WeDRAW: USING MULTISENSORY SERIOUS GAMES TO EXPLORE CONCEPTS IN PRIMARY MATHEMATICS

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WeDRAW aims to mediate learning of primary school mathematical concepts, such as geometry and arithmetic, through the design, development and evaluation of multisensory serious games, using a combination of sensory interactive technologies. Working closely with schools, using participatory design techniques, the WeDRAW system will be embedded into the school curricula, and configurable by teachers. Besides application to typically developing children, a major goal is to explore the benefits of this multisensory approach with visually impaired and dyslexic children.

Keywords: Mathematics, Multisensory, Serious Games, Geometry, Arithmetic.

MULTISENSORY LEARNING

Research from psychophysics and developmental psychology suggests that children have a preferential sensory channel for learning specific concepts, and that vision is not always the dominant channel, especially for children under 8-10 years of age (Gori et al., 2008). The use of different modalities can reduce cognitive load and improve learning (Moreno & Mayer, 1999). For example, musical training can improve the reading problems experienced by dyslexic children (Habib et al., 2016), and sensory spatial feedback can improve spatial cognition (Finocchietti et al., 2017). The WeDRAW project proposes an embodied and enactive approach to learning. Enactive knowledge is not simply multisensory mediated knowledge, but knowledge stored in the form of motor responses and acquired by the act of doing. The use of body movement has been shown to deepen and strengthen learning, retention, and engagement (Klemmer et al., 2006). Body movement is naturally associated with space and could be used to reinforce the understanding of spatial concepts found in geometry, which is weakened in visually impaired individuals. The links between music and mathematics have already been explored for the teaching of primary mathematics (An et al., 2013; Graziano et al., 1999). Musical concepts such as scales, rhythm, interval, harmony and temperament can be related to mathematical concepts of proportions and numerical relations, integers, arithmetical operations and geometry.

TECHNOLOGY AND SERIOUS GAMES

Digital technology has the potential to create new educational materials which exploit different sensory modalities, offering opportunities for new ways of thinking and processing information, and opening new avenues for creativity, for example through the ability to integrate digital technology into physical objects through tangible interfaces - so-called 'digital manipulatives' (Price & Marshall, 2013). Combining digital games and learning can enhance students' motivation to learn and increase their engagement (Prensky, 2005). Serious games have previously been applied to the learning of STEM subjects, but they have focused on teenage children, and as a result lack a developmental perspective (Ritterfeld, Cody, & Vorderer, 2009, Chapter 10,11). WeDRAW aims to mediate learning of mathematical concepts, such as geometry and arithmetic, for primary school children aged 6-11, through the development of three multisensory serious games, which take into account developmental psychology and classroom interaction.

RESEARCH PROGRESS

It is important to consider real-world settings when addressing needs in educational practice. Ethnographically-inspired fieldwork techniques are often integrated with more traditional participatory techniques in order to gain insights into unarticulated aspects of collaborative practices (Kensing & Blomberg, 1998). Working closely with primary school teachers, WeDRAW will use observations of everyday classroom activity and practice, interviews and ongoing workshops to inform design requirements. Initial teacher workshops and questionnaires (in the UK and Italy) have identified key areas of the primary mathematics curriculum that children find challenging, and where multi modal and multisensory engagement hold particular promise. These include isometric transformations, symmetry, adding and multiplying fractions, measurement and estimation, and making the link between fractions, percentages and decimals. Working with these, we will encourage the creative capacities of children, as well as support the role of the teacher in the learning process. The system will be flexible and modular, allowing teachers to customise content to best suit their students' preferred mode of learning (i.e. audio, tactile, motor and visual). A hardware and software platform will be developed to support this approach, and three serious games designed to evaluate it. The adoption of an embodied and enactive learning paradigm allows for mapping motoric behaviour onto the preferential sensory modality for typically developed children, or onto an alternative modality for impaired children. As a result, the same learning paradigm can be applied to all children, interacting together in the classroom, reducing differences and social barriers.

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