

STEM education: Are we forgetting infrastructures?

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Creativity is recognized to play a key role in Science, Technology, Engineering and Mathematics (STEM) education. In the broader area of STEM, our focus is on computing and programming. In this context, making activities are often claimed to be a way to promote richer learning experiences (Giannakos et al. 2015). Creativity is important both in terms of outcome and process. These two aspects contribute to promote learning, but also playful and inclusive activities. Producing something that is tangible and perceived as creative might impact on satisfaction and self-efficacy. At the same time, a creative process has the potential to promote engagement and to give voice to multiple talents.

In this context, we have worked for many years with co-design workshops that aim at helping students learning about new technology in a creative and reflective way. For example, the TILES toolkit, a set of 110 design cards and a workshop technique to involve non-experts in quick idea generation for augmented objects (Mora et al. 2017). The toolkit has been used in multiple occasions in secondary and tertiary educational contexts, proving an effective introduction to IoT and to promote a playful learning experience (Mavroudi et al. 2018). Through these workshops participants are not only learning about interactive objects and IoT (Internet of Things). They are also developing creative and design thinking, recognized as critical 21st century skills.

The proposed approach has proved to have interesting strengths. However, we also see, two related risks. First, the co-design process often results in “gadgets”, failing to make students appreciate the complex socio-technical nature of any IT system. Second, the focus on gadgets and disruptive innovation is neglecting issues of sustainability, at the societal, environmental, and economical level (Becker et al. 2014).

In this seminar, we are interested in discussing the need to bring more focus on infrastructures in STEM education. Our standpoint is that promoting responsible STEM education requires to help students to understand the infrastructures that are part of their design contexts. The challenge is how to bring these aspects into the learning experiences without overloading it. In fact, infrastructures are by nature complex and require time to be understood. How can one integrate awareness and

understanding of infrastructures into playful co-design activities, without interrupting the flow? In this perspective, it is important to make students aware of the infrastructures that they need to consider in their design, together with the opportunities and constraints that they introduce. In TILES, for example, we provide a set of cards that help participants think about the services that they can use to design their interactive objects. In a way, these cards provide some visibility of the underlying infrastructures in terms of possibilities that they offer. Another set of cards is also helping participants to reflect on their ideas from multiple perspectives, for example sustainability and feasibility. However, these are only initial steps, and the toolkit lacks a systematic way to help students learning about infrastructures.

At a more general level, given the complexity of the endeavor, there is a need to define an educational ladder that helps students moving from simple making activities with focus on gadgets to sustainable problem solutions in a socio-technical context.

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