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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2017 is also published.

INTRODUCTION

The Technical Faculty "Mihajlo Pupin", Zrenjanin, of the University of Novi Sad, the Republic of Serbia organizes VIIIth International Scientific Professional Conference "Information Technologies and Development of Education 2017" (ITRO 2017). The Conference will be held on 22nd June 2017 at the Technical Faculty "Mihajlo Pupin" in Zrenjanin, Serbia.

The Conference "Information Technologies and Development of Education 2017" (ITRO 2017) is organized due to the needs to connect science, profession and education through topics and content concept, first of all concerning the teaching process as base of information society. The tendencies of developed countries are in accordance with the efforts of UNESCO to improve this area related to the needs of life and work in the XXIst century. It is necessary to assess the state, detect the problems and perspectives of the development of education by competent professionals and teachers as well as the influence of the development of education on the development of the society as a whole.

The central topic of the meeting is the model of dual education as base for creating good base for the development of industry. Thus, our aim is to gather the representative entities who are able constructively contribute to establishing link between the educational system and industry as follows: Chamber of Commerce of Serbia – Centre for Dual Education, Ministry of Education, Science and Technological Development, Union of Employers of Serbia, ZREPOK – Business Organization of Zrenjanin and Companies that run their business in the region, directors of grammar schools and secondary vocational school, members of the academic communities and other participants who are interested in the topics.

The main topics of the scientific professional conference are:

- Model of dual education
- Teaching based on the concept of entrepreneurship

Other thematic areas of the Conference:

- Theoretical and methodological questions of contemporary Pedagogy
- Digital didactics media
- Contemporary communication in teaching
- Curriculum of contemporary teaching
- Developing teaching
- E-learning
- Management in Education
- Teaching methods of natural and technical subjects
- Information-communication technologies

The Chairman of the Organizing Committee of the ITRO 2017 Prof. Dragana Glušac opened the Conference. The participants were addressed by the vice dean of the Technical Faculty »Mihajlo Pupin«, Prof. Dijana Karuović; provincial secretary for science, higher education and scientific Research prof. Zoran Milošević, and the vice-major of Zrenjanin Mr. Dusko Radisic.

There were total of 143 authors that took part at the Conference from 12 countries, 2 continents: 82 from the Republic of Serbia and 61 from foreign countries such as: Macedonia, Bulgaria, Slovakia, Austria, Cyprus, Albania, Hungary, Spain, Bosnia and Herzegovina, USA, Portugal.

The Proceedings of papers contains 60 papers and it has been published in the English language.

President of the Organizing Committee
Prof. dr Dragana Glusac

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CONTENTS

Tangible user interface for pre-school children learning

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Abstract. New information technologies are giving rise to new possibilities in education even for the youngest. The use of innovative methods in education has the potential not only to improve education, but to generate interest in various areas, and to motivate children to learn better since they use multiple sensory modalities. The concept of tangible user interface (TUI) seems the ideal solution for preschool children. This paper presents the development and evaluation of an interactive educational game that uses tangible user interface. The application allows children to learn the characteristics and differences between animals, on a simple and easy way. They are able to manipulate the digital information by selecting and positioning physical object, representing the various animals. Developed application is augmented with the QR codes which enable the system to detect selected animal. The developed interactive educational game was evaluated with children in one kindergarten, and the results are presented in this article.

I. INTRODUCTION

Technology development and daily use of computers and mobile phones, have a strong impact of non-formal education. Various education materials, applications, and even games, can be used in learning process [1, 2, 3]. For the youngest games are the ones that most attract their attention, considering the fact that they are interesting and fun. But at the same time educational games can improve their cognitive skills [4], concentration, perception, ability for decision making [5], motor skills [6], social and emotional skills [7]. Playing games is essential for a child's development and for learning life skills [8].

One of the emerging research fields in human–computer interaction (HCI) is concerned with finding a new ways of interaction that aim to provide a more seamless bridge between the physical and digital worlds. Tangible user interfaces (TUI) aim to give physical form to digital information, employing physical artefacts as representations and controls of the computational data [9, 10, 11]. TUI can be seen as an alternative to GUI (Graphical User Interface) to allow direct manipulations: children will be able to control the system by selecting and positioning physical objects [12]. Games are especially prolific in putting into practice the TUI paradigm, giving rise to a new generation of games which combine traditional physical playing based on the manipulation of toys, with the new possibilities of digitally augmenting the player's area with computer images and audio feedback [13, 14].

This paper presents the design and evaluation of an interactive educational game, called Animals world that uses tangible user interface. The application allows preschool children to learn the animals and their characteristics, through fun and play. Children used physical object (animals) to manipulate the relevant digital information. The developed application is augmented with the QR codes [15] which enable the system to detect selected animal.

In order to investigate the application's acceptance and its impact on children's motivation for learning, the Animals world application was evaluated in real case scenario on a selected set of test users. The results of the evaluation have shown that this method of learning is interesting and at the same time fun and motivating for children.

II. ANIMALS WORLD EDUCATIONAL GAME

Many children learn animals by watching cartoons, collecting albums with stickers, browsing books with pictures of various animals and playing with musical toys that imitate the animals' sound. Motivated by these ideas, we have decided to create an application that will allow children to learn animals, in a fun and interesting way. The application is designed as an interactive educational game that uses TUI for supporting children's play and learning. It has a simple, but colorful design, enriched with interesting characters of animals that attract children' attention.

Background music and sounds are also important part of the game. Background music can be turned on or off, with a help of the button design to be visually meaningful for children,

while the sound emitted by the animals can be used to identify the displayed animal.

The first screen of the game shows three menus that can be used for choosing different kinds of animals: domestic animals, wild animals and both (Fig. 1).

Figure 1. Start menu

After selecting one of the offered menus, the animals of a chosen category appear, on a left side of a screen, one by one. The user can recognize animals by their appearance and sound, and can give the answer by selecting the appropriate physical toy from a set of available toys. Each physical toy has a QR code set on an underside of the toy (Fig. 2). [1]

Figure 2. Toy and QR code

The user needs to put the toy with the QR code in front of the computer camera so that it can be detected by the application. The QR code actually connects the physical world (toy) with the electronic (developed application), thus facilitating communication between the children and the computer. The application reads the QR code and interprets it in a form of an answer. If the answer is correct the user gets 1 point. If the answer is incorrect the user has another chance to answer. If the answer is incorrect in the second attempt then the user doesn't get any points. During the game, the user receives notification for correct and incorrect answers, visually and with sound. The number of earned points are shown at the top left corner of the screen, during the game (Fig.3).

Figure 3. Screen from Animal World application showing the incorrect answer (the selected QR code doesn't correspond to the displayed animal)

When the game is completed, the player can see the total number of earned points as well as incorrect answers, so he/she can put more attention to these particular animals next time. If the player is not satisfied with the result there is an opportunity to play the same game again.

Using points increases the competitive nature of the application, which positively affect users' motivation and engagement [16].

III. EVALUATION

The system usability was evaluated from the end users perspective. The evaluation was conducted in one kindergarten, where a total of 25 preschool children (12 boys and 13 girls) from 4 to 6 years were participated. The children were familiar with the animals and their characteristics. All of them also had some experience using computers.

The experiment was conducted in two steps: training phase – when the evaluator explained the rules of a game, and shows how the game is played, and testing phase – when the actual experiment was conducted.

All children were playing a mixed menu consisted of domestic and wild animals. Time needed for completing the activity (during the first and the second trial), as well as number of correct and incorrect answers (in both trials) were recorded.

To evaluate the system usability we used the well-known System Usability Scale (SUS) questionnaire. The SUS was developed by Brooke in 1986 as a tool for usability testing and has been

[1] QR (Quick Response) code is a form of two dimension bar code that can be read on devices such as a mobile device or a computer which, once accessed, will allow you to complete an action.

used extensively in evaluating user acceptance of various systems. Prior studies have shown that the SUS provides a good and valid method of assessing interface usability [17].

The SUS is a simple, ten-item scale that evaluate users' impressions about the system and their degrees of satisfaction. It uses 5-point Likert scale anchored at 5 = strongly agree and 1 = strongly disagree. Because the participants were preschool children we have used a smileyometer scale (Fig. 4), which is considered to be more acceptable for this age group.

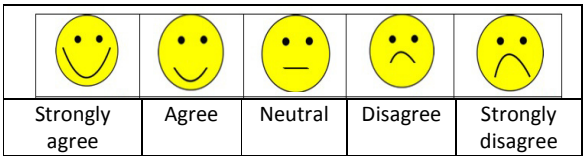

Figure 4. Smileyometer rating scale

The SUS questions elucidate the complexity, functioning, ease of use, self-efficacy, and difficulty level associated with operating the system from the user's perspective. To minimize bias based on agreement or disagreement, odd-numbered items of the SUS questionnaire are given more points for strong agreement, and even-numbered items are given more points for strong disagreement. After users finishing answering the questions, the scale offers a formula which transfers the subjective impressions of users into the objective data information for analysis. The range of possible values is from 0 to 100. The higher the score is, the more useful the system is and the more easily users can interact with it [18].

IV. Results and Discussions

Results obtained during experiment were summarized and processed during the phase of data processing. The mean value and standard deviation, for both trials are shown in Table 1.

From the results, it can be observed that children need less time for completing the level in the first trial, but the error is greater in this trial. During the second trial the time for completing the level is longer, but the error is smaller, which indicates that the children pay more attention during the second trial. This again indicates that the children are engaged and motivated during the play.

TABLE 1. QUANTITATIVE DATA FOR BOTH TRIALS

No	Time (minutes:seconds)		Correct		Incorrect	
	First trial	Second trial	First trial	Second trial	First trial	Second trial
1	05:25	05:38	8	9	2	1
2	04:15	05:12	9	10	1	0
3	04:37	04:22	10	10	0	0
4	05:29	04:45	9	10	1	0
5	04:34	05:10	8	10	2	0
6	05:11	04:49	10	10	0	0
7	04:10	05:11	10	10	0	0
8	04:26	04:32	9	10	1	0
9	04:47	05:11	9	9	1	1
10	05:33	05:47	10	10	0	0
11	04:44	04:54	10	10	0	0
12	05:09	05:11	9	10	1	0
13	04:50	04:25	10	10	0	0
14	05:10	05:05	10	10	0	0
15	05:15	05:18	8	9	2	1
16	04:24	04:36	10	10	0	0
17	05:25	04:25	10	9	0	1
18	04:12	04:25	10	10	0	0
19	05:15	05:41	9	10	1	0
20	04:10	04:45	9	10	1	0
21	04:17	04:42	10	10	0	0
22	05:15	05:37	8	9	2	1
23	05:32	05:23	9	10	1	0
24	04:44	04:58	10	10	0	0
25	05:01	05:15	9	10	1	0
Aver.	**04:52**	**05:00**	**9,32**	**9,8**	**0,68**	**0,2**
St.dev.	**0,01972**	**0,01783**	**0,74833**	**0,40825**	**0,74833**	**0,40825**

To see who has better results by gender, boys or girls, we made a sample t-test assuming unequal variances. Results from this test shows that p-value is less than α (p=0.00046; α=0.05), which means that there is statistically significant difference between the means of two data sets. Thus, we reject the null hypothesis which stated that there is no difference between boys and girls performance, and accept the alternative hypothesis which stated that girls perform better than boys.

Once all participants have finished the game, they fill out the SUS questionnaire. The results showed that the SUS score is 74.87 (which is above the average of 68) with a standard deviation of 9.88. The SUS scores ranged from 62.5 to 92.5. SUS scores were classified into four major categories: exceptional (scores in the 90s or above), good (scores in the 80s), acceptable (scores in the 70s), and minor usability issues (scores below 70).

On the basis of this classification, 16 percent (n=4) of the study participants had exceptional usability scores, 20 percent (n = 5) showed good scores and 36 percent (n=9) showed acceptable scores, while 28 percent (n=7) had a minor usability issues.

TABLE 2 RESULTS FROM SUS QUESTIONNAIRE

Candidate No	SUS Result
1	80
2	77.5
3	82.5
4	67.5
5	62,5
6	77,5
7	70

8	75
9	62,5
10	70
11	82.5
12	65
13	70
14	70
15	92.5
16	82,5
17	62.5
18	92.5
19	82,5
20	62.5
21	92.5
22	92,5
23	75
24	65
25	70
Average	**74.87**

From the results, we can see that this kind of interactive interface is well accepted by children. Using TUI as an interface for this game gives a new dimension to the game, making it very interesting and novel. Anyway, there are still some directions for improving the application. Participants commented that the game would be more interesting and challenging if they were more animals included in each of the groups. Some rare animals should be also included, in order to keep the attention of older children, because the game was too easy for some of them, and they were not willing to play the game after second trial. They said that the way of interaction is interesting for them, but they would like to play a game that would be more complicated and would require more mental effort.

V. CONCLUSION

It is commonly believed that physical action is important in learning. TUI used this concept to increase the engagement and motivation during the learning process. Tangible objects, used during TUI interaction, are thought to provide different kinds of opportunities for reasoning about the world.

Guided by these findings we have developed an interactive educational game that uses tangible user interface. The application allows preschool children to learn the animals, their characteristics as well as sounds they emit. The application was evaluated in one kindergarten. The results revealed that children have a positive impressions about using physical object for interacting with the game. They also said that the game is very interesting, useful and easy to use, and they wish to continue to learn through play.

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