Chapter 7
A Proposal for Creating Mixed Reality, Embodied Learning Interventions Integrating Robotics, Scratch, and Makey-Makey

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ABSTRACT

In current research we observe a clear trend that calls for novel teaching practices that involve multidisciplinary approaches that integrate information and communication technologies (ICT) into "traditional" workflows, employing embodied affordances in multimodal learning interventions. The educational process can therefore be augmented and transformed making use of available tools like educational robotics, tinkering with electronics (such as Makey Makey), and programming environments like Scratch to produce gamified versions of teaching sequences in a mixed reality context that "physicalizes" abstract concepts and improves both "21st century skills" and knowledge of traditional classroom material. Under the embodied cognition framework, the authors make use of robots as tangible agents in a gamified mixed reality setting. In this chapter, they provide a proposal for creating educationally effective, immersive, and engaging learning environments, as well as primary results from experimental application in various multi- and transdisciplinary teaching interventions.

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INTRODUCTION

Human cognition has been shown to be inextricably linked with the manifestation of objects around us. How we act directly influences the way we think and the way we interact with physical objects directly shapes our perception and understanding of concrete or abstract notions. From the time of the abacus to the era of virtual and augmented reality, embodied interaction has been consistently proved a fertile ground on which to build learning interventions that provide learners with conceptual anchors. The STEAM (Science, Technology, Engineering, Arts Mathematics) approach to learning employs interdisciplinary concepts from the Natural Science, Engineering, Technology, Arts and Mathematics as a base for developing and honing 21st century skills such as critical thinking, creativity, communication and cooperation in a framework that facilitates inquiry based experiential learning. Using a creative process (Nemiro, Larriva, & Jawaharlal, 2017), the STEAM approach enables students to develop their problem solving skills, engage in the design and evaluation process -facilitating design based thinking (Alimisis, Moro, & Menegatti, 2017; Jaipal-Jamani & Angeli, 2017; Khanlari, 2016), and advance their computational intelligence skills while cooperating and engaging in science-based dialogue.

The ultimate goal of employing STEAM learning scenarios is that students are familiarized with both concrete and abstract notions from engineering (simple and complex machines), advance their ability to think algorithmically (programming devices), design and build robots that perform a variety of tasks (Bers, Flannery, Kazakoff, & Sullivan, 2014).

In recent years, the virtual deluge of novel advancements in ICT has greatly improved our fundamental grounds of developing single- or multimodal and more importantly multidisciplinary teaching interventions. Mixed and augmented reality applications (Fleck, Hachet, & Bastien, 2015), virtual models and 3D representations (Sun, Lin, & Wang, 2010), tangible manipulatives and ubiquitous interfaces (Mpiladeri, Palaigeorgiou, & Lemonidis, 2016) as well as educational robotics (Alimisis et al., 2017; Karim, Lemaignan, & Mondada, 2015), have consistently proven to be great tools for leveraging conceptual change (Bonito & Almeida, 2016; D de la Hera, Sigman, & Calero, 2018).

Deploying ICT tools to develop multimodal and multidisciplinary teaching scenarios has been consistently providing highly praised outcomes, there has been so far a specific vital aspect that many applications miss, due to the nature itself of the employed mediums: Tangibility. More often than not, recent research has been shown to employ intangible representations of concepts, thus -not failing, but-limiting access to the full potential the availability of multiple and ubiquitous technologies offers to us. The use of physical manipulatives which the learner can use, tinker, build and feel, the use of embodied learning affordances can greatly and further advance the creation of conceptual anchors: The physicalization and operalization of processes, turns abstract, and possibly inaccessible from our POV. concepts (such as Earth's trajectory) to concrete instances with which learners can interact.

In this context, this chapter proposes the integration of multiple technologies, combined to provide a rich ground for the design, development and evaluation of STEAM learning scenarios. Mixing educational robots as tangible agents and interfaces with the digital world, Scratch programs to provide a gamified background and Makey-Makey hubs to facilitate interaction, this chapters aims at describing a concept of developing learning interventions where physical objects merge with digital representations to provide natural interaction, on which learners can build new knowledge (Xefteris, 2019; Xefteris & Palaigeorgiou, 2019a; Xefteris, Palaigeorgiou, & Zoumpourtikoudi, 2019).

The proposed frame of operation has been tested in multiple experiments, with 4 of them having been published in conferences and journals and others having been tested only unofficially during the