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MATHEMATICAL AND STATISTICAL ANALYSIS OF THE USE OF VIRTUAL PEDAGOGICAL TOOLS IN TEACHING ROBOTICS

Annotation
In this article, the effective methods of creating educational content through LearningApps in the organization of robotics training are described in detail and mathematical statistical analysis is performed. The creation of educational content for robotics training was created based on Bloom's taxonomy and its effectiveness was evaluated.
Key words: Robotics, Lego Education, Lego Wedo 2.0, LearningApps, Bloom's taxonomy, method Student.

ROBOTOTEXNIKANI O‘QITISHDA VIRTUAL PEDAGOGIK VOSITALARDAN FOYDALANISHNING MATEMATIK VA STATISTIK TAHLILI

Annotatsiya
Ushbu maqolada robototexnika mashg‘ulotlarini tashkil etishda LearningApps orqali ta’lim mazmunini yaratishning samarali usullari batafsil bayon etilgan va matematik statistik tahlil qilingan. Blum taksonomiyasi asosida robototexnika bo‘yicha o‘quv mazmunini yaratish yaratildi va uning samaradorligi baholandi.
Kalit so‘zlar: Robototexnika, Lego Education, Lego Wedo 2.0, LearningApps, Bloom taksonomiyasi, Student metodi.

МАТЕМАТИЧЕСКИЙ И СТАТИСТИЧЕСКИЙ АНАЛИЗ ИСПОЛЬЗОВАНИЯ ВИРТУАЛЬНЫХ ПЕДАГОГИЧЕСКИХ ИНСТРУМЕНТОВ В ОБУЧЕНИИ РОБОТОТЕХНИКЕ

Аннотация
В данной статье подробно описаны эффективные методы создания образовательного контента с помощью LearningApps при организации обучения робототехнике и проведен математический статистический анализ. Создание образовательного контента для обучения робототехнике было создано на основе таксономии Блума и оценена его эффективность.
Ключевые слова: Робототехника, Lego Education, Lego Wedo 2.0, LearningApps, таксономия Блума, метод Стьюдента.

Introduction. If we look at the world educational experience, the robotics course occupies a leading place in the modern educational programs of developed countries. In the era of increasing coverage of technologies controlled by artificial intelligence, studying robotics as a subject in school has become a necessary necessity. In the robotics classes held in foreign schools, it is observed that the student consolidates the information he has learned from other subjects with the help of practical tasks. For example, a child uses the knowledge he has learned in physics when making a mechanical device, he understands the essence of physical laws and regulations, he performs mathematical calculations, he refers to the commands he learned in computer science. Directs theoretical knowledge to practical management. In these lessons, students understand the basics of mechanics and develop analytical skills both during individual construction work and when completing tasks as a team.

In fact, since childhood, children are interested in trying to break something and find out what is inside that thing. He collects small details. If we form this interest at school, it will be the same. Due to the fact that robotics lessons require practical activities, it is natural that the problem of equipping the material and technical base of the school with equipment in this direction is cross-cutting. Because robotic equipment and equipment are rare and expensive. It is also necessary to create a methodical database on the organization of creation and creation processes. Therefore, I emphasize once again that the time has come to create an opportunity for students to learn the secrets of robotics at school.

The main part. Educational LEGO robotics kits and programming constructors (Lego Education), as well as robotics kits and programming from other leading manufacturers (VEX, BQ, RoboRobo, Fischertechnik, Huna, Matrix, Robotis Bioliod, Tetrix) sets can be used not only individually, but also for a group. Lego robotics kits are perfect for preschools and general secondary schools. Robot constructors are organically combined with physics, informatics or programming classes and serve to develop personal qualities such as inventiveness, logical thinking, and problem solving in the student.When creating virtual educational platforms, the following online services will help you create an interactive and interesting virtual platform. In order to make teaching robotics interesting and effective, it is advisable to organize educational content through the following services. This choice is very important for teachers, tutors, trainers and everyone who creates educational content [3].

It is difficult to imagine a modern educational product without game elements. In the online course, they solve several important tasks. The main thing is to encourage students to study independently, it is better to organize it in the form of an interesting daily activity, rather than forcing yourself to "I bought an online course and I have to learn it." Also, with the help of interactive tasks and mini-games, you can conduct control tests, infographics and videos present the educational material visually, and online whiteboards are useful for working in groups.

Learning Apps is an interactive task builder that helps to reinforce knowledge in a playful way. The service allows you to create various types of exercises: "Timeline", "Classification", "Crossword", "Fill in the blanks", "Quiz with the choice of the correct answer" and others. This online service can also be used to create a virtual educational platform for robotics. To do this, select the Lego Wedo 2.0 section and use "Find the details?", which serves to form basic knowledge of robotics. you can choose a set of tasks. Since the assignments are online, you can place them on your personal virtual learning platform through a special referral link provided by the program [7].

The set itself consists of 158 elements: Lego parts, Lego USB Hub, motor, motion and tilt sensors. The Lego USB Hub is a dongle that connects to your computer with a USB connector and allows you to control sensors and motors through the Lego Education Wedo software. The program can work with three keys at the same time.

From the point of view of educational robotics, this kit provides a framework for algorithmic learning. Children create simple model algorithms in the constructor program [6].

Figure 1. Lego Wedo 2.0 Finding the Details task tutorial on LearningApps.You can create your own exercise using a template or choose one from the catalog and add it to your course. All tasks are divided into subjects, from the exercise section in the "Matching" format, you need to match the names of the details with their descriptions in the section "Find matching details" for the robotics educational platform. The online service is very useful for creating virtual learning platforms, using which you can create and add interactive exercises to the lesson. The learning platform can be integrated with LearningApps so that tasks are entered automatically.The last method is that the learning content for finding the appropriate robotic details in LearningApps is focused on independent intellectual activity, requiring the ability to draw conclusions, evaluate, approve, support, recommend, criticize and draw conclusions. does.

Figure 4. Educational content on robotics detail matching in LearningApps.

Viewing robotics as a means of forming engineering thinking of schoolchildren, developing their interest in technical creativity, and choosing engineering professions and specialties is an important tool. The practice of using robotics in the educational system is gradually developing. In this direction, attention is paid to the preparation of popular scientific and educational manuals, and the publication of additional methodological developments for teachers [4].

The use of Bloom's taxonomy in the design of didactic tasks to organize the independent work of students in the process of learning virtual robotics is highly effective. Taxonomy is a theory of classification and systematization of complex organized areas of reality, which usually has a hierarchical structure. Taxonomy as a hierarchical interconnected system within educational technology was created by B. Bloom. In his seminal work, Taxonomy of Learning Objectives: Scope sought to create a hierarchy of learning objectives spanning the cognitive domain, describing step-by-step, levels of human reasoning and the resulting learning objectives. From Bloom's point of view, educational goals directly depend on the hierarchy of thinking processes, such as remembering, understanding, applying, analyzing, evaluating, and creating. A set of tasks using certain methods is offered for each level [5].

A total of 150 students involved in robotics circles were divided into 2 equally knowledgeable groups according to the results of a 5-point test based on general knowledge. 78 students participated in the experimental group 72 students participated in the control group. In the control group, training was organized in a traditional way, and in the experimental group, training was organized on the basis of virtual educational tools based on Bloom's taxonomy.We select hypothesis N1 and hypothesis N0 that contradict it, showing the effectiveness of learning in the experimental and control classes, and display it in the following tables

Table 1- Evaluation effectiveness of educational projects developed by students at the end of experimental work

Groups	Number of students	Indicators			
		Excellent	Good	Well done	Unsatisfactory
Experimental group	78	20	24	19	15
Control group	72	15	12	17	29

The chart corresponding to these selections looked like this:

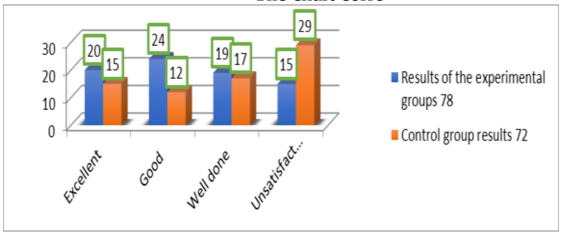

Diagram 1. Effectiveness of evaluation of educational projects

In order to facilitate statistical analysis from the above variation lines n_i, and n_j repetition (frequency) is the appropriate statistical probability $P_i = \frac{n}{n_i}$ and $q_j = \frac{m}{m_j}$ define in the style.

This is a student-developed quiz will have the following appearance:

$$\begin{cases} X_i & 5, & 4, & 3, & 2 \\ P_i & 0{,}25, & 0{,}30, & 0{,}24, & 0{,}19. \end{cases} \quad \sum_{i=1}^{4} P_i = 1 \quad \text{and}$$

$$\begin{cases} Y_j & 5, & 4, & 3, & 2 \\ q_j & 0{,}20, & 0{,}16, & 0{,}23, & 0{,}40. \end{cases} \quad \sum_{i=1}^{4} q_j = 1 \quad \text{and}$$

We start the statistical analysis by calculating and comparing the average learning indicators for both classes. The average learning indicators in the evaluation of the projects developed by the student gave the following results:

$$\bar{X} = \sum_{i=1}^{n} P_i x_i = 0{,}25 \cdot 5 + 0{,}30 \cdot 4 + 0{,}24 \cdot 3 + 0{,}19 \cdot 2$$

$$= 1{,}25 + 1{,}2 + 0{,}72 + +0{,}38 = 3{,}55$$

in percentage $\bar{X}\,\% = \frac{3{,}55}{5} \cdot 100\% = 72{,}0\%$

$\bar{Y} = \sum_{j=1}^{4} q_j\, y_j = 0{,}20 \cdot 5 + 0{,}16 \cdot 4 + 0{,}23 \cdot 3 + 0{,}40 \cdot 2 = 1{,}0 + 0{,}64 + 0{,}46 + +0{,}8 = 2.9$ in percentage $\bar{Y}\,\% = \frac{2{,}9}{5} \cdot 100\% = 58{,}0\%$

Determining the mastery indicators and the number of students in the experimental group by X_i and the control group by Y_j mj respectively, we have the following statistically grouped variation series., as well as we define an excellent level with 5 points, a good level with 4 points, a satisfactory level with 3 points and an unsatisfactory level with 2 points. This student-developed project will be assessed as follows:

Acquisition rates in the experimental group:

$$\begin{cases} X_i & 5, & 4, & 3, & 2 \\ n_i & 20, & 24, & 19, & 15\ (n = 78) \end{cases}$$

Attainment rates in the control group

$$\begin{cases} Y_j & 5, & 4, & 3, & 2 \\ m_j & 15, & 12, & 17, & 29\ (n = 72) \end{cases}$$

So, the average mastery in the experimental class (72,0 - 58,0) %=14,0 %. It is higher than 14,0 %. And this in turn $\frac{72{,}0\%}{58{,}0\%} = 1{,}2$ times is higher than.

First, we determine the mean squared and standard errors in order to determine the possible error in the process of determining absorption.

Mean squared errors in evaluating projects developed by students:

$S_y^2 = \sum_{j=1}^{4} q_j\, {y_j}^2 - (\bar{y})^2 = 1{,}1771$

Standard errors are: $S_x = \sqrt{0{,}8196} = 0{,}91$ $S_y = \sqrt{1{,}1771} = 1{,}09$.

Standard errors are: $S_x = \sqrt{0{,}4976} = 0{,}71$ $S_y = \sqrt{1{,}1739} = 1{,}08$.

From this, the standard error of the control class in evaluating the projects developed by the students was greater compared to the indicators of the experimental class., i.e. 1,09 > 0,91. In order to show this more clearly, we calculate the accuracy of the average value for both statistical samples through the coefficients of variation, that is, through the formula C_x and C_y:

$$C_x = \frac{S_x}{\sqrt{n} \cdot x} \cdot 100\% = \frac{0{,}91 \cdot 100\%}{\sqrt{78} \cdot 3{,}55} = \frac{91\%}{13{,}23 \cdot 3{,}02} = \frac{91\%}{39{,}95} = 2{,}28\% = 2\%,$$

and

$$C_y = \frac{S_y}{\sqrt{n} \cdot y} \cdot 100\% = \frac{1{,}09 \cdot 100\%}{\sqrt{72} \cdot 2{,}9} = \frac{109\%}{12{,}85 \cdot 2{,}23} = \frac{109\%}{28{,}64} = 3{,}81\% = 4\%.$$

So, the accuracy of the average acquisition rate in the experimental class is lower than that in the control class.

When evaluating the educational portfolio created by the students, the standard error of the control class was larger compared to the indicators of the experimental class., 1,08 > 0,71. In order to show this more clearly, we calculate the accuracy of the average value for both statistical samples through the coefficients of variation, that is, through the formula C_x and C_y:

$$C_x = \frac{S_x}{\sqrt{n} \cdot x} \cdot 100\% = \frac{0{,}71 \cdot 100\%}{\sqrt{78} \cdot 3{,}32} = \frac{71\%}{13{,}23 \cdot 3{,}32} = \frac{71\%}{43{,}92} = 1{,}62\% = 2\%,$$

and

$$C_y = \frac{S_y}{\sqrt{n} \cdot y} \cdot 100\% = \frac{1{,}08 \cdot 100\%}{\sqrt{72} \cdot 2{,}23} = \frac{108\%}{12{,}85 \cdot 2{,}32} = \frac{108\%}{29{,}81} = 3{,}62\% = 4\%.$$

Hence, the average mastery rate in the experimental class is accurate is smaller than the control class.

Now we test the null hypothesis based on the Student's selection criterion, taking into account the similarity of the unknown mean values of the two sets:

$$H_0 : \mu = \mu_y.$$

Based on this, we perform the following calculation when evaluating projects developed by students:

$$T_{x,y} = \frac{\bar{x}-\bar{y}}{\sqrt{\frac{S_x^2}{n}+\frac{S_y^2}{m}}} = \frac{3{,}02-2{,}23}{\sqrt{\frac{0{,}8196}{78}+\frac{1{,}1771}{72}}} = \frac{0{,}79}{\sqrt{0{,}0047+0{,}0071}} = \frac{0{,}79}{\sqrt{0{,}0118}} = \frac{0{,}79}{0{,}108} = 7{,}315.$$

We calculate the degree of freedom in evaluating projects developed by students based on the student criteria using the following formula

$$K = \frac{(\frac{S_x}{n}+\frac{S_y}{m})^2}{\frac{(\frac{S_x^2}{n})^2}{n-1}+\frac{(\frac{S_y^2}{m})^2}{m-1}} = \frac{(\frac{0{,}8196}{175}+\frac{1{,}1771}{165})^2}{\frac{(\frac{0{,}8196}{175})^2}{174}+\frac{(\frac{1{,}1771}{165})^2}{164}} = \frac{0{,}0014}{0{,}000000075+0{,}00000015} = \frac{0{,}0014}{0{,}00000023} = 600{,}86.$$

If we take the significance level of the statistical sign for this probability as $\alpha = 0.05$, then $r = 1-\alpha = 0.95$, and the degree of freedom in the evaluation of the student-developed projects is equal to $k = 600.86$, Student's function.

From the distribution table, the critical point of the two-way criterion in the evaluation of student-developed projects as follow

$$t_{1-\frac{(1-p)}{2}}(k) = t_{1-\frac{(1-0.95)}{2}}(600.86) = t_{0.975}(600.86) = 1.96,$$

It can be seen that the sampling value of statistics is greater than the critical point, that is, when evaluating projects developed by students

$T\_(x,y) = 7.315 > 1.96$,

so the null hypothesis N_0 about the equality of the main mean values is rejected. It can be said with 95% confidence that the mean achievement scores of the experimental classes were always higher than the mean achievement scores of the control classes, and they never overlapped. From this, it can be said with a significance level of x=0.05 that the average grade in the experimental class is higher than the average grade in the control class and the intervals do not overlap. So, based on the mathematical-statistical analysis, it turned out that a good result was achieved. From the obtained results, it can be seen that the criterion for evaluating the effectiveness of teaching is greater than one, and the criterion for evaluating the level of knowledge is greater than zero. It is known that the mastery in the experimental class is higher than the mastery in the control class. So, the experimental work on the evaluation of the projects developed by the students was successfully carried out.

Conclusion. Based on Bloom's taxonomy, LearningApps online service allows you to develop your existing knowledge and skills and consolidate new knowledge using different content. This technology will enable you to learn new things and work in a team, express your opinion, listen to other people and make your own discoveries, which can later be used as a basis for acquiring new knowledge. Organization of the educational process using this technology helps students to have a more exciting lesson, allows them to systematize the received information, and strengthens the previous material. According to the results of the experiment, when the mathematical statistical analysis of this process was carried out, the efficiency was 14%.

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