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CREATION OF CONTENT-BASED EDUCATIONAL COURSES AND ATTRACTIVE APPROACH FOR ACQUIRING NEW KNOWLEDGE IN THE FIELD OF APPLIED PROGRAMMING BY USING UGVS

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Abstract: *We now leave in technological world where everything around us become digital. The globalization of technologies makes us rethink the way children learn, educate and entertain. In this paper, the authors provide an attractive approach for acquiring new knowledge and skills by creating content-based training courses, which combines all of the above-mentioned activities – learning, education and entertainment. A different type of unmanned ground vehicle (UGVs) are going to be used in the course. They have API interfaces that will allow students enrolled in the course to make custom configuration and set missions for implementation via block-based programming approach. The platforms also have low level programing capability, which can be used, for advanced training in order to enhance student's programming skills. The authors believe that "*learning by playing*" method for acquiring new knowledge will have better success rate.*

Keywords: *block-based programming, API, UGVs, Robomaster, Microbit*
JEL Codes:

I. INTRODUCTION

The technological boom has changed many aspects of our lives. The globalization of the technologies make us to rethink the way we learn, educate and entertain. In this paper, we propose a modern way to improve education by creating attractive learning courses, which are based on content and practice. We start the paper with a brief comparison between the traditional education methods and the modern ones, which are content-based, and relies on practice. Fig. 1 illustrate the comparison between the traditional and modern education. As it can be seen in the figure traditional education is defended as a passive way of gaining knowledge.

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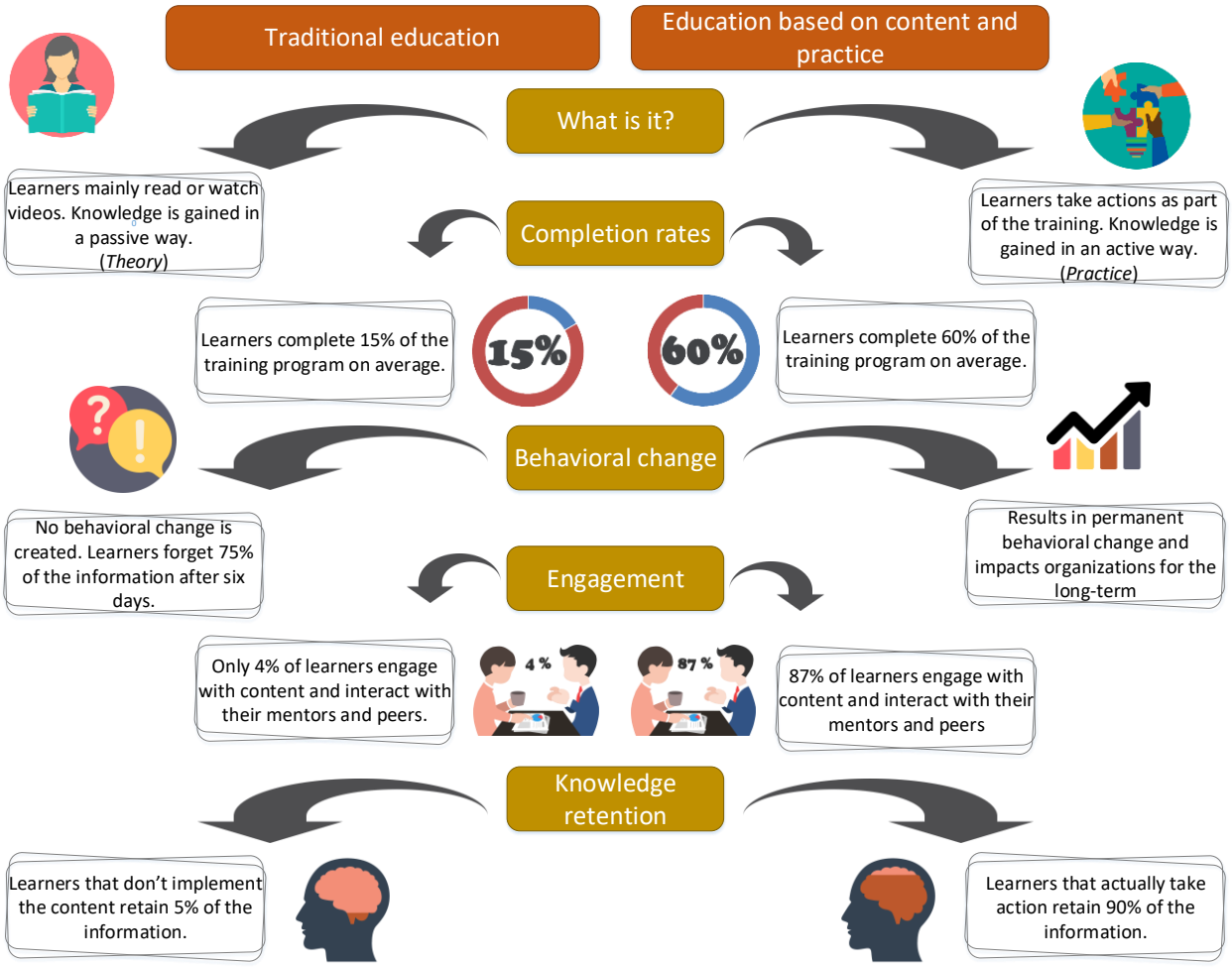

Fig. 1 Comparison between traditional education and education based on content and practice

The learners simply sit down together and listen to the teacher or another speaker who will recite the lesson. The learning materials are mainly text-based books and videos. On the other hand modern education teaches about the skills required today (for example skills of science and technology). In addition to the listening and watching videos, the modern education also includes writing, visualizing, imagining, and practicing skills. The methodology used for teaching in the modern educational systems is very interactive. Statistics show that approximately 87% of learners are engaged with content and interact with their mentors and classmates. In contrast, only 4% of students enrolled in traditional learning courses are engage with content and interaction with their mentors and peers is very poor. Learners that don not implement the content retain barely 5% of the information. On the other hand, learners that actually take action retain 90% of the information.

II. GAMIFICATION IN EDUCATION

In the paper, we also focus on a process also known as gamification [1]. The term gamification is generally used to denote the application of game mechanisms and strategies in non-gaming environment with the aim of improving engagement, organization productivity, training and many more. Gamification is not just playing games. In recent years, it has become extremely popular in the field of educations because of its capabilities to unlock student's potential by making learning more motivating and engaging [2]. The effective implementation of gamification in the education can lead to a number of improvements [3]. Some of the benefits of implementing gamification in the education are emphasized below:

- *Better learning experience* – the high engagement during the training leads to achieving better results and improving academic performance. A good gamification strategy with

high levels of engagement will increase the recall and retention. The better learning experience is obtained by combining both fun and learning during game playing.

- *Better learning environment* – the gamification provides an effective learning environment and help students practice real-life situations and challenge their skills in a safe environment. This leads to a more engaged learning experience that facilitates better retention of the knowledge.
- *Instant feedback* – providing instant feedback enables learners to test their knowledge or to understand what knowledge the need.
- *Prompting behavioral change* – receiving "awards" would certainly make the training great. By playing games participants usually receive points, avatars, badges, reputational levels and ranking that more or less motive students and stimulate learning process. This prompts to behavioral change. Behavioral change is very important since the behavior is a function of the individuality and surroundings. The individuality is determined by the abilities of a person, which are not fixed – they are acquired with knowledge and skills after the learning process.

Even that the gamification has some drawbacks, which we are not going to discuss, it is widely used in modern educational systems because of its capabilities to engage people, motivate action, promote learning, and solve problems [4].

III. STEAM EDUCATION

The educational course that is proposed in the paper is in the field of STEM education. Recently the STEM education has gain a lot of popularity since it is related to the most important field of education: Science, Technology, Engineering and Math. In most recent discussion about STEM education critics adds one additional subject – ART and makes STEM a STEAM education. The Art is also important subject, which can be integrated to the above-mentioned ones, because it is related to the ability of teaching creativity and dexterity. STEM or STEAM is not just a combination of all of the above subjects. According to teachers and researchers, STEAM is a philosophy, which is focused on teaching knowledge and skills in a way that resembles real life.

On the question, why STEAM education is so important, authors in [5] gives the following answer. According to the Department of Commerce in USA, STEAM occupations are growing at a 17% rate, while other occupations are growing at a 9.8% rate. Not only in the USA, but also around the word, science, technology, engineering, and mathematics employees play a vital role to sustain the growth and stability of a country's economy.

Introducing STEAM knowledge to kids helps them become more creative and critical-thinking as well as helping them learn to solve problems [6]. STEAM education is important for students because it promotes independent thinking, comprehensive approach and creative problem-solving skills. In STEAM education students usually has a project they are working one. This trains the students thinking ability, working in teams and problem-solving skills.

The course that we have developed is mainly oriented to the young students and kinds and is strongly related to STEAM education. In the course, the enrolled students will be provided with robotic kits that are specially designed for educational purposes. Developing a robotic course has many considerations [7]. One consideration is the hardware platform that is going to be used. Different robotic kits are discussed in the next section. Another consideration is the duration of the course, but this consideration depends on the average age of students enrolled in the class. For example, for kids at the age of 10 to 14 years old probably the best schedule time for classes will be two times per week for an hour class. Another important think is how the training materials will be provided to the students. We have set on-line platform for e-learning where student may read and watch material on demand. On the other hand, teachers have prepared presentations with training materials that are presented in front of students during the classes. All of the materials are content-based and provoke students to practice skills. A screenshot of the on-line platform for course materials is provided in fig. 2.

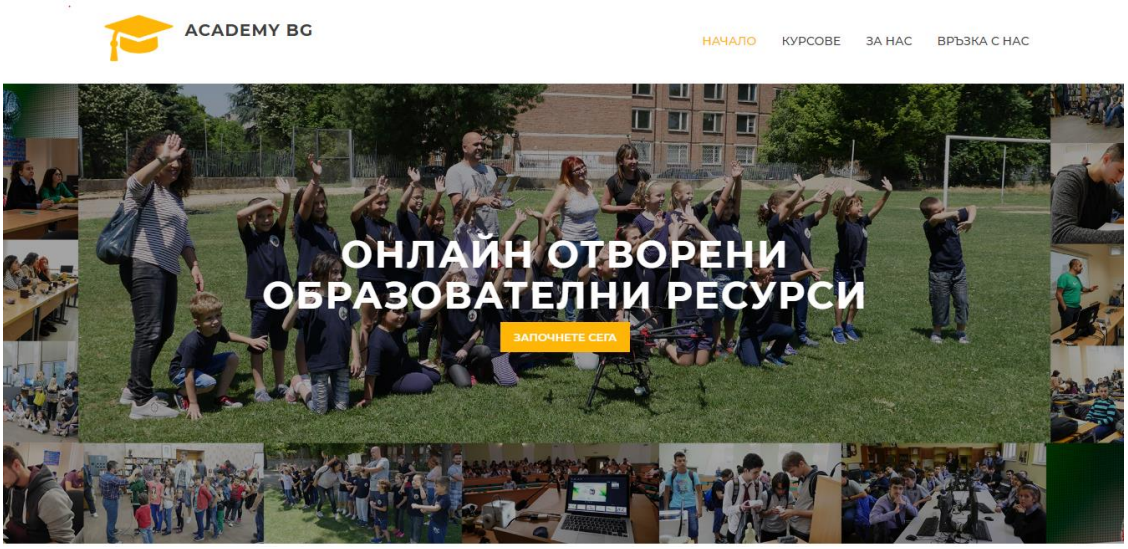

Fig. 2 On-line educational platform for e-learning and STEAM education

IV. ROBOTIC KITS

This section of the paper reviews available educational robotic kits that are applicable in the course that we have developed. Currently on the market, there are many robotic kits and the market will become more and more flooded with different solutions because of the popularity of STEAM education. We not going to make review of all founded in the market but instead only for the popular ones, and the robotic kits used in our course.

Popular robotic kits

A. LEGO Mindstorms

Probably the most important robotic kit available today is LEGO Mindstorm. The official mission of LEGO is *to inspire and develop the builders of tomorrow* [8]. LEGO Mindstorm kit has different version since in initial release on the market. They are mainly differ by complexity – each successor has increased complexity, thus allowing the development of more sophisticated and complex robots both from mechanical and the control software point of view. The most popular and newer version of LEGO Mindstorm is called EV3 and it was released in 2013. Like the other kits LEGO Mindstorm EV has a Lego Intelligent Brick, which serves as the I/O interface, communication interface and computational unit. The last version of LEGO Mindstorm is illustrated in fig. 3.

Fig. 3 LEGO Mindstorm EV3 educational robotic kit

There is rich choice of programming tools for the Mindstorm kit. Besides the official National Instruments GUI-based software, the most widely used languages include the RobotC, NBC and NXC, which are C-based environments with extensive LEGO Mindstorms libraries. All of the robots used in the educations comes with opportunity to be graphically programmed, thus making student more easily get familiar with the basic of programming.

B. RobotLab

Another hardware platform that can be used to transforms every class into a STEM-class is a RobotLab. RobotLab is a platform that is created for teachers by teachers, which use robots to enhance learning, understanding and information retention. RobotLab uses different robotic kits, computer science, coding and programming in order to help learners to acquire skills like problem-solving, critical-thinking and collaboration. The most up to date robots that the company announced is called Nao Robot.

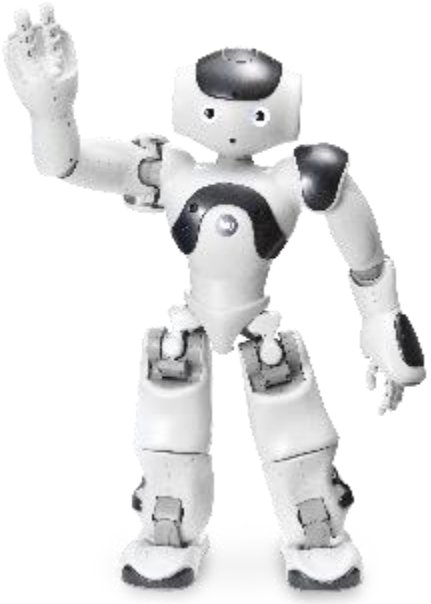

Fig. 4 Nao Robot from RobotLab for education

The Nao Robot is shown in fig. 4. It is a hands-on learning platform for teach coding as well as core subjects like: reading, writing, math, pre-algebra, geometry, algebra, trigonometry and pre-calculus. Nao is autonomous, programmable humanoid robot that is controlled by specialised Linux-based operating system. The OS powers the robot's multimedia system, which includes four microphones, two speakers and two HD cameras. All of the components are used for implementing artificial intelligence for voice recognition, sound localization, text-to-speech synthesis and computer vison – for face and shape recognition.

Robotic kits used in the course

A. Micro: Maqueen for micro:bit

In our lab we have bought 8 Micro:Maqueen robotic kits with micro:bit controller for the course (fig. 5). By taking the kit student can assemble mini robot, that is controlled by micro:bit (programmable board). The robot is powered by two gearboxes with wheels and it is equipped with sensor that allow a robot to follow a line, and ultrasonic sensor for measuring distance. The robot was design as educational kit for STEAM education. It offers interesting function to students and also plugins and games that allow students to learn programming while having fun. The students can program the robot via graphical editor, called MakeCode. The editor is free, open source platform for creating engaging computer science learning experience that support progression path into real-world programming. It is developed by Microsoft and it is applicable to other robotic kits. The MakeCode editor has three main components: simulator, block editor and

JavaScript editor. The simulator provides students with immediate feedback on how their program is running and makes it easy to test and debug their code. The block editor on the other hand is perfect beginning for students new to coding. The programs are constructed via coloured blocks that are dragged and dropped into the workspace. The next level of programming learning is moving toward JavaScript. It is full-featured editor with code snippets, tooltips, and error detection to help student learn more efficiently [9].

Fig. 5 Micro: Maqeen educational robot

A. DJI RoboMaster S1

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Fig. 6 DJI RoboMaster S1 educational robot

The robot comes in parts and the first task of it owner is to assemble the robot. This is very useful task since it allow student to train its dexterity and creativity. Unfortunately, the assembly is task that is conducted only once – during the initial setup of the robot. When the robot is assembled, it is time to learn how to program it. This robot also provides graphical editor for easy learning of programming. Behind the graphical blocks for programming stands a Python scripts for advanced teaching.

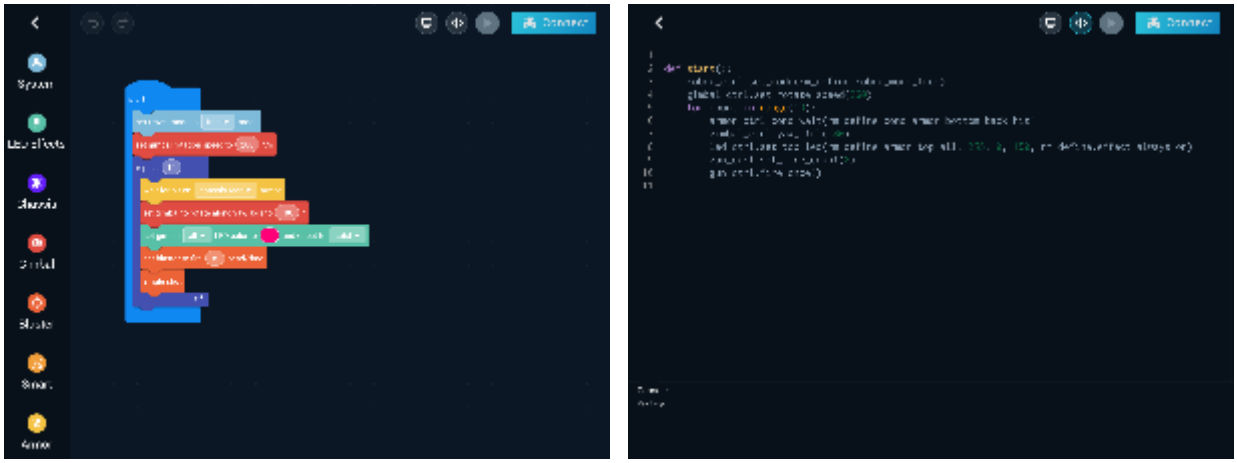

Fig. 6 An example lab given to students enrolled in the course

Fig. 6 shows an example code given to students during the class. The code is very simple but is good for beginning. In consist of several block that implement some task. The first block for example set the travel mode to free so that the student will be able to drive the robot during the mission. The second block assign a speed for gimbal rotation and after that two block there is one logical block that implement a loop. It is a repeat loop, which implements the code in its body ten times. The code is interactive because in consist of elements that require student to perform something before the code to continue. For example the yellow block when implemented will wait for "hit on chassis rear armor" to continue the code. If the chassis rear armor is hit then the gimbal is rotated to specified degree, than the LED lights of the gimbal are changed to purple as specified in the block and the blaster fires 8 bead per time. The program is also available as Python script, which is used for advanced study of programming.

V. CONCLUSION

Teachers have to apply teaching techniques that allow students to be active participants with strong motivation and engagement in order to implement active learning. With this paper, we propose interactive courses that are based on educational robots for STEM learning where the enrolled students will have fun by playing with the robots and acquire knew knowledge by setting up the robots to implement different tasks and missions on demand. We believe that the robots can nourish the interest of children in science and logical thinking.

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Official Web site of MakeCode, powered by Microsoft: https://www.microsoft.com/en-us/makecode

DJI RoboMaster S1 web site: https://www.dji.com/bg/robomaster-s1?gclid=-Cj0KCQiAtf_tBRDtARIsAIbAKe0SmoQRC1bHIhN14aWs3Trj0iEl3A1luIOpGHczva-Nsq3Iu-w_VFB4aAkHIEALw_wcB