Robotics in Primary Education – Robotique en Éducation Primaire: Introduction

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This Special Issue of the Journal "Review of Science, Mathematics and ICT Education" is dedicated to the Educational Robotics in Primary Education. There is currently a real enthusiasm for educational robotics which is supported by the incessant emergence of new educational robots and articles published by the media. Undoubtedly, at least at the level of primary education, a new wave of technology appeared in order for concepts of programming (or "coding") sweeps to be applied, which consequently raises the question of what it can bring to teachers and learners over time. At the same time, scientific research in this field is making significant progress in recent years by providing interesting results in both basic and applied research.

On the other hand, there are many challenges with obtaining data with respect to the appropriation of this type of approach by teachers. Indeed, initial and in-service training of teachers is a major challenge to develop learning activities with educational

robots which help develop specific learning objectives as well as the development of high-order thinking skills.

This special issue aims at modeling innovative practices and research results to enable the reader to liberate himself from "guided" approaches and to apprehend relevant pedagogical situations (techno-creative challenges) while choosing educational robotic technologies is flourishing. Through various case studies and research work, readers will get a synthetic view of the field of educational robotics in primary education.

In this context, this collection of papers brings into light the fact that allows us to take a step back on the different uses of educational robotics and develop a reflexive approach to the criteria of designing activities as well as of choosing robotic technologies. Therefore, it seems appropriate to propose a series of articles based on recent research and taking into account the lessons of a history written for several decades. As a result, this collection will provide some answers to the following questions:

- How can different types of educational robotic tools and new programming learning environments enrich didactic approaches in the classroom?
- What are the high-order skills - specialized, cross-disciplinary and interdisciplinary - that can be developed through robotic devices (tangible and virtual artefacts)? What types of pedagogical situations could be provided?
- What types of conceptualizations are necessary? What is the place of computational thinking in this approach?

In particular, the special issue comprises six articles by european researchers covering several themes of teaching and learning about educational robotics and robot programming in primary education.

Over the past decade, the assessment of the general educational value of computer programming, educational robotics and computational thinking has been constantly increasing and, as a result, they are introduced to increasingly younger ages. In parallel, educational programming environments and educational robotics tools are significantly progressing, providing a variety of options for different ages. The paper of Fessakis, Komis, Dimitracopoulou and Prantsoudi (Overview of the Computer Programming Learning Environments for primary education) refers to these aspects. This paper presents an overview of the modern learning programming environments and educational robotics tools for primary education and proposes a classification system with categories corresponding to the technological and educational dimensions of the area. The paper aims to support teachers in learning design for the interdisciplinary approach of programming and the development of computational thinking.

Unplugged computing activities became popular at the same time as the introduction of computer science learning at school. In The Romero, Duflot and Vieville's paper

(Le jeu du robot : analyse d'une activité d'informatique débranchée sous la perspective de la cognition incarnée) an interesting analysis of one unplugged activity is provided. Furthermore, the authors analyse the educational opportunities yielded by computer unplugged activities from the perspective of educational sciences. Theories related to embodied cognition are used here as a framework to analyse unplugged activities such as the robot game, where a student acts as a programmer and the other as a programmable object, such as a robot. This robot game allows us to discuss the potential of unplugged computing activities in connection with the learning of orientation in space, including the transformation from the plane to the three-dimensional space, taking the embodied cognition potential into account.

The paper of Bellegarde, Boyaval and Alvarez (S'initier à la robotique/informatique en classe de grande section de maternelle. Une expérimentation autour de l'utilisation du robot Blue Bot comme jeux sérieux) presents a comparative study of cognitive mediations at work in the scope of pedagogical device dedicated to introduce robotics and computer science to learners of last section of kindergarten (5-6 years old). The device used for the experiment is a robot named «Blue Bot» and presents three modalities in the scope of proposed serious games: the body, the robot and the digital tablet. This study highlights on how mediator-instruments influence the learners' reception and learning through their performances, strategies and conceptions built during programming activities. Beyond this observation, this paper proposes to apprehend these differences taking into account specificities of the mediator-instruments and their gap from the learner's physical reality.

The paper of Temperman, Durant and De Lièvre (Programmer pour s'orienter, s'orienter pour programmer) focuses on the impact of programming on the development of spatial skills among early elementary school students. This study is based on an experimental plan that evaluates the effect of two modes of use of the ScratchJr application: a mode with tangible material to prepare the coding and a mode without this tangible material. Our dependent variables concern the understanding, expression and production of spatial prepositions. Our results tend to show that students make significant progress in both conditions in terms of comprehension and expression. In terms of production, we observe that programming cards allow students to make more progress in this learning than students who do not have them.

The paper of Nogry (Robotique pédagogique à l'école primaire : quelle activité des élèves de Classe Préparatoire [6-7 ans] et quels apprentissages dans une séquence conçue par l'enseignant ?) analyses the pupils' activity during a robotic educational sequence designed and conducted by the teacher in first grade class. Video recordings are analyzed in order to characterize the activity of the pupils using instrumental approach. The analysis is focused on instrumental and conceptual geneses. It characterizes the social and instrumental mediations involved in these geneses. The study highlights the

role played by graphic representations in the process of abstraction during learning of programming skills.

The paper of Misirli, Komis and Ravanis (The construction of spatial awareness in early childhood: the effect of an educational scenario-based programming environment) delves into children's development of spatial awareness based on educational robots. To this purpose, a teaching intervention – educational scenario – was implemented by educators to 306 pre-schoolers in 17 classrooms. It was designed to foster children's spatial awareness so as to help them construct a model of spatial concepts with reference to a mobile object around the space, the programmable toy Bee-Bot. The educational scenario encompasses instruments designed for gathering data of the pre and post children's representations about direction and orientation concepts, the teaching activities conceived to deliver these concepts by using the programmable toy, and finally instruments designed for evaluation. The evaluation took place after a three-week implementation and the results indicated statistically significant difference in children's pre and post-test intervention representations and consequently construction of spatial knowledge not only to a functional context but also to a more symbolic one.