



STUDENT SESSION

APPLICATION OF ARDUINO ROBOTS IN EDUCATION

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Abstract:

In this paper, the aim of the research refers to the analysis of the attitudes of students of primary and secondary schools in Niš regarding the application of Arduino robots in education. In order to get a comprehensive answer to the topic, the literature review will provide an insight into the most important characteristics of Arduino robots, how and in which way they are used for educational purposes. In the empirical part of the paper, the research of the authors of the paper was carried out in connection with the subject of the research. The research instrument used in this paper was a survey, which was created online and then distributed to students of primary and secondary schools in Niš. The sample of respondents consisted of 104 respondents, from whom it was planned to get opinions regarding the Arduino robot concept, to what extent it has a positive or negative effect on the teaching process, but also on the strengthening of students' competencies, especially digital ones.

Keywords:

Arduino, Robots, Education, Schools, ICT.

INTRODUCTION

We are witnessing an accelerated digital transformation on a global level. It is also present in education, and especially the influence of technology has been significant since the beginning of the outbreak of the pandemic caused by the corona virus, where online teaching, AI, big data, machine learning, robotics have perhaps shown the future direction in which education is going. Within modern teaching, numerous ICT tools (Information and communication technology) have already been implemented, on which both teachers rely during the implementation of the teaching program, but also students, who rely on some of the mentioned tools every day when learning. One of the tools is a robot that is used for educational purposes. It is imperative that young people are prepared and properly trained in digital skills to cope with modern technology. The goal is to create a technologically literate society that knows how to manage and apply this knowledge. Learning robotics develops all important cognitive skills that are applicable in the professions of the future. Past practice has shown that robots have contributed to more effective teaching.

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The purpose of this paper is to gain insight into the characteristics of robots in teaching, with special reference to Arduino robots, which are already being used in schools throughout Serbia.

Although robots are viewed in an almost apocalyptic way, we believe that the attitude towards robots will change in a positive direction, in the sense that robots can contribute to the teaching process and not be like roles in science fiction movies.

2. LITERATURE REVIEW

“Arduino Education creates the next generation of STEAM programs that empower students on their learning journey through middle school, high school, and university and help them thrive.”

From official Arduino web page

From K-12 (this term is used in education in some countries, like USA, United Kingdom etc, from kindergarten to 12th grade), higher education and above, Arduino takes a very important place. Arduino helps students very early, gradually introducing solutions related to the basics of programming, electronics and science as an umbrella term. At the earliest age, Arduino teaches students the basic steps, trying to make the child concisely understand the essence of robotics, without the existence of a previous knowledge base. At the next instance, the range of knowledge in secondary education was expanded in such a way that it can meet the needs of both beginners and advanced students by combining an immersive learning experience and good practice. The student is directed to simulations of challenges from the real world, all with the aim of acquiring or strengthening the necessary digital skills. Based on this knowledge, the student can reach the stage of successfully mastering tasks within engineering, mechanical science, data processing and IoT (Internet of Things). [1-7]

Arduino represents a platform for educational robotics, which finds its purpose among different target groups - not only students. It is based on an easy-to-use interface for programming and controlling electronic devices, making it an ideal tool for teaching programming, electronics and robotics to students of all ages. In this context, the importance of Arduino robots in education is indicated, with a focus on robotics. The basic premise is that Arduino robots bring with them and introduce numerous benefits into educational processes. [2]

By using Arduino robots in education, we mean a set of resources, tools, and curriculum designed to help educators teach programming, electronics, and robotics using Arduino technology. It is designed to be easy to use and accessible for entry-level users. It covers all groups of students and at all levels. [3]

It is an open source platform, which effectively means that the student can use, modify and share it without restrictions, which makes it much easier for teachers and students to access and use technology, even if they have limited resources. Another feature that is important to mention is that Arduino is a comprehensive and complex platform that can be used for a wide range of projects, from the simplest to the most complex. This agility makes the Arduino an ideal tool for teaching students about electronics and robotics. In conjunction with the above, students can use it to create projects that match their interests and skill levels. [4, 5]

And in terms of financial parameters, Arduino proved to be very efficient, because it is a cost-effective solution – an option available for schools and educators with limited budgets. Also, Arduino notes numerous advantages, which can be formulated as follows: learning that is based on practice, application in a real context, a large and pronounced degree of adaptability during the implementation of projects, student engagement during learning, teamwork, aspects of communication and student interaction, accessibility and a pronounced degree of inclusivity, connecting several scientific segments into one whole, critical thinking, problem solving and cooperation skills, etc. In this way, Arduino prepares students for achievement in STEM fields (science, technology, engineering, and math). [6, 7]

3. METHODOLOGY

Statistical data processing and analysis were done using the software IBM SPSS (Statistical Package of Social Science) version 25. In this paper were used descriptive statistics to describe the sample and an independent t test to examine differences in relation to gender and school of students. A level of 0.05 was used for the threshold value of significance.



4. RESULTS AND DISCUSSION

In this research participated 104 respondents, of which 46 were male and 58 were female (Table 1). Furthermore, 40 students attend primary school, while 64 students attend secondary school (Table 2). The schools included in the research are: Elementary school "Toplički heroji" Žitorađa, Elementary school "Čele kula" Niš, Elementary school "Dušan Radović" Niš, Elementary school "Sveti Sava" Niš, Secondary school Žitorađa, Gymnasium "Svetozar Marković" Niš, Gymnasium "9. maj" Niš.

Based on the results shown in Table 3, it can be concluded that the vast majority of students believe that teachers and professors use ICT tools in teaching (66.3%). Schools mostly do not have educational robots available (70.2%) and students mostly have not heard of Arduino robots (72.1%) (Table 3). Almost half of respondents are satisfied with their knowledge of Arduino (48.1%) and Arduino has taught them to do something independently (51.9%).

Based on the results shown in Table 4, it can be concluded that the highest degree of agreement is that ICT teaching can contribute to effective teaching ($M=3.73$,

$SD=0.89$) and that the educational robot in teaching encourages greater student interest and interest in the teaching content ($M= 3.54$, $SD=0.97$), while the lowest degree of agreement is for the statements that in the future the role of robots will be equal to that of teachers and professors ($M=2.92$, $SD=1.19$) and students explore new ideas and discover new things using Arduino ($M=3.14$, $SD=0.97$).

Through research, we examined whether there is a significant difference in the degree of agreement for the statements made in relation to the gender of the students. The t test of independent samples was used to examine significant differences in relation to gender. Based on the results of the t test shown in Table 5, it can be concluded that a significant difference in relation to gender exists for researching new ideas and discovering new things using Arduino, where female students believe that this is possible using Arduino more. For other statements, there is no significant difference in relation to the gender of the students.

Table 1. Gender of the students.

| | Frequency | Percentages |
|--------|-----------|-------------|
| Male | 46 | 44.2 |
| Female | 58 | 55.8 |
| Total | 104 | 100 |

Table 2. School attended by respondents.

| | Frequency | Percentages |
|----------------|-----------|-------------|
| Primary school | 40 | 38.5 |
| High School | 64 | 61.5 |
| Total | 104 | 100 |

Table 3. Students' answers.

| | | Frequency | % |
|--|-----|-----------|------|
| Do your teachers/professors use ICT tools in teaching? | Yes | 69 | 66.3 |
| | No | 35 | 33.7 |
| The school I attend has educational robots available. | Yes | 31 | 29.8 |
| | No | 73 | 70.2 |
| Did you know about the Arduino robot before getting to know it in class? | Yes | 29 | 27.9 |
| | No | 75 | 72.1 |
| Am I satisfied with my Arduino knowledge? | Yes | 50 | 48.1 |
| | No | 54 | 51.9 |
| Did Arduino teach you that you can do something on your own? | Yes | 54 | 51.9 |
| | No | 50 | 48.1 |

**Table 4.** The degree of agreement of respondents with the stated statements.

| | Frequency | % |
|--|-----------|------|
| Do you agree with the statement that ICT in teaching can contribute to more effective teaching? | 3.73 | 0.89 |
| The use of educational robots in the teaching process improves teaching. | 3.44 | 0.97 |
| An educational robot in teaching encourages greater interest and student interest in teaching content. | 3.54 | 0.97 |
| Educational robots should be studied more in school. | 3.36 | 1.04 |
| I am interested in additional training in the field of robotics. | 3.24 | 1.08 |
| Arduino robots positively influence professional development, skill development, different perspective, interests and attitudes, solution-oriented approach to everyday life problems, building self-confidence, better communication skills, and effective use of technology. | 3.29 | 0.95 |
| Arduino robots positively influence the development of skills: problem solving, creativity, psychomotor development, analytical thinking, strengthening teamwork, algorithmic thinking, 21st century skills, engineering skills and science-related skills. | 3.34 | 0.95 |
| I explore new ideas and discover new things using Arduino. | 3.14 | 0.97 |
| In the future, robots will have an equal role with teachers/professors? | 2.92 | 1.19 |

*M - mean; SD - standard deviation

Table 5. Differences in the degree of agreement in relation to the gender of the students.

| | Male (N=46) | Female (N=58) | t | p |
|--|----------------|------------------|-------|--------|
| Middle value | | | | |
| Do you agree with the statement that ICT in teaching can contribute to more effective teaching? | 3.63 ± 0.99 | 3.81 ± 0.80 | -1.01 | 0.311 |
| The use of educational robots in the teaching process improves teaching. | 3.23 ± 0.99 | 3.60 ± 0.93 | -1.92 | 0.058 |
| An educational robot in teaching encourages greater interest and student interest in teaching content. | 3.41 ± 1.04 | 3.65 ± 0.90 | -1.26 | 0.210 |
| Educational robots should be studied more in school. | 3.36 ± 0.97 | 3.36 ± 1.10 | 0.03 | 0.971 |
| I am interested in additional training in the field of robotics. | 3.21 ± 1.11 | 3.25 ± 1.06 | -0.19 | 0.848 |
| Arduino robots have a positive impact on professional development,... | 3.17 ± 1.03 | 3.39 ± 0.87 | -1.18 | 0.239 |
| Arduino robots have a positive impact on skill development. | 3.28 ± 1.00 | 3.39 ± 0.91 | -0.60 | 0.547 |
| I explore new ideas and discover new things using Arduino. | 2.89 ± 0.97 | 3.34 ± 0.94 | -2.39 | 0.018* |
| In the future, robots will have an equal role with teachers/professors? | 2.84 ± 1.11 | 2.98 ± 1.26 | -0.56 | 0.570 |

*N - number of respondents; t test - data sets follow a normal distribution; p - statistical significance at the level of 0.05.

Table 6. Differences in the degree of agreement in relation to the student's school.

| | Male (N=40) | Female (N=64) | t | p |
|--|----------------|------------------|------|--------|
| Middle value | | | | |
| Do you agree with the statement that ICT in teaching can contribute to more effective teaching? | 3.92 ± 0.72 | 3.60 ± 0.96 | 1.88 | 0.062 |
| The use of educational robots in the teaching process improves teaching. | 3.70 ± 0.72 | 3.28 ± 1.07 | 2.37 | 0.020* |
| An educational robot in teaching encourages greater interest and student interest in teaching content. | 3.77 ± 0.76 | 3.40 ± 1.06 | 2.04 | 0.043* |
| Educational robots should be studied more in school. | 3.52 ± 0.96 | 3.26 ± 1.08 | 1.23 | 0.219 |
| I am interested in additional training in the field of robotics. | 3.57 ± 0.95 | 3.03 ± 1.11 | 2.55 | 0.012* |
| Arduino robots have a positive impact on professional development,... | 3.52 ± 0.90 | 3.15 ± 0.96 | 1.94 | 0.055 |
| Arduino robots have a positive impact on skill development. | 3.55 ± 0.81 | 3.21 ± 1.01 | 1.74 | 0.085 |
| I explore new ideas and discover new things using Arduino. | 3.40 ± 1.03 | 2.98 ± 0.91 | 2.14 | 0.035* |
| In the future, robots will have an equal role with teachers/professors? | 3.27 ± 1.26 | 2.70 ± 1.10 | 2.42 | 0.017* |

*N - number of respondents; t test - data sets follow a normal distribution; p - statistical significance at the level of 0.05.



Through research, we examined whether there is a significant difference in the degree of agreement for the statements made in relation to the student's school. The t test of independent samples was used to examine significant differences in relation to school.

Based on the results of the t test shown in Table 6, it can be concluded that there is a significant difference in relation to the student's school for the claims that the educational robot improves teaching, the educational robot encourages greater student interest and interest in the teaching content, the student's interest in additional training in the field of robotics, exploring new ideas and discovering new things using Arduino and that in the future the educational robot will be equal to teachers and professors. Elementary school students are more likely to think that the educational robot improves teaching, elementary school students have more interest and interest in scientific content when the educational robot is used, are more interested in improving in the field of robotics, more explore new ideas and discover new things using Arduino, and more think that in the future, educational robots will be completely equal to teachers and professors. For other statements, there is no significant difference in relation to the gender of the students.

In accordance with the literature review and research results, we can make a conclusion with the findings of other conducted research that Arduino represents a significant educational didactic resource, which finds equal use value at different educational levels - starting from elementary to higher education [8-12]. However, it was noted that in the context of formal education in Serbia, the application of robots for educational purposes has a lot of unused potential and space for further implementation, especially at the elementary school level, because it is important to introduce students to the world of robotics from the earliest days.

5. CONCLUSION

Our presentation of the opinions of students of selected primary and secondary schools from Niš represents a stable basis for perceiving the importance and application of educational robots in education, and what could be explored in some subsequent research. The intention was to point out the difference or similarities in opinions between younger and older students regarding new technologies in teaching, in the case of this paper, Arduino educational robots.

The main limitation in this research could be related to a smaller sample of respondents, so a subsequent research with a larger number of respondents will certainly be interesting, because the technology in the field of educational robots is continuously developing, and it is important for the next coming generations to follow their development. Future research should pay special attention to students' reliance on Arduino robots, but also on other technological educational tools, such as AI.

Finally, it is necessary to remove the aversion of the teaching staff, as well as the students, regarding the role of educational robots, in the sense that their purpose is to help the teaching process, and in the extreme, positively influence the acquisition of knowledge by students, and better achievements. The above is especially important for older students, i.e. high school students, because robotics knowledge can be used in further education, especially in the field of natural sciences, including modern technologies. In addition to removing aversion among teachers, it is important to work on increasing accessibility and education about the advantages and possibilities of the Arduino platform.

On the basis of the conducted research, it can be concluded that there are almost no differences in relation to the gender of the respondents, while there are significant differences for certain statements where the respondents from primary schools believe that the use of educational robots contributes to the improvement of teaching and motivates students more to follow the teaching content and discover new things.

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