Chapter 3
A Method for Multi-Perspective and Multi-Scale Approach Convergence in Educational Robotics

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ABSTRACT

The exponential growth of publications on educational robotics (ER) in the last 10 years, undoubtedly, in many ways, is due to the introduction and the ubiquitous application of such platforms as Arduino, micro:bit, Raspberry Pi, and others. These instruments offer a variety of ways for STEM curricula introduction. Being centered on technological and engineering issues, the ER methodology offers an excellent opportunity for students of different ages. By lowering the entry-level effort, the platforms significantly simplify the first steps in the field. Nevertheless, as every simplification presumes, a significant part of "underlying machinery" remains hidden. Indeed, the character of in-school ER projects barely holds enough space for a detailed treatment of the concepts. Nevertheless, the chapter illustrates the importance of exposing students to the currently available instruments and providing in-depth conceptual insight. To support the thesis, several examples, unifying multi-perspective and multi-scale approaches, are provided.

INTRODUCTION

The modern advancement of educational robotics (ER) has received a decisive impact by introducing such platforms as Arduino, Raspberry PI, micro:bit and others with user-friendly Integrated Development Environments (IDEs) and simplified treatment of coding and electronics. Indeed, the primary enthusiasm in co-involvement such systems provide is an outstanding achievement by itself because it

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enables all interested in unveiling a deeper level of technology passing from users to co-creators. At the same time, the teaching community must be aware that the future evolution of robotics, rooted deeply in science, is linked both to the latest ICT achievements and the progress in material science based on our current understanding of the nanoscale in particular.

As a natural bridge between the atomic and macroscopic worlds, nanosized objects are under the close attention of a large and diverse army of scientists. The results of this collaborative effort are manifested in the new types of materials for sensors, actuators and, in a longer perspective, create the foundations for a new element base of the future electronics, so-called functional electronics, and robotics (Kramer, 2015).

Currently, the robotics research community faces a variety of problems, e.g. new materials (Tan, Susanto, Anwar Ali, & Tee, 2021), energetic efficiency (Boscariol & Richiedei, 2019; Hobart, Mazumdar, Spencer, Quigley, Smith, Smith, Bertrand, Pratt, Kuehl, & Buerger, 2020), cognitive and artificial intelligence issues (Taylor, Berrueta, & Murphey, 2021). To be solved, the tasks require deep professional knowledge and such skills as lateral and creative thinking and problem-solving (Durak, Yilmaz, & Yilmaz, 2019), i.e. the ones considered ER and STEM (Science, Technology, Engineering, Mathematics) methodology pillars. These refer to all skills, named transversal, which are those determining how a person relates within a working or social context. According to the ISFOL (italian abbreviation of the Institute for Vocational Training of Workers) definition, transversal is "a set of skills of wide thickness that are involved in numerous types of tasks, from the most elementary to the most complex, and that are expressed in situations between them different and therefore widely generalisable" (D'Agostino, 2013). Unlike the technical skills, which relate to specific knowledge acquired through study or professional experience, crosscutting skills are an added bonus that can make a difference during job recruitment. Among those considered most important there were time management, motivation and flexibility. However, the world of work is a scenario in continuous evolution. Therefore, today's most requested skills are different from those sought in the past and especially from those that will be asked to workers in the coming years. According to the report "The Future of Jobs" of the World Economic Forum (Forum, 2020; Rainie & Anderson, 2017), in the next five years, the possession of certain transversal or soft skills will become crucial for almost every profession. In particular, it is expected that the most in demand will be:

- Ability to analyse and be innovative;
- Learning skills and strategies;
- Problem solving;
- Critical thinking;
- Creativity, originality and initiative;
- Leadership and the ability to influence others.

In this regard, present chapter illustrates that due to its introductory character, the last should be able to provide students with a coherent exposure of the related concepts and solid contextualised problem solving skills. In particular, two approaches are touched upon here - multi-perspective and multi-scale. While the former concerns the variety of perspectives the ER projects are generally characterised by, the latter instead aims at assisting the acquisition of a deeper view of the robotic artefacts at different scales and levels of consideration. STEM methodology is considered as the unifying framework for both approaches.