Computational thinking and robotics in education

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ABSTRACT

After the computational thinking sessions in the previous 2016-2018 editions of TEEM Conference, the fourth edition of this track has been organized in the current 2019 edition. Computational thinking is still a very significant topic, especially, but not only, in pre-university education. In this edition, the robotic has a special role in the track, with a strength relationship with the STEM and STEAM education of children at the pre-university levels, seeding the future of our society.

KEYWORDS

Computational thinking, robots, coding in schools, computational thinking skills and curriculum, programming, computer science in K-12, STEM, STEAM.

1 Introduction

Nowadays the development of computational thinking [1-6] skills is a real need for future generations of workers that should know, at least, the basic laws of a computer-based society and, without demerit to humanities or social sciences, trying to reduce the current gap with STEM (Science, Technology, Engineering, and Mathematics) [7, 8] and STEAM (Science, Technology, Engineering, Arts, and Mathematics) [9-12] careers.

Several countries have usually adopted several priorities for developing ICT competences from kindergarten to secondary education [13, 14], others are trying to [15, 16]. Most of them are focused on the development of key competences and/or coding skills. Although coding may be very attractive for young students and a very good practice or experience, it could be more interesting to develop students' logical thinking skills and problem-solving skills throughout programming approaches [17-20] or through the use of physical devices [21-23] and robots [24-26].

This is a very exciting challenge with lots of possibilities regarding coding, robots, mobiles devices, Arduino-based application, game-based learning and so on. Thus, it is very important discuss the experiences that are being developed worldwide in specialized for a with researchers that are working on this field, such as for example TACCLE3 coding [27], VALS [28, 29], W-STEM [30-32] or RoboSTEAM [33, 34] European projects.

Developing computational thinking is not easy due to the students require working the related skills from their early ages, something that use to be linked to STEM or STEAM education. These disciplines that have shown to be necessary in order to have more efficient workers in our digital society [35]. However, integrating and fostering STEM/STEAM in our current educational landscape is very complex because it is not easy to summarize all this knowledge in a set of subjects, and it cannot be focused only on some subjects or courses.

Following the previous editions of this track in TEEM Conference [36-38], this space is devoted to identifying, sharing, and valorizing best practices and experiences (including technological and methodological issues) that focused on the development of computational thinking and related skills and competences [39] in any level of pre-university education and also at the university level. We have the aim to explore and debate these issues related to the education with a critical and solid base of the future generation in technological aspects to help them to tackle the problems they will have to face with an open innovation orientation [40], with the final goal to be useful to the society in general [41, 42].

2 Papers in the track

Now, the seven accepted papers will be briefly presented.

2.1 Initial learning scenarios based on the computational thinking evaluation for the course Programming fundamentals at INACAP

In this paper Rojas-López and García-Peñalvo [43] introduce the design and the planning of initial learning scenarios for the course Programming Fundamentals, from the evaluation of computational thinking to new students of the careers Computer

engineering and Programmer analyst of the Technological University of Chile and Training Center Technical respectively at INACAP, to increase the motivation and autonomy of study through the recognition of skills and the use of the instructional design of the face-to-face course.

2.2 Interpretation of computational thinking evaluation results for enrollment prediction

Rojas-López and García-Peñalvo [44] advance in their research about the computational thinking evaluation, which has been carried out in order to establish learning scenarios for programming methodology new students at the Technological University of Puebla in México [45-48]. The present work analyzes the results obtained from the computational thinking evaluation to 242 new students, generation 2018.

2.3 Learning computational thinking and social skills development in young children through problem solving with educational robotics

Caballero-Gonzalez et al. [49] present some results obtained in the development of a learning experience in computational thinking and social interaction skills, using problem solving activities and educational robotics in a playful way. The experience involved 46 students and 2 teachers of the first level of primary education of a concerted school in Salamanca, Spain, during the period 2017-2018. This means the continuation of their previous research outcomes presented in TEEM Conference [50-52].

2.4 RoboSTEAM - A Challenge Based Learning Approach for integrating STEAM and develop Computational Thinking

Conde et al. [34] introduce the RoboSTEAM European Project [33] (http://robosteamproject.eu/), which is devoted to defining a methodology and a set of tools that will help learners to develop computational thinking by using/programming PD&R (Physical Devices and Robotics) in pre-university education stages. The project will also improve teacher education, providing them with a framework for easy STEAM integration in different educational contexts by providing guidelines for good practices and lessons learned adapted to different contexts.

2.5 Bringing Computational Thinking to Hospital Classrooms

González-González et al. [53] presents an exploratory case study on an educational intervention that is inclusive and adaptable to the characteristics of hospital classrooms for the teaching of computational thinking in a transversal way and programming without screens and robots, including working with emotions. In this study, 22 boys and girls participated in five sessions developed in a hospital classroom. The results indicate that the intervention has improved the emotional state of the children, as well as their knowledge regarding computational thinking. This research is another example of using computational thinking in different context such as the research previously by this group [54, 55].

2.6 Educational Robotics Summer Camp at IPB: A Challenge based learning case study

Gonçalves et al. [56] present an educational experiment in the mobile robotics domain within the RoboSTEAM European project RoboSTEAM [33, 34]. The applied approach in the summer camp was a challenge-based learning methodology, being involved in the experiment 3 professors, 4 monitors, working with a group of 16 secondary school students.

2.7 Predicting Student Failure in an Introductory Programming Course with Multiple Back-Propagation

Figueiredo et al. [57] propose an early identification of potential problems and immediate response to avoid programming student's failure and reduce dropout rates. Thus, they define a machine-learning (neural network) predictive model of student failure based on the student profile, which is built throughout programming classes by continuously monitoring and evaluating student activities. This means the next step in this research for the authors [58-62].

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