Interactive Toy to Strengthen the Memory, Attention and Logic of Primary Education Students Using Sphero, Arduino and Neurosky Mindwave EEG

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Abstract. Due to the importance of primary education to acquire basic knowledge, it is necessary to use technological tools that allow students to provide their knowledge through educational games and that allows generating the necessary feedback to know the level they are. Using interactive toys implies developing basic skills in learning, necessary for the integral development of students. The present investigation develops an interactive toy that measures the attention, memory and logic of primary level students; Through the Sphero and the Neurosky MindWave, the speed will depend on the attention that the user has, instead the logic and memory measurement is developed with the help of a 6X4 track, the control panel and a mobile application showing the logic and memory questions. The results show that 5th and 6th-grade students of both genders have fun learning and take interest in interactive toy, strengthening logic, memory and attention through the use of technological equipment.

Keywords: Interactive Toy, Atenttion, Memory, Logic.

1 Introduction

The training of primary education students is of the utmost importance due to the rapid development of capabilities and abilities, mental, cognitive, psychomotive, social and affective [1]. According to [2] the children like to play with someone or have fun with a game that implies a challenge. In child psychology [3], mention the importance of the interactive toy that will be able to develop the cognitive and affective part of children.

Currently, there is a great diversity of interactive and technological games that allow activating different cognitive areas of children, constituting a key part in its integral development [4]. Playing is no longer considered as a pastime, but allows the child to discover, interact, explore and experience with movements, sensations that form a concept in the world [2], [5]. There are several investigations that allows

teaching them programming by robots [3] or by the Lego blocks can learn with different construction games, with high costs within scope for the children of Latin America [6].

Since the mid-2014, the Arduino plate became well known because it allows to develop several innovative projects and provide customized solutions according to the situation raised, several projects have been created that allows to encourage the education of children [7], [8], [9].

The proposal aims to capture attention, strengthen the memory and logic of students, through an interactive toy; Which, through a mobile application developed on Android, answer the questions, return the attention values and, on the web page, you will register to users and generate the appropriate reports. Additionally, the proposal has a physical control command that allows to move the toy car by means of a 6x4 track with obstacles. Finally, to capture attention to the Neurosky MindWave will be controlled by the Sphero that is a device in the form of a sphere that has wireless connection.

2 Related Works

Although E-Learning has many advantages for students and teachers, it brings with many challenges also, since the teacher cannot monitor whether students are paying attention, that is why [10] propose an intelligent system of e-learning that predicts video based on emotion, by a Neurosky brain wave detector to predict appropriate adolescents. Neurosky can also be used in areas of health and entertainment as they report in [11] through a Parkour game system capture "degree of attention", the "degree of meditation" and the "Electro-Oculogram (EOG)" of the participants to help control hyperactivity disorders and also to patients with cerebral palsy. Then, there is another research that allows controlling a car [12], according to signals captured by the Neurosky device either by levels of attention, meditation or blink, that when processed you can identify the orientation that the truck must be followed and that it is your route.

Open source projects, each time has a larger audio demonstrating its effectiveness in education [13], has the 2 projects proposed by [14] using sensors and music for the development of basic aptitudes of mathematics and physics. Finally [15] developed 2 applications, one for patients who need a rehabilitation process of lower or higher extremities, and the other application for therapists to keep them updated the progress and improvement of patients, this was implemented with Raspberry Pi and Arduino.

3 Materials and Methods

For the development of the project, we are based on the methodology of extreme programming (XP), which consists of the following stages:

- **Planning**. - The user stories are elaborated together with all researchers, with the support of psychologists and the interviews prior to students.

- **Design**. - The mockups of the mobile and mobile web functionalities are designed from the user stories.
- **Coding**. - It consists in the preparation of the code of the mobile application and the web system, of the Arduino plates, the control board and the toy car.
- **Tests.** - Functionality tests are verified by module implemented through psychologists specializing and experienced developers. Acceptance tests are validated with students, in three educational institutions.
- **Interpretation of results**. - With the data obtained, comparative tables are made of the responses of the students in the two types of tests made to reach the conclusions of the investigation.

There was a group of 104 5th and 6th grade students from three types of schools (private, state and para-state).

4 Implementation of the Project

For the understanding of the proposal, the project architecture is presented (see Fig. 1), which shows the elements that communicate with each other, and comply with the proper functioning of the system and strengthening the logic, memory and attention of students of 5th and 6th primary school.

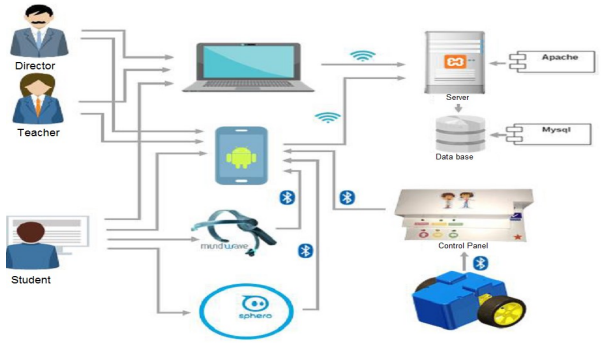

Fig.1.Architecture of the Project

The elements of the architecture of the project are:

- **Teaching user. -**Earchard of the student's record in the web system to which grade has been assigned previously, as well as their identification in the application to initiate the tests. In the web system you can also see the reports by student, grade, and edit their profile.
- **Director User. -**All the teacher can be identified in the mobile application, has all the degrees assigned to its disposal and can see the reports by grade in the web system and edit its profile.
- **User student. -** It is the one who performs the two types of test through the mobile application, the same user or his parents have the possibility to visualize their results by the web system.

- **Web System.-** Performed in HTML, with CSS, PHP and Bootstrap Bookstores, Fontawesome, Highcharts and Dompdf, for this means users can see the results of the tests.
- **Mobile application.-** Developed in Java for smartphone devices with Android operating system, the same one that performs the two types of tests to the students; This is communicated with the database (Volley Library), Sphero (Robotlibrary) library, Mindwave (ThinkKear library), and the control board; These last 3 communicate through Bluetooth.
- **Sphero. -** Programmable sphere that will be mobilized according to levels attention student, previously linked with the smartphone.
- **Neurosky Mindwave EEG. -** It has as purpose, obtain the attention values, to record the average attention in the database.
- **Control board. -** Send signal signals to the printed toy car (forward, right, left) and access button, so that the student can continue answering questions in the application, inside the Mega Arduino has to comply with these functions.
- **Toy car. -** Receive signals from the control board to mobilize the two tires connected to the bridge H of the Nano Arduino found in the interior of the car.
- **Web server.-**The Apache server is used for the proper functioning of the web system and the application, with the respective connection with MySQL.
- **Database.-**The base used is MySQL, in charge of storing the information of the users and the responses of the tests.

5 Tests

Project tests were made in three educational institutions with a total of 104 students, in two parts:

- The memory and logical of the students are evaluated through a 6x4 matrix, which through a toy car is moving according to the orders that the students provided on the control board (see Fig. 2).
- The level of attention of the students registered with the MindWave and eaters as evaluated, is the Sphero sphere (see Fig. 2).

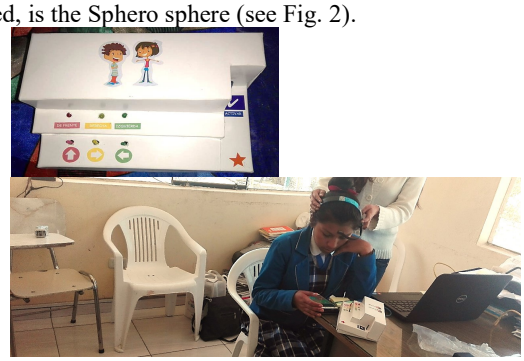

Fig. 2. Control Board

5.1 Logic and Memory Test

This type of test consists in controlling the 3D printed toy car to advance on the obstacle track using the control board, and responding at the same time logic and memory questions, the process is described in Fig. 3.

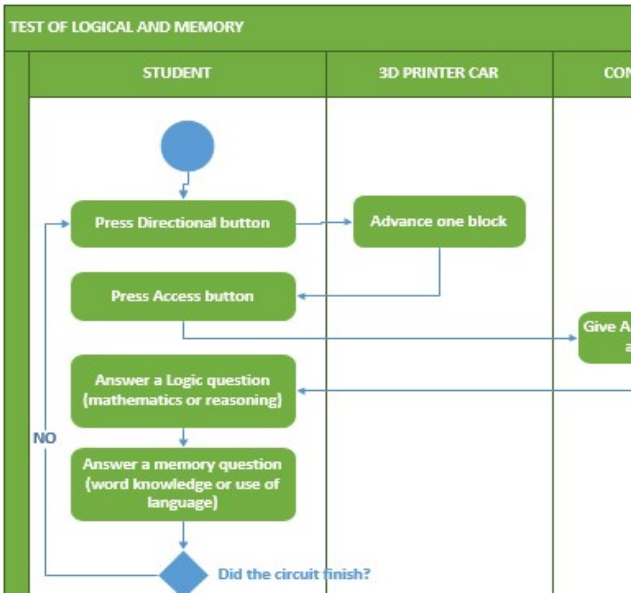

Fig. 3. Activities Diagram – Logic and Memory Test

The questions of this test are answered through the mobile application, it is given 4 options to the student for each question, so that he selects the opposition he considers correct (see Fig. 4); To enable the response option, the student has to continue to be mobilized by the obstacle track.

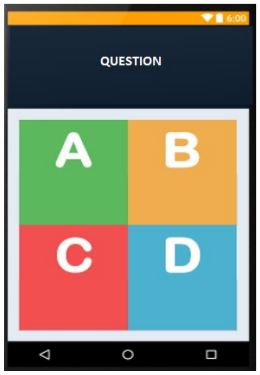

Fig. 4. Mobile Application Interface (Logic y Memory)

5.2 Attention Test

This second type of test is to measure the student's attention, the sphere (Sphero) moves at a speed according to the student's attention level that captures the headband of Mindwave. The steps to follow are (see Fig. 5).

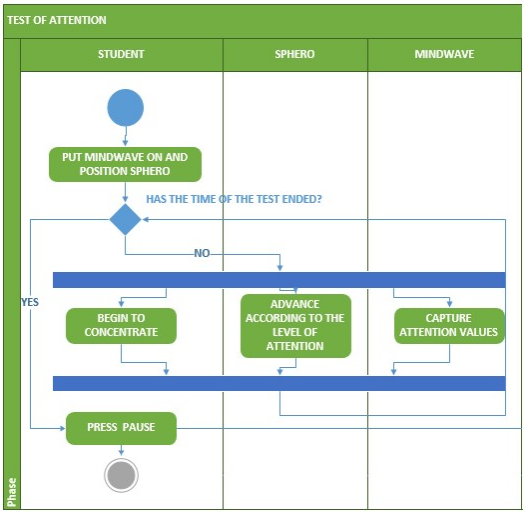

Fig. 5. Activities Diagram – Attention Test

At the top of the mobile application (see Fig. 6) the student's attention and meditation values is shown, in the central part a joystick to control the Sphero in case, a clonomer that will start at the time of receiving signals of the Mindwave. The little joystick serves to calibrate the Sphero.

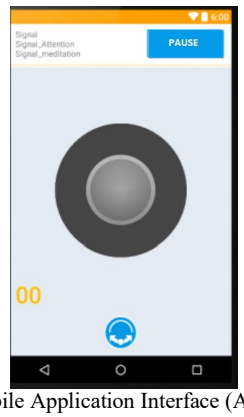

Fig. 6. Mobile Application Interface (Attention)

6 Results

For this research, was experienced with the logic, memory and attention of 104 students of 5th and 6th primary (10-12 years) in three educational institutions, of which 35 belong to a school of Misses, 35 to a college of males and the remaining 34 to a mixed school. For reasons of confidentiality, we will call them together School 1, School 2 and School 3.

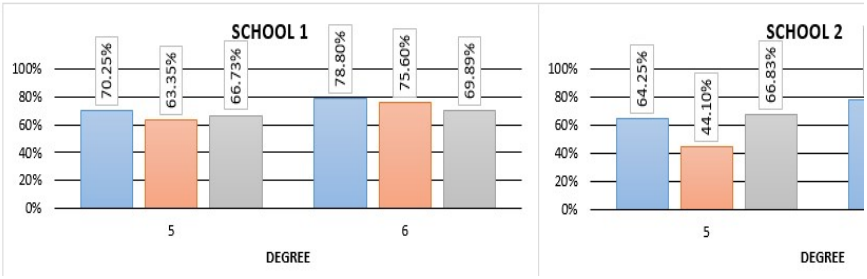

Fig. 7. School of Misses and Males

In Fig. 7 shows that, the School 1 of Misses and the School 2 of Males have an increase in logic, memory and attention according to the degree they are studying (5th and 6th degree of primary), that because children are constantly development of their brain over the years and technology promotes this [16].

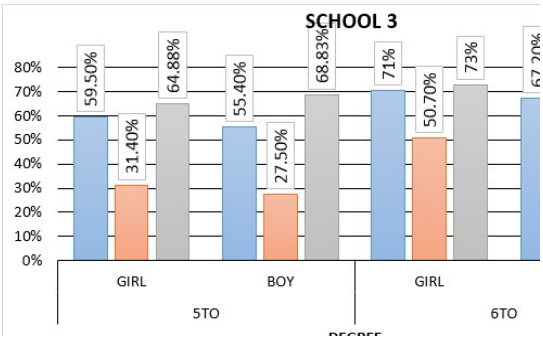

Fig. 8. Mixed School

Respect to Fig. 8, it shows that in the Mixed School, it has the same trend as in Fig.7, that the overview of years are higher percentages than their predecessor.

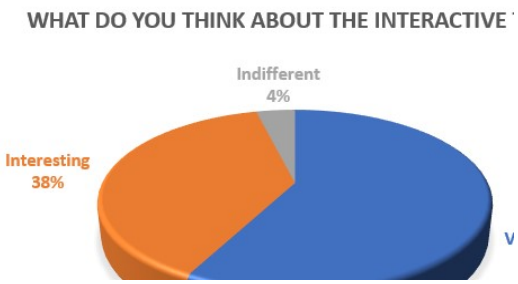

Fig. 9. Survey about Interactive Game

Finally, the total of students had been made a set of questions linked to interactive toy, in Fig. 9, shows that 58% seems very interesting, 38% interesting and only 4% indifferent, the result reflects the interest it has on the game.

7 Discussion

The results of this investigation are in a medium-high range, as well as research [17], where participants reflect higher attention levels by interacting with a toy or a digital object. Also regarding research [18], our averages of attention during the test are between 60 and 70%, both projects are based on stage games, to maintain the interest and high attention of the participants. Finally, it is verified that participants who came to obtain better levels of attention have higher percentage of hits in logic and memory tests, this is in relation to research [19], where students have a middle in meditation and attention, so they get a smaller qualification in the exam.

As noted in Fig. 9 our toy showed a high level of acceptance by participants as in [20] that proposes a game using Arduino showing high level of enthusiasm in the participants. Also, in [21] the results show the highest level of satisfaction in those participants to make use of Sphero.

Finally, [16] is in accordance with our results shown as it concludes that the cognitive development of children with technology brings good results. This conclusion is based on research [22] where repetitive sections in the participants entail better results, as they are reflected in our research where the participants of higher grades had better results compared to others.

8 Conclusions and future works

Apply integrated games with technological objects in education, it is of great benefit for students, as these compared to conventional games, are to be more entertaining, increase motivation and managing to capture the attention and interest of

the students, so, it is a resource that must be taken advantage, since it contributes to the development of intellectual skills and capabilities.

With the Arduino plate, the toy car, the command board, the 6x4 track, Neurosky MindWave EEG, and Sphero was achieved to develop an interactive toy that allowed to attract attention and entertain the elementary students and improve their memory, logical and attention.

The evaluation of the 104 primary education students allowed to verify, that students with better levels of attention, logic and memory are the superior years, due to the development of the brain reached in school ages.

The integration of the sphere (Sphero) was achieved with the Neurosky MindWave EEG, so that, when the student reaches the level of concentration required, this is reflected in the speed of the movement of the sphere, that is to say higher concentration greater speed and vice versa, lower concentration lower speed.

The didactic toy has an acceptance of 96% of the 104 students surveyed, in three different educational schools of primary, showing that students have an entertaining learning to develop memory, logical and attention.

With the developed proposal, the schools are expected to adapt new learning strategies to learn the deficiencies of the students in the different degrees, since it is necessary for teachers and managers to use new technological tools to complement the student's methodology.

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