Educational robot-technologies for developing democratic technological formation in education

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1. ABSTRACT

1.1. Technologies suitable for learning

Education is a key player in our aim for implementing ethical future standards, morality, awareness and consciousness-raising among citizens – and especially children as future citizens - towards technological development. If we, in education, wish to comply with the rapid technological development and the enclosed ethical challenges - and to teach to a more valuable and meaningful approach to robots and robotics in educational settings, then we must discuss and have a focus on which robot-technologies, that are useful for educational purposes and look at the qualities that make a technology suitable for learning. If we want our kids to be able to control the (robot)technology and not the other way around, then we have to work with the technologies where you can *booth* interact with, create and design your own robot, simply having the possibility of *creating* your own technological look and behavior of the technology. If kids are to develop consciousness in depth about the technologies that surround them, then they must have *hands-on experiences* with the technology itself. Hands-on experiences as a mix between on screen learning with the programming part and on floor learning with the design and the creation of the robot. Learning happens when children play, create, interact and have hands-on experiences using 'objects to think with' and 'objects to talk with' (Mor, Y. 2013) and the interaction gets even more valuable for the child having created their own personal robot (outcome). Hands-on experiences with the design and creation as well as the programming part develops the learning process more in depth, because this can be recalled in other settings and new situations as a 'transferable value' (Illeris, K. 2013), the process considers a cognitive perspective (Ziehe, T. 2004) developing knowledge for the children when they grow up in a world surrounded by technologies.

1.1.1. Open-ended projects and valuable transferable processes

If we invite for open-ended learning processes in educational settings, and the use of robot's function as transformers of imagination to action, of idea to narrative storytelling and to real-world Human-Child hands-on experiences, promoting the 21st century learning skills: creativity, collaboration, communication and critical thinking – then we have a solid starting point for the kids to engage and to be responsible, conscious and active future citizens in our society and in the knowledge economy.

Our responsibility as adults, as educators, teachers, parents and researchers in the field of Child-Robot Interaction is to support children and youngsters with knowledge and tools to qualify and develop their ability to engage and to be responsible themselves, as active citizens, that can decide themselves when to say yes and no, when to choose to engage with the (robot)technology, and when to set the personal limit.

Education can help supporting the didactical implementation of teaching with the use of robots, aiming for a critical-constructive consciousness-raising (Klafki, W. 1996; 2001) by using technologies that are suitable as a learning tool for children and for students to study, and to get further involved in the world of robotics, when at the same time aiming for creative, innovative, valuable and democratic critical pedagogical-theoretical formation in education.

1.1.1. 1. Interaction design and developmentally appropriate robot design

Many educational robots have a starting point in STEM subjects (Science, Technology, Engeneering and Math) but teaching robotics doesn't only relate to instrumental education in robotics within STEM. Educational robots have a great potential in Humanities and they can indeed be used beyond STEM and developing further value for the society with more interdisciplinary approaches (Paaskesen, R.B. & Nørgård, R.T. 2016). We need critical thinking and analytic reasoning when developing robots and by the practical use of robots, and we need cross-cutting thinking, not only scientifically.

Within an interdisciplinary approach robots can be suitable to integrate in subjects like social science (sociological and critical thinking), in language subjects (storytelling, communication and cooperation) and within digital formation (technological concept formation and vocabulary).

EV3 Mindstorm educational robots relates to the first definition of what defines a robot – *An artificial device that can sense its environment and purposefully act on or in that environment* (Winfield, A. 2012: p. 8) which is the first of three characteristics, that defines a robot. They have got sensors and effectors and they act purposive related to their surroundings and the way that they are coded to react. In contrast to classified educational robots, educators (as well as parents) must pay attention to robots produced in the toy industry, market as *learning toys,* but which are not certified nor accepted as educational robots.

It is not the exploration or the development of artificial intelligence that is going on, when robots are being part of educating for technological imagination and drive in the Child-Robot interaction. Neither is it about robots for industry that we can construct and code, so that they can perform tasks for humans. Here, there is talking about robots for education, aiming for technological imagination, being an open-ended technology that leaves the children with possibilities to design, create and interact. Robot technologies that are open for multiple possibilities for

solutions and open towards ideas and iterative design processes in a combination of on floor activities and on-screen activities.

2. Democratic critical-pedagogical and technological formation in education

2.1. Learning design as participatory design

Through specific approaches, actions, interaction design and practices with robots and robot technology there is opportunity that children, students and educators can develop technological imagination (Nørgård, R.T. & Paaskesen, R.B. 2016) and drive that builds on- and develops communication, collaboration, creativity and critical thinking through experiencing to contribute by "doing something" relevant and meaningful to the world with the use of technologies. From this perspective robots and robot technology are more a telling tool and a production tool than a programming tool. Programming robots doesn't have any value in itself. What have got value is collaboration, communication, creativity and critical thinking about *how* they shall be programmed and more important *why.*

With help from storytelling and design thinking, the children get better at cooperating together about a societal challenge and a solution. They develop technological courage and they get conscious about problematic issues in society, in culture and in nature aiming for a solution by showing technological drive through hands-on activities and develop technological imagination and 'idea power' (Papert, S. 1980; Papert, S. 2000). It can be about a Future Island for the youngest children in primary school, where the Mindstorm robots have to save the WeDo robots from lava coming down from a mountain on the island or it can be a Future Society (*casework in:* Paaskesen, R.B. & Nørgård, R.T.) as a frame for midschoolers and elder children in secondary school to discuss, investigate, cooperate and make decisions about where the robottechnology is good, as a help for human beings and where it can appear as a threat for human beings; dealing with participatory design and ethics. This all together has got transferable value to later in life, when the children, as citizens, have to confront similar challenges. And not least providing the fear of upgraded superhumans, as Harari expresses it, referring to an old woman who cannot understand neither contribute the world around her: "This is what we fear collectively, as a species, when we hear of superhumans. We sense that in such a world, our identity, our dreams and even our fears will be irrelevant, and we will have nothing more to contribute" (Harari, Y.N. 2016: p. 49). Altogether, this approach – developed and explored in learning design as participatory design - combines with the critical constructive didactic of Wolfgang Klafki, a didactic that is mainly critical formative and society oriented aiming for an increased consciousness about our real societal challenges, where all human beings are responsible for – and willing to contribute to solving these challenges (Klafki, W. 1996; 2001).

Keywords

"Valuable Child-Robot Interaction in learningdesigns; Hands-on experiences in Child-Robot Interactions; Robots and 21st century learning skills; Technological Imagination and Idea Power; Critical-constructive didactic and consciousness raising; STEM & Humanities"

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