International Journal of Engineering & Technology, 7 (2.13) (2018) 150-154

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper



The creation of junior schoolchildren's interest in the experimental study of physical phenomena using the elements of the technology of problem-based

Sabirova F.M [1] *, Deryagin, A. V [2]

[1] *PhD (Physics and Mathematics), Associate Professor of Physics Kazan (Volga) Federal University, Elabuga Institute*
[2] *PhD (Pedagogics), Associate Professor of Physics Kazan (Volga) Federal University, Elabuga Institute*
**Corresponding author E-mail:*

Abstract

The goal of the paper is to define the place and role of the technology of problem-based learning in demonstrating physical phenomena and processes to junior schoolchildren within a framework of the Child University and InteLSummer projects of Elabuga Institute of Kazan Federal University for higher interest in learning physics – a science about nature. The method is the technology of problem-based learning. Children face a certain problem, which is a cognitive task, and students (themselves or assisted by a teacher) investigate the ways and methods to solve it. We can use the elements of problem-based technology (creation of a problem, joint scientific learning, and primary reinforcement of the obtained knowledge) in teaching junior schoolchildren. Results: we considered the ways of creating particular problem situations with both a teacher and, most importantly, children participating in their solution on the example of a cycle of laboratory and practical classes devoted to electrical and magnetic phenomena. In the end, the experience of applying the technology of problem-based learning has shown that children's participation in looking for the ways to solve a learning problem supports a cognitive interest of junior schoolchildren in the study of physical phenomena. The participation of pedagogical university students - future teachers - in the Child University and Intel Summer projects is a perspective form of a practice-oriented approach to future professional activity.

Keywords: *Interest in Learning; Physics, Junior Schoolchild; Motivation; Technology; Problem-Based Learning; Experiment; Electricity; Magnet; Magnetism; Experimental Check; Physical Properties.*

1. Introduction

Today, the creation and development of junior schoolchildren's interest in the study of physical phenomena and their applied significance in life and technique is relevant [1-6], since the cognitive interest motivates them to obtain knowledge and skills useful for everyday life and the development of intellectual abilities. At present, every person should possess basic knowledge of physics to have a right idea of the world around. Nowadays, we cannot ignore a rapid development of physics and the application of its results in practice. However, modern Russian schoolchildren begin to study physics only in the 7th form, though they face physical phenomena - the phenomena of nature - from the early childhood.

Therefore, it becomes important for pedagogues to develop the interest in studying physical phenomena from early school age. It is known that elementary school is the crucial stage in the establishment of children's scientific-cognitive, emotional-moral, and practical-activity attitude to the world and themselves. Cognitive interests appear quite early in a child; he often enters the school with a much broader knowledge than the information in textbooks and teaching materials provided by the school program. However, child's pre-school knowledge is usually fragmentary, non-systematized and far from being scientific [1]. A pedagogue should help in transforming this knowledge into a logical and full picture of the world [2-4]. The work of pedagogues on the development of interest in physics will enable to broaden knowledge and prepare children to perceive the system information of the school course of physics and to receive natural-scientific education further [5-7]. We assume that one of the ways to raise a cognitive interest is to create problem situations during the scientific-popular lectures and practical laboratory sessions in small groups of junior schoolchildren. The authors have the experience of this work [8].

2. Materials and methods

Physics occupies a special place among school disciplines [2-4], since it creates the idea of a scientific picture of the world in learners. Physics is a basis for scientific-technical progress. It develops learners' creative abilities and worldview. If the interest in knowledge is developed during the study, all this enables to achieve the goals of training and education. However, a junior schoolchild may be not ready to perceive physics yet, especially such serious and difficult topics as magnetic and electric phenomena. In this case, we can adapt any learning material depending on the age and give it in a proper time [5].

Foreign experience of learning physics in the elementary school is of great interest for research [5-6]; however, basic physical phenomena are not taught in Russian elementary school, while elementary school teachers do not have enough knowledge of physics [7].

Copyright © 2018 Sabirova F.M, Deryagin, A. V. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Therefore, extra-curriculum activity with high school teachers of physics or university professors becomes a priority in developing children's interest in studying physical phenomena. This activity may have various forms: individual and group developmental classes, mentorship, the elaboration of creative home assignments etc. [8]. Lectures and practical classes for junior schoolchildren arranged and conducted by the universities within a framework of practice-oriented projects is one of the forms of extra-curriculum activity. It contributes to the development of interest in physics.

The use of the elements of problem-based learning technology is one of the most adequate and available ways to stimulate junior schoolchildren's interest in learning physics. Problem-based learning is "learning, where a teacher creates problem situations regularly and arranges children's activity in solving learning problems; thus, he provides the optimal combination of their independent research and the acquisition of ready-made scientific conclusions." [9], [p.149] Children's participation in looking for the ways to solve a learning problem supports their cognitive interest [10]. The technology of problem-based learning enables to develop junior schoolchildren's creative abilities dynamically. Children master knowledge and skills and develop their thinking abilities successfully [11], [12].

3. Results and discussion

Classes within a framework of practice-oriented projects in Elabuga Institute of Kazan Federal University including Child University, IntelSummer, Summer Physical-Mathematic School, Masters Course for Children etc. are a favorable basis for the creation of problem situations [13-16]. These projects involve the classes on literature, mathematics, chemistry, physics, astronomy, history, law and some others disciplines. They are given at a high scientific level. Thus, the Child University educational project of Kazan (Volga) Federal University (KFU) is designed for children aged 8-13. It involves lectures and practical laboratory sessions in small groups created by interests. As we know, many elementary school teachers do not have enough knowledge of a subject that would corresponds to the modern level of scientific development [2]. Besides, teachers should have deep knowledge to work with children, first of all, they should be perfectly informed about their discipline, in our case, physics [7]. Thus, high quality teachers with large experience of working with children and skills of experimental work were engaged in the project.

The professors of the physics department of KFU Elabuga Institute have accumulated a large experience of classes in Physics during the projects. These classes can be united under a topic "Physics around us". Teachers give lectures and practical classes in Physics to junior schoolchildren regularly. Most of them have not yet acquainted with the learning course of physics. However, they already have the initial ideas of natural phenomena obtained both at the period of pre-school education and at the classes of nature study. Therefore, the content of classes within a framework of the project is based on a certain topic, which is clear and easy for junior schoolchildren. For example, "How does electricity occur?", "Magnetic phenomena around us", "The discovery of atom". These classes enable to describe various phenomena and to formulate physical laws. New knowledge is reinforced by the demonstration of experiments during practical laboratory sessions. Certainly, such sessions differ from laboratory or practical exercises in schools or universities. The material given to children is adapted according to their age and the level of their knowledge and representations. To make classes with children more available, we include interviews, question and problem situations, which are solved during the discussion and demonstration of physical experiences, into them. Usually, various experiences, especially performed by children, stimulate a keen interest in junior schoolchildren [16]. Teaching junior schoolchildren according to formulated topics motivate them to obtain knowledge and skills useful for everyday life and the development of intellectual abilities. This makes them ready to obtain knowledge in physics later, during the study of this discipline in senior classes and in further education.

To solve the tasks successfully, it is reasonable to use problem-based learning, when children learn the logic for solving various problems created by a teacher intentionally [10]. However, when we create problem situations, we should strike a balance between the level of junior schoolchildren's training and the difficulty of problems, since a problem situation occurs only if a student can solve the task (even if he is assisted by a teacher), i.e. his intellectual abilities should correspond to the level of the problem. However, during the organization of problem situations, we should bear in mind that a cognitive need occurs in children only if they have serious preliminary training [10, p. 160]. In our case, one of the first stages of such training is to give a basic material in the lecture, the next stage is a home assignment with the tasks in a working sheet, the third stage is to repeat the learnt material and supplement it with the information given by a teacher in the practical laboratory sessions.

Thus, the very topic "How does electricity occur?" is a problem situation. To solve it, children first get acquainted with the development of the representations of electricity from antiquity to the present time. A teacher reveals the origin of such notions as electron, electricity, charge, discharge, and battery using bright animated illustrations. Little listeners are quite capable of understanding that there are two types of a charge, positive and negative. They answer the questions of a lecturer and give the examples of how we can obtain these charges.

Another problem situation is looking for the answer to the question: how did a man learn how to use electricity? To help schoolchildren to find the answer, the teacher acquaints them with the history of devices, which enables to observe electrical phenomena: Guericke conductor, Wimshurst machine, electroscope, Leyden jar, and the sources of electric energy, from the Volt galvanic element and alternate current generator to modern thermo- and photo-elements.

After every lecture (no more than 30 minutes), children receive working sheets elaborated by the lecturer to reinforce new knowledge: to answer the questions, to solve riddles, to make the simplest experiments on electrification or magnets at home, and, thus, to prepare for a practical laboratory session devoted to the experimental research of the simplest phenomena. Such class is planned after the lecture. In the result, children acquire deeper representations of electric and magnetic phenomena reinforced by a number of demonstrative-learning experiments.

Each of these practical exercises aim at stimulating schoolchildren to study electrical and magnetic phenomena and applying them in everyday life; and developing the skills of research, physical experiment, and the analysis of results.

Thus, after the lecture "How does electricity occur?" children work in small groups at the classes devoted to "Sources of Electricity". At the beginning of the class, children repeat the learnt material with the teacher. Then, they have a more detailed study of the types of charging and learn that there are two types: charging by friction and induction. The first type of electrification – by friction – is seen in everyday life and natural phenomena. A teacher shows the experiments on charging by friction and explains that many years ago, at the initiative of Benjamin Franklin, a prominent politician and a scientist, they began to treat a charge that emerges on amber when it is rubbed with wool as negative, and a charge that occurs on a glass rod – as positive.

Learnt information is immediately reinforced by the examples from observations in the environment. In this case, it would be correct to ask a question: "Where in nature did you observe similar phenomena?" and gradually bring children closer to the answers to these questions: Why do you often have tingly hands, hear a typical crack or flicks and see sparks at night when you stroke a cat? Why do you observe the same phenomenon when you take off synthetic clothes? Children easily answer that these are electric charges obtained by rubbing hands with the animal's fur or rubbing a body with the clothes.

The information about the origin of lightning and bursts of thunder often observed by children during the thunderstorm contributes to the development of interest in studying electric phenomena. Again, this is charging by friction: a cloud moves in the atmosphere, electrifies and becomes negatively charged. As soon as a considerable charge is accumulated, it flows down on the earth and we see a lightning. A powerful electric charge makes the atmosphere around hotter. Therefore, a gas widens and a soundwave is created. In the result, we hear a thunder. Again, we ask a question to children: why do we first see a lightning and then hear a thunder, if these processes are almost simultaneous? In this case, a teacher explains to children that the speed of light differs from the speed of sound. It turns out that if we know the time from the occurrence of lightning to the emergence of thunder, we can define the distance of a thunder epicenter from the place of observation.

Children see micro-charges during the demonstration of experiments with the Wimshurst machine. They got to know about its history and construction at the lecture and learnt again that this device transforms mechanic energy into electric. Children see a strong charge accompanied by a loud flick with the professor of Child University. It turns out to be a model of natural phenomena observed by little learners many times: this is a lightning and a thunder in miniature.

Little students of Child University begin their acquaintance with the properties of magnets with the lecture "Magnetic phenomena around us". Here they learn what a magnet is and who and when discovered it; what a magnetic field of the earth is and what magnetic phenomena we observe in the Earth; they learn about a compass, a natural compass in migrating animals, the use of magnets by a human etc. A lecture is accompanied by vivid examples, simplest demonstrations, visual presentations and video fragments.

After the lecture, inquisitive children visit a practical laboratory session again. Here, they face cognitive tasks: to get children acquainted with the notions of magnetism, magnetic forces, magnetic field; to develop a representation of the properties of a magnet through the experiment; to supplement children's knowledge of the use of magnet properties by a human. The important objective of the session is to stimulate children to go on studying magnetic properties and phenomena independently, to learn to generalize, to find possible solutions within a framework of experimental activity; to check these solutions; and to make conclusions with the results of this check. Together with cognitive tasks, the session enables to develop child's cognitive activity (speech, attention, logical thinking, and curiosity) during the acquaintance with the covert properties of a magnet.

Therefore, at the beginning of the practical laboratory session, a teacher get children interested by telling them a well-known fact that a man perceives the world around by five sensory organs (children enumerate them). However, it turns out that sensory organs given to a man by nature have quite a narrow range. They do not allow a man to receive quite full information about the world around. Therefore, to discover many phenomena, scientists had to use devices that enabled to extend this range. Thus, a teacher suggests a problem situation and asks what natural phenomena children know but can neither see, no hear, nor feel. Basing on the topic of the session, children gradually agree that there is an invisible magnetic field of the Earth, though we cannot visually observe magnetic forces. Children reproduce the material of the lecture and tell that the Earth's magnetic field is very important in our life, since it protects the planet and all the living things from harmful space radiation. Asking such a question and looking for an answer to it is far more efficient than just repeating the learnt material. Further, the information is supplemented by the notion "magnetic field" as a special form of substance: a magnetic field is a power field that attracts or rejects objects. I.e. magnetic properties are manifested in the attraction of objects.

Again, the teacher suggests a problem situation and formulates it during the representation: if magnets attract objects, do any objects are subject to their impact? First, children try to answer the question relying on their observations for the phenomena of the world around, but then the teacher demonstrates the following experiment: he places various small objects (iron bolts, screws, clips, pieces of aluminum foil, paper, rubber, copper (brass), plastic and wooden buttons, glass balls etc.) into a plastic container. The he places a plane magnet into the container with small objects and offers children to analyze what objects are "interested" in the magnet. There is a difficulty that children are offered to cope with. Children see that metallic objects are attracted; however, after they repeat the experiment several times and reproduce it themselves, they notice that not all metallic objects are attracted by the magnet. Neither copper nor aluminium, which are also metals, do not "react" to it. This problem situation is resolved by a conclusion: it turns out that only iron objects were attracted by the magnet. Thus, a magnet attracts only iron objects. During the experiment, the teacher explains that there are different types of metals including copper, aluminum etc. and iron occupies a special place among them, since only iron and its alloys (steel) are attracted by a magnet. Apart from iron and its compositions, only nickel and cobalt have manifest magnetic properties. All these materials are called ferromagnetic (ferrum - from Lat. iron).

After children and the teacher find out that a magnet can attract iron objects, the teacher creates another problem situation and offer children to resolve it through the experiment: to find out how the environment where iron objects are situated influences their ability to be attracted by a magnet? For this purpose, iron clips are placed in a plastic container and covered by river sand. Children are offered to bring the magnet close to the surface of sand. As shown by the experiment, the magnet attracts metallic clips despite of friable environment between them. This experiment enables to form a hypothesis that environment does not influence the ability of a magnet to attract iron. This hypothesis is checked by the experiment again: clips are watered or the container in covered by a list of cardboard or organic glass. Children see that in these cases, the magnet attracts iron objects too. The experiment during the solution of a problem situation headed by the teacher enables children to conclude: magnetic forces go through various materials (sand, water, cardboard).

The teacher repeats again that a magnet field enables magnets and iron objects to interact. This notion is quite a new for children, therefore, a teacher explains: a magnet field is a space, where magnetic effects and magnetic states of a substance are observed. Thus, a magnet field exists around magnets wherever their effect is found. A magnetic field is invisible; however, we can show that it actually exists using a well-known experiment: a magnet is placed under a sheet of cardboard, metallic cuttings are poured on the cardboard from the small height. In the result, we see that cuttings formed a pattern determined by the form of the magnet. A teacher offers to analyze it: look, there is a pattern, if we have a ring magnet, the cuttings are arranged in rings according to the form of the magnet, if we have a plane magnet, magnetic forces are stronger on its ends (the density of magnetized cuttings is bigger). These are the poles of a magnet. Conclusion: magnetic field "makes" iron particles arrange along the lines called magnetic lines. The pattern of cuttings enables to define the position of magnet poles (magnet poles are situated where the density of cuttings glued to the magnet is higher); a magnet has two such places. Therefore, we have a new provision: any magnet has two poles.

Children already know that there are two geographic poles - northern and southern. To confirm this provision, the teacher shows that a free-hanging magnet takes quite a definite position, when it turns one of its ends to the geographical north, and another end - to the geographical south. The structure of a compass, which is used to define the north-south direction, is based on this phenomenon. Children are already acquainted with the history of compass discovery form the content of the lecture. A compass needle always occupies a definite position, which is indicative of the Earth's magnetic field that affects it.

The teacher stimulates children's interest by a problem situation: how to prove that a magnet has two poles? This situation usually provokes a great interest too, and children offer the most varying hypotheses and arguments. In the end, it turns out that an experiment is the best argument. If we take two magnets and bring them

closer to each other, we will see that they are attracted by one end and rejected by another end. One end is called a southern (or positive) pole of the magnet and is marked with "S" or with a red color. Another end - a northern (negative) pole of the magnet is marked with "N" or with a blue color. Magnets attract each other by unlike poles and reject each other by like poles. After that, children are offered to see it themselves. They are to take two magnetic bars and find out whether it brings them together with like poles or unlike poles.

At the next stage of the practical laboratory session, a teacher argues again that there are substances with magnetic properties. i.e. magnets. At the previous stage, children were just shown magnets of varying forms. Now, another problem situation is created: can we make a magnet ourselves? If yes, how can we do it? To resolve this situation, we place an iron nail into a strong magnetic field created by a constant magnet. It turns out that it attracts iron objects, for example, clips, too, i.e. it becomes a constant magnet. Such way of magnetization is called magnetization through impact. However, there is another way to make a magnet from an iron nail. For this purpose, we should wind an isolated wire tightly in one, or, better, in two layers (the more coils we have, the stronger magnet layer we can create with less values of wire circuit), and the obtained spool is switched to the source of constant regulated current. We can control the existence and value of the spool current if we switch an ammeter or a 20 Watt automobile incandescent lamp to a circuit sequentially. The deviation of an ammeter hand indicates the existence of current in the circuit, the angle of hand deviation indicates the value of current. Analogously, if we switch an incandescent lamp, the heat of the lamp needle indicates the existence and value of current (if a spiral shines, there is current, the stronger the lamp spiral stronger, the more is current). The teacher makes the obtained wind carry a current and then switch the source off. Thus, the experiment shows that the nail begins to attracts iron objects. It turns out that an electric current runs through the spool coils and creates a magnetic field, which pierces a nail and gives it magnetic properties. The nail will preserve them even if the wind is switched off from the source of a current. Therefore, we can create magnets artificially: we can magnetize them by impact (by placing a magnet near other magnets) or place them in the magnetic field created by an electric current. However, not all materials can be used to make a magnet. Only iron and iron alloys will do. These materials may have magnetic properties; therefore, they were called ferromagnetics. In these materials, large groups of atoms can orient themselves is a strictly definite way, this enables them to have magnetic properties. Now, the teacher creates another problem situation: if a substance can be magnetized. i.e. if it can acquire an ability to attract iron objects, can a magnet lose its properties? If yes, how and why can it do it? Children are not ready to answer to this question yet; however, the level of their knowledge enables to bring them closer to the solution of this situation by experiment. For this purpose, a teacher hits some massive metallic object hardly several times with a magnetized iron rod. Then, he brings the rod closer to the objects (for example, clips) attracted by it before the hit. Children see that clips remain "indifferent" to the nail, which attracted them before, and conclude that a magnet can lose their properties because of a hard hit. The teacher makes one more experiment: he hangs a magnetized nail on the base and brings it closer to the iron objects again. They remain "indifferent" to it. Therefore, children solve a problem situation through the experiment and find out that a magnetized object can be neutralized by a hard hit or heat. The teacher repeats that ferromagnetics have the entire areas, where atoms orient themselves in a definite way. Therefore, such substances have magnetic properties. Hence, this orientation is impaired by a hit or heat. At the end of the class, children repeat the problem situations. The teacher suggests them to make the simplest experiments with magnets again and to draw basic conclusions from the learnt material. Thus, knowledge and skills obtained during the sessions are reinforced.

4. Conclusions

The experiment demonstrations for junior schoolchildren for studying electric and magnetic phenomena has been used and improved for 4 years within a framework of Child University project. Lectures were available for everyone. They were attended by all signed-up learners (70-90 children aged 8-11). Usually, they were conducted twice a year on schedule. Practical laboratory sessions were conducted in small groups. They were attended by children interested in the topic of lecture.

Problem situations became a favorable basis for stimulating children to learn physics. In 2012-2013, at the initial stage of the projects, practical laboratory sessions were attended by 7-8 persons, in 2015-2016 - by 10-12 children, in 2017 – by 14 persons.

The IntelSummer project for junior and intermediate schoolchildren during summer vacation enables to represent experiment demonstrations more fully. The authors elaborated the program for 10 classes (5 classes for studying electric phenomena and 5 classes - for magnetic phenomena, the classes are also based on the elements of problem-based learning). Classes are given during school vacations; therefore, the experiments also acquaint children with the elements of safety precaution in nature.

It is important that a pedagogical university is used to stimulate junior schoolchildren to learn sciences including physics within a framework of the projects of Elabuga Institute of Kazan Federal University. This enables to use the potential of the university, for example, to invite the students specializing in physics as teacher assistants or to arrange further training courses for elementary school teachers. This enables to implement the majority of projects elaborated in the institute for the purpose of a practice-oriented approach to training pedagogues [16-20] for solving various educational tasks.Thus, our practical laboratory sessions are based on the technology of problem-based learning, when a teacher does not only explain a new material and reinforce it with demonstrations, but also suggests and formulates problems and stimulates junior schoolchildren to solve them. When a teacher formulates a problem situation, a teacher does not only solve it himself and allows children to listen to him actively and discuss the problem, but also encourages them to look for a solution themselves [16, p. 154]. The experience shows that in this case, schoolchildren's interest and initiative are manifested clearly. The advantages of this form of activity within a framework of Child University and IntelSummer projects are also obvious, because their tempo does not depend on weak, strong or average students. Laboratory and practical tasks are not limited to a rigid time-frame; the tempo of material presentation depends on the structure of the learners' group. In the result, students apply the obtained knowledge in new situations more easily and develop their skills and creative abilities.

The work is supported by the state subsidy provided by Kazan (Volga) Federal University to raise its competitiveness among the leading world education research centers.

References

[1] Ravanis, K., Boilevin, J.M. (2009) A Comparative Approach to the Representation of Light for five-, eight- and ten-year-old children: Didactical Perspectives. Journal of Baltic Science Education 8 (3), p. 182-190.

[2] Gur, C. (2011) Physics in Preschool. International Journal of Physical Sciences. Six (4), p. 939-943.

[3] Schroeder, C. (2007) the Importance of Physics in the First Four Years of Elementary School. [An Importância da Física nas Quatro Primeiras Séries do Ensino Fundamental]. Revista Brasileira de Ensino de Fisica, 29 (1), p. 89-94.

[4] Ahtee, M., Johnston, J. (2006) Primary Student Teachers' Ideas about Teaching a Physics Topic. Scandinavian Journal of Educational Research, 50 (2), p. 207-219.

[5] Ľubomíra Valovičová1 and Eva Sollárová (2017). Empirical Learning of Children at Kindergartens. AIP Conference Proceedings 1804, 050008; doi: http://dx.doi.org/10.1063/1.4974396.

[6] De Carvalho, A.M.P. (2004) Building up Explanations in Physics Teaching. International Journal of Science Education. 26(2), p. 225-237.
[7] Jankovic, L., Cucic, D. (2010) Working with Advanced Primary School Students in Physics // AIP Conference Proceedings. V.1203, p.1333-1335.
[8] Shurygin V.Yu., Deryagin A.V. (2013) Razvitiye Tekhnicheskih Sposobnostei Odarennyh Detei vo Vneklassnoi Rabote [The Development of Technical Abilities of Gifted Children in Extra-Curriculum Activity]. Sovremennye Problemy Nauki i Obrazovaniya. 2013. No2; URL: http://www.science-education.ru/108-8773.
[9] Sitarov V.A. (2009) Problemnoe Obuchenie kak Odno iz Napravleniy Sovremennyh Tekhnologiy Obucheniya [Problem-Based Learning as One of the Trends of Modern Technologies of Teaching]. Znanie. Ponimanie. Umenie. V.1. Pp. 148-157.
[10] Makhmutov M.I. (1972) Teoriya i Praktika Problemnogo Obucheniya [Theory and Practice of Problem-Based Learning]. Kazan. Tatknigoizdat. Pp. 288-289.
[11] Campos, B.S., Fernandes, S.A., Ragni, A.C.P.B., Souza, N.F. (2012) Physics for Children: Approach Physics Concepts from Problem Situations. Revista Brasileira de Ensino de Fisica, 29 (1), p. 34 (1), p. 1402.
[12] Edens, Kellah M. (2000). "Preparing Problem Solvers for the 21st Century through Problem-Based Learning". College Teaching. 48 (2), p. 55–60. Doi: 10.1080/87567550009595813. JSTOR 27558988.
[13] Krasnova L.A., Shurygina V.Yu. Realizatsiya Printsipa Posledovatelnosti i Preemstvennosti v Rabote s Odarennymi Detmi [The Principle of Consequence and Succession in Working with Gifted Children]. Sovremennye Naukoemkie Tekhnologii. 2016. No 5-2. Pp. 358-362.
[14] Sabirova F.M., Deryagin A.V. (2016) Iz Opyta Formirobaniya Interesa k Izucheniyu Fizicheskih Yavleniy u Detei Shkolnogo Vozrasta v ramkah proekta “Detskiy Universitet” [From the Experience of Developing an Interest in Physical Phenomena in Junior Schoolchildren Within a Framework of the Child University Project]. Sovremennye Problemy Nauki i Obrazovaniya. No five; URL: http://cyberleninka.ru/article/n/obosnovanie-effektivnosti-proektirovaniya-zdorovieformiruyuschego-obrazovatelnogo-prostranstva-shkoly-na-osnove-sportizatsii (access date: September 10, 2016).
[15] Taştan, S.B., Davoudi, S.M.M., Masalimova, A.R., Bersanov, A.S., Kurbanov, R.A., Boiarchuk, A.V., Pavlushin, A.A. (2018). The Impacts of Teacher’s Efficacy and Motivation on Student’s Academic Achievement in Science Education among Secondary and High School Students, EURASIA Journal of Mathematics Science and Technology Education, 14(6), 2353-2366.
[16] Sabirova F.M., Deryagin A.V. Ispolzovanie Elementov Tekhnologii Problemnogog Obucheniya pri Izuchenii Fiziki Mladshimi Shkolnikami [The Use of the Elements of the Technology of Problem-Based Learning in Teaching Physics to Junior Schoolchildren Within a Framework of the Child University Project]. Deryagin// Problemnoe Obuchenie v Sovremennom Mire [Problem-based Learning in the Modern World]. Collection of the papers of the VII International Makhmudov Readings. Elabuga. The publishing house of the KFU. Elabuga, 2016. Pp. 460-465.
[17] Davoudi SMM, Fartash K, Venera G. Zakirova, Asiya M. Belyalova, Rashad A. Kurbanov, Anna V. Boiarchuk, Zhanna M. Sizova (2018). Testing the Mediating Role of Open Innovation on the Relationship between Intellectual Property Rights and Organizational Performance: A Case of Science and Technology Park, EURASIA Journal of Mathematics Science and Technology Education, 14(4), 1359-1369.
[18] Samedov M.N.O., Aikashev G.S., Shurygin V.Y., Deryagin A.V., Sahabiev I.A. (2015) A Study of Socialization of Children and Student-Age Youth by the Express Diagnostics Methods // Biosciences Biotechnology Research Asia. 12(3). P.2711-2722.
[19] Krasnova L.A., Anisimova T.I. (2013) Particularities of Remote-Acting Courses to Upgrade Teaching Qualification. World applied sciences journal. V 27. № 13 a. p. 158-161.
[20] Damasio, F., Steffani, M.H. (2008) The Physics in the First Four Grades of Elementary School: Developing and Applying a Program for Teachers Qualification: Revista Brasileira de Ensino de Fisica [A Física nas Séries Iniciais (2a a 5a) do Ensino Fundamental: Desenvolvimento e Aplicação de um Programa Visando a Qualificação de Professores]. 30 (4), p. 4503.1-4503.9.