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TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN**



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INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT



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Using Educational Games for Learning Natural Science

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Abstract – The intrinsic connection between play and technology is becoming increasingly significant in early years education. This is especially true for children who belongs to the Generation Alpha. Gen Alpha generation is greatly influenced by technology, and they seek personalized and interactive education delivered through technology. Game-based learning offers a new way of learning, which conforms to the habits and interests of Gen Alpha. This paper provides an overview of a custom developed educational game and its applicability in the teaching of natural science and also investigates the outcomes obtained through game-based learning, in primary school children.

Keywords: game-based learning, educational games, natural science

I. INTRODUCTION

Technology use in education is not new. There have been many instances of technology-based games used to engage students at various skill levels (some popular examples from the 90's include: Math Blaster, Spyro The Dragon, Carmen Sandiego, Civilization, RollerCoaster Tycoon, SimCity etc.). The adoption of technology and its proper use, especially in early childhood education, is of global interest. We are living in an age where the technology used represent yet another environment in which children are expected to learn. This is especially true for children who belong to the Generation Alpha (Gen Alpha) - a term coined by social researcher Mark McCrindle [1].

Generation Alpha is composed of individuals who were born at the crossover of Generation Z and the new age, or to put it in another way - those born after 2010 [1]. In fact, their appearance coincides with the launching of iPad and creation of Instagram. The most important about this generation is the digital environment they are being born into.

Since technology is part of their everyday lives, it is natural for them to learn through technology [2, 3, 4, 5, 6]. The technology can

support educators in their day-to-day activities and make it easier for them to bond with young generations [7]. Gen Alpha are digital natives that find gaming as an especially important part of their identity. According to them, games can make learning fun and provide them with educational content in a medium they understand and love. Game-based learning provides an opportunity for teachers and educators to incorporate active learning into their lessons, promote students' interest and engagement, increase motivation, and provide immediate feedback on performance [8]. The fun of gameplay is a critical part of why this method is so successful with children. According to educators, games can help disguise the learning of essential but challenging skills that kids might otherwise resist.

However, game-based learning environment do not set enjoyment and fun as its primary objectives, but rather its environment includes educational content in a challenging and enjoyable way which promotes active learning. Educational games are based on four main elements which are: engagement, autonomy, mastery, and progression [9].

Engagement takes place when students are actively involved in their learning. Sometimes educators might think that students are engaged because they are behaving well, however, engagement is much more than "passive" student participation. According to Schlechty, if the student sees the activity as personally meaningful and worthy of trying to get it right, it means that the student is engaged [10]. Engagement is closely related to motivation; higher motivation tends to lead to higher engagement and vice versa. Numerous studies have reported the increased level of engagement when students were involved in digital game-based learning [11, 12, 13, 14, 15], as well as students' high motivation when playing educational games [16, 17, 18, 19, 20, 21]. Educational games allow player to be more autonomous, to think critically, make decisions and take appropriate actions, based on those decisions. Mastery, as a characteristic in

educational games, is the degree of repeatability of players' specific actions in order to gain full control of the game. And finally, progression, refers to the reward players receive for their success. It includes, levels, stars, points, badges etc., that create a high situational interest. In fact, progression is the main motivation for players to accomplish the game's goals while learning at the same time [22].

In view of the variety of games, it becomes important to identify the effect of educational games on learning outcomes. This paper provides an overview of a custom developed educational game and its applicability in natural science teaching. It also explores learning outcomes in the game-based learning context.

II. NATURAL SCIENCE EDUCATION IN PRIMARY SCHOOL

Rapid technological development, scientific advances and innovation on one side, as well as various socio-economic factors such as the process of globalization, economic crisis, permanent migrations, demands for skilled and efficient workforce, on the other side have huge influence in shaping and defining the basic set of fundamental skills that the students need to have in order to be able to respond to the demands and be competitive on the market. Multiple scientific studies have been conducted in various countries across the world and their conclusions have one common denominator, namely they are evidencing that the skills in science, technology, engineering, and mathematics are of fundamental importance in the 21st century.

Acknowledging the need for STEM (Science, technology, engineering, and mathematics) skills and recognizing its importance, leads to the conclusion that development of these skillset should be stimulated since early childhood, and it should be an intrinsic part of the education system.

Although children get aware of the nature and are capable to identify some phenomenon or distinguish between species, their knowledge is not exact and deep. Therefore, it may be useful and beneficial to create dedicated pre-school, and later on in primary school, programs that will help in brothing their knowledge in natural science.

Currently, the primary education system in Republic of North Macedonia, integrates the natural science education fundamentals in several subjects related to the development period of the child and following the nine-year primary education concept.

Biology, physics, chemistry, geography, but also ecology and environment are part of these courses. Moreover, multiple reforms in the primary school are aimed at supporting the integration of natural science and social science with the final goal to develop the required skillset during primary school.

However, many analyses and studies from both academia and business world show that there is a huge decline of students' interest about natural science subjects, absence of deep understanding, lack of capacity to apply the gained knowledge and worrying apathy for studying natural sciences.

Therefore, in addition to the reforms of the curriculum, mechanism for increasing children motivation becomes one of the biggest problems. Motivation should be considered an intrinsic part of learning and education. One of the key drivers for increasing the children motivation are the teachers. In this process they may use and rely on various tools. However, among variety of available education tools for increasing motivation for learning natural sciences, digital tools with an emphasis on educational games, are the most preferred ones by Gen Alpha.

In this context, multiple education games have been developed and integrated in the national education platform called Eduino.

EDUINO is a web-based collective platform, created using the design thinking methodology as well as the principles of co-creation and collective action, involving more than 1200 teachers, educators and parents (Figure 1).

Although multiple scientific studies evidenced that game-based learning has the potential to increase the learning motivation in primary school children, this study aims to provide scientific evidence that it is valid and applicable to natural science education.

To advocate that carefully tailored dedicated education games could be an efficient tool for enhancing the natural science learning, we have followed some basic game-based principles and characteristics. As an outcome of this process, a dedicated education game entitled "Knowledge hunter" (Figure 2) for self-paced learning and evaluation of knowledge was developed. Later on, we have evaluated its impact on the learning process.

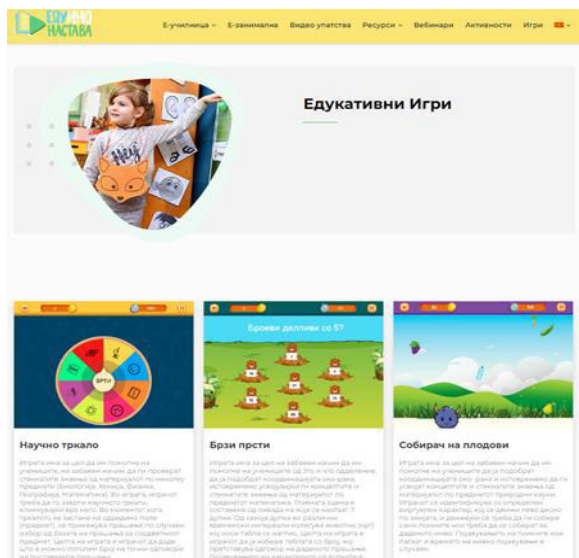


Figure 1. Education games developed and hosted on the EDUINO collective platform



Figure 2. Education game “Knowledge hunter” developed for game-based learning of natural science

III. METHODOLOGY AND RESULTS

The research was conducted in a primary school in the capital of North Macedonia - Skopje. 32 pupils from 5th grade, at average age of 10.2 years were selected for this study. 16 of the pupils included in the study were males, and 16 girls. This study was conducted at the end of first semester after the pupils were thought natural science material foreseen for that semester.

The single group pre-test and post-test design was used in this study. Pre-test and post-test were executed before and after the use of educational game. Pupils’ achievements were assessed, both before and after the applied game-based learning process. Assessment was done using dedicated tests that were conducted to obtain pupils scores.

The main goal of our study was to reveal the influence of game-based learning on learning

natural science. Therefore, we have posed one basic research question:

Does using game-based learning enhance primary education pupils’ learning of natural science?

We have tried to answer the question, using the scores of each pupil in pre-test and post-test. The scores were then normalized on the scale from 0-100%. Obtained dataset was processed using IBM SPSS Statistics Version 23 application.

No missing values, in both pre-test and post-test scores, were found and therefore, responses from all 32 pupils were taken into account. The obtained results show that the scores for the pre-test were varying in the range from 34 to 82, while the mean value was 60 with a standard deviation of 9.42. For the post-test the scores were varying in the interval from 67 till 98, with a mean value of 82.69 and standard deviation of 8.86.

The descriptive statistics of the obtained results is reported in the Table 1.

As one may observe, there is significant shift of the mean values between pre-test and post-test scores. Moreover, this is valid also for the minimum and maximum obtained scores. This may lead to a conclusion that the game-based learning has a positive impact and enhanced the learning of the subject natural science.

TABLE I. DESCRIPTIVE STATISTICS

		<i>PreTest</i>	<i>PostTest</i>
N	Valid	32	32
	Missing	0	0
Mean		61.5000	82.6875
Std. Error of Mean		1.66438	1.56669
Median		60.0000	84.0000
Mode		60.00	79.00
Std. Deviation		9.41516	8.86253
Variance		88.645	78.544
Range		34.00	31.00
Minimum		48.00	67.00
Maximum		82.00	98.00

Sum	1968.00	2646.00
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IV. CONCLUSSION

Designing and developing educational games is more than creating games for playing and entertaining the pupils. It is a process that should lead the student through the material towards an end goal. The carefully designed and developed education games can significantly motivate the pupils and enhance the learning of natural science.

The outcome of this study shows that the game-based learning can have a positive impact on student outcome as indicated by the increase in scores from pretest to post-test on the natural science knowledge assessment. These results correspond to the use of digital games in game-based learning in previous studies. Moreover, the use of the educational game, also enhanced learning motivation and increased students' interest in learning of the subject natural science.

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