UDC 374:004

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AUTHOR'S EXPERIENCE IN TRAINING PUPILS OF SPECIALIZED OUT-OF-SCHOOL EDUCATIONAL INSTITUTIONS TO RESEARCH WORK BY MEANS OF INFORMATIONAL AND COMMUNICATION TECHNOLOGIES

DOI: 10.14308/ite000612

In the article the author's experience in pupils' training of Junior Academy of Sciences of Ukraine to research work by means of informational and communication technologies is presented. The three-tiered approach (popular science, experimental, fundamental levels) to the organization of personal oriented study in Physics covered such didactic principles as accessibility, visibility, scientific and systematic is considered. At the first level, pupils should be inculcated by interest in physics, its specificity, the terms etc. At the second level the experiment and demonstration of physical phenomena have a paramount importance, which aims to encourage students to make self-facilitated conclusions. At the third level the laboratory works and method of problem learning allow students to develop the ability independently to solve physical tasks. It is concluded that at each of these levels the means of information and communication technologies should be used. As an example, the author reviews the experience of open online course «Introduction to Physics of Sound», designed for pupils of specialized out-of-school educational institutions. We presented the main issues of the online course and examples of cognitive activity of pupils.

Keywords: *cognitive activity, personal-oriented teaching, open online course*

Introduction. Scientific, technical and technological development has contributed to change the nature of work of teachers and students. Technics got complicated, the level of computerization and informatization was increased, and demands for knowledge were raised. New requirement for person who lives in informational age is the ability to update the knowledge every five years, i.e. be professionally mobile.

A specific task of the teacher is to form interest to the academic subject. Then the pupil can feel emotional satisfaction at mastering new material. Theoretical analysis of many scientific studies allows to isolate such problems of teaching Physics in Ukraine [1; 2; 3]:

1) a sharp reduction in the need for physical and technical specialists as a result of industrial production decline;

2) falling of prestige of physical science; reducing of the number and quality of physical demonstration experiment;

3) lack of complete visual methods at presenting educational material;

4) partial mismatch of interdisciplinary connections;

5) low social status of teachers;

6) focus on memorizing and reproduction of knowledge instead of understanding the nature of physical phenomena and laws.

These problems lead to the fact that the study of Physics as a subject is difficult and uninteresting; trend of increasing tendency to study humanities study was developed. Therefore, urgent tasks today are to improve the content, forms and methods of Physics, create favorable conditions to support gifted young people.

One of the specialized out-of-school education institutions, which have a network of centers throughout Ukraine, is Junior Academy of Sciences (JAS) of Ukraine. Research work in JAS is

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organized by academic departments and sections according to the structure approved by the Presidium of the JAS. The outstanding event is the annual All-Ukrainian competition-defense of research works of pupils – members of the JAS.

Working as head of physics section in the Luhansk Regional Junior Academy of Sciences in 2008–2014 years and the head of the Section of Theoretical Physics of Kyiv Junior Academy of Sciences in 2014–2015 years, the author developed and tested the own three-tiered approach in training pupils for research work, including the use of information and communication technologies (ICT). Thus, under the guidance of the author two pupils won (2012 – third place; 2014 – third place) at All-Ukrainian stages of the competition-defense of research works of pupils – members of the Junior Academy of Sciences of Ukraine, seven students occupy the prize-winning place at II (municipal) stage of Ukrainian competition-defense of research works of pupils –members of Kyiv territorial department of Junior Academy of Sciences of Ukraine (Kyiv Junior Academy of Sciences, 2015). Consider the methodological base of the developed approach.

The author's approach to personal oriented study. At first level of training pupils it is need instilling of interest in Physics. Its specificity and the meaning of terms should be shown. You can use techniques such as conversation, discussion, analogy. At the beginning of classes it is reasonable to make recapitulation in a form of conversation to test pupils' knowledge. Then it is useful to consider examples from their life experience related to the investigated issues. In the form of interviews it is also useful to conduct surveys. However, the questions should be carefully planned and had all possible answers. Using interdisciplinary examples allows showing the unity of the laws of nature, teaching correctly interpret natural phenomena, revealing in the new situation studied physics concepts and thus deepen the knowledge. The important role is the principle of historicism, which uses historical material that reflects the milestones of Physics, the most fundamental discoveries, the role of Ukrainian scientists. This material should promote understanding of the studied subject. Good result brings the use of cognitive tasks, as well as tours, meetings with prominent scientists.

In addition to simple educational material, on the second level the paramount role is the experiment. Without the implementation of experiments there is not success in learning Physics. Demonstrations of physical phenomena should encourage pupils to make independent conclusions. At this level it is advisable to use different means of visibility – videos, presentations, interactive quizzes. It is important to teach pupils to give logically reasoned answers to questions. At the third level the special urgency is the method of problem-based learning, which allows pupils to develop the ability to solve physical tasks. The problem should be extracted in the process of solving new task for student. Laboratory work plays particular importance. They promote thinking and learning to analyze phenomena, applying theoretical and practical knowledge in setting work and obtain in conclusions. For their performance the author uses full-scale, virtual practical works.

Among the interactive computer programs there are: software tool «Virtual physics laboratory 10–11 grades» (Developer – «Kvazar-Micro»), a multimedia course «Open Physics» (the developer – «Fizikon»), an interactive simulator PhET, developed by employees University of Colorado (https://phet.colorado.edu/en/simulations/category/physics/sound-and-waves). Distance tasks Open natural demonstration of Physics, placed at the All-Ukrainian tournament of Natural Sciences (http://www.vpd.inhost.com.ua/index.php/arkhiv) is good, and virtual educational laboratory VirtuLab (http: //www.virtulab.net); environment BARSIC (Business And Research Scientific Interactive Calculator, http://barsic.spbu.ru/www/lab_dhtml/common/index.html).

The proposed approach to teaching Physics is briefly disclosed in the table.1 [4]. This approach can be applied not only to a complete cycle of study, but also to individually chosen lessons. In this case, it is explained the essence of physical phenomena (first level), supplemented with visual demonstrations (second level), and then examined the physical theory of mathematical structure (third level). The possibilities of forming cognitive motivation are revealed at every level with the use of some of the forms, methods and tools, including ICT. ICT impact on structural and methodological components of educational system and encourage the search for new teaching methods.

Table 1.

Three-tiered approach to organize personal oriented leaching

Level	*Domineering principles*	*Description*	*Domineering teaching methods*	*Purpose*
I. Popular-science	Availability, the principle of historicism	Research the phenomenon at initial theoretical level	Verbal and visual (method of analogies, conversation, discussion, posters, ICT)	Updating cognitive interest, formation of theoretical image
II. Experimental	Visibility	Demonstration of experiments	Visible (audio-visual materials, models, patterns, ICT)	Supplement of theoretical image by practice
III. Fundamental	Scientific, consistency	Understanding the physical theories (facts, concepts, models, laws, principles)	Verbal and practical (problem-based learning method, laboratory works, ICT)	Forming a holistic understanding

The experience of open online course. A large number of scientific papers and publications are dedicated to use distance learning technology. At the same time distance learning courses in Physics, focused on training pupils of specialized out-of-school educational institutions of Ukraine to the research work is nonexistent. We believe this is due to the specifics of the training and motivation of teachers [5; 6; 7; 8].

Thus, among the national distance learning courses for pupils there are following projects:

1) Physics of sound (Project 2009, Project Manager – O. Antikuz, http://project.iteach.com.ua/best-projects/0912-129);

2) Learning Physics together (Project 2011, Project Manager – O. Antikuz) – the course is based on the platform Windows Live, where pupils are organized in the virtual community;

3) Distance learning of pupils (scientific and pedagogical project 2009–2012, http://testportal.org.ua/dls, author and supervisor of the project – Yu. Bohachkov).

June 1st, 2016 there was designed the Bank of lectures in Ukraine – network video collection of lectures delivered by Ukrainian lecturers (http://lecbank.jimdo.com), where videos are grouped by degree of difficulty (popular science, for pupils, for students, for specialists). These lectures are devoted to a wide range of subjects (astronomy, biology, biophysics, mathematics, medicine, art, linguistics, music, science and society, law, physics, philosophy, chemistry, etc.), they are selective and do not covers the full content of the course.

In order to find and create the conditions for supporting talented youth, testing methods and technologies of distance out-of-school education in 2011, the author of the article held open online course «Introduction to the Physics of Sound» [9; 10], which is based on connectionism pedagogy [11].

Information about the course was placed on forums, social network «Ukrainian scientists in the world». Information of the lesson conducting is published in the news of information-educational portal «Distance Learning Technology» (www.tdo.at.ua). The corresponding message was hosted in Twitter with the following repost in social network Facebook (Fig. 1).

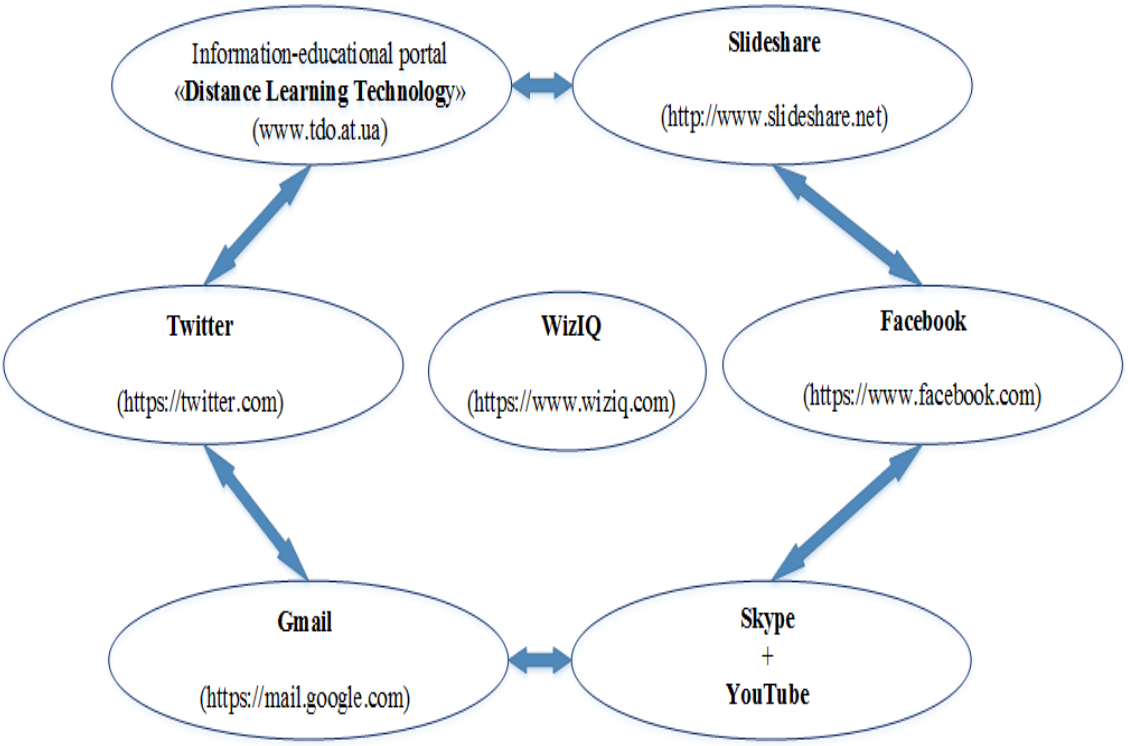


Fig.1. *Generalized scheme of course realization using Internet services*

Participation in the course included:

- continuous systematic process of interaction with the teacher and other pupils;
- receiving individual tasks;
- consultation;
- collective discussion of thematic plan and objectives.

22 participants took part in learning process of the course from Ukraine (Luhansk and Transcarpathian region), the USA (Boston), Africa (Egypt, New Delhi, Republic of Botswana), Jordan (Irbid), India (Chandigarh, Bangalore), Algeria, Sri Lanka, Saudi Arabia and Russia. 7 students from Ukraine (Luhansk) and the USA (Boston) were more active. Only 2 listeners showed the high readiness.

The course had 8 lessons: 6 lectures, 1 seminary and final practical work, held in virtual online classes as webinar. WizIq platform was used for webinars, demonstration of physical experiments was conducted by the integrated Media Player, which allowed relay open video Youtube resources to project participants. In addition the fragments of learning video were loaded to Youtube from other Internet resources; its show was agreed with the authors and copyright holders. As an example, here are a piece of correspondence with Doctor of Science (Physics), Professor of Massachusetts Institute of Technology W. Lewin:

«Dear Alexey. Thanks for your kind words! You can watch 101 of my lectures (with great demos) on the web, 94 on OpenCourseWare (OCW) and 7 on MITWorld. They can also be viewed on YouTube, iTunes U, Academic Earth and Facebook. These lectures are being watched by about 3000 people daily from all over the world, that's a million people per year! Many teachers show them regularly in their class rooms. The many responses that I receive daily are quite wonderful and often very moving... Greetings, Walter H.G. Lewin» (e-mail: lewin@space.mit.edu, 14.02.2011).

Online course organizational forms are summarized in Table. 2 and thematic plan is shown in Table. 3.

Table 2

Organizational forms of education

Forms of study	The amount of hours, including:		
	Total	Webinars	Self-activity
Distance	28	14	14

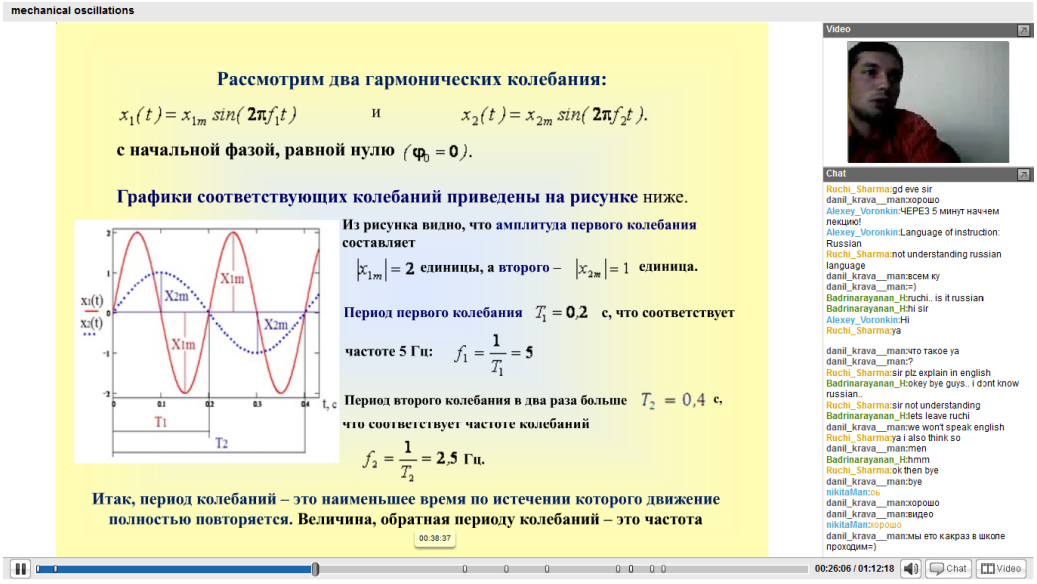
Table 3

Course Topics

Date	Lesson	Number of hours
29.10.2011	Physics and methods of scientific knowledge	2
30.10.2011	Mechanical vibrations	2
13.11.2011	Wave processes and sound	2
27.11.2011	Acoustic resonance phenomena. Interference and diffraction	2
03.12.2011	Standing waves and musical instruments	2
11.12.2011	Beat. Characteristics of the sound	2
29.12.2011	Infra-,ultrasounds and their usage	1
30.12.2011	Final lesson	1

During the webinar, participants were able to hear and see each other, microphone, headphones, webcam and standard software installed on PC were used. The platform WizIq allowed

1) show presentation (Fig. 2,*a*);
2) capture screen;
3) use «Whiteboard» (Fig. 2,*b*);
4) to broadcast video to all participants simultaneously (Fig. 3);
5) provide the opportunity to speak and rule the presentation by other participants;
6) communicate in chat.



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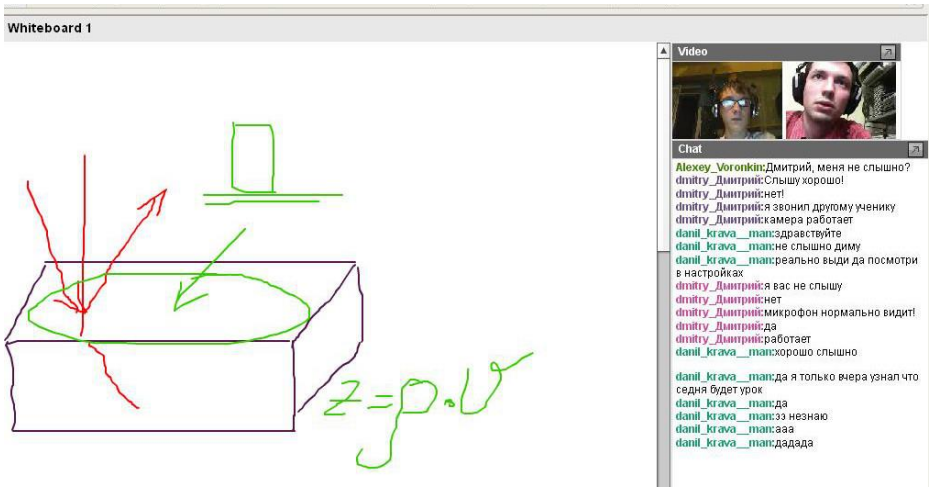

Fig.2. WizIq: a – webinar photo-fragment; b – use whiteboard to explain the physical principles of ultrasound diagnostics

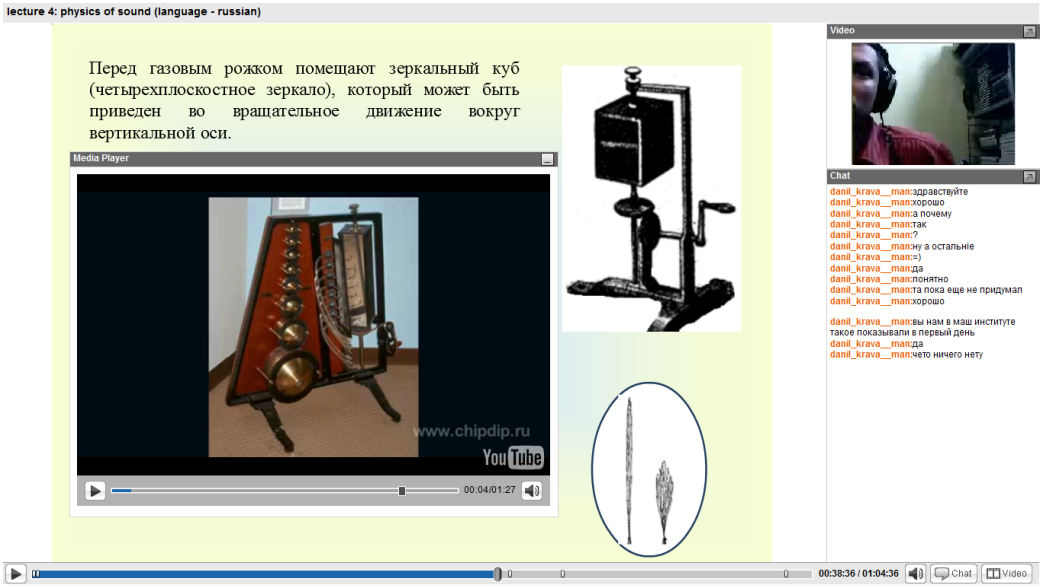

Fig.3. *WizI: broadcasting educational video from YouTube*

Pupils:

1) read only the interesting learning material from recommended list of bibliographical sources;

2) they should not have to keep synopsis;

3) conducted observations of physical phenomena;

4) gave explanations of observed phenomena and form hypothesis;

5) predicted behavior of studied phenomena;

6) analyzed regularities;

7) made conclusions and generalizations.

Users who cannot take part in webinar by any reason were able to download video lessons later. E-mail and Skype were used for counseling students.

Consider the content of each topic of the course.

Topic 1. *Physics and methods of scientific knowledge*

Physics. Physics is the science of nature. Sciences Classification. Methods of scientific knowledge. Correlation of theory and experiment in Physics. The history and role of great experiments. The study of the universe. Subjective observations on the example of optical illusions.

The lesson task is formation of philosophical perception of physical reality, an overview of the physical world, its main theoretical principles and methods of knowledge, awareness of the role

of physical knowledge in person's life and social development.

Topic 2. *Mechanical vibrations*

Mechanical vibrations and waves. Free oscillations. The amplitude, period, frequency. Harmonic oscillations and oscillator. Mathematical and Physical Pendulum. Forced oscillations and resonance. Self-oscillation. Classification oscillation.

The lesson task: a study of one of the most popular motion in nature and technology is oscillatory motion, its types and characteristics resonance phenomena.

Topic 3. *Wave processes and sound*

The emergence of a wave. Wave from point source. Wave process. Longitudinal and Transverse Wave Motion. Rayleigh surface waves. The connection between wavelength and speed of propagation period. Wave surface and wave front. Plane wave equation. Waves in the Air. Speed of sound.

The lesson task: to familiarize pupils with the wave phenomena, to introduce the concept of transverse, longitudinal and surface waves, the wave surface, wave front. To give an idea of the sound wave propagation speed in different environments.

Topic 4. *Acoustic resonance phenomena. Interference and diffraction*

Acoustic resonance. Experiment with spherical Helmholtz resonator. Reflection and refraction of waves. Echo and reverberation. Superposition principle. Interference of sound waves. In-phase coherence (constructive interference). Antiphase coherence (destructive interference). Interference and conservation of energy. Diffraction.

The lesson task is to investigate acoustic resonance phenomenon in the case of some musical instruments, to determine the nature of interference, diffraction, echo and reverberation.

Topic 5. *Standing waves and musical instruments*

Standing waves in strings. Standing waves in open and closed tubes. Demonstration of sound using standing wave with Rubens 'tube and Kundts' tube. König Method. Demonstrating of sound standing wave in Rijke tube. Standing wave on a circular membrane. Standing waves in water experiment. Geometry of sound vibrations in a container with a colloidal liquid (figures from the two-dimensional and three-dimensional structure).

The lesson task is to investigate the nature of standing waves on example of strings, pipes and plates.

Topic 6. *Beat (acoustics). Characteristics of the sound*

Mathematics and physics of beat tones. Subjective characteristics of sound (volume, pitch and timbre). The objective characteristics of sound (intensity, frequency and spectrum). Dependence of speed of wave expansion on environment properties. The intervals in music. Weber-Fechner law. The volume level of sound. The structure of person's organ of hearing.

The lesson task is to investigate subjective and objective characteristics of sound, the mechanism of perception of sound vibrations by person.

Topic 7. *Infra-, ultrasounds and their usage*

Infra- and ultrasound: source and application performance on the human body. Piezoelectric effect and converse piezoelectric effect. Magnetostriction. Ultrasonic and hydrodynamic cavitation. Sonoluminescence. The problems of cold fusion.

The lesson task is mastering skills and abilities to use theoretical knowledge.

At preparation for the lesson «Infra-,ultrasounds and their usage», participants identified the list of issues for discussion and created the presentation.

Time spent accounting . There were spent 137 hours on learning, methodological and organizational work to support online course, including:

- ✓ 12 hours for program course development (1 hour to 2 hours of total course);
- ✓ 7 hours for work with network resources and physical demonstrations of video lectures (1 hour to 1 lesson);
- ✓ 14 hours for preparing for lessons (1 hour to 1 hour lesson);
- ✓ 81 hours for presentations development for classes (0.4 hours – one slide, averaging 13.5 hours – presentation);

- ✓ 14 hours – conducting webinars;
- ✓ 9 hours for participants' consultation (1 hour per week).

Let us consider the methods of cognitive activity of students during training in online course.

Activity approach implementation. During the webinar presentational support with graphic demonstration materials and animations were used, there was a detailed description of the physical experiments which supplemented by sufficient number of video support: an average at 1 lesson – 10 demonstrations. This approach helped to increase the interest and desire of participants to repeat the experiment by themselves.

Acoustic phenomena modeling. Software simulators. We know that among the many methods of scientific knowledge a key place has the modeling method. Therefore, during the study there was also used the original training equipment created by pupils. Thus, the listener of Physics section of Luhansk Regional Junior Academy of Sciences, T. Hohola created in graphical programming environment LabView (Laboratory Virtual Instrument Engineering Workbench). It is demonstration system consisting of four simulation models at writing the research work «Modeling of physical phenomena in study section «Oscillations and waves» led by the article's author [12].

The first program is audiovisual demonstration model that helped to replace oscilloscope and sound generator by virtual one. The graphics of harmonic oscillations at different amplitudes, frequencies and initial phases, accompanied by appropriate sound tone were reproduced. Block-diagram of programming model is shown in Fig. 4.

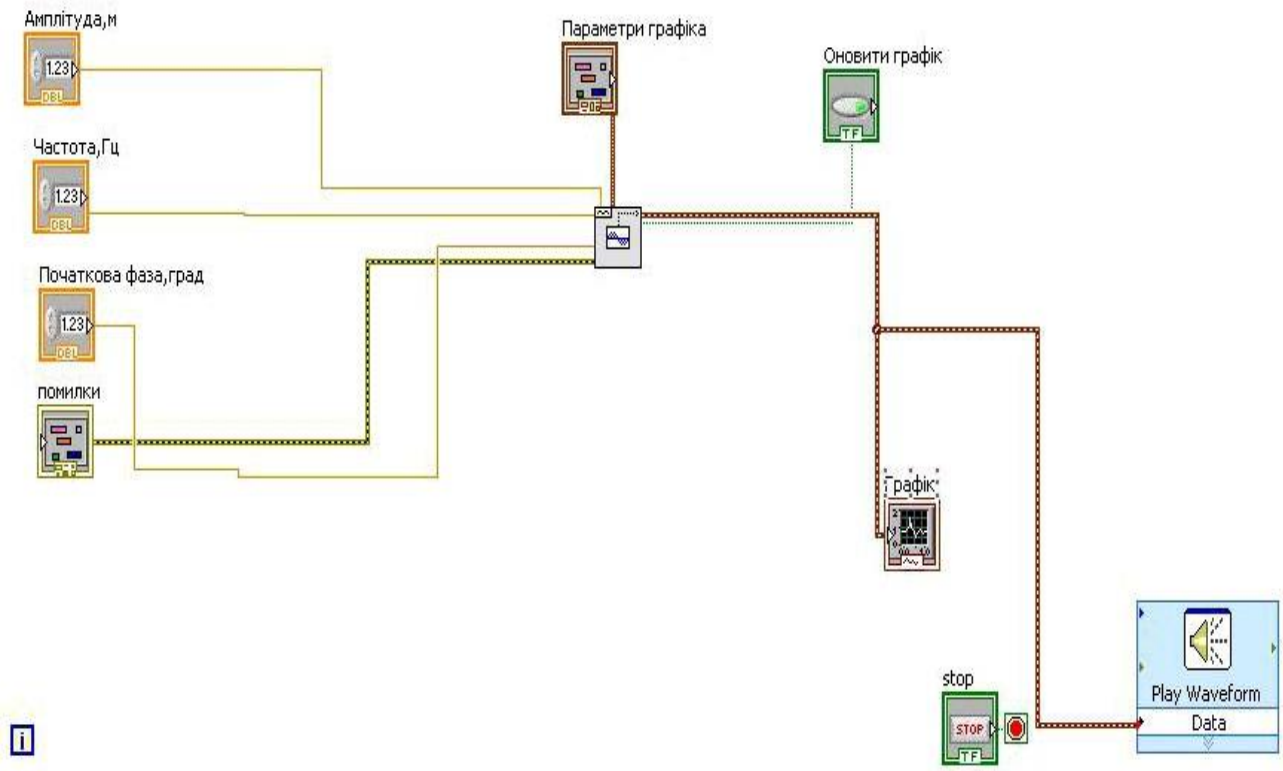

Fig.4. Block-diagram of first program model in LabView

The second program allowed simulating the speed of sound dependence on gas environment, and listeners of online course to make sure that with increasing of temperature the speed of sound will increase. It was useful in performing a number of practical tasks, in solving tasks in determining the speed of sound in gases with different molar mass and temperature.

The third program allowed familiarizing with the concept and the nature of the beat. Block-diagram of program model is shown in Fig. 5, and the front panel – Fig. 6.

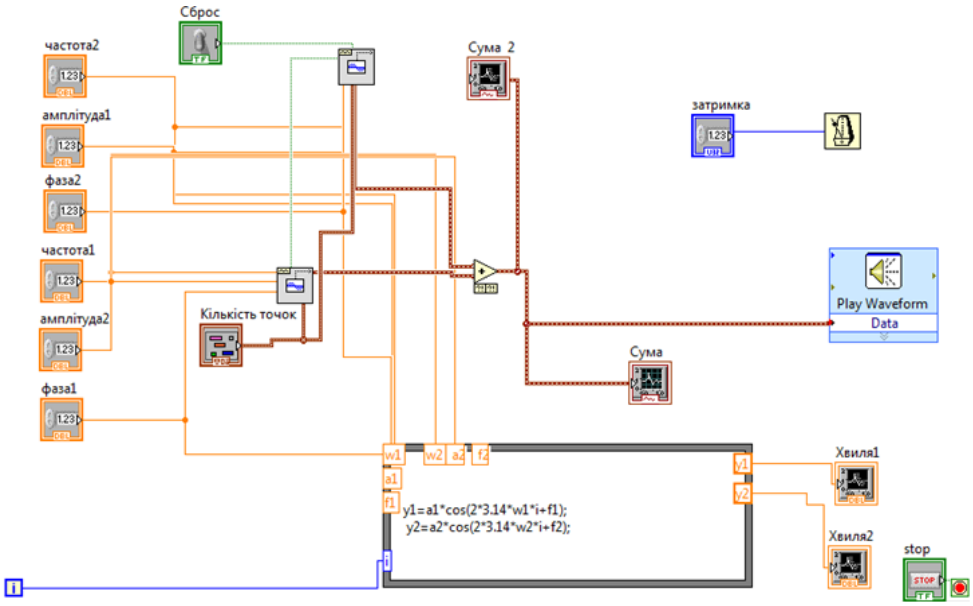

Fig.5. *Block-diagram of the third program model in LabView*

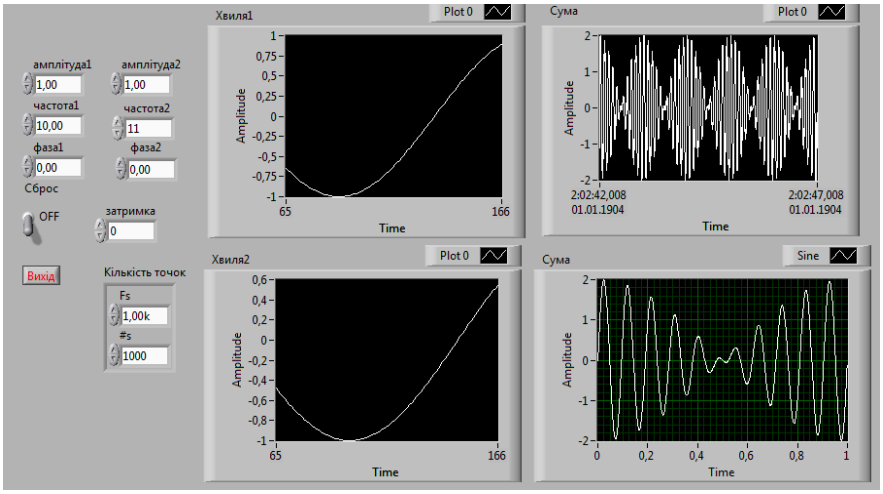

Fig.6. *The front panel of the simulation program to demonstrate the nature of the beat*

Fig. 7 shows the block-diagram of the fourth program model designed to familiarize students with the superposition principle. Students had the opportunity to not only see but also hear the changing of sound perception with form's changing of complex signal depending on changes in the amplitudes, frequencies and initial phases of each of the four harmonic oscillations. The program helped demonstrate tone is determined by number of harmonics and size of their amplitudes and does not depend on the values of the initial phases of higher harmonics. Fig. 8 shows the front panel of the program.

Problem situations making and cognitive and search interest intensification. It should be noted that the most difficult issues of the course were dealt without the use of complex mathematical apparatus, differential equations, and there were situations that pupils on base of analysis of facts and observations of phenomena made conclusions and generalizations, answered simple but interesting questions.

Consider some examples of problem situations that allow intensifying the cognitive scientific research interest of pupils.

✓ If the sound source and a man are at the same height, then sound is better on wind direction than the opposite. How can we explain this phenomenon?

✓ It is known that sound speed is less in gas than in liquids, and the speed of sound is smaller liquids in than in solids. Very often, pupils explain this fact that the density of liquids and solids

larger than in gas. But how to explain that the speed of sound in the gas decreases with increasing its molecular weight, i.e. density. For example, at inhaling xenon ($M=131\cdot10^{-3}$ kg / mol) the human voice is more low frequency and at inhaling helium ($M=4\cdot10^{-3}$ kg / mol) the human voice is a high-frequency (frequency change is explained by change the speed of sound $f = \upsilon/\lambda$). Try to find deficiencies in pupils' explain.

✓ It was notice that the closer the distance between the ears, then sounds of greater frequencies are distinguished by animals. Elephant, for example, feel sound vibrations till 12 kHz, dogs – up to 44 kHz, rats – 72 kHz bats – to 115 kHz. How does it can be explained?

✓ Well known fact is oscillations – motions repeated at regular intervals. Let's assume that on the table the body of mass m rotates uniformly in a circle. If we look from above, we see that the motion is really a circle. But the man, who looks in «butt end» of the table and sees a projection of circular motion, may think that observes oscillatory motion back and forth. How do define oscillations? Suggest your own versions.

✓ If on the metal disc fixed in the center put sand mixed with fine dust, and on the edge of the disc the bow is drew, the sand will create some geometric figure, and dust completely different. Explain why at the drive vibration sand and dust separate and create independent figures.

✓ If you will draw by wet finger along the edge of the glass with thin walls, you will hear a clear sound – glass is «singing». What does make the sound and why the finger should be moist and not greasy? What is determined the frequency of the sound? What oscillations of edge of the glass are excited - transverse or longitudinal?

✓ Why the length of resonance box of tuning fork should be equal to a quarter of wavelength of $(1/4)\cdot\lambda$, radiated by tuning fork?

✓ Can you hear the echo indoors and reverberation outdoors? Explain your opinion.

✓ If the sound intensity increases linearly, then the person will feel an increase of volume in steps. How does it explain and what law should be used to change the sound intensity and person feel a linear change of volume?

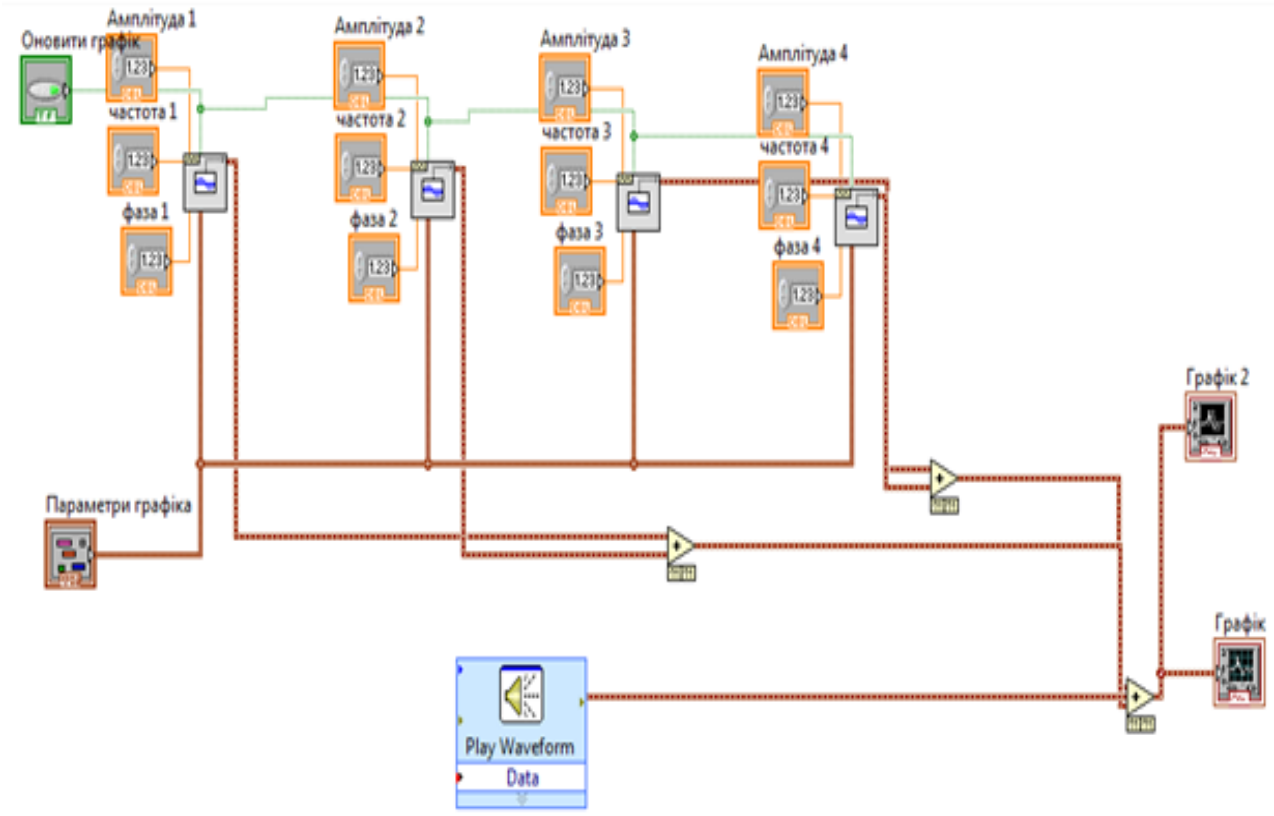

Fig.7. *Block-diagram of the fourth program model in LabView*

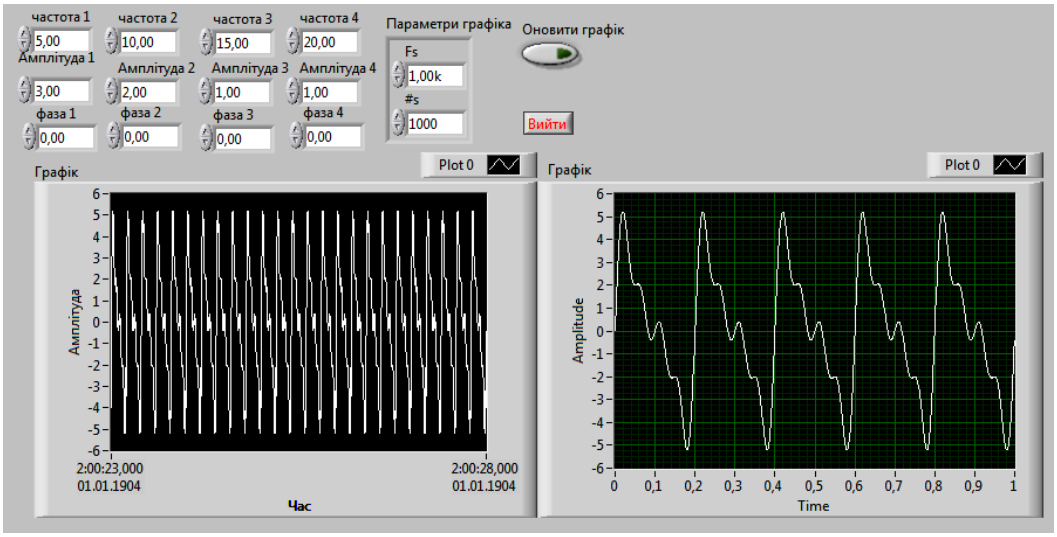

Fig. 8. *Front panel program to demonstrate the principle of superposition*

Self-activity of participants. Popular movies viewing. For the purpose of self-activity organization and deepen study of topics of course participants were recommended a series of articles of popular science journals. Accept thematic unit related to the physics section «Oscillations and waves», the audience was recommended to familiarize with books V. Turchin and R. Feynman [13; 14].

It was also proposed to view the following non-fiction films that are available in the Internet:

✓ «Study of phenomena, processing in the ultrasonic field» (Central film laboratories of the Ministry of Higher Education of the USSR, 1957);

✓ «Changes of aggregate substance states» (Kiev film studio of popular science films, 1970);

✓ «Forced oscillation of mechanical systems» (Kiev film studio of popular science films, 1974);

✓ «Main types of nonlinear systems oscillations» (Kiev film studio of popular science films, 1977);

✓ «Damped oscillations» (Kiev studio of popular science films, 1978);

✓ «Damped oscillations of material point» (From the archives of educational television of technical learning tools department of the National Technical University of Ukraine «Kyiv Polytechnic Institute»);

✓ «Physics basis of acoustics» (Center science film, 1980);

✓ «Resonance in mechanical systems» (Kiev film studio of popular science movies, 1985).

Students' impressions after learning. At the end of the distance course pupils were recommended to fill in the questionnaire on evaluation of the tutor's activity and the course. Some participants' responses we present below:

✓ «Took part in this event for the first time. Especially I liked the visual examples and accessibility of demonstrations. Information is interesting, because in school we do not learning it. The course helped to understand better Physics of sound vibrations and waves, the principles of formation and propagation of waves in different environments. Especially I liked topic of standing waves and their visualization methods»;

✓ «I took part in an open online course at first. I liked this form of learning! It would be nice to attract more participants in such projects! I liked to make report – it was easy to communicate using platform, managed slides and demonstrate the video ...»

✓ «Projects of this kind are uncommon in Ukraine. Open online course was rich in content, covered all aspects of the discipline, accompanied by a large number of demonstrations ... and some of the issues, observed in this project are not covered in school physics course ... »;

✓ «I heard about e-learning, but I took part in the course for the first time. It is easy form of learning. I liked interesting visual materials (demonstrations), openness of online course and the

lack of strict control».

After the course, some participants wanted to continue to combine classroom learning with distance learning. So, the author of the article created the virtual school of scientific and technical work, which was active from 2012 to 2015. Group of the course was opened in social network «VKontakte» [15].

Presentations of all classes were places in SlideShare platform and available for public viewing, so Youtube video demonstrations can be reused in asynchronous mode [9]. Textbook «Linear oscillations and waves: Introduction to acoustics» was published on the base of the course. It is for pupils of high school, pupils of Physics section of Junior Science Academy of Ukraine and participants of preparatory departments of higher education institutions [16].

Conclusions. Without Physics study it is difficult to develop thinking of understand of reality, identifying of natural connections, connection with practice. The important task is to develop interest in study Physics. It is known the attention of the student is determined mainly by interest in the situation (the content of a particular class, experience, task). Author proposed a three-tiered approach to personality oriented teaching Physics, it can develop the sustainable motivation, create conditions for development of students' intellectual and practical skills, creative abilities and skills of independent acquisition of knowledge.

ICTs provided fundamentally new opportunities for obtaining knowledge and gained wide popularity among people from all over the world. In 2001, MIT OpenCourseWare project was announced by Massachusetts Technological University, the aim of it is placing in the public domain the learning materials of all courses that are taught in university. Since 2004 the boom of social networking in education (LinkedIn, MySpace, Facebook, etc.) was started. In 2005, Canadian researcher S. Downes proposed a new philosophy of teaching E-learning 2.0. In 2008 J. Siemens and S. Downes had a massive open online course «Connectivism and Connective Knowledge», more than 2000 people of all over the world took part. These and other projects (edX, Udacity, Coursera, FutureLearn etc.) stimulated representatives of the academic community in Ukraine to create online courses, based on the mass, continuity, transparency and mobility.

Among the national practice of online courses there is the Ukrainian Institute for Information Technologies in Education of National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute»(2004), problem laboratory of distance education of the National Technical University «Kharkiv Polytechnic Institute» (since 2011) and the project «University Online» (Taras Shevchenko Kyiv National University (2013), the public project «Prometheus» (founders – Taras Shevchenko Kyiv National University, National University of «Kyiv-Mohyla Academy», the Ukrainian Catholic University and Lviv IT School, 2015).

At the same time, the vast majority of these projects are designed for student and adult audiences. Teachers-enthusiasts train pupils of specialized out-of-school educational institutions using ICT and try optimally combining classroom learning with distance (blended learning).

The author's experience of organizing the open online course and managing virtual school of scientific and technical work has shown that pupils of out-of-school educational institutions are open to collaboration in virtual environment and are ready to work together. Analysis of learning results leads to the conclusion that participation in the course «Introduction to Physics of Sound» allowed pupils to expand knowledge in the subject, but also intensify their interest in further study of Physics, develop logical thinking.

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Стаття надійшла до редакції 12.12.16

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АВТОРСЬКИЙ ДОСВІД ПІДГОТОВКИ УЧНІВ ПРОФІЛЬНИХ ПОЗАШКІЛЬНИХ НАВЧАЛЬНИХ ЗАКЛАДІВ ДО НАУКОВО-ДОСЛІДНОЇ РОБОТИ ЗАСОБАМИ ІНФОРМАЦІЙНО-КОМУНІКАЦІЙНИХ ТЕХНОЛОГІЙ

У статті висвітлюється авторський досвід підготовки учнів Малої академії наук України до науково-дослідної роботи засобами інформаційно-комунікаційних технологій. Розглянуто трирівневий підхід (науково-популярний, експериментальний, фундаментальний рівні) до організації особистісно зорієнтованого навчання фізики, що охоплює такі дидактичні принципи, як доступність, наочність, науковість і системність. На першому рівні учням потрібно прищепити інтерес до фізики, показати її специфіку, значення термінів тощо. На другому рівні першорядне значення починає відігравати експеримент і демонстрація

фізичних явищ, що має на меті стимулювати учнів робити самостійні висновки. На третьому рівні особливої актуальності набувають лабораторні роботи та метод проблемного навчання, який дозволяє виробити в учнів уміння самостійно розв'язувати фізичні задачі. Робиться висновок, що на кожному з цих рівнів доцільно використовувати ті чи ті засоби інформаційно-комунікаційних технологій. Як приклад розглядається досвід проведення авторського відкритого он-лайн курсу «Вступ до фізики звуку», призначеного для учнів профільних позашкільних навчальних закладів. Викладаються основні питання організації он-лайн курсу й наводяться приклади активізації пізнавальної діяльності учнів.

Ключові слова: пізнавальна діяльність, особистісно зорієнтоване навчання, відкритий он-лайн курс.

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АВТОРСКИЙ ОПЫТ ПОДГОТОВКИ УЧАЩИХСЯ ПРОФИЛЬНЫХ ВНЕШКОЛЬНЫХ УЧЕБНЫХ ЗАВЕДЕНИЙ К НАУЧНО-ИССЛЕДОВАТЕЛЬСКОЙ РАБОТЕ СРЕДСТВАМИ ИНФОРМАЦИОННО-КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ

В статье представлен авторский опыт подготовки слушателей Малой академии наук Украины к научно-исследовательской работе средствами информационно-коммуникационных технологий. Рассмотрен трехуровневый подход (научно-популярный, экспериментальный, фундаментальный уровни) к организации личностно ориентированного обучения физики, охватывающий такие дидактические принципы, как доступность, наглядность, научность и системность. На первом уровне ученикам нужно привить интерес к физике, показать ее специфику, значение терминов и т.д. На втором уровне первостепенное значение играет эксперимент и демонстрация физических явлений, что должно стимулировать учащихся делать самостоятельные выводы. На третьем уровне особую актуальность приобретают лабораторные работы и метод проблемного обучения, позволяющий выработать у учеников умение самостоятельно решать физические задачи. Делается вывод, что на каждом из этих уровней целесообразно использовать те или иные средства информационно-коммуникационных технологий. В качестве примера рассматривается опыт проведения авторского открытого он-лайн курса «Введение в физику звука», предназначенного для учащихся профильных внешкольных учебных заведений. Рассматриваются базовые вопросы организации открытого он-лайн курса, приведены примеры активизации познавательной деятельности учащихся.

Ключевые слова: познавательная деятельность, личностно ориентированное обучение, открытый он-лайн курс.