The Role of Tangible Technologies for Special Education

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Abstract
The physicality and multisensory aspect of tangibles make them particularly suitable for children with special needs. To date, however, there is little empirical research on tangibles for supporting cognition and learning difficulties. This research aims to investigate the role of tangibles in supporting attention, verbal memory and abstract thinking of children with learning needs, particularly when collaborating with peers.

Keywords
Tangibles, learning disabilities, science learning.

ACM Classification Keywords
H5.2. Information interfaces and presentation: User interfaces. K.3.m Computers and education: Miscellaneous.

General Terms
Human Factors, Design

Introduction
Children with learning difficulties or disabilities perform significantly below average, due to some permanent condition acquired from birth or early childhood [2]. They are included in the 'cognition and learning' category of special educational needs (SEN).

Since the first half of the 80's, personal computers have been used to support the education of children with learning disabilities in the UK. However, with the advent of personal computers, many physical instruments, which used to be present in schools, have been replaced by digital on-screen models [5]. The richness of the physical world, in which touch and physical manipulation play a key role, has been sought back with the emergence of tangible technologies, which enable the embedding of digital data in physical objects.

The physicality and multisensory aspect of tangibles make them particularly suitable for children with special needs. To date, however, there is still little empirical research on tangibles and SEN, primarily from an educational perspective. The aim of this work is to investigate how tangibles can be integrated in learning processes to enhance the experiences of children with cognitive and learning needs in collaboration with their peers (who might or might not have learning difficulties). The research focuses on science learning, which allows students to identify and relate their own experiences to concepts and can be effectively taught through multimodal activities, but in which students with learning disabilities still face many difficulties.

Learning disabilities

Common general difficulties presented by children with learning needs include: short attention span, poor verbal memory, cue-seeking and imitative answers ('outerdirectedness'), and poor logical reasoning and abstract thinking [3], [8]. These difficulties are also generally accompanied by immature social and emotional skills, under-developed motor/ coordination skills, and lack of confidence, typically leading to behavioural difficulties. Recommended teaching strategies to deal with these pupils include [3], [8]: establishing routines, keeping tasks short and varied, using a VAK approach (visual, auditory, kinesthetic) with the aid of resource materials, to utilise all the senses, and using practical, concrete, visual examples to illustrate explanations.

Tangibles and Special Educational Needs

Tangibles aim to build on the alleged benefits of educational manipulatives and constructivist learning [6] through the use of hands-on experimentation with embedded computer technologies. By taking advantage of multiple senses and the multimodality of human interactions with the physical world, tangibles provide a rich multi-sensory experience [4], [5], fundamental for children with cognitive and learning needs.

Providing accessibility and ways of communication for the physically disabled has been one of the main roles of technology in the field of special needs [1]. The focus of this work, however, is on cognitive and learning needs rather than physical impairments. Overall, research on new technologies to support cognitive disabilities has focused on improving access to information and ways of dealing with it (including learning contexts), and on increasing independence of people with cognitive impairments.

Research outline

This research is investigating the role of tangible technologies for the education of children with cognition and learning needs, particularly moderate learning difficulties (MLD). Specific aims are to understand:

- The effect of tangibles in participation of pupils with learning needs and collaboration among them and their peers. Outcomes may inform theory on the connection between tangibles and peer collaboration, with a specific focus on children with cognition and learning needs.
- The effect of tangibles on the main difficulties presented by children with learning needs, namely: short attention span, verbal memory, outerdirectedness and abstract thinking. Outcomes may add empirical results to the field that looks at how tangibles affect cognition in the case of children with learning needs.

Methodological approach

To achieve the research aims, choices must be made as to: (i) participants; (ii) learning domain; (iii) technologies to be used for the empirical studies; (iv) kinds of activities for the empirical studies and methods of analysis.

PARTICIPANTS

Participants will be pupils with moderate learning difficulties between the ages of 11 and 14 years old. MLD are among the most common kind of cognition and learning needs, and the age group was selected as pupils with MLD are likely to become seriously disengaged in the early years of secondary school. School teachers with experience with SEN will also participate in this research by being interviewed and/ or observed in class.

LEARNING DOMAIN

The research focuses on science learning, which allows students to identify and relate their own experiences to concepts and can be effectively taught through multimodal activities, but in which students with learning disabilities are still not performing satisfactorily.

TECHNOLOGIES

There are many kinds of tangible technologies which could be used for science learning. As this work takes place alongside the London Knowledge Lab's project Designing Tangibles for Learning (www.lkl.ac.uk/research/tangibles), the studies will make use of the tangible artefacts for science learning developed in the project. So far, an interactive tangible tabletop for learning basic concepts of physics of light has been developed (figure 1)

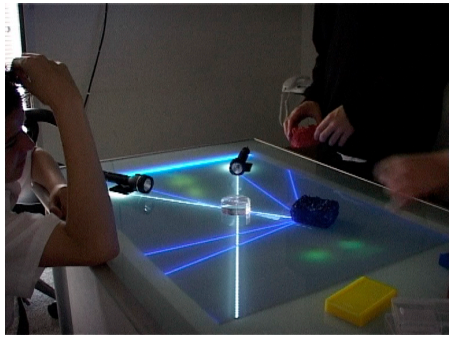

figure 1. The tabletop with physical interaction devices

EMPIRICAL STUDIES

The empirical studies will be designed according to guidelines found in the literature for teaching students with learning disabilities plus qualitative data collected from the interviews with teachers and observations in classrooms. Considerations must be made as to the structure of the activities (i.e. free exploration versus well defined tasks); level of external support (guidance and coaching from facilitator); stance of the facilitator

(e.g. delivery and repetition of instructions, addressing pupils, praising); time frames, among others. The empirical sessions with the pupils will consist of groups of three children (at least one of whom will have learning needs) interacting with the tangible environment with the facilitation of the researcher, for 30 – 40 minutes.

Qualitative analysis will look at aspects of participation, collaboration, and knowledge construction, drawing on previous work [7]. Possible categories for the analysis of collaboration include: sharing of resources, interference with others, level of participation, building on others' explanations. Knowledge construction will be analysed based on how (if at all) the tangible system supported attention span, verbal memory, outerdirectedness and logical reasoning and abstract thinking.

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