
Robotics-based learning interventions for preventing school failure and Early School Leaving
2015-2017
Is Robotics only for gifted children?

• Towards a democratisation of opportunities to access learning with robotics for every child, for every citizen

• Robotics as learning tool for children at risk of school failure and early school leaving
Changing teacher’s role
ROBOESL curriculum

- **pedagogical approaches** to cope with school failure/ESL
- **learning methodologies / constructivism and project-based learning**
- training activities for **familiarisation** with robotics kits and software
- **guidelines** for using resources
- **Worksheets** for exemplary robotics-based learning activities
- **evaluation guidelines and tools** for validating the impact on **learners**
- **evaluation criteria and tools** for validating the impact on **teachers**
the ROBORAIL project

Scenario

Imagine a train travelling in a straight rail. The distance between two successive stations is the same. A train runs over this rail travelling at constant speed on the track between two stations, and stops for some time at each station before leaving again. When it reaches the end of line, it waits a bit longer and then it comes back in reverse way towards the starting station. Discuss within your group the scenario...
Making a mock up...

Draw the rail with a straight line and some stations in the same distance on a long sheet of paper and put it on the table or on the floor and some short pieces of tape in same distance to stand for the stations.
Building the robot…

Make a robot to emulate the train on the monorail. You will need a robot with 2 motors but no sensors. Each motor will drive one wheel. Add a ball caster on the rear to allow steering…
Explorations...

Examine how the block Move Steering works...
Some tips...

The next step is to make the train to wait for some seconds when it reaches a station. The `Wait` block helps here.
Not revealing solutions...

Now make your train to travel all the line stopping in each station for some seconds.

• Can you think of a command that would help to do this programming task?

• Write your idea here ........................
revealing solutions at the right moment...

Here is the Loop block to repeat the motion as many times as you wish. You can insert your blocks inside one Loop block.

Make your train to travel all the line using the Loop block.
Experimentations…

Now, make your robot to reverse direction in the final station experimenting with the steering block.
Finally, put all these tasks together: make your train to travel all the rail stopping in each station for a certain time, reverse direction in the final station and come back to the starting position stopping again in each station for the same time.
What if experimentations...

**What happens if** the distances between the stations are not equal??
Going beyond trial and error strategies

Working again with the “trial and error” method takes time!
Let’s use some maths to make the train to travel the distance between the stations.
Towards a scientific method...

Tips!
In the Move Steering block, the ‘duration’ can be also typed in terms of rotations or degrees of the motor.

Remember! When the wheel rotates 360 degrees (1 full rotation) the robot travels \(2\pi R\) distance (\(R=\)radius of the wheel).

Write here your solution ……………
Check your solution, does it work?

\[2\pi R\]
Half-baked solutions...
Embodiment & embodied cognition

• How to instruct the robot to move along a triangle?
• Play the robot with your own body using your own senses
The ROBOESL curriculum is available online with open access at www.roboesl.eu
STEM & 3D printing in education
MAKE IT REAL project

• Design and model an active, learner-centered teaching approach for engaging underachievers into STEAM related projects through real product design and making practices

• Plan and enact activities and workshops that promote teacher professional learning and pedagogical change
• Create Open Educational Resources that will support school community members to apply the MAKEITREAL learning intervention

• Open STEM education though the infusion of arts moving beyond clichés according to which only STEM-talented students can make it

• Establish synergies among schools, academia and the industry towards creative and meaningful engagement in STEAM education
Robotics + 3D Printing + DIY electronics + maker movement ...

Can we integrate all of them in one lab?
Maker movement in education
STEM or STEAM?
This project has received funding from the European Union’s Horizon 2020 Coordination & Research and Innovation Action under Grant Agreement No 731345.
Co-design, co-create suitable computer-supported artefacts

World exploration – challenges identification

Ideation

Planning

Information gathering – what skills are needed to solve the problem?

Creation

Programming

Making the built artefacts interactive

Sharing

Showcasing and sharing their ideas and implementation.
a paradigm shift...

• from “black box” and silo products to the “white box” paradigm

• learners become “makers” of transparent computer-supported artefacts
eCraft2Learn pilots in Athens

Working in an industrial scenery
eCraft2Learn pilots in Athens

Ice-breaking-activities
eCraft2Learn pilots in Athens
Working in groups
The Lighthouse project

eCraft2Learn pilots in Athens

The Lighthouse project
The sunflower project

eCraft2Learn pilots in Athens
eCraft2Learn pilots in Athens

The shy rabbit project
eCraft2Learn pilots in Athens

The Christmas tree project
eCraft2Learn pilots in Athens

3D modelling and 3D printing skills
printing simple objects
eCraft2Learn pilots in Athens

Robotic car or bug in motion
eCraft2Learn pilots in Athens

The robot is equipped with AI

• speech recognition implemented in Snap4Arduino environment that allows a motor to turn clockwise / counterclockwise

• voice-aware robotic artefact
eCraft2Learn pilots in Athens

Finally, an open project...
Simple worksheets...

**The lighthouse project**

What is a Lighthouse – why people are making Lighthouses – Have you ever visited a Lighthouse;

Discuss within your group:
- in a lighthouse without a keeper how the flashing light is turned on when it is getting dark?
- How it is turned off in daylight?
Write your ideas here…

Plan within your group: how can you make a model of a lighthouse? What materials and devices you need?
Write or draw your plan here…

...............
Virtual reality tools

**Tinkercad circuits**
eCraft2Learn innovations...

• Low cost, low energy tools
• Recycled and everyday life materials
• Crafting
• Transparent DIY robots
• Collaborative design
A new role for teacher...

- Teacher training
- Teamwork
- Collaboration
- Design
- Practical tasks
- Curiosity!
- Trainers help discreetely
21st century skills...

• Critical thinking
• Designing
• Problem solving
• Creativity
• Making culture
• Coding
• Teamwork
• environmentally sensitive citizens with a low cost sense
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