BlockMagic, A Hybrid Educational Environment Based on RFID Technology and Internet of Things Concepts

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Abstract. The new improvements of ICT technologies allow the opportunity to use these tools in the learning context and create smart environments for children and teachers in schools. In this paper, we present Block Magic (BM), a tool that exploits the Internet of Things theory using RFID technology. This tool allows the children to play traditionally with well-known didactic materials, the traditional Logic Blocks, but in connection with a PC and a dedicated software that increase the interaction. BM stimulates different learning activities for specific skills as mathematics, logic, language, problem solving and creativity. This low-cost and user-friendly technology allows enhancing the learning/teaching session due to the software feedbacks and the session tracker. The software is able to track the sessions of each child, and supporting the learner with a hidden Adaptive Tutoring System (ATS) that presents to the children the right exercises, based on the learners' replies. BM was tested in four different countries (Germany, Spain, Italy and Greece) in the kindergartens and the primary schools, the target groups were in the range 3–7 years old. The tool was tested in a larger scale evaluation that involved 22 teachers and 495 children. The results shows a high degree of acceptability; that appreciated the concept and the innovation features. The trials showed some issues to be fixed, as the usability. BM was a research developed in the framework of a funded by the EU Commission.

Keywords: Internet of things · Innovation · Augmented Reality System · Research projects · RFID technologies · Assistive learning

1 Introduction

The Internet of Things theory was the drive of the research of Block Magic. The project, funded by the European Commission and ended in the November 2013, aimed to start from the Radio Frequency Identification Technology (RFID) creating a sort of interactive net between the children in schools, the learning materials and the teachers. This hybrid environment [1, 2] was based on traditional psycho-pedagogical activities

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well-know from the teachers. These activities exploited the structured materials used in rehabilitation centers, baby-parks, children's hospitals and the homes. The structured materials are materials that have a fixed numbers of "n" elements and "m" categories. The structure is represented by the rules that connect the single parts. Typical examples of structured materials are logic blocks, cards, teaching tiles, etc. These materials allow analytical thought, using the isolation of a single quality (e.g. dimension, shape, color, etc.) and allowing the focalization of attention on a single part of the object, and then, with a gradual analytical process, the ability for clustering and serialization, in order to understand the object.

The Logic Blocks was the didactic materials chosen in the Block Magic project for their wide adoption by the schools. These are different pieces or blocks that differ each other for different attributes as color, thickness, geometric shape and dimension. (see Fig. 1).

Fig. 1. The Block Magic system

Traditionally these materials aim at empowering the proactive function of learning processes and cooperative dynamics between the pairs (children in our case). It is fundamental underline, that these Logic Blocks, in the traditional uses, propose an important hurdle. It allows the active participation of pupils, but is extremely expensive because of the continue supervision of the teachers/parents and the needs of personalized educational interventions that are impossible in this context.

The research project Block Magic, ended in November 2013 and funded in the framework of the programme LLP-Comenius by the European Commission, worked in order to overcome this limit, and connect the smart learning environment exploiting the strength of the manipulation. These interactions seem to be determinant in the human knowledge cognitive representation as showed by the theoretical perspective of the Internet of Things [3, 4] and the Embodiment Cognition [5]. It demonstrated using experiments, empirical studies, clinical observations and computational modelling [6] that it is captured in our neurocognitive structures as a holistic space-based sensory-motor representation.

1.1 Technology

The technology becomes important for an increase of the satisfaction of the users and the Internet of Things rules require an interconnection between the things in a smart configuration enhanced by the technology.

In this point of view, the technology that matches with these purposes is the RFID (Radio Frequency Identification/Near Field Communication).

RFID systems consists of an antenna and a transceiver, which is able to read the radio frequency and transfer the information to a device, and a small and low cost tag, which is an integrated circuit containing the RF circuitry and information to be transmitted.

The aim of the project Block Magic was to create hybrid platforms matching two different contexts, from one side the digital world usual for the new digital natives interconnecting more tools in a traditional environment (school or home, etc.), for the other side the physical world with strong and well-consolidated psych-pedagogical practices.

These hybrid systems propose some improvements respect the state of art of the physical and the digital world. The strength points are the ability: (i) to overcome the limits of the excessive orientation of the screen, typical of the digital applications, because the user (the child) is active in the execution of the task, playing with the device and with the environment tools in the same time; (ii) to assess the session performed by a learner, giving a supporting tool for the teachers; (iii) to reduce the costs of the traditional lesson that use the structured material, because they need a continue support of the teacher; (iv) to permit an highly individualized learning path; (v) to connect the elements in a traditional environment, creating a smart environment.

On these bases, an international research Consortium funded by the European Commission produced the first prototype of BlockMagic based on STELT (Smart Technology to Enhance Learning and Teaching) a developing tools to build-up educational games with RFID sensors [7].

From a more general point of view, the ambition of BlockMagic project is to redefine the learning-teaching Logic Block materials through the use of a cheap Smart Technology creating hybrid smart environments. In this prospective BlockMagic aims to reinforce the traditional teaching methods for kindergarten and primary school.

2 The Block Magic Framework

2.1 Block Magic Platform

Block Magic is a hardware-software prototype that uses RFID sensors and an Artificial Tutoring System in order to connect different tools in an environment like school or home. The general objective is to reduce the presence of an adult that supervises the activities (teacher or parent). The hardware is based on RFID-TAG (tiny stickers) are on traditional logic block pieces that can be recognized by an active reader connected to a Tablet/PC. The PC/tablet is equipped with the Block Magic software that simulate the actions of teachers, proposing exercises, giving feedbacks and maintaining a record of an individual learning history (Fig. 2).

Operatively, when a user places one or more blocks on the active reader of BlockMagic, in connection via Bluetooth or cable to a PC/tablet, the system recognizes the blocks and gives some opportune aural and sound feedbacks to the learner. These feedbacks support the pupil in order to solve different exercises regarding different skill

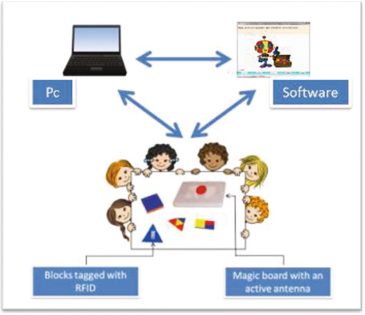

Fig. 2. The framework of the Block Magic system

(mathematics, logic, problem solving, creativity, etc.). The "smart" software engine, developed during the project, receives input from the board and generates an "action" directly on the screen.

2.2 Scenarios/Learning Activities

The methodology defined in the project has three main scenarios: (1) Individual Game Scenario and (2) Social Game Scenario, (3) Special Needs Scenario. In the Individual Game Scenario, the learner has to solve a task autonomously using life skills (mathematical, logical, strategic, and creative or language skills). In the Social Game Scenario, the group plays/learns with Block Magic and the "social skill" can emerge in this context. In the Special Needs Scenario, special games were proposed to children having severe disabilities.

The teacher has the role to set the classroom and introduces the blocks and the magic board to the children, leaving the kids free to play these materials. The BlockMagic software allows to the educators to personalize the training for every child, choosing the exercises proposed for the children in order to seek defined educational objectives. The teacher acts differently in the Individual Game Scenario and in the Social Game scenario. In the first case, the educator represents an observer and in case of request of help, he/she could support the kids. In the second case, the teacher interacts with the children, providing support, observing, creating obstacle, based on the characteristics of the specific exercises.

2.3 Trials

The methods, exercises and technologies developed by BlockMagic Consortium were tested in kindergartens and primary schools with selected children and teachers in Greece, Italy and Spain between 3 to 7 years old. The trials involved 10 teachers, 257 students, and 2 children with special needs in 4 schools. In Italy, in the structures of LegaDelFiloD'Oro were performed trial for children with special needs.

During the trails, the researchers of the project supervised the sessions reporting observations and comments. After the sessions, the researchers made some face-to-face

interview with teachers that participated in the trials. The interview were focused on three aspects (ergonomics, usefulness and satisfaction) for the three scenarios.

3 Results

The observations and the interview with the experts collected about the Individual Scenario shows an encouraging view. The hidden nature of the tools permits a high degree of acceptance from the teachers and the kids in the schools. Their main approaches was positive and they considered it as a normal tool for the schools, underlining some positive points and some weaknesses.

Regarding the usefulness, the teachers considered Block Magic an important tool that could be added in the daily school routines, with some improvements that will allow an easier use. The exercises provided in BlockMagic are considered balanced for children in that range of ages. In their opinion BlockMagic stimulates mainly mathematical and logical skills and with a minor degree also creativity, strategic and language. In particular, the creativity is stimulated but the children prefer to build picture using the blocks out of the BlockMagic platform. The feature that the teachers mainly appreciate was the direct feedback. The teachers considered that Block Magic stimulates the children to learn, in particular the children with problems in concentrations.

Regarding the ergonomics, the teachers referred that the prototype has some features to be improved, some exercises contain some obstacles for a correct performing. For example: the repetition of a same action, the need of place a block in order to start a game, etc. However, the observations showed that the children after a little time of understanding were highly confident with the tool. The pupils learned quickly the functionalities of BlockMagic and there was few requests of support from teacher. The learners asked for helps only when lacked the exercise information. However, a problem emerged with the children between the 3 and 4 years old for the difficulty in distinguishing the thickness of magic blocks.

Regarding the satisfaction, the children appreciated the whole tool, with a strong preference for the aural feedback (the BlockMagic software is set to call the user by own name). This feature surprises the children and allows a quick interaction. All children looked forward to play again with the BlockMagic tool. The teachers appreciated this element, because the children enjoyed “to learn” because they considered they were playing a game.

4 Conclusions

The BlockMagic project funded by the EU Commission, developed a structured methodology that take from the experience of well consolidated psycho-pedagogical approaches and a functional platform (hardware/software) using the RFID technology and the Internet of Things (IoT) approach. The BlockMagic kits were tested it with selected children and teachers in Greece, Italy, Germany and Spain in kindergartens and primary schools. The results achieved during this experimentation were very encouraging for all the three real cases: individual scenario, social scenario and special

needs scenario. The observations performed by the researchers and the interviews collected with the teachers involved demonstrates that the BlockMagic prototype is a tool that could be easily introduced in the daily routines of real classrooms. The children are very attracted and excited during the BlockMagic session and they consider it as a game. The system allows a good interaction in social contexts and supports the group activities. In addition, BlockMagic reduced the negative feedbacks for children with special needs during the execution of the sessions in comparison with traditional methods.

It is necessary to underline some limits reported by the teachers in particular regarding the ergonomics. This element will represent the direction that the authors will seek in order to improve the features of this hybrid system.

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