

ROBOTICS IN SUPPORT OF OBTAINING KNOWLEDGE IN COMPUTER SCIENCES BEFORE UNIVERSITY STUDIES.

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Abstract

Gaining good knowledge in computer science before university education is considered a necessity in the most developed countries of the world. Currently, in our country, the education of ICT in pre-university studies begins from the fourth grade of primary education. How interested are students in acquiring this knowledge? Do they have difficulty in gaining programming comprehension? Would the use of robotics help in their motivation and gaining good knowledge in the field of programming? When applied to education, robotics and simulators can change the way students learn and ultimately create a more well-informed and systematic student.

Keywords: *robotics, programming, Arduino, motivation, education, knowledge, computer sciences, development, simulation.*

1. Introduction

Technology has played and continues to play a major role in changing the education environment in so many schools that implement it. The appropriate use of technologies which support teaching and learning process is an innovative, more productive and more interesting way. Combining new technologies with efficient methods and tools will help us increasing students' skills, attitudes and knowledge. As a result, high school students will be more competent as we live in the age of information technology and we will gain lifelong learning skills. Acquiring knowledge through technology, mainly in the 12th grade of secondary education in programming's field is becoming more and more difficult for students.

A student can learn to explain and understand a programming concept, e.g., what does it mean a pointer but still does not use it appropriately in a program. Students may also know the syntax and semantics of individual statements, but they do not know how to combine these features into valuable programs. Even when they know how to solve the problem manually, they have difficulty translating it into an equivalent computer program.

We must therefore incorporate robots into

education in order to stimulate a stronger interest and gaining the best knowledge in the field of programming.

When applied to education, robotics and simulators can change the way students learn and ultimately create a more well-informed and systematic student.

2. Problem definition

This paper initially aims to analyze the interest that is being shown every day by primary cycle's students to acquire knowledge in the field of programming. Based on the fact that students are facing difficulties in programming, mostly in the use of variables and cycles in coding has come to the aid of robotics as an efficient tool in motivating them and gaining good knowledge in programming's field. In the last part of this study, in order to gather as much information as possible, about how technology affects and how it helps students to acquire new knowledge, we have conducted some questionnaires for the age group 7-10,11-14,15-18 years old near the center Albanian ICT Academy, which gives the opportunity to all enthusiasts to increase their comprehension making available laboratories with innovative

technologies.

Furthermore, on the collected data from the questionnaire we created the database on which later generated graphs and tables in the statistical software R. Based on this questionnaire, the idea was first born to make a comparison about the students who are already using robots for coding and how much they wanted to program before using the robots to obtain knowledge in programming.

3. The use and impact of robotics in learning

How to use robots in education

The use of robots is becoming progressively common around us - in our workplaces, but also in our schools. Although the use of robots is quite new in the field of education, some experts predict that within the next ten years they will be used regularly in classrooms around the world.

Many types of robots are being involved in education. They range from simple “microprocessors on wheels” (boe-bot) robots, to advanced tools (Mindstorms) to humanoids (human-like robots).

The choice of robot is usually dictated by the study area and the age group of the student.

Robots or small tools are especially used to teach us computer science. These tools can be physically manipulated by allowing students to learn a variety of disciplines. However, the human form of humanoids makes them easier to interact with, and is therefore often used for language lessons.

Education is one of the areas of society in which the artificial intelligence has the most positive impact. How will new technologies in education change, and how will artificial intelligence significantly affect students in relation to their learning processes?

Instructions for implementing robots in the classroom

Robots can be amazing teaching tools, but it is important to implement them properly for the best possible results.

Four basic guidelines when planning to use robots in the classroom:

Have a clear goal: Identify the specific learning goal you want the robot to help you achieve and then use the robot only for that purpose.

Use robots to help with repetitive tasks: Today’s robots are becoming very good at repetitive tasks, which can often be boring and time consuming for humans.

Make sure children do not become too attached to the robot: Because children need a lot of human social interaction, it is important to make sure they understand that the robot is there to help them with learning, rather than being a friend or companion.

Follow ethical guidelines: When using robots in the classroom, it is essential that you follow proper ethical guidelines. As technology becomes more powerful every day, the role of ethics is becoming more important, and this applies to the use of robots.

Following the above guidelines will help to maximize benefits for students and teachers, ensuring that robots are not misused in any way.

Robots in Education - Today

Did you know that some schools around the world have already started testing the use of robots in the classroom? For example, in the Finnish city of Tampere, schools have begun testing a social learning robot called Elias, which is mainly used for language and math teaching. As entertainment is becoming an important element of effective learning, Elias is programmed to dance and encourages students to sing and dance as well. Elias can also speak and understand 23 different languages. So far, testing of this robot is going very well, with most students reacting very positively to it. **Here are some of the benefits Elias promises to provide:**



Figure 1. Elias robot.

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Provides safe and neutral learning environment: Elias as shows in Figure 1, will never judge or laugh at anyone who makes mistakes. This is especially helpful for children who are shy or do not learn as quickly as others, allowing them to focus on learning without any shame or peer pressure.

Do not tire of repetition: This robot never goes impatiently, allowing children to feel free to learn at their own pace. Students can get everything they need to learn something new, making as much effort as possible to get something right, and robots will never make them feel like they are taking too much time.

Asks questions at the student level: Elias can personalize each child's learning on their own personal level. This is usually quite challenging, even for the most experienced teachers.

Encourages students to participate: It encourages students to actively participate in the lesson. This feature is vital, as getting motivated and engaged children helps them achieve their learning objectives much faster.

Provides feedback to teachers: Elias provides teachers with feedback on each student's progress, keeping them better informed and allowing them to make appropriate adjustments. This helps teachers do the job more efficiently, which improves the overall learning experience for students.



Figure 2.Irobi robot,Thomas Hawk / flickr, CC BY

Humanoids such as Irobi robot, Figure 2, have the ability to provide real-time feedback and their physical shape increases engagement. This often leads to a personal connection with the student, which research shows can help resolve issues related to the shyness, reluctance, confidence and frustration that can arise when dealing with a human teacher.

For example, a robot will not get tired no matter how many mistakes a child makes. Humanoid robots are being widely used in the classroom in many countries, including Japan and South Korea.



Figure 3.Pepper robot from Softbank Robotics to Japan. Amber Case / flickr, CC BY.

For example, Nao, Pepper, Figure 3, Tiro, IROBI and Robovie, are mainly used to learn English.

Telepresence - where a teacher can be remotely connected to the classroom via a robot - is also being used as a way to teach English to students. The teacher can participate in the class by being practically present through a display mechanism. In some cases, the screen is embedded in the robot torso.

Western countries have been far more reluctant in recognizing the integration of robots into the classroom, with privacy, developmental barriers, rising unemployment, and technical shortcomings identified as the main obstacles.

Robots as teaching tools

Humanoid robots are still a fair way to not be placed autonomously in schools, mainly due to technological constraints such as incorrect recognition of words or emotions.

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However, the goal of most researchers in robotics is not for robots to replace teachers. Rather, the design goals of most robots should function as a classroom aid and increase the added value they can bring as a stimulating and engaging educational tool. In order to facilitate the integration of robots in the classroom, we need to be able to provide convenient interconnection mechanisms (software, hardware or even mobile applications), allowing the human teacher to control the robot with minimal training.

Facilities offered by the use of robotics in teaching

Four main themes were discovered where the robot was able to assist in the behavior or development of the child.

Topic 1: Problem solving skills, team skills and collaboration

Studies by Barak (2009) and Varney et al. (2012) were developed to investigate how the entry of robots could influence education change, particularly to help prepare children with 21st century skills and increase student interest.

The study conducted by Barak (2009) showed that high school students were able to come up with creative solutions to problems and could benefit from working on project-based programs. Robotic kits such as the LEGO Mindstorm allowed students to work in teams as they completed their projects in small groups.

Robotics was further seen as an effective tool for developing “team skills” in students (Varney et al., 2012). The use of robots in various activities with young children supports constructivism as a teaching method.

Students discuss, solve problems, work with their colleagues, and combine their knowledge in order to build their own robots. In Chang et al. (2010), the results from the study further argued that robots can create an interactive and engaging learning.

Robots in elementary school helped foster collaboration and problem-solving skills in

children when they became involved in the process and building their own facilities for their robotic projects.

This was further emphasized by Hong et al. (2011), where robots allow children to engage in deep reflections when solving problems and collaborating with their peers, who have enhanced their learning experience.

Topic 2: Achievement results, science concepts, and ranking skills

The study conducted by Baker and Ansoorge (2007) examined the results of students’ achievements with the use of robots in their science program. Robots were found to be effective in teaching students science 9-11 years old, engineering and technical concepts. Results from another experimental study conducted by Kazakoff et al. (2013) supported the use of robotic programs such as CHERP, a tangible program that helped increase skills for kindergarten children.

Topic 3: Articles that have reported on skills development

Williams et al., 2007 The study shows a significant difference in the acquisition of physical knowledge, but not research skills

Barak, 2009 The study shows that students often come up with quick creative solutions to the problem of learning with robots.

Highfield, 2010 The score showed significantly that they showed perseverance, motivation and reaction.

Whittier & Robinson, 2007 The results showed that all students received significant benefits in understanding.

Slangen et al., 2011 Robots helped students to manipulate, reason, predict, hypothesize, analyze. Robots were also used to develop and enhance learning the concepts of science, technology and problem solving, which was further supported by Barak (2009) qualitative analysis of observations, interviews and reflections of students working on their projects.

In the Highfield study (2010) they showed that robotic toys could be catalysts for solving mathematical problems through multiple participation by integrating and interconnecting concepts and skills through dynamic tasks.

Topic 4: Development of language skills

In the study of Chang et al. (2010), a humanoid robot was used to teach a second language in an elementary school.

The results showed that robots could create interactive and engaging learning experiences with children with whom they responded with high motivation. The use of robots for language development was found to be useful as well as allowing the demonstration of highly mobile behavior.

Sugimoto (2011) used the robot for storytelling, where the robot was used in teaching students and enabled children to learn in an environment. The children engaged strongly in expressing the story and acted in a coordinated manner.

Children's reaction to the design or appearance of the robot

In addition, a study conducted with 184 (Beran et al., 2011) showed that a significant proportion of children describe the cognitive, behavioral characteristics of robots.

159 children were asked to rate 40 images of the robot through questionnaires to investigate how children perceive the robot's appearance (Woods, 2006). The study showed that children perceive robot goals and robot-based presentation skills.

In education, the use of robots has the potential to help children develop a variety of academic skills such as the science process, developing mathematical concepts, and improving achievement outcomes (Barker & Ansorge, 2007; Williams et al., 2007; Highfield, 2010).

In addition, the introduction of robotics in the curriculum also increases the interest of students. As reported in Chang et al., 2010, the use of the robot in education allows children to engage in interactive and engaging learning experiences.

Learning coding at a young age

Learning coding at a young age can lead your child to a successful life. What is coding for kids? What are the appropriate ages to learn coding?

Coding, or computer programming, is a creative process performed by programmers to show a computer how to do a task. Coding involves writing software using programming languages. Coding for children is usually taught using content that is of high interest when creating projects that involve creative input.

In short, coding for kids becomes like a kind of game making it fun for kids to learn!

Since coding can be done in the form of games, children can start learning coding with visual blocks or text coding classes that are designed for younger ages from the age of 5.

What are the best programming languages for children?

Many parents prefer to start blockchain visual platforms with new students. Some, however, prefer their children to write from an early age.

It always depends on what field you want your child to learn to program. If you want your kids to create websites, then you can run them in HTML, CSS and JavaScript, if you want to teach them how to make applications, you can run them in Java or Swift. If you want your kids to move towards robotics, Lua and Scala are languages that are more accessible to children as well.

Another language that has grown in popularity is Python.

Python is a written language that many consider one of the easiest to learn. Python was used to create Instagram, YouTube and Spotify, and students can even use it to develop a website using Django, a popular web framework.

Finally, learning coding from an early age is a very good idea. The earlier children learn, the more time they have to reach the highest peaks and find jobs in various areas of programming.

4. Test results of how robots affect children ICub Research Robot: Programmed to learn

ICub Figure 4, sees through cameras what is shown to it. Through microphones he can hear what is being said. The robot is programmed to react to changes, such as movement and a change in sound level. Schillingmann points to one of the graphs: "Here you see what data the iCub is analyzing. It records when something changes within the frame that it distinguishes. Be careful when I start talking and when I stop talking."

Schillingmann says that the principle applies here: the more changes in the starting situation, the more interesting it is for the robot and the faster it will intertwine the recorded signals. In this way he learns step by step how to put in context the visual and audio information transmitted by people.

The energy for programming makes it difficult to use robots

CoR-Lab computer scientists have been collaborating since 2007 with engineers and neuroscientists, psychologists and linguists in the construction of machines that adapt to human behavior and are able to learn from humans. This is because the more ubiquitous robots are in the workplace or at home, the more necessary it is for them to interact with humans and be flexible. It is true that a number of different models of home robots or service robots are currently being tested, but in most cases they can not be used effectively, says Sven Behnke, professor of practical computing at the University of Bonn.

He himself is developing with Coseron students (and knows its limits). "For example, at the World Robotics Championships last year Cosero cooked omelets," says Behnke. The robot grabbed a bottle of egg juice, lit the cooking plate, on which was a pan, and poured the egg mass into the pan. "But this is a rigidly programmed course of action, which requires a lot of things: for example, to have a cooking plate the same as this, and not another." So this thing may look nice and show what is possible, but it is far enough away from use, says Behnke.

Listen and Imitate: Robots learn like children

On the other hand at the CoR-Lab in Bielefeld the foundations for the development of the cognitive abilities of the robots themselves will be explored. "The people who will be dealing with robots in the future will not all be robotics experts," says Lars. Robots can be programmed to distinguish what humans naturally know: talk and demonstrate, says Schillingmann. That is why iCub basically learns like children from adults, he adds: through listening and imitating, failing and trying.

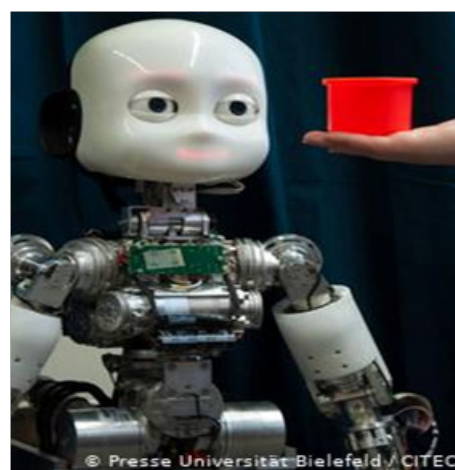


Figure 4. ICub and glasses

5. Realization of questionnaires at the Albanian ICT Academy Methodology center

The methods used during this study are:

Method of using the literature.

Data collection and analysis begins with the collection of data, which are specified in the purpose of the research and related to the hypotheses we have put forward.

We have researched how robots affect children's motivation in various scientific texts and websites on the Internet.

Statistical method

The statistical method used to analyze and recommend issues related to the impact of robots on students' knowledge acquisition is the questionnaire. Through questionnaires for

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age groups from 7 to 18 years who attend the programming course on robotics at the Albanian ICT Academy, the data were extracted and compared.

The sample of this questionnaire was determined by primary school students and 12th grade students at the Albanian ICT Academy. There were selected 80 students where none of them refused to complete the questionnaire. A total of 80 questionnaires were completed. The questionnaires were completed by 80 students from the age group of 7 to 14 years old that have been willing to respond.

Questionnaire:

1. What class are you in?
2. Did you do ICT at school before you came here?
3. Did you learn coding in school before coming here?
4. Did you know what coding was before you came here?
5. How much did you wish to learn coding from 1 to 10 before coming here?
6. Have you attended lectures on coding robots?
7. If yes:
 - a. Why did you start taking lessons on robot coding?
 - b. How much did you want to learn coding before you started coding robots?
 - c. How long did it take to take lectures on robot coding?
 - d. What robots do you use during lectures?
 - e. What programming language do you use to command visual or standard robots (python, javascript java)?
 - f. How much do you wish from 1 to 10 to learn about coding now after taking lectures coding robots?
 - g. How has attending robot coding lessons affected you?
 - Developed my logic
 - I am more active in the subject of ICT
 - It has stimulated my motivation to learn coding
 - Has not affected
 - Other

If the answer is different, how?

Questionnaire analysis:

This questionnaire was conducted by Grigorina Boce, Alma Hyra, Frida Zisko, to assess how robotics affects the acquisition of knowledge in children aged 7-18 years near the Albanian ICT Academy, the first academy established in Albania which gives the opportunity all enthusiasts to increase their knowledge by making available laboratories with innovative technologies.

In cooperation with the Albanian ICT Academy, we initially received information about the development of trainings in the field of programming and robotics which were conducted 3 times a week, in total of which 2 hours per week were theory, teaching and 1 time practice in the laboratory. Some groups children, developed training related to programming, through robotics, every day of the week in theory and practice. In this center, were used curricula from Massachusetts, suitable for different age groups, so that there is no information load on children. The programming was mainly used with color blocks, where each block is related to colors as: DreamWeaves, Notepad ++ and microbit.org.

After this complete analysis we had the opportunity to guide students in completing the questionnaire to see how robotics has influenced the growth of interest, boost motivation and open a new door to the future. 80 children, around the age group 7-18 years, were selected to participate in this questionnaire. They were part of the Albanian ICT Academy, as **table 1** below based on the following data: **Table 1**

Table 1: Distribution of children by gender

Gender	Number of children	Age
Female	30	7-18 years
Male	50	7-18years

From the analysis of the results of the questionnaire developed in the statistical program R we managed to derive the following results.

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As can be seen from the graph in the Figure 4, the average time that children spend programming with the help of robotics is 2 hours.

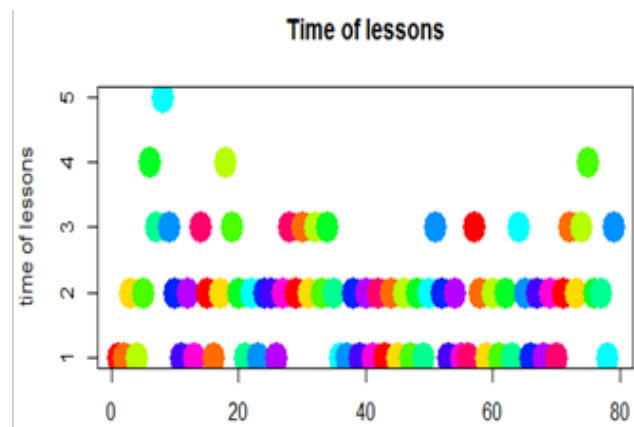


Figure 4. The graph of average time lessons.

Pie chart of programming languages

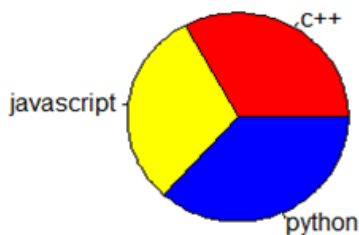


Figure 5. Pie chart of main programming languages.

The graph above in Figure 5 shows a distribution of the most used programming languages according to children's responses. Thus, with small differences, there is almost an equal distribution between the three programming languages: Python, JavaScript and C ++.

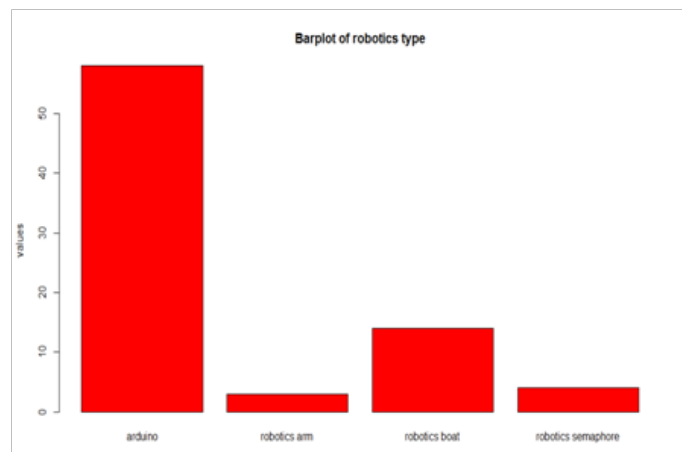


Figure 6. Barplot of robotics type

As for the robots, which they used during the lecture, as can be seen from Figure 5, most of the students said that Arduino is one of the favorites. This is due to the fact that it is visually simpler and practical in implementation.

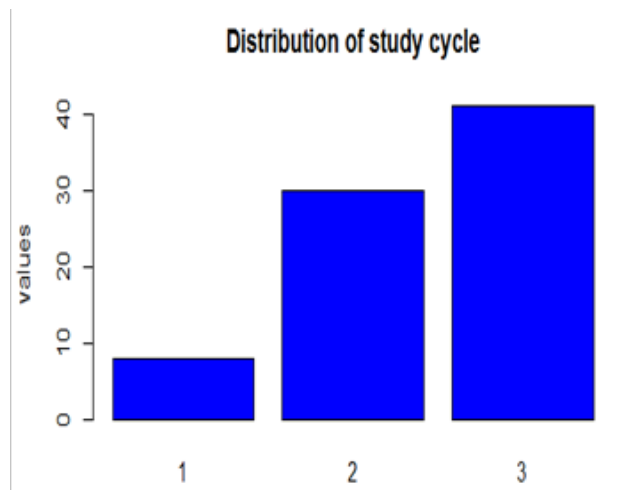


Figure 7. The distribution of study cycle.

Our study aims to assess the distribution of children learning in the ICT center, thus giving an overview of the distribution of their age groups. Since the first cycle of the study includes the age group 7-12, the second cycle includes the age group 13-15 and the third cycle 16-18. In fig.2.2 it is noticed that most of the students who study programming through robotics, respectively 53% of them belong to the third cycle of study, i.e. the age group 16-18 years, while the rest, respectively 9% and 38% of belong to the first and second cycle.

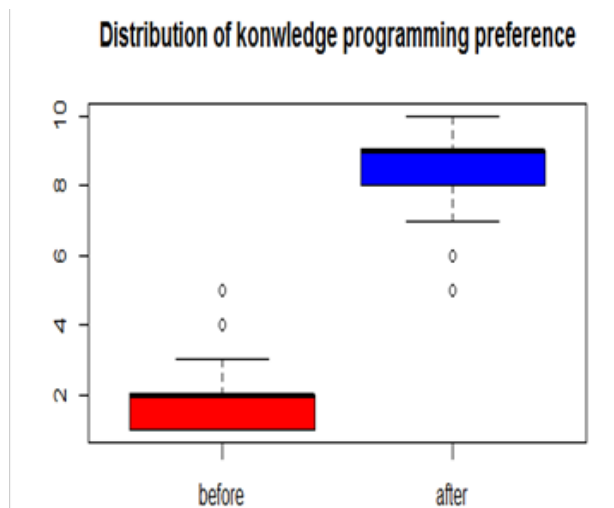


Figure 8. Boxplot of lessons preference

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In Figure 8.above is presented the distribution of preferences for gaining knowledge on programming using robots before and after training in the ICT center, where it is clear that the preferences have increased after the use of robotics in programming.

In the completed questionnaire the children were ready to answer as follows:

1. What class are you in?

About 25 out of 50 boys, were around 12 years old and were studying at Fan Noli School, while about 17 out of 30 girls, were between 12 and 14 years old.

2. Did you do ICT at school before you came here?

About 29 out of 50 boys, in the ninth grade, did not learn coding in school, so they did not know programming, while about 14 out of 29 girls in the ninth grade, developed programming languages like python, C ++ in school and about 15 out of 30 girls, in the fourth grade, did not know coding.

3. Did you learn coding in school before coming here?

About 30 out of 50 boys, have answered this question, that they have not yet learned coding from school, because there they develop only basic knowledge about Word, Exel, PowerPoint. The girls in the ninth grade,about 15 out of 30 girls, have expressed that they have learned to program in school, in the language of like C ++, Python and is already in the phase of developing this knowledge, at the Albanian ICT Academy. The girls also said that in school, they were mainly involved in creating blogs, web pages on how to control a social network and materials in Word

4.Did you know what coding was before you came here?

About 34 out of 50 boys, uttered that individually at home, having and a push from

The family, especially from their mothers who are computer teachers, have seen several videos individually about programming via Python, mainly related to building microbial and Arduino circuits. The ninth-grade girls,about 10 out of

30 girls, expressed that they are familiar with school coding in the subject of ICT mainly with C ++ programming languages, Python and have reinforced this knowledge, in the coding week OPEN CODING AND ROBOTICS DAY, an edition offered by Albanian ICT Academy, in the framework of Albanian Skills 2017.

5. How much did you want to learn about coding from 1 to 10 before coming here?

About 42 out of 50 boys,answered this question, that before they were part of the Albanian ICT Academy, they did not want to learn about coding, so their grade was 1. Whereas now that they attend the trainings at this academy, their desire to continue and strengthen their knowledge related to coding has increased, so their evaluation was 10. About 14 out of 30 girls, expressed that before, without starting the academy, they wanted to learn about coding. Given the fact that they had the impetus from parents, who are computer teachers, the grade was 9, while now attending

training near this center, their desire to acquire knowledge, especially on robotics, has increased. So, their evaluation was maximum 10.6.



6. Have you attended lectures on coding robots?

Related to this question, about 35 out of 50 boys, indicated that they have attended online lectures individually, regarding the coding of robots, which allow the development of intelligent mechanical devices. The boys said that common tasks in robots include response ring, control, path finding, data filtering, data retrieval and sharing.

About 18 out of 30girls, said that they have seen some videos on the Internet, on the coding of robots with artificial intelligence, on how to build small robots, traffic lights, digital clocks, alarm systems, photoresistors, microbial and arduino circuits, intelligent cars.

7. Why did you start taking lessons on robot coding?

About 44 out of 50 boys, answered that they have passion and motivation from the family while about 15 out of 30 girls, expressed that they feel more active in school. This stimulates their motivation and develops their logic.

8. How long did it take to take lectures on robot coding?

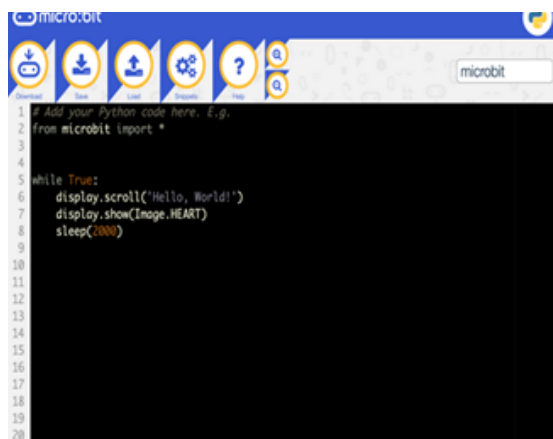
The children replied this question by saying that taking lectures on robot coding lasted seven weeks organized in three hours of course per day each day of the week of which two hours are theory and one hour practice in the laboratory.

9. What robots do you use during lectures?

About 43 out of 50 boys, responded they use the Arduino Robot as shows in Figure 9, which is a chip or minicomputer consisting of two processors, one on each of its two boards. The Motor Board controls the motors and the Control Board reads the sensors and decides how to operate. Each of the boards is a complete programmable Arduino board using the Arduino IDE and generating codes in the Python programming language. Both Arduino processors have built in USB communication, eliminating the need for a secondary processor. This allows the Robot to be displayed on a connected computer as a virtual / COM (virtual) (CDC) port. As always with Arduino, every element of the platform - hardware, software and documentation - is freely available and open source.

About 20 out of 30 girls, answered that during the lectures they use the microbit circuit which is an integrated system based on the ARM system with open base. The device has an ARM Cortex-M0 processor, battery and magnetometer sensors, Bluetooth and USB connection, a screen consisting of 25 small lights and two programmable buttons. This microbial circuit works with programs, which are programmed in the MakeCode Editor, in Microbit.org platforms, through javascript and python blocks and languages.

Mikrobit Circuit MakeCode Editor Python Editor



10. What programming language do you use to command visual or standard robots? (python, javascript, java)?

The children said they use python and javascript programming languages to command the robots.

11. How much do you wish, from 1 to 10, to learn about coding now after taking lectures on coding robots?

All the children replied that already after gaining knowledge of robot coding lessons, their desire to learn has increased, so the rating is 10 maximum because they said that it is something interesting and necessary which we did not know before.

About 20 out of 30 girls, also stated that they already feel even more motivated, more active in school and find it easier to learn the functions of codes in other programming languages.

12. How did attending robot coding lessons affect you?

About 24 out of 30 girls, uttered that attending robot coding lessons has increased interest in the field of ICT as everything is digital, everything has become a trend around the world, science is evolving and in the future the world will become electronic. After all, why should we not follow the footsteps of the world and become skilled programmers?

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About 22 out of 30 girls, also responded that coding through robots has developed logic, the creative aspect, critical thinking. This made them more active in school in the subject of ICT, developed intelligence and opened a new door to the future, to create career and get a lucrative profession as a programmer.

6. Conclusions

This paper aimed to demonstrate that today in the XXI century, Information and Communication Technology (ICT) has become almost essential in the development of the learning process and in gaining good knowledge in the field of programming using robotics.

The use of appropriate technologies and the introduction of robotics in the learning process is an innovative, more productive and interesting way. It also helps to develop logic, trains intelligence, enhances the creative aspect and critical thinking. Combining new technologies, with efficient methods and tools and using robots in teaching, will help us increase students' skills, attitudes and knowledge in the field of programming. As a result, high school students will be more competent and active in the subject of ICT, as we live in the age of information technology and will gain lifelong learning skills.

Since digital education starts at an early age and has become a worldwide trend, why not following the footsteps of the world and prepare children for the future by opening a new door to the field of programming which is increasingly being developed and considered as one of the most profitable professions.

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