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МЕТОДИКА ПРЕПОДАВАНИЯ ФИЗИКИ
METHODS OF TEACHING PHYSICS

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Additional education of schoolchildren in physics at the Children's University

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The article describes physics projects created by students as future physics teachers to organize classes on the educational platform of the Children's University. The study was aimed at examining the performance of physics students through physics projects. The advantages of the Labster 3D virtual reality learning environment for motivating students to study physics are also considered. Generally, the results of the study showed an increase in interest among primary school students in STEM education and science. The study involved children from 10 to 12 years old in the amount of 250 schoolchildren in the city of Kokshetau (Kazakhstan). The article used methods such as mixed methods, questionnaires, and semi-structured interviews for children. The Likert scale questions allowed the analysis using descriptive statistics. Open-ended questions and data from the interviews were classified using content analysis and analytically interpreted through the theory of the development of cognitive interest in children. Children were provided by links to short 10-minute educational videos posted on Youtube video hosting called FIZMAT KSU While they were working remotely. During distance learning, children used different forms of virtual laboratory work. The results and conclusions of the study revealed the followings: visiting the Children's University increases children's interest in STEM - education and science, as well as the participation of future physics teachers in the activities of the Children's University forms the skills of organizing informal forms of work with children.

Keywords: future physics teachers, additional education, children, Children's University, experiments, virtual 3D Labster laboratory, project, STEM.

Introduction

Relevance

The purpose of creating a Children's University at the university is to identify and study indicators of extracurricular activities in STEM education, as well as to demonstrate the successful activities of university students and school students through the use of entertaining forms of education that are developed by future teachers and teachers of the university. Discussion of learning outcomes is conducted under the guidance of teachers based on the theory of the development of cognitive interests of younger students [1].

The basis for conducting STEM education at the Children's University was the creation of an informal learning environment that stimulates interest in science, research on the activities of the Children's University was carried out in the work of Susanne Walan, Niklas Gericke, 2019 [2]. There are many ways to stimulate interest in the exact sciences, in our study we offer several: first, voluntary participation in these activities (Potvin and Hasni) [3]; second, non-evaluative activities; third, interactivity of classes (Shabi, Assaraf) [4]; fourth, the use of 3D gaming virtual laboratory work.

The format of the Children's University in the pedagogical environment is not new, so the European Children's Universities Network has been created in Europe [5]. The activities of teachers and students involved in the Children's University of Sh. Ualikhanov Kokshetau University is focused on creating new learning platforms, expanding the educational space, and implementing joint pedagogical and didactic research. The format of the Children's University captures not only the creativity of using teaching approaches but also the active involvement of students - future teachers in the education of students, when the boundaries of communication are blurred and there is interest in serious academic subjects, both on the part of students and on the part of students. Such meetings became possible thanks to the Children's University, which became the main one in the strategy of cooperation of university teachers, parents, students, and teachers of the Akmola region [6].

Materials and methods

When forming a cognitive interest in the system of non-formal education, it is necessary to take into account the psychological factors of its formation by L. S. Vygotsky [7-9].

It is generally accepted that not all academic subjects are of interest, and when the content of research affects the daily life of a person, students are interested. So in our study, we conducted 4 classes and then asked students to choose the most interesting topics.

The system of additional education, which has been conceptually introduced in Kazakhstan since 2019 [10], is considered the most important component of the educational space, and it is not just an element of the existing system of general education, but an independent source of education that contributes to the achievement of key competencies in various areas of the child's life self-determination. In the Republic of Kazakhstan, the system of additional education of students requires the availability of qualified teachers who have basic training in the field of additional education and can implement interesting and modern educational programs.

Ualikhanov Children's University makes a significant contribution to the system of additional education in Kazakhstan. The purpose of the children's university is to stimulate the scientific interest of children aged 8 years-12 to STEM. Since 2016, the Children's University has been working to expand the horizons of students, deepen scientific knowledge in several natural sciences, as well as form an active life position for children.

Students of the city's schools are offered eight classes, which are held every month during the academic year at the university. Students of the 3rd year of pedagogical specialties of the Faculty of Natural Sciences under the guidance of methodologists conduct practical classes and laboratory experiments in physics, chemistry, biology, mathematics, computer science, geography and talk about their applied features of the application in human life.

By the time, classes last about 2 hours, usually in the morning, for example, from 10.00 to 12.00 with 10-minute psychological training or musical warm-up activities every 20 minutes. In the context of the pandemic in 2020, classes of the Children's University were held in a remote format.

Training under the program of the Children's University developed and successfully implemented by the teaching staff of the departments of the Faculty of Natural Sciences and aimed at deepening knowledge in biology, chemistry, physics, mathematics, computer science, geography. The summer camp of DU allowed uniting children who show interest in research work, in order to organize their interaction with peers, with university teachers in the conditions of joint creative, research activities.

The main strategy of the Children's University is for children to meet with researchers, visit the university's laboratories, and be able to conduct simple physical experiments on their own. To date, about 250 children have visited the Children's University, not counting those students who signed up for our classes again.

In the study, the following tasks were set (Q1): does attending a Children's University increase children's interest in STEM? (Q2) How did physics students evaluate the experience of participating in the organization and conduct of a Children's University? The use of a mixed-method, including both questionnaires and semi-structured interviews, was developed specifically for the Children's University in order to determine the growth of interest in STEM, their general interest in science. Closed elements of the Likert scale [11] were used in the questionnaire to check whether students report an increase in interest due to participation in extracurricular activities of the Children's University (Q1). The ratings were: 1 = not interesting at all, 2 =not very interesting, 3 = no opinion, 4 = interesting and 5 = very interesting.

During the summer vacation period of 2019 and 2020, semi-structured interviews with 60 children were conducted in the classes of the Children's University. The children volunteered to participate in the interviews, and the parents ' consent was obtained. Interviews were conducted in focus groups of four to six students to encourage discussion and allow children to be more talkative. These interviews were conducted after the Children's University classes when the season was closed and was conducted in parallel by all researchers (the authors of the article). Each of the interviews was recorded audio and lasted about 8-10 minutes.

The Likert style questions in the questionnaire were analyzed based on descriptive statistics to highlight the characteristics of the change in interest (Q1). The open points of the questionnaire were analyzed using content analysis. Audio recordings from the interview were transcribed verbatim and also analyzed using content analysis, transcripts (from open questionnaire items and interview transcripts) were read repeatedly.

Children who participated in the study were encoded as I = interview, Q= questionnaire, B or G for a boy or girl, the number of the respondent, for example, IG4 means an interview with a girl who was identified as the fourth among all respondents.

Results of the research

In the second half of the 2016-2017 academic year at the Children's University, all children who attended classes in the second semester were offered a questionnaire. 100 percent of the children answered (40 responses in total). The questionnaire was submitted on paper after classes, the adults who accompanied the children were informed about the questionnaire and we asked them to help the children if there were any questions that they did not understand. Most of the children who answered the questionnaire were students from the same class.

The question «How does attending a Children's University affect children's interest in STEM?» was answered as follows (Figure 1).

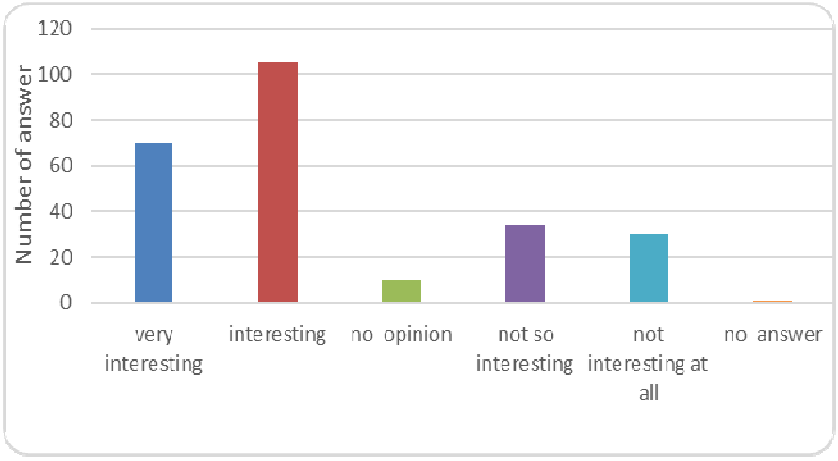

Figure 1. Children's interest in science before attending a Children's university

About 42 percent (105 children) rated science as interesting, and 28 percent (70 children) rated science as very interesting before attending a Children's University. In this question, the answers can be ranked from not at all interesting to very interesting; therefore, the answers can be considered as ranked on the points of the Likert scale, with as the most positive answer. The average was 3.6 out of 5.0 for the total number of responses.

Regarding the question of whether interest changed after attending a Children's University, children found science as interesting as before attending (120 children, 48 %), or even more interesting (110 children, 44%) (Figure 2). This can be thought of as a three-point Likert scale, giving an average of 2.4 out of 3.0.

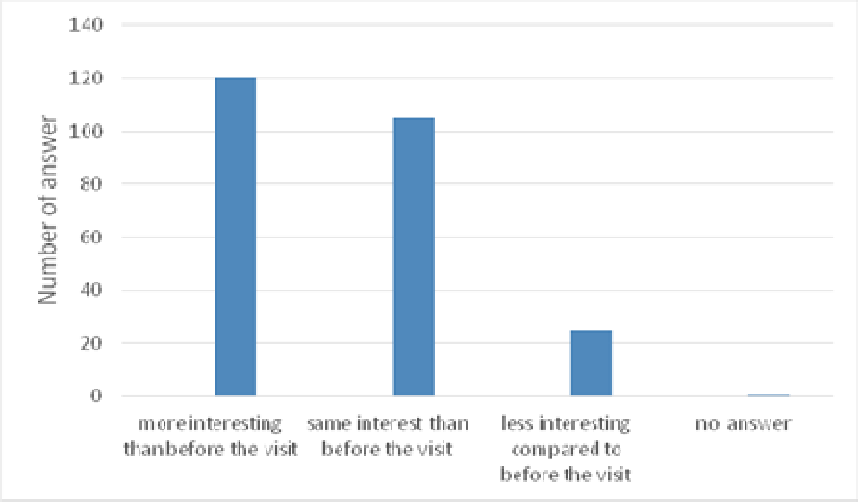

Figure 2. Children's interest after attending a children's university

We compared how the children rated the topics of the Children's University most of the children from the interview attended all classes.

In setting the topic, we sought to ensure that the activities of children at the Children's University were a continuation and deepening of the school's physics curriculum. The emphasis in working with children is not so much on improving their general education performance, preparing for exams, etc., as on educating future researchers, inventors, and creative personalities.

Participants of the Children's University summer camp in June 2020 had the opportunity to work in Labster virtual laboratories on the following topics: Newton's Law of Motion, Electrical Resistance, Fundamentals of Electricity, Electromagnetic Spectrum, Wave Model of light.

Activities in the 3D Labster laboratory are scientific and educational with a practical focus, during which the student must learn new things and learn to act, feel, and make decisions. It is carried out by including extra-curricular issues and problems of science in classes, as well as at the expense of a higher scientific level and depth of disclosure of program material.

Labster.com - this is a web service built on the principle of cloud technologies, with the help of which virtual laboratory work is performed and research activities are modeled.

In the educational sphere, this service is almost unknown even in neighboring Russia, a unique opportunity is provided by Sh. Ualikhanov KU. Performing 3D virtual laboratory work contributes to the development of cognitive interest due to the dynamic, well-animated plot of laboratory work, as well as develops visual-figurative and abstract-logical thinking through additional and virtual reality in a playful way.

Labster stimulates the imagination of the student, promotes the development of a creative approach, the development of their creative abilities in the organization of scientific and technical work. As previous experience shows, it is very interesting and comfortable for children to work with this service, as well as an aesthetic function, the process gives students more pleasure and scope of creative thought, makes it possible to go beyond the standard and limited vision.

Labster is an English-language service and the default language of the program interface is English. You can use the online photo translator program. This contributes to the adaptation of children to a foreign language and is an additional language practice for both teachers and students. This laboratory considers areas of natural sciences such as biology, physics, and chemistry. The virtual 3D lab includes more than 159 simulations. Of these, 39 in biology, 18 in physics, and 98 in chemistry are simulations.

The short 10-minute training videos posted on the Youtube channel of FIZMAT KSU [13], which the children used while performing virtual laboratory work, helped the children a lot in remote work.

In the responses of children, it was noted that working in a learning environment with physical devices stimulated their interest. This is the device of the nuclear magnetic resonance laboratory, which they saw at the university, and the virtual research environment Labster [14].

In the course of classes, the basic knowledge about the subject of activity is assimilated and the techniques of working with real objects and devices of educational laboratories of physics departments are developed. The classes not only covered science, but also included aspects from the entire STEM spectrum.

Any lesson is interesting because there is a mandatory feedback, such as we see, this is the active participation of students, future teachers, who came up with various reflexive and relaxation techniques for students, so that children do not get tired.

Students of physics of the 3rd year of the Faculty of Natural Sciences at the Children's University conducted: mass holidays with elements of intellectual activity, intellectual games and projects, practical classes with elements of research activities, an excursion to the NMR laboratory, individual work with children to perform research works of different levels.

A vivid example is the celebration of the New Year for children (photos and videos on the university's website). During the holiday, a special information table was organized, where children received information about the work of the Children's University, colorful advertisements, balloons were distributed, and enrollment in study groups was conducted.

Survey of 3rd year physics students after completion of professional practice. The majority of physics students rated their experience of participating in the organization of a Children's University as very interesting (52%) or interesting (32%) (Figure 3). Using the same thing on the Likert score scale as in the previous question, the average was 4.0 out of 5.0 for the total number of responses.

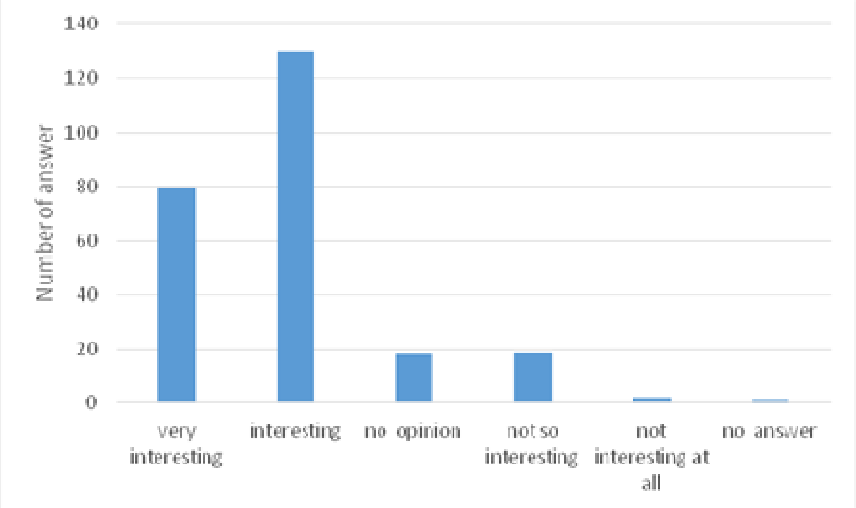

Figure 3. Results of a survey of 3rd year physics students after completing their professional practice

In addition to students and teachers, adults, teachers, and parents also took part in the work of the Children's University. Children attended these events with their teachers or relatives until 2020. The high degree of interaction between children and adults at the Children's University can be explained by the fact that children realize the importance of their families during the Covid-19 pandemic. The work is carried out in close contact with parents who acted as consultants during the first virtual laboratory work and strongly supported the children. Children, answering questions of the questionnaire, noted high activity and emotionality of adults. Parents ' reviews are posted on the website of the Children's University of KU.

Discussion of the results

Many researchers Baram-Tsabari and Yarden [15] Jones, Howe, and Rua [16], Holbrook [17] Newton [18] argue that the relevance of the topic is important to motivate students and interest them in physics. Since most of the children in our study rated the proposed topics as interesting, it can be concluded that choosing different topics at a children's university stimulates interest in STEM. Previous researchers Agranovich, S., and B. B. Z. Assaraf have indicated an interest in the experiments [19]. The results of our study suggest that topics should be seriously considered when planning future extracurricular activities.

Early research by Susanne Walan, Niklas Gericke notes the importance of impressive, spectacular activities in extracurricular activities. We used virtual laboratory works of the company Labster in the remote work of the children's University, which aroused great interest of children and parents, including those whose experience was not previously investigated. It is important to note here that the complexity of mastering a new software interface is evident in the first lesson with virtual laboratories. But the 3D effect, anima-

tion, and game form of presentation of scientific material motivate children to quickly get acquainted with the Labster program.

In our study, children talked about the Labster STEM learning environment. The Labster online laboratory allows you to engage in science, opens access to complex experiments and scientific discoveries from anywhere in the world. At the same time, students in Labster do not study haphazardly, but according to pre-prepared lessons playfully. This means that in the laboratory they do not just experiment and have fun, but learn to work with laboratory equipment and learn real physical, chemical, and biological laws. The kids found Labster jobs impressive and most interesting, often calling them cool.

Creative physics students with high academic and research achievements were allowed to prepare and conduct classes. The children talked a lot about the student researchers who conducted the classes. When the children were asked questions about the researchers presented at the Children's University, they had positive comments.

The children noted that there were a lot of students at the Children's University and unlike one teacher for the whole class, this is very good. Participation of students in the activities of the Children's University allows you to individualize the learning process, this is not enough for children at school. Parents spoke about the need to accompany the research and creative activities of children, which can also be implemented with the help of students. The activity of the Children's University belongs to the field of non-formal education, related to the individual development of the child in culture, which he chooses himself by his desires and needs. This is a key area for future research, as well as an area where there are opportunities to improve the training of future teachers at the university.

We were interested in what happened after the visits, in the cultures where children spend time (at home and school). The children were asked if they later discussed the lectures with their classmates, teachers, and relatives. All the students claimed that there were discussions in their classrooms after the visit. Children told their parents about their visit to the Children's University and we received feedback from parents via messenger. Therefore, it is also an important area for improvement that the children's university should develop, that is, cooperation with schools, teachers, with relatives to improve training and integration into school activities, to create a common culture of science education.

Conclusions and suggestions

Extracurricular activities are an important factor in helping students make future choices when it comes to studying and pursuing a career in STEM. However, along with other activities and hopefully good school teaching, attending extracurricular STEM events such as a Children's University can serve as a trigger for developing interests.

3D Labster laboratory, integrating different areas of knowledge and providing flexibility, multilingualism the variable nature of additional education allows you to introduce new 3D technologies of additional and virtual reality in the system of additional education of schools in Kokshetau.

Students of physics of Sh. Ualikhanov KU during the period of professional practice mastered the skills of working in the 3D Labster laboratory and developed video sessions for remote work in virtual STEM laboratories.

As shown in this study in the organization of extracurricular activities, students must experience some of their regular exercises. First of all, the place is important, that is, the learning environment, the extracurricular environment.

Topics should be chosen with the potential to surprise children, entertainment should be created, and ultimately, the program should be aimed at a cognitive level of activity, as children expect to learn something.

The results of our study highlight indicators that may also be of interest to various STEM activities to generate interest in the study of physics. Having the opportunity to learn something new in a learning-friendly environment, under the guidance of energetic student lecturers, in an eco-friendly environment, or a virtual 3D lab is essential for children.

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С.К. Дамекова, Н.Н. Шуюшбаева, Н.К. Танашева, Г.С. Алтаева, А.К. Калиева

Балалар университетінде физика пәні бойынша оқушыларға қосымша білім беру

Мақалада Балалар университетінің оқу платформасында сабақтарды ұйымдастыру үшін студенттердің, соның ішінде болашақ физика мұғалімдері жасаған физика жобалары сипатталған. Зерттеу жұмысы физика жобалары арқылы физика студенттері қызметінің тиімділігін зерттеуге бағытталған. Сондай-ақ оқушыларды физиканы оқуға ынталандыру үшін Labster 3D-виртуалды болмысының оқу ортасының артықшылықтары қарастырылған. Зерттеу нәтижелері негізгі мектеп оқушыларының STEM арқылы білім беру және жалпы ғылымға деген қызығушылығының артқанын көрсетті. Зерттеуге Көкшетау қаласының (Қазақстан) мектептерінен 250 оқушы, яғни 10-нан 12 жасқа дейінгі балалар қатысты. Авторлар аралас әдіс, сауалнама және балалардың жартылай құрылымдалған сұхбаттары сияқты әдістерді қолданған. Лайкерт шкаласының сұрақтары сипаттамалық статистиканы қолдана отырып талдау жүргізуге мүмкіндік берді. Сұхбаттағы ашық сұрақтар мен мәліметтер мазмұнды талдау арқылы жіктелді және балалардың танымдық қызығушылығының даму теориясы арқылы аналитикалық түрде түсіндірілді. Балалармен қашықтықтан жұмыс істеу кезінде КМУ ФИЗМАТ деп аталатын You Tube видеохостингінде орналастырылған қысқа 10 минуттық оқыту бейнелеріне сілтемелер берілді. Қашықтықтан оқыту кезінде балалар виртуалды зертханалық жұмыстарды орындаудың әр түрлі формаларын қолданды. Зерттеу нәтижелері мен қорытындылары мынадай болды: балалардың Балалар университетіне баруы, STEM арқылы білім алуы мен ғылымға деген қызығушылығын арттырады. Сонымен қатар болашақ физика мұғалімдерінің Балалар университетінің қызметіне қатысуы балалармен жұмыс жасаудың бейресми түрлерін ұйымдастыру дағдыларын қалыптастырады.

Кілт сөздер: болашақ физика мұғалімдері, қосымша білім беру, балалар, Балалар университеті, тәжірибелер, Labster виртуалды 3D зертханасы, жоба, STEM.

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Дополнительное образование школьников по физике в Детском университете

В статье описаны проекты по физике, созданные студентами — будущими учителями физики, для организации занятий на учебной платформе Детского университета. Исследование было направлено на изучение эффективности деятельности студентов-физиков посредством проектов по физике. Рассмотрены преимущества учебной среды 3D-виртуальной реальности Labster для мотивации учащихся к изучению физики. Результаты исследования показали рост интереса у учащихся основной школы к STEM-образованию и, в целом, к науке. В эксперименте приняли участие 250 учащихся школ г. Кокшетау (Казахстан) в возрасте от 10 до 12 лет. Авторами были использованы следующие методы: смешанный метод, анкета и полуструктурированные интервью детей. Вопросы шкалы Лайкерта позволили провести анализ с использованием описательной статистики. Открытые вопросы и данные из интервью были классифицированы с помощью контент-анализа и аналитически интерпретированы через теорию развития познавательного интереса детей. При дистанционной работе с детьми были предоставлены ссылки на краткие 10-минутные обучающие видео, размещенные на видеохостинге YouTube под названием ФИЗМАТ КГУ. Во время дистанционного обучения дети использовали разные формы выполнения виртуальных лабораторных работ. Резюмируя, можно отметить, что посещение Детского университета повышает интерес детей к STEM-образованию и науке, а также участие будущих учителей физики в деятельности Детского университета формирует навыки организации неформальных форм работы с детьми.

Ключевые слова: будущие учителя физики, дополнительное образование, дети, Детский университет, эксперименты, виртуальная 3D-лаборатория Labster, проект, STEM.

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