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The effectiveness of organizing robotics circles using virtual didactic tool

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***Absrtact*–Scientific research on the use of robotics elements in the formation of the competencies of elementary school students in programming and electronics, research on their organizational and methodological foundations are conducted on a global scale. In this research paper, distance education platforms that allow creating online circles on robotics are considered, the methodology of organizing circles on robotics is described in detail on the example of primary classes of secondary schools using virtual didactic tools, i.e. LMS systems. The significance of such circles is the organization of employment of students in their free time.**

Keywords—pandemic, robotics, LMS, Schoology, iSpring Learn.

INTRODUCTION

In the world, research work is underway to widely use the means of robotics circles in the development of logical thinking and constructive ideas of primary school students, as well as to expand the child's ability to form skills in working with technical devices from an early age. International programs in developed countries on the involvement of students in robotics clubs provide for the improvement of robotics training and the assessment of the level of self-acquisition of knowledge as a separate parameter.

Significant work is being carried out in Uzbekistan aimed at improving the mechanisms for organizing and managing the educational process based on the widespread introduction of information and communication services, the use of innovative pedagogical technologies that meet modern requirements. In turn, this necessitates the organization of robotics clubs to develop competencies such as programming and design in elementary school students of general education schools[1].

The concept of development of the system of public education until 2030 in Uzbekistan defines such priority tasks as “the introduction of modern information and communication technologies and innovative projects into the field of public education; improving teaching methods; gradual introduction of the principles of individualization in the educational process, the development of scientific research of a practical nature aimed at studying and scientifically substantiating alternative approaches[2]. In this regard, given the need to improve the mechanism for the formation of competencies in primary school students such as the ability to program and design, as well as the need for distance learning during the COVID-19 pandemic, the organization of robotics circles for primary school students using virtual didactic tools becomes very relevant. . In recent years, students have a growing interest in self-study, studying various programs as an addition to the school curriculum. A striking example of this is the posting of videos on social networks by students in the framework of their interests. At present, the development of digital technologies allows young people to gain knowledge in the direction of their interests through the Internet. To do this, they require knowledge of Russian and English at a conversational level, as well as knowledge of modern Internet technologies, in particular knowledge and skills of working on platforms such as SMM, LMS, CMS, MOOC[3].

I. MAIN PART

Through this research work, an online robotics training course for general secondary school students will be created. The study of robotics depends on the age categories in which the knowledge gained at school in academic subjects acts as the basis. It also allows the MOOC to put the acquired knowledge of the subjects into practice. The open online course of robotics circles consists of 3 classes:

1. Robo start for elementary grades -

Lego Wedo 2.0(grades 1-4);

2. Robo intermediate for high school -

LegoMindstroms EV3(grades 5-11);

3. Robo Advanced for those over 12 years old -

Arduino (starting from grade 5).

Online lessons in each of the above classes are organized on the basis of circle programs, using various online pedagogical technologies through simulation models of the Lego Wedo 2.0 configuration. As you know, robotics is one of the newest and most promising activities for any child. This course gives students the knowledge to create robots and other objects. This industry is developing along with Internet technologies, and it seems that there is no need to emphasize that our future lies behind this. By enrolling in open online courses in robotics, students not only develop scientific, logical thinking, but also ensure a sustainable future. Open online robotics courses are very interesting for children, this virtual training course explains how to learn how to make robotic structures through simulation content in a convenient and simple way, and provides all the necessary knowledge about robotics through simple video tutorials, suitable for simple presentation and demonstration. This science reveals and develops the creative abilities of the child, contributes to the development of his intellectual abilities.

Every year, exhibitions are organized around the world, which present works created by robotics and scientists, with the opportunity to show the world information about what development opportunities they can give to certain industries

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of our planet. These virtual courses will form the basis for future knowledge and experience in disciplines such as mechanics, mechatronics, electronics, as well as the basics of mathematics and physics, as well as the basis for the implementation of new ideas.

The development of digital technologies has expanded the possibilities of distance learning via the Internet. Distance online learning is an innovative and fun way to get an education. At the same time, the student independently learns, assimilates knowledge, controls himself, independently thinks and draws conclusions. To organize the educational process in a remote form, educational process management systems (LMS - Learning management systems) are used.

Advantages LMS

- Freedom of use - the student can use the system almost anywhere. And those who are older can get an education without leaving their main job. Reduced training costs - no funds are required to purchase methodological literature.
- Flexibility of learning - the learning process can be organized based on the capabilities and requirements of the teacher and student.
- Compatibility with modernity - users of e-learning courses, in particular teachers and students, will develop their knowledge and skills in accordance with the most modern technologies and standards. This allows you to quickly and timely update the materials of e-learning courses.
- Equity in general learning – learning does not depend on the quality of teaching in a particular educational institution.
- The possibility of establishing an objective criterion for assessing acquired knowledge - it is possible to establish specific criteria for assessing the knowledge acquired by a student in the learning process.
- You can use the chat, blog, forum and conferences to share experiences - communication, messaging.
- Statistics - since data such as attendance, learning, are recorded in the system, the teacher can get a report in the right form at any time.

LMS is an online platform that organizes, implements e-learning programs, and also allows you to monitor and track the results of learning by students. Learning management systems help simplify the learning process by providing a central location for developing and monitoring course content. The LMS is also an unrivaled platform that allows students to submit the additional resources they need to enrich the knowledge gained during class[4].

LMS platforms are divided into three types: cloud platforms, server-based and integrated with CMS LMS.

Cloud platforms LMS. Course materials are hosted on the web service provider's server computer on LMS cloud platforms. This type of LMS cannot be installed on a school or organization server computer. Cloud LMS platforms work on the principle of a web service, which means that a web service can create training courses after registering at the proposed address. To do this, the web service allocates space on its server, and all data is stored on this server. To do this, you need to install, configure the LMS, ensure its integration with the software of the organization or educational institution. In educational institutions and training centers, the following LMS are mainly used: Moodle, BlackBoard, Canvas, Absorb LMS, etc.

In LMS integrated with CMS, special programs that perform the functions of LMS are added to the CMS and extend the capabilities of the CMS. There is a division in the CMS structure that works with individual training courses. Schoology is a cloud-based LMS designed for educational institutions. Schoology can integrate with Google Drive, Microsoft OneDrive, Blackboard Collaborate, Moodle, Powershool, Evernote and YouTube. It also syncs with the school information system. iSpring Learn is a platform for training staff in educational institutions and companies. However, educational institutions are currently the main clients in practice. Using the lecture editor section of the platform, the module and its materials (text, audio, video, presentation, simulator, task, test, etc.) can be used to create presentations. Using the reports section, you can analyze and statistics on user activity and development results. With iSpring's amazing technology, you can create and run a training program in just a few hours. iSpring's intuitive user interface makes the LMS extremely easy to use for both students and educators. iSpring Learn LMS automatically manages learning deadlines and sends you invitations and reminders so you can focus on what really matters.

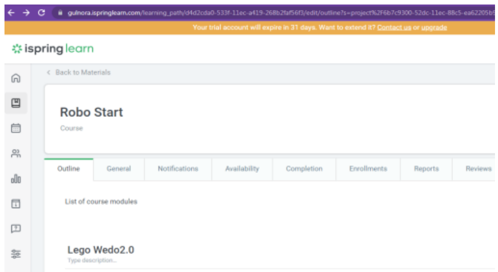

Fig 1. Creating a Robo Start course in iSpring Learn.

• Track the learning progress of each team or individual with detailed iSpring reports. Use this information to make better decisions about students and increase learning efficiency. Unlike many other LMSs, iSpring Learn comes with the award-winning authoring tool iSpring Suite. It helps you develop interactive courses, quizzes and networking scenarios in record time[5].

With the free iSpring Learn apps for iOS and Android, students can learn anytime, anywhere, even saving courses to their offline reading devices.

The figures below show fragments of creating a course in iSpring Learn. (Fig.1,2,3)

Fig 2. Course creation in iSpring Learn.

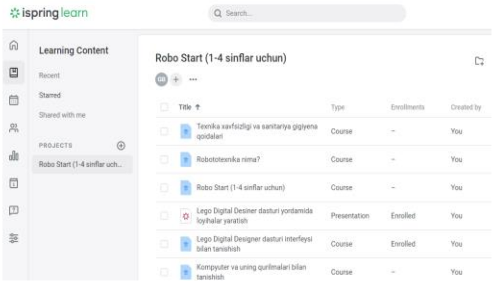

Fig 3. Content creation in iSpring Learn

Google Classroom is an educational platform that provides features such as creating a course class and adding students, including and providing students with the necessary learning materials, completing assignments for students, evaluating their work and monitoring their academic performance and communication with students. Google Workspace for Education allows administrators to choose which Google services are available to students and provides additional privacy and data security (Figure 4.).

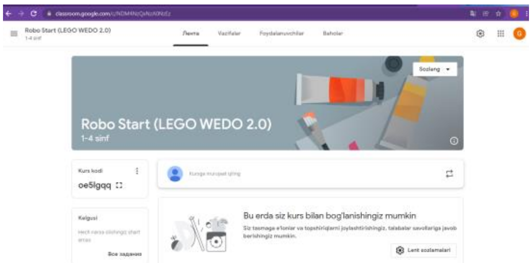

Fig 4. Creating a course in Google Classroom.

Whether they are compulsory or voluntary, more and more students are turning to virtual learning. The number of students using virtual learning continues to grow depending on our current situation. While it is still too early to determine the full impact of long-term virtual learning on the individual as opposed to traditional learning, we need to look at areas where virtual learning can actually be beneficial for student growth. Here are four ways virtual learning can positively impact learners and help them be more prepared for the future.[6]

Distance learning helps students develop time management skills. We can all agree that time management is an essential skill for life in general. Even for adults—whether we're balancing work and household chores, completing household projects, or simply planning the day—time management is critical. With virtual learning, students can learn on their own time and at their own pace, which is the main reason why most parents choose this way of learning. Having a flexible schedule means students are responsible for managing their time to participate in online virtual sessions and speak up when they need extra help to make sure they complete and submit all of their assignments. Students must devote time to watching videos, video conferencing with teachers, doing homework to get a grade. Time management shapes their work ethic by providing structure and helping them prioritize their workloads. Learning this skill is important, but students who can manage their schedules can benefit from it for a lifetime. In addition to flexible scheduling, students can access more resources and courses than in a traditional classroom. Older students may be allowed different courses depending on their interests and advanced education where they can choose their future profession. For example, students who want to learn more about accounting can attend special accounting courses that take place outside of their school [7].

Another digital communication skill that ready-made virtual learners may use in the future is collaboration. Students should have conversations with other students about projects or even video conferences. They can learn to behave in such conditions. When it comes to collaboration, virtual students also benefit from learning how to properly use microphones and headphones instead of using computer or phone microphones. They learn quickly by discussing working with digital equipment while using digital tools. Blended education prepares students for work. With the skills students acquire through virtual learning, they are poised to become workers sooner and with greater success. They shape their work ethic because the nature of virtual learning often includes aspects that develop spontaneously and are self-controlled. This self-guided learning will help students in the future as they complete their projects and tasks at work [8].

The methodology developed in the study for creating robotics circles using virtual didactic tools in the primary grades of a general education school was used in extracurricular activities of general education schools.

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 LMS.

We select hypothesis N_1 and hypothesis N_0 that contradict it, showing the effectiveness of learning in the experimental and control classes, and display it in the following tables

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:

Attainment rates in the experimental group:

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

Attainment rates in the control group

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

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**
Results of the experimental groups	78	20	24	19	15
Control group results	72	15	12	17	29

The chart corresponding to these selections looked like this:

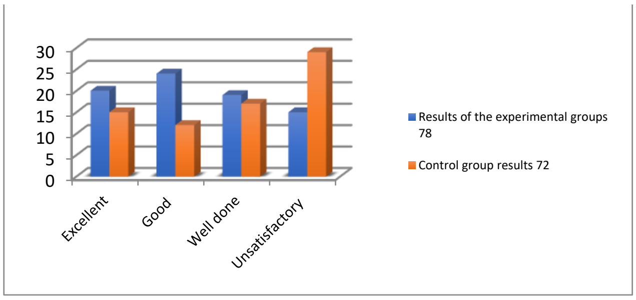

Fig 5. Effectiveness of evaluation of educational projects

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:

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

and

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

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 $\bar{Y}\% = \frac{2{,}9}{5} \cdot 100\% = 58{,}0\%$

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 are 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:

$S_{\bar{y}}^2 = \sum_{j=1}^{4} q_j\, y_j{}^2 - (\bar{y})^2 = 0{,}16 \cdot 4^2 + 0{,}25 \cdot 3^2 + 0{,}25 \cdot 2^2 + 0{,}34 \cdot 1^2 - 2{,}23^2 =$

$$= 0{,}16 \cdot 16 + 0{,}25 \cdot 9 + 0{,}25 \cdot 4 + 0{,}34 \cdot 1 - 4{,}9729$$
$$= 6{,}15 - 4{,}9729 = 1{,}1771$$

Standard errors are:

$S_x = \sqrt{0{,}8196} = 0{,}91 \qquad S_y = \sqrt{1{,}1771} = 1{,}09.$

Standard errors are:

$S_x = \sqrt{0{,}4976} = 0{,}71 \qquad S_y = \sqrt{1{,}1739} = 1{,}08.$

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:

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

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

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

$$K = \frac{(\frac{S_x}{n}+\frac{S_y}{m})^2}{\frac{(\frac{S_x^2}{n})^2}{n-1}+\frac{(\frac{S_y^2}{m})^2}{m-1}} = \frac{(\frac{0,8196}{175}+\frac{1,1771}{165})^2}{\frac{(\frac{0,8196}{175})^2}{174}+\frac{(\frac{1,1771}{165})^2}{164}} = \frac{(0,0047+0,0071)^2}{\frac{(0,0036)^2}{174}+\frac{(0,005)^2}{164}} = \frac{(0,0118)^2}{\frac{(0,000013)^2}{174}+\frac{(0,000025)^2}{164}} =$$

$$= \frac{0,0014}{0,000000075+0,00000015} = \frac{0,0014}{0,00000023} = 600,86.$$

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.

III. Conclusions

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 in the training of robotics circles through educational platforms was successfully carried out. The efficiency index with method Styudent is 13%. The organization of robotics training on virtual educational platforms through various educational contents will ensure the inclusion of more students in extracurricular education in the future. Also, this method develops children's independent thinking, problem solving, critical and logical thinking skills. But in robotics, I believe that it is a more effective way to organize training with the existing sets while holding them in the medical hand. However, it is necessary to use educational platforms for educational institutions that do not have a material and technical base.

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