Digitalizing Real Environments to Improve Learning

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Figure 1. Session of children using the Educational Game based on Distributed and Tangible User Interfaces

ABSTRACT
Nowadays, the real and digital worlds have joined, offering interaction mechanisms that are more natural and tangible. However, this involves the search for new user-centered interaction techniques. It would be ideal if the users could focus on their task and take advantage of advances in technology at the same time. In this work, we describe a pervasive and collaborative educational game. The main objective has been to motivate and encourage children to explore and play through wearables and a digitized real environment where the objects are connected to each other. The proposed interaction technique is based on Distributed and Tangible User Interfaces and allows the users to focus their attention on the game. The system consists of wearables and smart objects/tangible interfaces that include both NFC and Bluetooth technology, which is used to guide and engage the user in the environment. A preliminary evaluation was conducted to check the participants' satisfaction, usability and motivation. The results have been very positive. The real and tangibility factors in the system increase engagement and usability. The user technology interaction was simple and intuitive for the users.

CCS Concepts
Human-centered computing → Human computer interaction (HCI) → Interaction techniques

Keywords
HCI, Tangible User Interfaces; NFC technology;

1. EDUCATIONAL GAME
Interaction through tangible user interfaces and wearable devices has a great potential to support learning thanks to hands-on engagement, enabling collaboration and the role to be played by each student. These elements also eliminate technological barriers, even making it possible to integrate children with special needs in the classroom [1]. This work describes a prototype based on collaborative games for teaching foreign languages, in this case English. It simulates a real-world environment. In this way, children learn to associate scenarios with words, objects, and more importantly through interactions with their peers under the supervision of the teacher. Students explore and play through wearables and digitized real-environments where the objects are interconnected. In a given scenario, an object may be associated with a real-world environment, allowing the child to perform the tasks related to it (Figure 1). For instance, a monitor may display the ingredients of a recipe to be prepared. The group of students will share the responsibility for finding the various objects required to proceed with the task of preparing the recipe. While some children will have to go shopping by following the instructions provided via remotely activated signals, others will be in charge of finding the appliances and kitchenware. All the objects are represented by flash cards which are labelled and identified with NFC tags. All the objects (distributed around the environment) will have to be brought close to a tag reader and the progress of the task will be displayed together with the name of the students having performed the task. For each object that has been recognized, the name of the object will be announced, allowing the student to hear and repeat the name of the object. The instructions will be sent to the children through the wearables (smartwatches and bracelets) or mobile devices. The wearables (via audio messages, text) help children to play in the real world. They interact with tangible user interfaces (objects with NFC tags inside). The wearables, Bluetooth beacons, NFC technology, wireless connections and the server are interconnected to form the digitalized environment (See Figure 2).

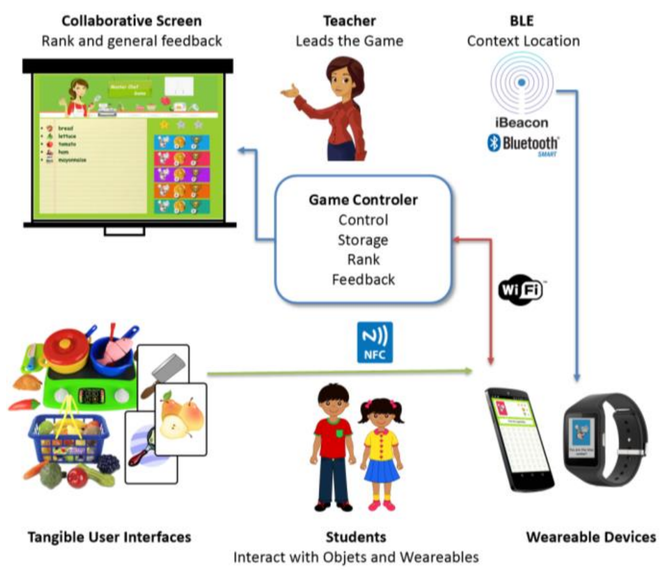

Figure 2. System components

2. EVALUATION

A preliminary evaluation was conducted to check the participants' satisfaction, usability and motivation [2].

The main objective of the work herein is to show that the use of distributed and tangible user interfaces based on wearable and NFC technologies can enable the creation of friendly and engaging task-based learning environments. To guide our work, we therefore focus on the following three main research questions:

RQ1: Can students' engagement be generated and maintained through the use of distributed and tangible user interfaces/wearable assisted task-based environments?

RQ2: Do distributed and tangible user interfaces/wearable-enabled learning scenarios enhance collaboration and communication among students?

RQ3: Do distributed and tangible user interfaces/wearables successfully guide the students through the tasks?

In order to obtain data on engagement, motivation, verbal sentences, etc. while performing the task, two video cameras were used during the sessions. We used the direct observation method [3]. At the end of the sessions the students filled in a survey based on the Smileyometer scale [4].

Fifteen young children participated in the evaluation. They were all able to follow simple instructions and to participate in a simple conversation in English. In order to evaluate the impact and benefits of using distributed and tangible interaction/wearable technologies in the teaching process, we conducted the same activity using flashcards (paper-based task). Accordingly, we organized the children into two groups. The **Experimental Group** participated in the distributed and tangible interfaces/wearable task-based class activities (Figure 3.a), while the **Control Group** carried out the same activities using the flashcards (Figure 3.b). Their ages range from five to ten years, with a mean of 7.33 and standard deviation of 1.885.

Figure 3. (a) Experimental group using the proposed system (b) the Control Group carried out the same activities using the flashcards

After analyzing the video (Figure 4), we witnessed that in the experimental group there was an increase in factors for intrinsic motivation such as curiosity, exploration, collaboration, challenge, control [6]. The Smileyometer test results were as follows: 100% of the children thought that the games were “brilliant”. However, in the control group there was an increase in the factors for extrinsic motivation such as competitiveness, points, rewards, and external comments. The Smileyometer test results were as follows: 40% of the children thought that the games were “brilliant,” versus 20% of the children who thought they were “really good” and 20% of participants who thought they were “not very good” and 20% of the children who thought they were “awful.”

The children were more cooperative when it came to interacting with the system. In the control group the kids showed little interest in collaborating, and competitiveness among them increased.

Finally, when children used the system, they paid more attention to the objects and interfaces. That is, the devices supported the children but did not distract them from their main task.

At the end of the sessions with the experimental group, the teachers filled in a System Usability Scale (SUS) questionnaire [5]. Our proposal scored 81.25 (out of 100), i.e. the teachers had a very positive view of the system.

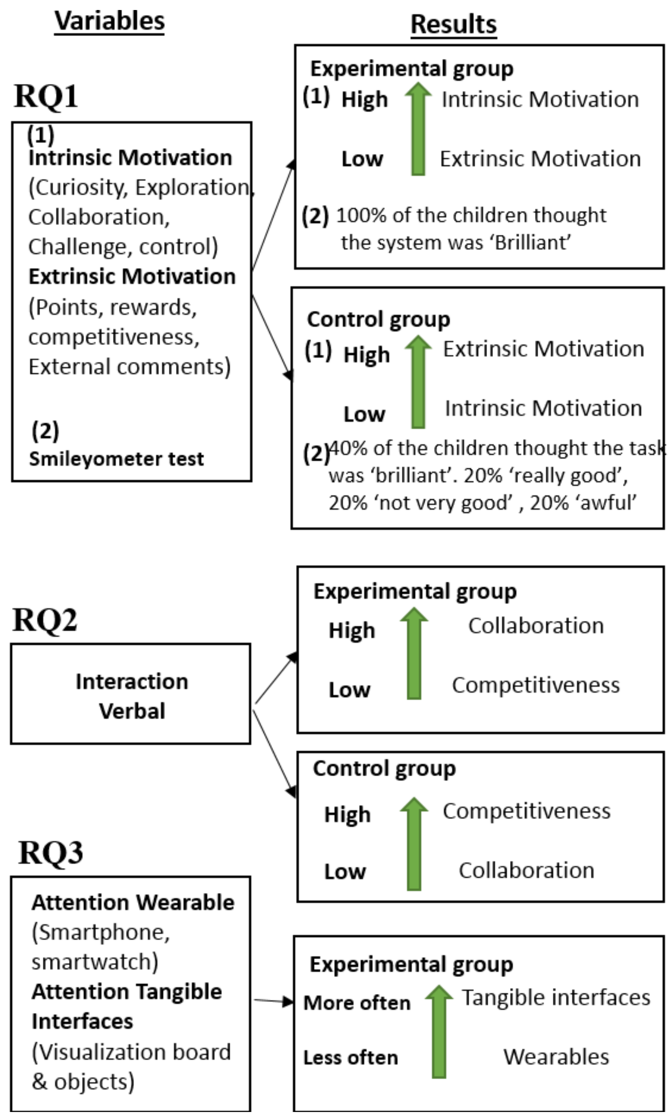

Figure 4. Evaluation results

3. CONCLUSIONS AND FUTURE WORK

A preliminary evaluation was conducted to check the participants' satisfaction, usability and motivation. The results have been very positive [2]. Participants were motivated by performing the educational game. The interaction techniques based on distributed and tangible user interfaces were simple and intuitive for them. Most of the time they were focused on the game. The tangible objects were used to interact with the game. However, they did not distract them from performing their primary task. Thus, future work will involve providing design tools such as models, guidelines, and taxonomies in order to support future designers in developing software based on distributed and tangible user interfaces through wearables, and mobile technologies.

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5. REFERENCES

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