A paradigm shift to make robotics education inclusive for all the children.

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In the last two decades curricula and open educational resources (OERs) are very often developed in robotics education according to a narrow perception that robotics should address only talented youth or science- and technology-oriented students. Current societal developments call for moving away from this elitism to the recognition that fluency with robotic technologies is no longer just a vocational skill, but it is knowledge and skills valuable for every citizen.

The robotics kits available in the market come often with inherent lock-in mechanisms, closed hardware and/or software, instructions to assemble pre-defined models and teaching/learning materials that dictate step-by-step guided approaches for learners. This way the commercial kits define in a rather authoritarian way what is best for teachers and learners handling them just as consumers who have simply to follow step-by-step recipes to construct and program pre-defined robots. Not surprisingly this situation results often in poor learning that doesn't go beyond superficial and trivial knowledge acquisition instead of deep learning and skills development that can support the development of future generations of empowered citizens [i].

On the other hand, lately, the educational community proposes a change in educational methodologies and curricula in order to adopt the maker movement [ii, iii, iv]. The maker movement appears to provide broad access to learning opportunities in formal and informal settings, for everyone, emphasizing mostly on the relationship between learning and making through exploration. The idea behind the adaptation of maker's and Do-It-Yourself (DIY) movement has its origins in the constructivism theory that proposes the generation of knowledge from the interaction between ideation and experience [v] arguing that learning is more effective when students have to deal with meaningful real word objects [vi]. The adaptation of DIY and maker culture in educational robotics suggests a paradigm shift and a radical change in robotics curricula.

Contrary to the conventional educational robotic practices, the new paradigm encourages students to develop their own robots and robotic mechanisms using 3D printed, open-source and low-cost tools instead of using pre-fabricated and ready-made robots. Although the incorporation of the maker movement is very attractive and has deep theoretical roots in Papert's constructionism ideas, it is hardly identified in the existing STEAM and robotics curricula in the European schools.

To make robotics education inclusive for all the children, the INBOTS interventions have introduced a paradigm shift inspired by sound pedagogies (Papert's constructionism [vii]) and emerging educational trends (maker movement in education). The suggested paradigm might be summarized with the motto "make your own robots" with the focus on creativity and the other 21st century skills: problem solving, critical thinking, and teamwork. We are aware that the realization of a new paradigm must be supported by appropriate curricula and technologies at both hardware and software level.

The new paradigm needs support from relevant curricula and proper technologies. To this end, in addition to a collection of available resources, a set of specific exemplar curricula and open educational resources for school education was developed in INBOTS to exemplify the new paradigm. The INBOTS curricula and resources have been piloted with teachers and children in courses held in Athens (Autumn-Winter 2019); a short video from pilots is available on YouTube. The curricula and resources are presented in the next sections and intended for teachers and educators to help them implement the proposed paradigm in their classes and labs and hopefully to inspire them to create their own curricula and resources.

Moreover, the new paradigm - and the INBOTS curricula - needs support from appropriate technological tools. We have already provided a systematic review of the most prominent available educational robotics technologies that appear in the literature [viii].

The proposed paradigm and a review of technologies that can serve the proposed paradigm are reported in the already cited publications derived from our work in the INBOTS project [ix].

The paradigm shift was presented by the EDUMOTIVA team to teachers across EU through a live webinar on July 20, 2020 that attracted attention from 66 registered teachers. The webinar was recorded and is available here allowing more teachers to attend on demand. During the webinar the teachers were invited to "discover a new paradigm in educational robotics inspired by the maker movement: make your own robots!" The webinar was oriented towards lab activities: through simulations and audiovisual materials, presented two versions of the "lighthouse project" to exemplify the "old" and "new" paradigm. The attendees were invited to provide their feedback filling in an online questionnaire (link). The analysis of the feedback received has shown a clear support to the new paradigm.

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[i] Alimisis D. (2020) Emerging Pedagogies in Robotics Education: Towards a Paradigm Shift. In: Pons J. (eds) Inclusive Robotics for a Better Society. INBOTS 2018. Biosystems & Biorobotics, vol 25. Springer, Cham. https://doi.org/10.1007/978-3-030-24074-5_22

[ii] Alimisis, D. (2013). Educational robotics : Open questions and new challenges. *Themes in Science & Technology Education*. https://doi.org/10.1007/s12273-008-8106-z

[iii] Schön, S, Ebner, M, and Kumar, S 2014, "The Maker Movement. Implications of new digital gadgets, fabrication tools and spaces for creative learning and teaching", eLearning papers, 39, pp.14-25.

[iv] Blikstein, P. (2014). Digital Fabrication and 'Making' in Education The Democratization of Invention. In *FabLab*. Bielefeld: transcript Verlag. https://doi.org/10.14361/transcript.9783839423820.203

[v] Piaget, J. (1973). To Understand is to Invent: The Future of Education. In *International Commission on the Development of Education*.

[vi] Papert, S., & Harel, I. (1991). Situating Constructionism. *Constructionism*, 1–12.

[vii] Papert, S 1993, Mindstorms: Children,Computers, and Powerful Ideas, London: Basic Books, 2nd

Edition.

[viii] Sapounidis, T., & Alimisis, D. (2020). Educational Robotics for STEM: A Review of Technologies and Some Educational Considerations. In L. Leite, E. Oldham, A. Afonso, V. Floriano, L. Dourado, & M. H. Martinho (Eds.), Science and Mathematics Education for 21st Century Citizens: Challenges and Ways Forward (pp. 167–190). Nova science publishers.

[ix] Alimisis, D. Technologies for an inclusive robotics education, Open Research Europe 2021, 1:40 (under review).