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Development of the electronic physics textbook for students of secondary school

The work the results of using the developed electronic textbook on physics for organizing the independent work of secondary school students is analyzed. The possibilities of an electronic textbook are shown, the advantages of using the textbook in the learning process are noted. For the development of the electronic textbook, the C# programming language was used in the Microsoft Visual Studio software environment. The main idea of developing an electronic textbook is the relationship between theoretical teaching and practical skills. The electronic textbook provides two modes of operation: training mode and control mode, thus the electronic textbook contains a block of theoretical material and a module for interactive testing of students' knowledge. The theoretical material of the textbook has been developed in accordance with the standard curriculum for the subject “Physics”. The interactive testing module includes standard physical problems of different degrees of complexity, as well as practice-oriented problems on physics. A set of practice-oriented problems has been developed, the use of which in the process of teaching physics will allow to ensure the formation of students' theoretical knowledge and practical skills, to prepare students for practical activities. The main advantage of an electronic textbook is interactivity. The novelty of the development of an electronic textbook is implementation in accordance with a new approach aimed at shaping students' knowledge about the practical applications of physics and developing their practical skills.

Keywords: electronic textbook, information and communication technologies, interactive testing, physical problems, pedagogical experiment.

Introduction

Electronic technology becomes an important component in all areas of social activity. Education is one of the most significant components in the process of personality formation and development of a man of today; therefore it needs constant improvement and modernization.

Modern education cannot be imagined without electronic technologies, since their use makes it possible to ensure the fulfillment of a number of important problems, such as providing access to educational materials as part of the implementation of distance learning programs, conducting online courses, and the use of innovative technologies contributes to the modernization of education.

The study of the concept of teaching by using information technology is one of the prospective lines of research today. The concept of e-learning is one of the main directions of research in educational technologies, and most scientific works on the e-learning education theme are devoted to the study of teaching and learning strategies, interactive learning environments, e-learning in education sector and massive open online courses [1]. This indicates an increase in interest in the study of the application of information and communication technologies in education sector, due to the development and dissemination of these technologies.

Information technologies make it possible to gain access to educational material at any time, simplify the transfer of information, provide greater clarity of the material and automate the process of knowledge control; make it possible to conduct virtual laboratory works. The textbooks created by using these technolo-

gies have a number of advantages and disadvantages. The advantages of electronic textbooks include the ability to fill the textbook with various visual aids, the ability to use hyperlinks and animations. The disadvantages of electronic textbooks include the complexity of development, the high cost of devices for reproducing educational material, the need to have an Internet connection, if necessary to display various elements of the textbook [2, 3]. Electronic textbooks on physics can be equipped with tools of self-control and testing of students, as well as tools for conducting virtual physical experiments, which will improve the quality of learning the material by students [4].

In work [5] authors investigated how elements of course structure influence the usage patterns of electronic textbooks (e-texts) in introductory physics courses. Found that course structure has a strong influence on how much of the e-texts students actually read, and when they do so.

The scientific and methodological basis of the use of the electronic textbooks and virtual laboratory works in the formation of an applied orientation in students were discussed in [6]. The article noted that conduction a physical experiment and frontal laboratory works by using virtual models and electronic books via computer, then can compensate the lack of equipment in the physics laboratory.

The theory of creating and using an electronic textbook, solving the requirements of innovative technologies and practical problems in the process of professional training of students, in particular, training future teachers with electronic textbooks, and also forms skills and abilities in practice, were discussed in [7]. The study is devoted to overcome the above contradictions by finding the best option for the creation and use of electronic textbooks illustrating its impact on the quality of education.

The structure and content of the electronic educational and methodological complex for students «Physics: social and humanitarian direction of specialized education» were described in [8]. The offered complex was developed on the basis of application software. Didactic and basic principles of organization of the electronic educational and methodical complex on the subject, which are the basis for the development of the author's complex, were highlighted.

The work [9] considers the organization matter of the training process in Physics with the “Educon” helping as an electronic support. The article noted that the practice of using electronic textbooks shows that students assimilate the material qualitatively. The development of the information and communication educational environment represented by electronic educational resources opens the way for new methods in physics studying, thereby improving the educational quality.

The purpose of the research in [10] is to identify students’ preference for e-textbooks or analog, printed books, analyze the perception of student benefits and limitations of the medium, and investigate potential impacts of e-textbook use in educational process. The survey analyzed five beneficial and five limiting features of e-textbooks, confirming that eyestrain is the most problematic feature for e-textbook users, while ease of access was the most significant positive feature. Although the research does consider factors that may influence e-textbook preferences among students, there may be other factors that were not addressed in this research that may influence students’ preferences for electronic texts and printed texts.

At the Department of Physics and Nanotechnology of the Physics and Technology of Faculty of the Karaganda University named after academician E.A. Buketov, work is underway to develop and use electronic teaching aids in the educational process [11–16]. At the principle of the concept of electronic edition developed by lecturers at the Department, much attention is paid to the methodological component, which allows using electronic educational resources as self-training for students and a simulator for self-testing.

According to the State Compulsory Standard of general secondary education [17], the purpose of general secondary education is to create an educational space to ensure the development of the following skills:

– functional and creative application of knowledge;
– critical thinking;
– carrying out research work;
– use of information and communication technologies;
– the use of various methods of communication;
– ability to work in a group and individually;
– problem solving and decision making.

This purpose can be achieved by using electronic teaching textbooks, since working with the textbook will improve the skills of using information and communication technologies among students, and can also contribute to the development of the above skills.

The purpose of this work is to develop the electronic textbook and practice-oriented problems on physics. To achieve the purpose of the work, the following tasks were set and solved:

– to develop the theoretical material of the textbook in accordance with the standard curriculum on physics [18];

– to develop practice-oriented problems on physics.

Practice-oriented problems were included in the textbook, since the preparation of students on physics, according to the State Compulsory Standard of general secondary education, involves the use of the knowledge gained to explain various physical processes and phenomena, the principles of operation of the most important technical devices. Solving applied problems helps to establish a connection between the studied theories and phenomena occurring in the real world, and contributes to the use of acquired skills in various life situations [19].

The electronic physics textbook

The electronic textbook was developed by using the C # programming language in a development environment «Microsoft Visual Studio» for Windows operating system. The main structural elements of the textbook are a block of theoretical material and a module for testing students' knowledge. The main menu of the program is shown in the Figure 1, where the structural elements of the textbook are indicated by numbers 1–3.

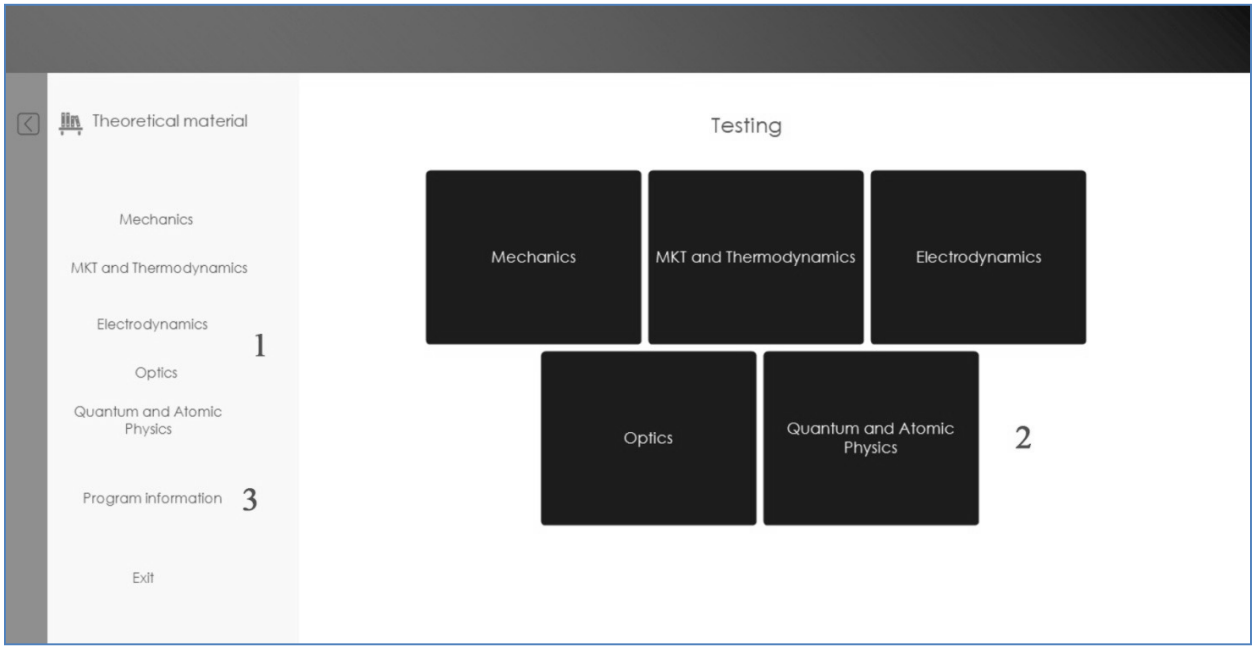

Figure 1. Main menu of the electronic textbook

Description of the structural elements of the electronic textbook:

1 — the block containing theoretical material on the sections of physics. The theoretical material is compiled on the main themes of a typical curriculum on physics;

2 — the testing module, when you click on a specific section, the test for the section opens in a separate window, the program window is hidden until testing is complete;

3 — the block containing information about the structure of the electronic textbook, when the button is pressed, this information is shown to the user.

All sections of the theoretical material are divided into subsections. For example, the “Electrodynamics” section includes the following subsections: electrostatics, direct current, magnetism, electromagnetic oscillations and waves. Each subsection is broken down into themes. On the themes included in the subsections, a brief reference material is presented, which is necessary for solving physical problems, supplemented by process diagrams and graphics, various figures that make the material more visual and improve its perception. The Figure 2 presents reference material on the themes “The motion of a body thrown at an angle to the horizon”, included in the subsection “Kinematics”.

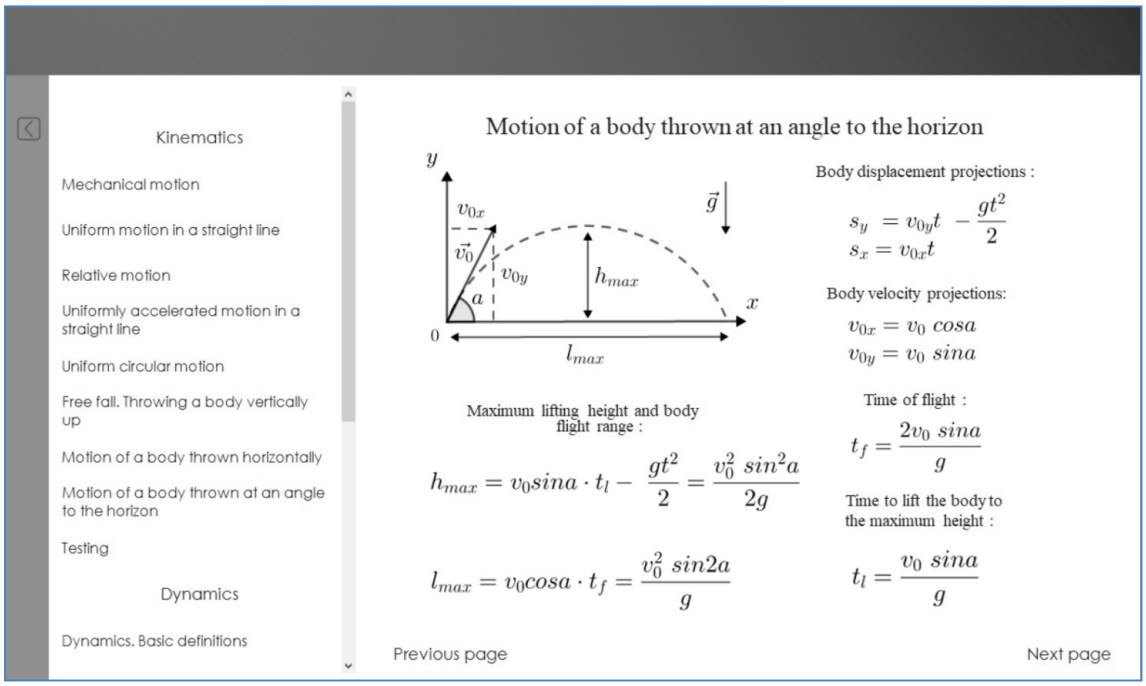

Figure 2. Reference material on theme “Motion of a body thrown at an angle to the horizon”

The material is structured in such a way to make it easier to find the information you need. When you click on each of the subsections, a list appears containing all the theme of the subsection, clicking on the theme name from the splash list allows you to open the reference material. The non-linear structure of the material of textbook allows you to start studying it from a specific theme and return to previously studied material if necessary. The splash list also contains a link for passing testing by subsection. Testing is a set of problems with a choice of one answer out of five proposed, as well as problems with a choice of several correct answers out of eight proposed. All problems, including practice-oriented problems, were compiled according to the themes included in the subsection.

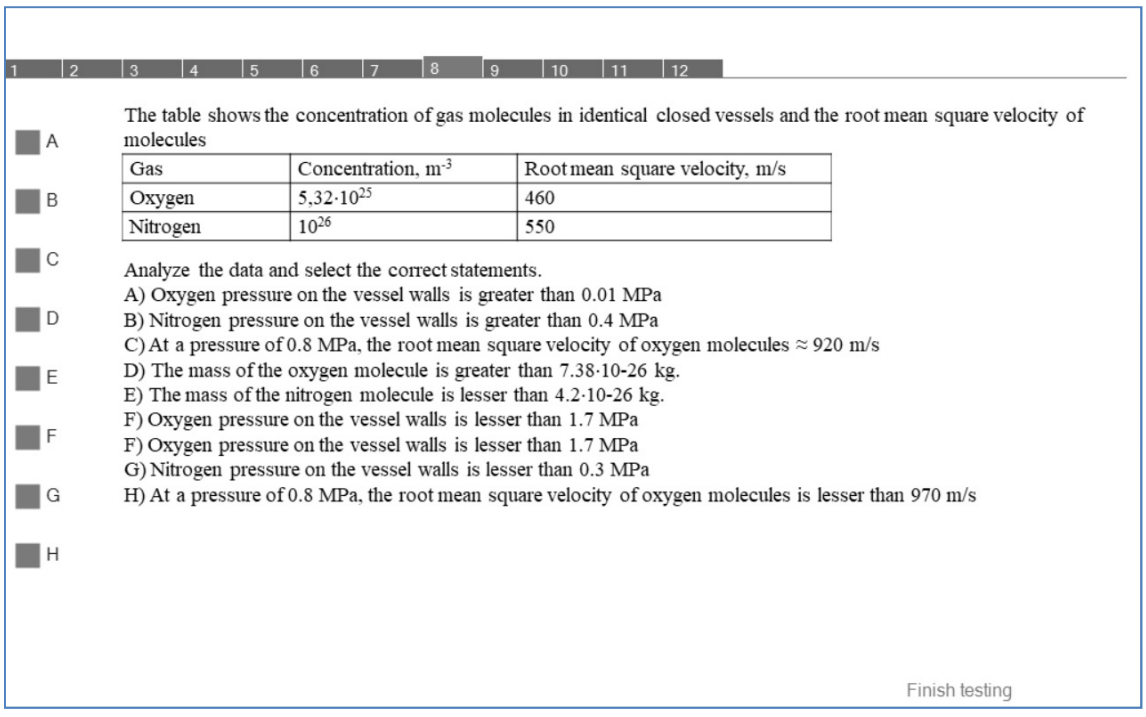

Figure 3. Testing window for the section “Molecular-kinetic theory and thermodynamics”

The testing module allows to testing the entire section. The testing window is shown in the Figure 3. Test tasks include tasks from testing on subsection. When generating a test variant, each task is selected randomly from a list of tasks of a certain number, generated from all testing variants on a subsection. This allows creating many different test variants and gives the ability to test multiple times. Each variant of the test consists of 12 tasks (9 tasks with a choice of one answer and 3 tasks with a choice of several correct answers). Tasks with a choice of one correct answer are evaluated at 1 point; tasks with a choice of several correct answers are evaluated from 0–2 points, depending on the selected answers. Thus, having completed all the tasks correctly, the student receives 15 points.

The information block of the textbook program contains information about the structure of the program, the structure of test tasks and the assessment of test items.

Results and its discussion

The approbation of the electronic physics textbook was carried out in the 10th grade of the secondary school. The students studied the theoretical material of the textbook, after which they completed the tasks from the test module of the textbook. When conducting a pedagogical experiment for students, test variants were created for the sections “Mechanics”, “Electrodynamics”, “Molecular-kinetic theory (MKT) and thermodynamics”. The testing results are shown in the Table 1.

Table 1

Student testing results

Section	Themes of section including in testing	Average score received by students
Mechanics	Uniformly accelerated motion. Relativity of motion. Graphical representation of movement. Uniform circular motion. Forces in nature. Newton's laws. The movement of a body thrown at an angle to the horizon. Body movement along an inclined plane. The law of conservation of momentum and energy. Work done by a constant force. Free and forced vibrations. Harmonic vibrations. Oscillations of mathematical and spring pendulums. Sound waves. Conditions for equilibrium of bodies. Archimedes' law. Hydrostatic pressure. Rule of moments.	10,1/15 (67,3 %)
MKT and thermodynamics	Fundamental principles of MKT. The amount of substance. Molar mass. Molecular speed. Isoprocesses in gases. Internal energy of gas. Ideal gas equation of state. Basic equation of MKT. I and II laws of thermodynamics. Heat balance equation. Heat engines. Humidity.	11,32/15 (75,46 %)
Electrodynamics	Electric charge. Conservation law of electric charge. Capacitors. Connection of conductors. Electric field. Electric current. Ohm's law for a section of circuit. Electromotive force. Electric current in various environments. A magnetic field. Magnetic induction. Ampere force. Lorentz force. Work and power of current.	11,68/15 (77,86 %)

These data show that the learning material was assimilated by the students, since the average score obtained as testing result on the sections is more than 67 % of the maximum possible score. The analysis of the students works showed that each of the students successfully solves at least 7 physical problems with the choice of one correct answer and at least 1 problem with the choice of several correct answers, which is 66.6 % of the number of proposed problems. These results indicate that the developed theoretical material of the textbook can be useful for students for independent study, repetition of previously studied themes, and the testing module can be used to practice the skills of solving physical problems. The analysis of the test results also showed that the greatest difficulties for students arise when solving problems on the following themes: “Body motion on an inclined plane”, “Law of conservation of momentum and energy”, “Rule of moments”, “Magnetic induction”, “Humidity”. Students also had difficulties in solving practice-oriented problems. This can be attributed to the lack of students' experience in solving this type of problem.

Conclusion

The electronic physics textbook was developed for for students of secondary schools. For the development of the textbook, the Microsoft VisualStudio software development environment was used. The

theoretical material and tasks of the test part of the textbook were developed in accordance with the typical curriculum for the subject.

The results of the pedagogical experiment showed that each student successfully completes more than 66 % of the proposed test tasks. The presented electronic physics textbook can be useful for achieving various educational goals. The electronicphysics textbook can be used by students in the process of independent preparation to practice solving problems, repeating previously studied themes and consolidating theoretical material.

References

1 Valverde-Berrocoso J. Trends in Educational Research about e-Learning: A Systematic Literature Review (2009–2018) / J. Valverde-Berrocoso, M.C. Garrido-Arroyo, C. Burgos-Videla, M.B. Morales-Cevallos // Sustainability. — 2020. — Vol. 12, No. 12. — P. 5153.

2 Никитина Е.О. Электронные учебники как средство обучения в эпоху информатизации образования / Е.О. Никитина // Наука и школа. — 2013. — № 4. — С. 21–23.

3 Прутько А.С. Преимущества и недостатки использования электронных учебных пособий по курсу физики / А.С. Прутько // Научное сообщество студентов XXI столетия. Гуманитарные науки. — 2019. — № 11(83). — С. 85–89.

4 Гурин Н.И. Мультимедийный электронный учебник по дисциплине «Физика» (раздел «Физические основы механики») / Н.И. Гурин, В.В. Чаевский, И.И. Наркевич // Высшее техническое образование. — 2011. — № 8(146). — С. 169–171.

5 Seaton D.T. Analyzing the impact of course structure on electronic textbook use in blended introductory physics courses / D.T. Seaton, G. Kortemeyer, Y. Bergner, S. Rayyan, D.E. Pritchard // American journal of physics. — 2014. — Vol. 82, No. 12. — P. 1186–1197.

6 Usembayeva I.B. Electronic Resources in Physics as a Means of Formation Applied Orientation of Students / I.B. Usembayeva, A.N. Bahtibayev, K.M. Berkimbayev, A.Ch. Saribaeva // Procedia Social and Behavioral Sciences: 5th World Conference on Educational Sciences. — 2014. — Vol. 116. — P. 4310–4314.

7 Беркимбаев К.М. Электронный учебник как средство совершенствования профессиональной подготовки будущих учителей / К.М. Беркимбаев, А.Х. Сарыбаева, А.Л. Ташимова, А. Миндетбаева // Междунар. журн. эксперим. обр. — 2012. — Т. 8. — С. 13–16.

8 Myslitska N.A. Electronic teaching and methodological complex in physics for students of social and humanitarian type of studies / N.A. Myslitska, V.F. Zabolotnyi, I.Yu. Slobodianiuk // Information Technologies and Learning Tools. — 2019. — Vol. 74, No. 6. — P. 43–55.

9 Polovnikova L. Electronic textbook efficiency in studying physics at the technical university / L. Polovnikova, A. Novikova // Proceedings of 4th International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM 2017 (24–30 August 2017). — 2017. — Vol. 17, Book number 4. — P. 179–184.

10 Chang Lor. Benefits and Limitations of E-textbook Use [Электронный ресурс] / Lor Chang // Journal Student Research. — 2017. — Vol. 16. — P. 32–47. — URL: https://minds.wisconsin.edu/bitstream/handle/1793/77573/E-textbooks.pdf?sequence=1&isAllowed=y

11 Камбарова Ж.Т. Күрделілігі жоғары есептерді шығару әдістемесі. Молекулалық физика және термодинамика. Электронды оқу құралы. Свидетельство о внесении сведений в Государственный реестр прав на объекты, охраняемые авторским правом, № 3296 от 14 мая 2019 г.

12 Копбалина Қ.Б., Камбарова Ж.Т., Маженов Н.А. Электростатикалық өрісте зарядталған бөлшектердің қозғалысын компьютерлік модельдеу. Электронды оқу құралы. Свидетельство о внесении сведений в Государственный реестр прав на объекты, охраняемые авторским правом, № 3283 от 11 мая 2019 г.

13 Копбалина Қ.Б., Камбарова Ж.Т., Толекова М. Механика элементтері. Электронды оқу құралы. Авторское свидетельство о внесении сведений в Государственный реестр прав на объекты, охраняемые авторским правом № 11262 от 7 июля 2020 г.

14 Мусенова Э.К. Физика курсын оқытуда сандық ресурстарды қолданудың тиімділігі / Э.К. Мусенова, Т.Е. Сейсембекова, А.С. Утепова, Б.И. Казанкап // Қарағанды ун-тінің хабаршысы. Физика сер. — 2015. — № 3(79). — С. 116–121.

15 Ильина Л.Ф. Сравнительный анализ методики проведения занятий по электростатике в 8- и 10-х классах с использованием интерактивных технологий / Л.Ф. Ильина, А.Н. Колесникова // Вестн. Караганд. ун-та. Сер. Физика. — 2012. — № 3(67). — С. 66–71.

16 Ильина Л.Ф. Использование инновационных технологий при изучении магнитных явлений / Л.Ф. Ильина, Д.К. Тажибаева // Вестн. Караганд. ун-та. Сер. Физика. — 2010. — № 3(59). — С. 68–77.

17 Приказ Министерства образования и науки Республики Казахстан «Об утверждении государственных общеобязательных стандартов образования всех уровней образования». — URL: http://adilet.zan.kz/rus/docs/V1800017669.

18 Типовые учебные программы по общеобразовательным предметам общего среднего образования по обновленному содержанию. — URL: https://online.zakon.kz/m/document/?doc_id=33519278.

19 Ильясов В.Х. Направления развития методов преподавания и практико-ориентированный подход к преподаванию курса физики / В.Х. Ильясов, В.Н. Шамбулина // Балт. гуманит. журн. — 2018. — Т. 7, № 2(23). — С. 247–250.

А.С. Прутько, А.С. Кудусов, Э.К. Мусенова, Ж.Т. Камбарова

Орта мектеп оқушылары үшін физика пәні бойынша электрондық оқу құралын әзірлеу

Мақалада орта мектеп оқушыларының өздік жұмыстарын ұйымдастыруға арналған физика бойынша әзірленген электронды оқу құралын қолдану нәтижелері талданған. Электрондық оқу құралының мүмкіндіктері, оқу процесінде оқу құралды қолданудың артықшылықтары көрсетілген. Электрондық оқу құралын әзірлеу кезінде Microsoft Visual Studio бағдарламалық қамсыздандыру ортасында C# бағдарламалау тілі қолданылды. Ұсынылған электронды оқу құралын әзірлеудің негізгі ойы — теориялық оқыту мен практикалық дағдылардың өзара байланысы. Электрондық оқу құралы екі жұмыс режимін ұсынады: оқу режимі және бақылау режимі, яғни оқу құралы теориялық материалдар блогынан және оқушылардың білімін интерактивті тестілеу модулінен құрылады. Оқу құралының теориялық материалы «Физика» пәні бойынша типтік оқу бағдарламасына сәйкес әзірленген. Тестілеу модуліне тапсырмалар ретінде күрделілігі әр түрлі стандартты есептер, сонымен бірге физикадан практикаға бағытталған есептер енгізілген. Физиканы оқыту процесінде қолдану оқушылардың теориялық білімі мен практикалық дағдыларын қалыптастыруға, оқушыларды практикалық іс-әрекеттілікке дайындауға мүмкіндік беретін практикалық-бағытталған есептер кешені әзірленген. Электрондық оқу құралының басты артықшылығы оның интерактивтілігінде болып табылады. Электрондық оқу құралын әзірлеудің жаңалығы — оқушыларда физиканың практикалық қолданылуы туралы білімдерін қалыптастыруға және олардың практикалық дағдыларын дамытуға бағытталған жаңа әдіс-тәсілге сәйкес жүзеге асыру.

Кілт сөздер: электрондық оқу құралы, ақпараттық-коммуникативтік технологиялар, тестілеу бағдарламасы, физикадан есептер, педагогикалық эксперимент.

А.С. Прутько, А.С. Кудусов, Э.К. Мусенова, Ж.Т. Камбарова

Разработка электронного учебного пособия по физике для учащихся средней школы

В статье проанализированы результаты использования разработанного электронного пособия по физике для организации самостоятельной работы учащихся средней школы. Показаны возможности электронного учебного пособия, отмечены преимущества использования пособия в процессе обучения. При разработке электронного учебного пособия использован язык программирования C# в среде программного обеспечения Microsoft Visual Studio. Основная идея разработки электронного учебного пособия — взаимосвязь теоретического обучения и практических навыков. Электронное учебное пособие предусматривает два режима работы: режим обучения и режим контроля, таким образом пособие содержит блок теоретического материала и модуль интерактивного тестирования знаний учащихся. Теоретический материал пособия разработан в соответствии с типовой учебной программой по предмету «Физика». В модуль интерактивного тестирования учащихся в качестве заданий включены стандартные задачи различной степени сложности, а также практико-ориентированные задачи по физике. Разработан комплекс практико-ориентированных задач, использование которого в процессе обучения физике позволит обеспечить формирование у обучающихся теоретических знаний и практических умений, а также подготовку учащихся к практической деятельности. Основное преимущество электронного учебного пособия — интерактивность. Новизна разработки электронного учебного пособия заключается в ее выполнении в соответствии с новым подходом, направленным на формирование у учащихся знаний о практических применениях физики и развитие у них практических умений.

Ключевые слова: электронное учебное пособие, информационно-коммуникативные технологии, интерактивное тестирование, физические задачи, педагогический эксперимент.

References

1 Valverde-Berrocoso, J., Garrido-Arroyo, M.C., Burgos-Videla, C., & Morales-Cevallos, M.B. (2020). Trends in Educational Research about e-Learning: A Systematic Literature Review (2009–2018). *Sustainability*, *12, 12*, 5153.

2 Nikitina, E.O. (2013). Elektronnye uchebniki kak sredstvo obucheniia v epokhu informatizatsii obrazovaniia [Electronic textbooks as a means of learning in the era of informatization of education]. *Nauka i shkola — Science and school*, *4,* 21–23 [in Russian].

3 Prutko, A.S. (2019). Preimushchestva i nedostatki ispolzovaniia elektronnykh uchebnykh posobii po kursu fiziki [Advantages and disadvantages of using e-learning manuals on physics course]. *Nauchnoe soobshchestvo studentov XXI stoletiia. Humanitarnye nauki — Scientific community of students of the XXI century. Humanitarian sciences, 11(83),* 85–89 [in Russian].

4 Gurin, N.I., Chaevskij, V.V., & Narkevich, I.I. (2011). Multimediinyi elektronnyi uchebnik po distsipline «Fizika» (razdel «Fizicheskie osnovy mekhaniki») [Multimedia electronic textbook on the discipline «Physics» (section «Physical foundations of mechanics»)]. *Vysshee tekhnicheskoe obrazovanie — Higher technical education, 8(146),* 169–171 [in Russian].

5 Seaton, D.T., Kortemeyer, G., Bergner, Y., Rayyan, S., & Pritchard, D.E. (2014). Analyzing the impact of course structure on electronic textbook use in blended introductory physics courses. *American Journal of Physics, 82(12), 1186–1197.*

6 Usembayeva, I.B., Bahtibayev, A.N., Berkimbayev, K.M., & Saribaeva, A.Ch. (2014). Electronic Resources in Physics as a Means of Formation Applied Orientation of Students. *Procedia Social and Behavioral Sciences: 5th World Conference on Educational Sciences, 116, 4310–4314.*

7 Berkimbaev, K.M., Sarybaeva, A.Kh., Tashimova, A.L., & Mindetbaeva, A. (2012). Elektronnyi uchebnik kak sredstvo sovershenstvovaniia professionalnoi podhotovki budushchikh uchitelei [An electronic textbook as means of professional training perfection of future teachers]. *Mezhdunarodnyi zhurnal eksperimentalnoho obrazovaniia — International Journal of Experimental Education, 8,* 13–16 [in Russian].

8 Myslitska, N.A., Zabolotnyi, V.F., & Slobodianiuk, I.Yu. (2019). Electronic teaching and methodological complex in physics for students of social and humanitarian type of studies. *Information Technologies and Learning Tools, 74, 6,* 43–55.

9 Polovnikova, L., & Novikova, A. (2017). Electronic textbook efficiency in studying physics at the technical university. *Proceedings of 4th International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM 2017 (24–30 August 2017), 17, 4,* 179–184.

10 Lor, Chang. (2017). Benefits and Limitations of E-textbook Use. *Journal Student Research, 16,* 32–47. Retrieved from: https://minds.wisconsin.edu/bitstream/handle/1793/77573/E-textbooks.pdf? sequence=1&isAllowed=y

11 Kambarova, Zh.T. (2019). Kurdeliligi zhogary esepterdi shygaru adistemesi. Molekulalyq fizika zhane termodinamika [Methods for solving problems of increased complexity. Molecular Physics and Thermodynamics]. *Electronic textbook*. Certificate of entering information into the state register of rights to objects protected by copyright, No. 3296 dated May 14, 2019 [in Kazakh].

12 Kopbalina, Q.B., Kambarova, Zh.T., Mazhenov, N.A. (2019). Elektrostatikalyq oriste zariadtalgan bolshekterdin qozgalysyn komputerlik modeldeu [Computer modeling of the motion of charged particles in an electrostatic field.]. *Electronic textbook*. Certificate of entering information into the state register of rights to objects protected by copyright, No. 3283 dated May 11, 2019 [in Kazakh].

13 Kopbalina, Q.B., Kambarova, Zh.T, Tolekova, M. (2020). Mekhanika elementteri [Elements of mechanics]. *Electronic textbook*. Certificate of entering information into the state register of rights to objects protected by copyright, No. 11262 dated July 7, 2020 [in Kazakh].

14 Mussenova, E.K., Seisembekova, T.Ye., Utepova, A.S., & Kazankap B.I. (2015). Fizika kursyn oqytuda sandyq resurstardy koldanudyn tiimdiligi [Efficiency of the use of electronic resources on lessons of physics]. *Qaragandy universitetinin khabarshysy. Fizika seriiasy — Bulletin of the University of Karaganda — Physics, 3(79)*, 116–121 [in Kazakh].

15 Ilyina, L.F., & Kolesnikova, A.N. (2012). Sravnitelnyi analiz metodiki provedeniia zaniatii po elektrostatike v 8- i 10-kh klassakh s ispolzovaniem interaktivnykh tekhnolohii [Comparative analysis of methods of conducting studies on electrostatics in the eighth and tenth grades, using interactive technologies]. *Vestnik Karahandinskoho universiteta. Seriia Fizika — Bulletin of the University of Karaganda — Physics, 3(67)*, 66–71 [in Russian].

16 Ilyina, L.F., & Tazhibayeva, D.K. (2010). Ispolzovanie innovatsionnykh tekhnolohii pri izuchenii mahnitnykh yavlenii [The using of innovation technologies during magnetic phenomenona study]. *Vestnik Karahandinskoho universiteta. Seriia Fizika — Bulletin of the University of Karaganda — Physics, 3(59)*, 68–77 [in Russian].

17 Prikaz Ministerstva obrazovaniia i nauki Respubliki Kazakhstan «Ob utverzhdenii hosudarstvennykh obshcheobiazatelnykh standartov obrazovaniia vsekh urovnei obrazovaniia» [Order of the Ministry of Education and Science of the Republic of Kazakhstan «On approval of state compulsory education standards at all levels of education»]. *adilet.zan.kz* Retrieved from: http://adilet.zan.kz/rus/docs/V1800017669 [in Russian].

18 Tipovye uchebnye prohrammy po obshcheobrazovatelnym predmetam obshcheho sredneho obrazovaniia po obnovlennomu soderzhaniiu [Standard curricula for general education subjects of general secondary education according to updated content]. *online.zakon.kz* Retrieved from: https://online.zakon.kz/m/document/? doc_id=33519278 [in Russian].

19 Ilyasov, V. Kh., & Shambulina, V.N. (2018). Napravleniia razvitiia metodov prepodavaniia i praktiko-orientirovannyi podkhod k prepodavaniiu kursa fiziki [The directions of development of methods of teaching and the practical-focused approach to teaching a course of physics]. *Baltiiskii humanitarnyi zhurnal — Baltic humanitarian journal, 7, 2(23),* 247–250 [in Russian].