Internet Of T(eac)hings: Assessing Children's Learning In The IoT Era

Fabio Sorrentino
Department of Mathematics and Computer Science
University of Cagliari
Cagliari, CA 09124, Italy
sorrefabio@gmail.com

Lucio Davide Spano
Department of Mathematics and Computer Science
University of Cagliari
Cagliari, CA 09124, Italy
davide.spano@unica.it

Riccardo Scateni
Department of Mathematics and Computer Science
University of Cagliari
Cagliari, CA 09124, Italy
riccardo@unica.it

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Abstract
This paper discusses an early prototype aiming at providing teachers with means for configuring connected objects that can be used for assessing the understanding and the creative reworking of children's learning. In order to do that, we support teachers in defining the information flow between the connected objects and the interactive manipulation events considered relevant for the assessment. Considering that in the last years classrooms have been more and more equipped with different technological supports, we propose to use them in a more customisable way, helping both teachers and students in making lessons more enjoyable and pleasant.

We focus on already available and low cost technologies, since more advanced ones may have a high impact on school budgets. Due to this, we propose an approach that uses modular and low cost components that could be embedded in different physical objects and easily replicated by schools with a low investment.

Author Keywords
Internet of things, Children learning, NFC

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]

Introduction

It is a common belief that people learn while studying and that testing is needed since teachers and educators must somehow measure what actually has been learned. Indeed, in order to improve learning it is usual to spend more time and effort improving teaching rather than testing.

On the contrary, Roediger [4] said that *testing memory not only assesses what we know but changes it*, underlining the important of this task that could be, in some way, underused by educators. Roediger found that *testing as often as studying leads to better long-term retrieval, and that studying once and then testing often allows students to retaining the information well in both the short and long term*. Testing is one of the most important parts of a successful learning experience [1], it is that particular moment when students demonstrate their understanding of the facts and notions explained by teachers and educators. Testing could be done in different ways and through many methodologies. It could be carried out orally or through written material, it could use, for example, true-false statements, multiple choice questions or short answers. Our approach is motivated by a simple question: What if learners could play while testing?

Testing does not always have to be a serious and stressing experience. It can be immersive, interactive, fun and creative. Playing is fun for children and it represents one of the way they actually learn [5] [3] [2]. Through play, they learn about their environments, their relatives, friends and the whole world around. Positive play experiences develop positive emotional well-being. So we can use of this positive factors to turn testing into a positive experience. The target user is represented by the school-aged child between 5 and 12 years old. Our approach analysed the possible testing scenarios, and the required hardware, in a low budget school setting.

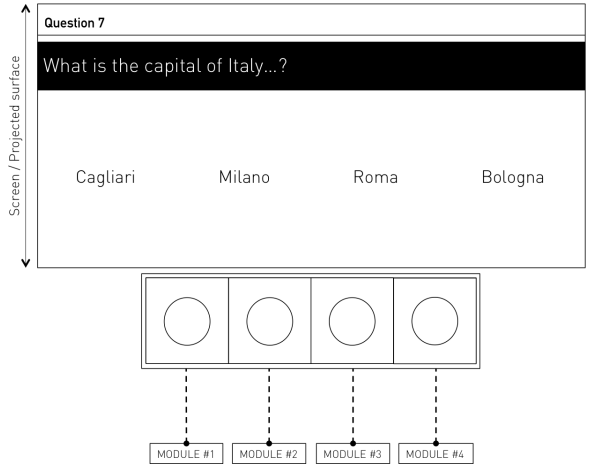

Figure 1: Assessment game developed in the pilot study. A large screen shows the question with multiple answers. The child can answer the question inserting a ball inside one of the baskets below the screen.

An EUD learning assessment platform

Today, teachers can choose among dozens of available learning assessment tools and they can easily create their tests by using free or paid web material. We are currently studying a solution for creating assessment exercises that combine physical exercises and question for rehearsing lesson concepts.

Figure 3: Components used in the very first prototype: an Arduino nano, an NFC RC522 module and an NFC tag.

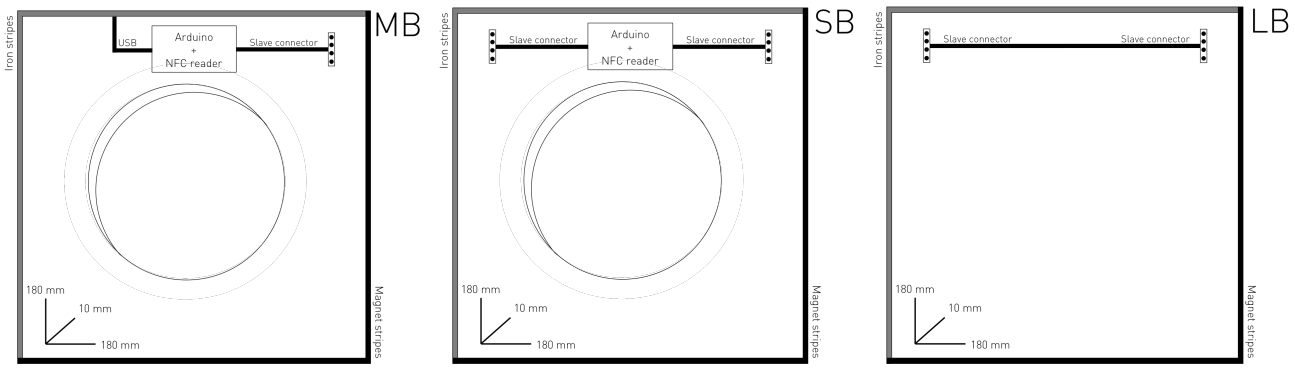

Figure 2: Master, slave and link modules.

Our main idea is to provide an end-user development (EUD) environment that would enable teachers to use cheap hardware for sensing physical objects, for creating learning games that would take advantage from both the physical and the digital world.

The teacher, through the support of the EUD environment, defines the game rules and the playing field. From such definition, the environment will suggest how to configure a set of smart modules for supporting the game. The smart modules will be different low-cost sensors and hardware devices, that will be automatically configured for receiving the data. In the rest of the paper, we will describe a small pilot study for a multiple answer question game.

Smart module design

In our first prototype we built a simple platform that manages both the creation and the game experience. It allows teachers to create a single ten-item quiz, where each item is a question which has only one correct answer. We envision the developed tool as freely available online where teachers can create their own questions thus sharing their tests. Users, browsing among the available categories in the system can select which of them are suitable for the lesson, and, if necessary, they can create a set of questions combining more categories by simply removing or adding single items.

Each module is designed as a square of a rigid material (i.e. wood or plastic) with a 180mm side having a thickness of 10mm. At its centre we find a circular hole with a 10mm diameter. A magnet stripe is placed both on the right and the bottom side, while an iron one is placed on the left and on the top side. These stripes allow teachers to connect them in different configurations. The only constraint for the set-up is that there will be a single module labelled as master while the others will be labelled as slaves. Their smartness come from a combination of two main elements: an Arduino nano micro controller and a near field communica-

tion (NFC) reader connected to it. This combination gives to each module the computational ability to read an NFC tag and to send its code to a PC through the master module that continuously retrieves all the information read by the slave modules.

The NFC technology is a set of communication protocols that enable two electronic devices to exchange information by bringing them within a short distance. NFC tags are passive component which can be read, and under some circumstances written to, by an NFC device.

The composed modules create a single block that can be connected to the main PC through an USB cable. From now on, all the data read by the modules will be sent to the system making possible the user interaction. The game requires a initial configuration, in fact the user may insert the number of players and their NFC ID. The association between user and ID is a guided operation; firstly, the system requires the name of the player, secondly the player may bring its physical widgets within four centimetres of the master module. This way the name of the player will be associated to the widget and the given answers will be recorded for the right player.

Even if the default physical widgets are simple foam balls equipped with an NFC tag, teachers can create different ones working together with their students 4.

Testing scenario

We describe the usage of these modules for a quiz game, combining them with a screen or a projected surface. Modules can be combined by using the magnet stripes, securing them with an optional frame that can hosts up to four module as shown in figure 1. This smart component allows students to give their answers to the test by using physical widgets equipped with NFC tags.

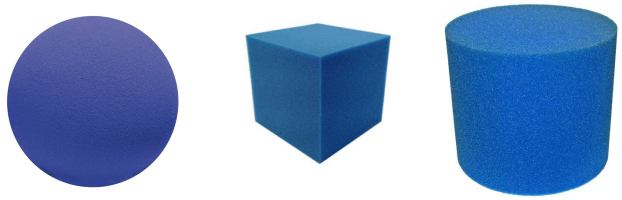

Figure 4: Different examples of physical widget

These widgets could have different shapes and materials (it is sufficient that they fit inside the hole placed in the square module) and in our early test we used foam balls placing an NFC tag inside of them. At this point we can associate widgets students/players and the modules represents the available answers for the current question. The system can actually identify the answers given by the players checking their correctness.

Conclusion and future work

In this paper we discussed our idea for creating an EUD environment supporting teachers in developing learning assessment games. We developed a first game prototype for understanding the requirements and technical difficulties in automating the configuration of the physical object sensing hardware.

In the future we would like to implement the environment, focusing on two main parts: the first one is the configuration engine, that will receive the teacher-defined configuration and would generate the instructions for connecting the hardware and generate the code for reading data and playing the game.

The second part is the EUD support, applying the existing

state of the art metaphors for defining the data flow, and studying how to represent the start modules in a simple yet precise way the different modules.

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