Playing With Fractions on an Interactive Floor: An Exploratory Case Study in the Math Classroom

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Abstract: The notion that engaging the body brings additional value in learning has lead researchers in evaluating technology-enhanced, whole-body learning experiences. Yet, we still need compelling evidence for the applicability of relevant tools and methods in school classrooms. We conducted an exploratory case study with 20 elementary-school students using three interactive floor applications in a typical school setting. Results demonstrated positive emotions; yet, cognitive phenomena require more careful investigation.

Introduction

Interactive spaces and surfaces such as interactive tabletops, interactive walls, interactive floors, and interactive rooms afford embodied forms of interaction. In this case, digital information can be manipulated directly with fingers, feet, and body movements, or through a physical intermediary such as token, pen, or other tractable object (Evans & Rick, 2014). Such technology-enhanced, whole-body experiences may promote learning, enabling the reunification of body, action, and the mind. Yet, we need compelling evidence for the applicability and effectiveness of such technologies and methods in formal educational settings. This study aimed to examine: (i) how students react to a whole-body, game-based learning experience on an interactive floor in a typical math lesson and (ii) what types of interaction design and learning design approaches might be considered for establishing meaningful integration of such technology and methods.

Background work

Interactive spaces and surfaces offer several potential advantages for whole-body learning experiences. They support direct interactions by groups of collocated participants, can engage children in playful learning, and can provide links between physical action and digital artefacts which might, then, lead to increased engagement, exploration, and reflection (Price & Rogers, 2004).

The idea of whole-body learning experiences can be considered through the lens of Embodied Cognition, as a theoretical framework that tries to understand how being in a body and interacting with a physical world shapes and impacts the development of thinking, problem solving, and learning (Wilson, 2002). This embodied perspective asserts that human cognition is deeply connected to our sensorimotor system and the body's interaction with the physical environment and therefore, plays a central role in understanding of the world (Johnson-Glenberg et al., 2011).

The last 30 years has been a period of renewed interest in the issue of embodiment in learning. SMALLab work constitutes the most systematic research in formal educational settings concerning learning benefits of embodiment. Studies by SMALLab indicate that there are significant achievement gains and therefore positive impact on collaborative learning when students can work with their whole body in mixed reality environments, compared to traditional learning (Johnson-Glenberg et al., 2011). Despite the enthusiasm for these technologies as well as widespread conviction that embodiment brings about additional value to users, findings are still inconclusive (Malinverni &Pares, 2014) whilst we miss compelling evidence for the applicability of such methods in typical school classrooms (i.e., without the cost of a SMALLab).

Methodology

This exploratory case study was conducted with 20 fourth-grade students (aged 9-10; 11 males, 9 females) at a public elementary urban school in Cyprus.

A down-pointing projector was mounted on a special (portable) tripod and was connected to a laptop. The visual output was projected on the floor (as in Figure 1) and the students could move around the periphery of or directly on the visual output. Visual and auditory feedback was given on the projected display.

Three applications on fractions were created. The goal in the first app was to identify fractions as part of a whole (played individually). The goal in the second app was to recognize equivalent fractions (played in a group). The third app was about adding and subtracting fractions with common denominators (played individually).

Multiple video cameras were setup in the classroom to capture facial expressions, physical movement, social interactions and verbal communication around the interactive floor.

Results and discussion

In this exploratory case study we first aimed to examine how students react to a full-body, game-based learning experience on an interactive floor in a typical school setting. First, the results demonstrate that it is possible to integrate such methods in the math classroom. Judging from the preliminary results of the study, these types of learning experiences appear to have value in terms of students' positive emotions; excitement and participation were overwhelmingly evident. These results confirm outcomes of previous research that relates physical activity to positive emotions (Bianchi-Berthouze et al., 2007; Kosmas & Ioannou, 2017; Price & Rogers, 2004).

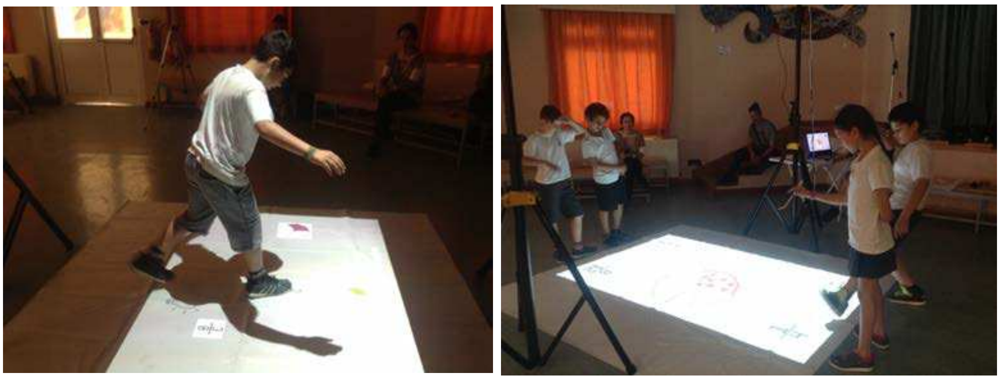

Figure 1. Whole-body interactive floor experience.

We further sought to understand design elements, in terms of interactions and learning, for meaningful integration of such technology in school lessons. Despite the excitement, cognitive phenomena were scarce. A few students played the game only for fun and their choices were incidental selections with no evidence of cognitive engagement. We think that our design choice to allow for multiple selections, until the correct answer was chosen, let students make random choices at no cost. On the other hand, inquiry learning approaches to lesson design -- in which students are guided to solve problems, collaborate, then interact with the floor game -- might encourage cognitive engagement.

Overall, this work revealed opportunities for the integration of novel methods in classroom environments and provided ideas for future work in terms of interaction design, learning design and integration strategies. In future studies we aim to capitalize on the properties of the interactive floor and deepen into the relationship between physical activity and cognitive engagement and redesign the apps to truly enact cognitive engagement through play. Future work should aim to understand possible links between cognitive phenomena and design elements, focusing on patterns of thought and behaviour. Studies of longer duration are also necessary to eliminate novelty effects and allow the researchers to assess the true impact of technology use.

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