UDC 004.738.52:004.92(45)

Iryna A. Slipukhina
Doctor of Education, Associate Professor, Professor of General Physics Department
National Aviation University, Kyiv, Ukraine
ORCID ID 0000-0002-9253-8021
slipukhina@i.ua

Viacheslav V. Olkhovyk
Student
National Aviation University, Kyiv, Ukraine
ORCID ID 0000-0001-5044-8282
mcflobots@gmail.com

Oleksandr O. Kurchev
Student
National Aviation University, Kyiv, Ukraine
ORCID ID 0000-0002-7793-005X
samson.alex97@gmail.com

Vitalii D. Kapranov
Student
National Aviation University, Kyiv, Ukraine
ORCID ID 0000-0002-9439-4033
youtrouble1@gmail.com

DEVELOPMENT OF EDUCATION AND INFORMATION PORTAL OF PHYSICS ACADEMIC COURSE: WEB DESIGN FEATURES

Abstract. The purpose of this article is to present the main components and features of designing an educational and informational portal for students. Selection of personal trajectory is realized through the use of personal account, which includes electronic laboratory reports, information materials on studying progress, means of communication with a teacher, etc. The created portal allows the administrator to easily monitor and check laboratory reports, keep an e-journal with grades. To develop the website design, functional modules and components, the Adobe Photoshop ™ environment was used, as well as the HTML and CSS layout of the web portal. The modern Bootstrap technology was applied to adapt the web page interface. The didactic opportunities of using this portal as a part of personalization process in teaching physics were considered.

Keywords*:* Web design; educational informational portal; layout; HTML; CSS; Bootstrap; framework; physics academic course.

1. INTRODUCTION

Problem statement. Current global socio-economic processes are bringing essential changes to the labour market structure; one of its main features being the growing demand for high technology jobs. Meanwhile, modern public educational systems are focused on acquiring knowledge and standardization [1]. Awareness of the need for a comprehensive approach to the development of courses and their curricula focused on interdisciplinary and practically meaningful subjects, formation of innovative approach and analytical skills, social, cross-cultural and other important competencies are building up the basis for various directions in education [2] and teaching approaches, e. g. STEM [3].

Among the ten key skills of youth, declared in the conceptual principles of the secondary school reformation "New Ukrainian School" an important role belongs to the competence in natural sciences and technologies, as well as computer science competence [4].

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At the stage of acquisition of higher education in engineering, such skills are transformed into technological competence of future specialists, which characterizes their readiness to systematic use of new methods, procedures and processes on the base of optimal application of technical means, information and communication technologies (ICT) [5].

The knowledge of physics makes up the theoretical basis of engineering activity. Modern methodological systems of teaching physics involve the use of new approaches to learning, a variety of information technologies (IT), digital measuring systems [5], laboratory reports [7], online communication tools etc. being fundamental to them. The education and information portal is a resource that provides an effective interaction between the participants of educational process. It contains a significant number of components that require design, analysis, regulation, research and coordination as the united system[1]. Considering this, it is obvious that the participation of students in the development of such a software product, on the one hand, promotes the development of particular IT-skills and on the other hand, forms an understanding of the technical and technological picture of the world, which is based on the physical picture of the world [8].

Analysis of recent studies and publications. The previous analysis has shown that in accordance with the standards of European Association for Quality Assurance in Higher Education (ENQA) the professional competence of future engineers consists of five main units [9]: engineering analysis – the use of modern software, mathematical modelling of an engineering object; engineering design – development of applied software, originality of decision making and scientific novation; engineering research – level of a research purpose substantiation, a choice of a research method, quality and level of the experiment; engineering practice – experimental verification of the adopted solutions and the level of feasibility study of research and design work.

The following main competences among the general ones were distinguished during the international project "Tuning" (in the order of decreasing significance): ability to analyze and synthesize; problem solution (of professional tasks); lifelong learning; ability to apply knowledge in practice; creativity and ability to work in a team [10].

Awareness that the origins of fundamental knowledge are contained, first of all, in an experiment, enabled to make an important conclusion that the formation of practically all professional skills of technical university students begins with the laboratory workshops, especially physical ones [6]. This is the reason for the assumption about the effectiveness of the application of the interdisciplinary approach to teaching physics to future engineers, which comprehensively forms general scientific and professional competencies [11].

The analysis carried out during the research revealed that a number of competences are formed in the training of future engineers using a computer-oriented system of teaching physics (especially, a physical experiment), which is the basis for the training of all technical disciplines. One of the previously obtained results is that technological competence of future engineers is an integral system. It consists of a cognitive, operational and activity, reflexive and analytic, value and motivational components [8].

In modelling of modern methodological teaching systems, personally oriented and problem oriented pedagogical technologies are widely used [1], [8].

However, the value and motivational component determines the involvement of axiological approach to the process of training of future engineers [12]. It has been determined that a person's abilities and motivation of educational activities are in the complex dialectical unity: high positive motivation can compensate for a lack of the special skills and insufficient competency and plays the role of a compensatory factor. Motivation of educational activity is connected with internal (the need of certain activity) and external

[1] Specified are the engineering activity functions.

(possibility of realization) factors. According to L. Vygotskii, cognitive interest is a positive attitude of a person to his/her activity and is considered the main motive of a person's activity [13]. In particular, the main motives in education are cognitive (S. Rubinstein) [14].

Currently, in the system of higher engineering education the introduction of the axiological approach is impossible without the use of ICT in the teaching of technical disciplines, which led to the choice of direction of the study. A more detailed examination of the problem has shown that a distinct pedagogical impact can be achieved by involving students in educational activities on the basis of already formed special competencies, for example, in the technology of designing web pages. Therefore, the creation of a web portal on "Physics" is an interdisciplinary training activity of future engineers with a high degree of axiology.

A particular website development is known to be different in each case. Web design, depending on the type of website and its purpose, can range from strict classical[2] to extravagant to extraordinary[3].

The analysis of information sources reveals different approaches to the definition of the education portal, which reveals its static (information) and dynamic (instrumental) essence, e.g. "website that allows access to many resources and services, such as instructional materials, lesson plans, news about current events, instant messaging and e-mail, and the ability to conduct controlled search" [15] or "multi-function website that includes public and private sections, data retrieval and submissions tools, personalized content, and often links or connections to education related systems or services" [16]. Development of education information portal (EIP) requires a special web design approach too [17].

In this article, the EIP is treated as a resource, whose main content consists of informative topical articles and educational materials. Provided its purpose EIP volume and structure may differ, ranging from portals in the form of university educational and methodological complex to web pages of certain subjects, teaching modules, highly specific themes and teachers' personal pages.

In general, EIP is a complicated website with a large number of pages and ramified structure. Therefore the main feature of its development and web designing is specification of all elements by creating a multilevel structure and well-conceived navigation. Otherwise, the usage of EIP would be rather complicated [18], affecting the degree of interest of existing and potential users.

It should be noted that EIP navigation development must follow the determination of its content and volume of text, graphics, multimedia, databases, etc. that users have access to. Otherwise, the "navigation collapse" may occur while adding a new content. The best EIP structure is known to consist of three or, in some cases, four levels. The possibility of future website expansion while designing the navigation system should also be considered.

The main task of the EIP being to provide various information, it should be optimally balanced in its ratio of text and graphics. The best result is achieved, when images are accompanied with explanatory texts which facilitate perception and acquisition of necessary information.

The essence of EIP content is of primary importance aiming: to attract more visitors and perform the tasks effectively, therefore it has to be unique, interesting and useful for them [19].

EIPs development also involves the design and processing of a large number of functional modules for interactive communication among portal visitors to discuss and exchange experiences and recommendations through the forums, chats, comments, etc. [20].

[2] Beyerdynamic. [Online]. Available: http://eastern-europe.beyerdynamic.com. Accessed on: July 31, 2017.
[3] Chamberlain's leather milk. [Online]. Available: http://leathermilk.com. Accessed on: July 31, 2017.

Another aspect of EIPs development is to ensure the ease-of-use not only for students, but for administration too. That means it should have a convenient system of content management [21], without which administration would have to add a huge amount of material manually, involving the website source code editing that will be inevitably accompanied by errors or shortcomings.

Adaptability of website design is a feature, which determines proper website displaying in any browser and on the screens of various resolutions. It also implies the acceptable website download time, because "super-heavy" design often makes users wait a long time for a full load of its pages, which in its turn reduces the number of portal users and its general attendance.

Optimal EIP design, which means its suitability for users, is all about fonts, which should be easily perceived through the optimal selection of colour and sets, adequacy and proportionality of element sizes and their location [22]. In general, the experience of using the portal is taken into account in the design and implementation of the EIP.

Research has shown that one of the determining factors is the originality of EIP design, which plays an important role for building reputation and search engine promotion.

Therefore, EIP development requires precise knowledge of modern web design technologies, professional skills of creators, acquired in regular processing of such web projects and conducting research activity aimed at studying the portal audience and their behaviour.

The article's goal. Information technology has currently become an integral part in teaching and research activities of future engineers. The conducted interdisciplinary research had several interconnected aspects: engineering (technology of web-portal creation), competence (development of the general scientific and professional competencies of future engineers) and didactic (study of peculiarities of the formation of subject competencies on physics based on the use of the web-portal). The purpose of this article is to highlight the mainly technological results associated with the peculiarities of developing and creating by the future engineers of electronic educational product such as a web portal for both teachers and students, which can be used for doing laboratory works, monitoring students' grades and providing a quick «teacher-student» feedback. Another objective was anticipation of modern interface development that would encourage users' interaction with the portal.

2. RESEARCH METHODS

According to the established purpose, the authors have used the *theoretical* (analysis and synthesis to clarify the matter of the product's main components and categories; conceptual and comparing analysis of the similar electronic educational tools; structural and system analysis and synthesis, as well as modelling for the purpose of construction of structural and logical model, revealing of the laws and peculiarities of its functioning, etc.), *engineering* (the actual creation of a software product, its multiple technical testing and view change according to the needs of the user) and *empirical* methods of pedagogical research (approbation of the web-portal in the educational process, observation of the features of its use, communications with students and teachers, analysis of laboratory reports in physics).

3. THE RESULTS AND DISCUSSION

One of the most popular design environments used for website development is Adobe Photoshop ™. Almost any designer's idea can be accomplished with this editor.

Designing any website based on the use of Adobe Photoshop ™ should begin with an appropriate concept development. At first, you should think over how to arrange items on the page, then define page blocks size in pixels, which means developing a modular grid of the page.

By using «View – New guide» option you can mark a page according to the modular grid. It allows achieving the exact size match of the sketch to the final document. In addition, you can use the grids prepared in advance and designed for different monitor resolutions. Quite often these grids are offered for free by their creators [23].

The best way to design a website using Adobe Photoshop™ is to build it as if using a construction set. To achieve this you have to place different elements conveniently on different layers, which you can move, merge, hide, etc.

Using different filters and plug-ins in Adobe Photoshop™ significantly accelerates the website design process. Batch processing of files (or simply *action*) aims to simplify working with multiple documents. *Action* allows you to apply several actions to the document by one simple click.

Plug-ins in Adobe Photoshop™ are special add-ins that add new functions to the editor or modify them. Using plugins, the visual effects of website design in Adobe Photoshop ™ can be created by one click.

The first stage was the study of existing solutions used by other high schools, such as the Igor Sikorsky Kyiv Polytechnic Institute campus[4] or the modular environment of the Kyiv National University of Technology and Design[5]. They have been created for a similar purpose, but they are not focused on any particular subject, which, in turn, makes the website navigation difficult and inconvenient to users. Studying these portals revealed the following disadvantages: navigation complexity, obsolete trends in the interface design, which also makes the website usage less convenient.

The second stage of the research process was the development of EIP design. The design is expected to be easy to use, concise, without unnecessary and unwanted items such as advertising, useless shapes, bright banners. The colour spectrum of the website should be acceptable for all users making neutral colours a requirement.

Therefore, the layout development process was started using the Adobe Photoshop™ design environment. First of all, the colour scheme was designed, with mainly blue and green shades used due to their sufficient contrast, satisfying almost every user and encouraging them to learn new information [24]. Further development involved arrangement of elements on the page, followed by detailing their design. The top navigation bar of the web portal was the first to be designed. Then some useful links to National Aviation University portal[6] were placed, as well as buttons to enter student's personal account or register a new user (student) (pic. 1, at the top).

The next step was to create convenient tabs in private user account, such as «Grades», «Settings», «Messages», «Laboratory works» (pic. 1, to the right).

Finally the EIP design developers focused on the context menu design, making it quite simple without unnecessary elements for quicker and easier use of the website by its users.

At that point the first phase of website development was fully completed. Design of personal account that significantly improves the portal usability for users and administrators was of particular importance. Students prepare for a laboratory work and report about its accomplishment, monitor their progress and receive notifications related to the educational

[4] Igor Sikorsky Kyiv Polytechnic Institute: campus [Online]. Available: http://login.kpi.ua/. Accessed on: July 31, 2017.

[5] Modular environment of educational process in KNUTD. [Online]. Available: https://msnp.knutd.edu.ua/. Accessed on: July 31, 2017.

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process. It also simplifies for teachers monitoring of laboratory works and communicating with students.

After creating the website design, preparing all the functional modules and components, developing a layout, designing the instruments for the potential user activities (ensuring the ease of use of all website components: navigation menu, works downloading, user's account, etc.), it is necessary to connect all the elements together, namely to design the website layout. This is the next stage of its development.

Website layout design is an intermediate stage between the user interface development and backend structure creation. Its aim is to define text and graphics displaying in different browsers. The trends of modern web design account for the use of a combined website layout, which allows increasing the layout design opportunities without portal adaptability loss.

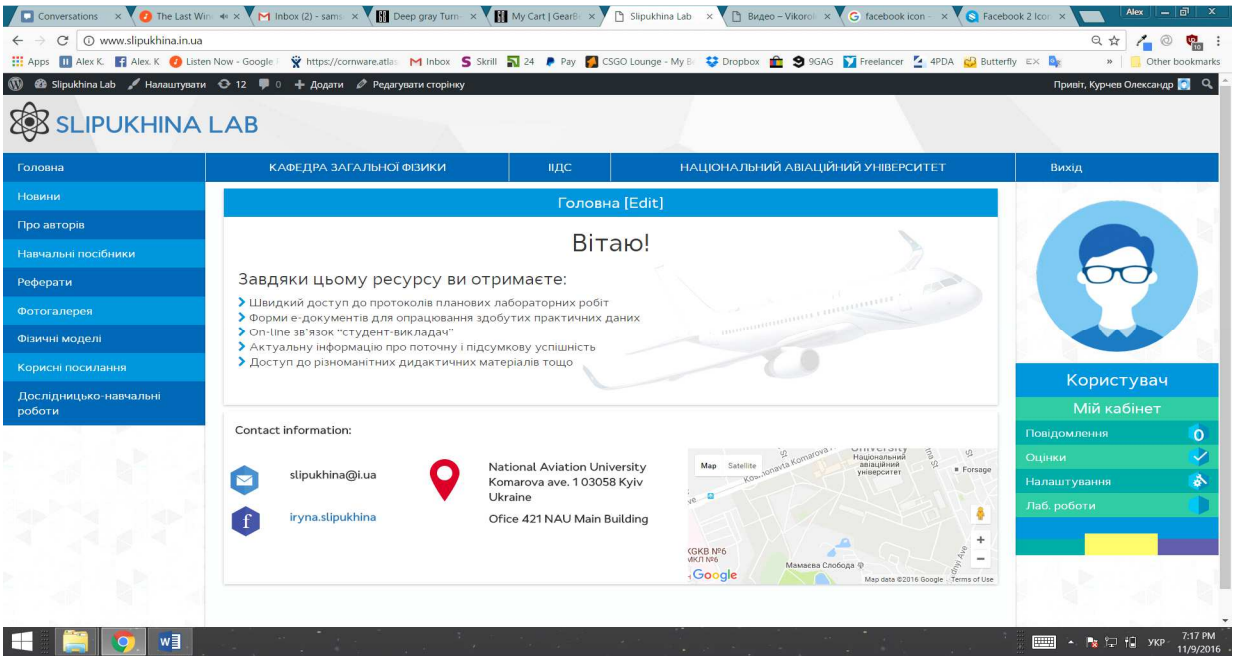
Modern style layout of the website can be made in different ways [25]. We used HTML and CSS-based website layout.

HTML website layout is based on hypertext mark-up language. Depending on the basic elements of HTML, there is an HTML table layout or HTML block layout.

The most currently relevant is a block layout based on elements. This website layout has several advantages: code brevity, high download speed, ease in command operation, etc.

Cascading style sheets (CSS) layout is sometimes singled out as a separate website layout; however, nowadays CSS is used in every single website layout process. Cascading style sheets describe the appearance of pages, written in HTML mark-up language.

The layout of this type uses linked style that makes it possible “to separate” code from an external design: all formatting tags are placed in a separate CSS file.



Pic. 1. The main page final design: at the top – web portal navigation toolbar; to the right– personal account interface

To simplify the process of web portal code writing bootstrap framework is also used.

Bootstrap is a CSS / HTML framework for website layout. In other words, this is a set of tools. Due to a number of its advantages, it is considered the most popular among its kind.

This framework offers the following advantages: high speed (the set of ready-to-use elements is time-saving for the layout design), scalability (when adding new elements, the

structure is kept stable), easy adjustment (editing styles is accomplished by creating new CSS rules executed instead of standard ones. The use of "!Important" and some other attributes becomes unnecessary).

The Bootstrap framework based convenient navigation bar created in this project is presented below.

```
     <nav class="container-fluid top-nav">// including Bootstrap styles, setting
styles for top bar
            <div class="row">// including row styles
      <div class="visible-xs mob-open-menu">// setting styles for columns on small
screens
            <a><i class="fa fa-bars"></i> Меню</a>// link to the “Menu” page
                  </div>// closing tag
            </div>
            <div class="row nav-links hidden-xs">// including link styles
                  <div class="col-sm-2// setting a size for column
                        <a href="/">Головна</a>
                  </div>
                  <div class="col-sm-3">
      <a href="http://zfiz.nau.edu.ua/" target="blank">КАФЕДРА ЗАГАЛЬНОЇ ФІЗИКИ</a>
                  </div>
                  <div class="col-sm-1">
            <a href="http://iids.nau.edu.ua/" target="blank">ННІІДС</a>
                  </div>
                  <div class="col-sm-4">
     <a     href="http://nau.edu.ua/"     target="blank">НАЦІОНАЛЬНИЙ     АВІАЦІЙНИЙ
УНІВЕРСИТЕТ</a>
                  </div>
                  <div class="col-sm-1">
                        <?php wp_loginout();?>

                  </div>
                  <div class="col-sm-1">
                        <?php if(!is_user_logged_in()):?>
            <a class="signup" href="wp-login.php?action=register">Реєстрація</a>
                        <?php endif?>
                  </div>
            </div>
      </nav>
```

We consider it necessary to take a look at the code of the contacts panel for quick communication with the teacher.

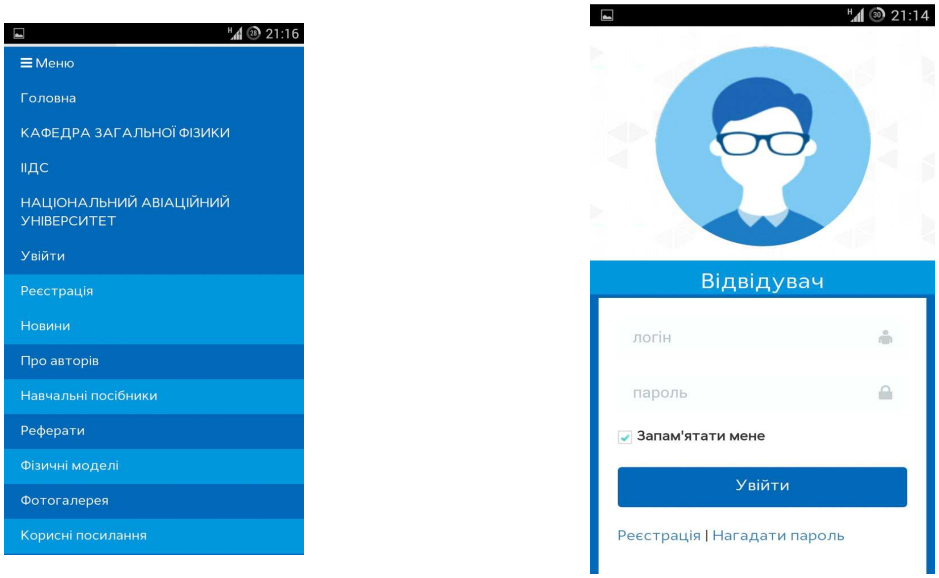
```
      <div class="contacts">
            <div class="row">
                  <div class="col-xs-12">
                        <div class="header"><b>Contact information:</b></div>
                  </div>
                  </div>
                        <div class="row">
                              <div class="col-md-3 margin-top">
                                    <div class="row">
                                          <div class="col-md-4">
                                    <img   class="img-responsive"    src="/wp-
content/themes/bluesquares/img/mail.svg">
                  </div>
                        <div class="col-md-8">
                              <div class="contact-info">
                                    <b>slipukhina@i.ua</b>
                              </div>
                        </div>
                  </div>
                        <div class="row">
```

```
                                <div class="col-md-4">
                                        <img   class="img-responsive"    src="/wp-
content/themes/bluesquares/img/facebook.svg">
                        </div>
                                <div class="col-md-8">
                                        <div class="contact-info">

      <b><ahref="http://fb.com/iryna.slipukhina">iryna.slipukhina</a></b>
                                        </div>
                                </div>
                        </div>
                </div>
                                <div class="col-md-4 margin-top">
                                        <div class="row">
                                                <div class="col-md-3">
                                                 <img  class="img-responsive"
      src="/wpcontent/themes/bluesquares/img/location-pin.svg">
                                                                </div>
                <div class="col-md-9">
                        <p><b>National  Aviation  University  Komarova  ave.  1  03058  Kyiv
                Ukraine</b></p>
                        <p><b>Ofice 421 NAU Main Building</b></p>
                                        </div>
                                </div>
                        </div>
                                <div class="col-md-5">
                                        <div id="googleMap"></div>
                                                </div>
                                        </div>
                                </div>
```

One of the features of this project is the use of new adaptive and sensitive layout technology that provides high-quality displaying on different devices, connected to the Internet: personal computers, laptops, tablets, smartphones, etc.

This layout dynamically adapts web page to fit a particular size of the device screen [26]. The use of this technology makes it possible to create multiple versions of the same website for particular types of devices (pic. 2).



a *b*

Pic. 2. Mobile version of the navigation unit and signing up (a – navigation bar; b – signing in)

Adaptive and dynamic technology was applied in this information product using the following tags:

```
<meta name="viewport" content="width=device-width, initial-scale=1">
<link type="text/css" rel="stylesheet" href="/wp-content/themes/bluedocument/css/bootstrap.min.css">
<link type="text/css" rel="stylesheet" href="/wp-content/themes/bluedocument/css/main.css">
<link type="text/css" rel="stylesheet" href="/wp-content/themes/bluedocument/css/bootstrap-theme.min.css"> // including Bootstrap technology
```

Thus, new original design convenient both for students and a teacher has been created during the project implementation. That was the main purpose of using HTML and CSS layout. The website is gaining more and more popularity thanks to its sharing among students, its dedication and the unique content outlined.

4. CONCLUSIONS AND OUTLOOK FOR FUTURE RESEARCH

The accomplished work has resulted in the creation of an education and information portal for “Physics” academic course, with personal account for a student, where one can control their progress, do interactive laboratory works, use informational materials and communicate with a teacher online [27]. Besides, this portal was developed to be convenient for teachers, providing them with an opportunity to control and check laboratory works, communicate with students and keep an electronic grade journal. The work started with the elaboration of the website design. At that stage the Adobe Photoshop™ environment was used. The next stage was the web portal layout development, using HTML and CSS layout. At this stage web pages optimization for devices of different resolution presented a challenge while modern Bootstrap technologies offered a solution. So, finally, education and information portal was created, students are actively using this website during the learning process. The web page can be displayed easily on different types of devices, making it convenient for use at any time. The task was completed and the website operates in the normal mode.

During the project development, a new, user-friendly interface design was implemented, interface components improving the usability of the website for both users and administrators. Registration form, feedback, etc. are easily accessed and designed in a modern web style. In order to create user-oriented interface, the principles of user experience were taken into account [28].

User experience describes how people feel when using the product. The main idea is the research of the user impression obtained from interacting with design elements. According to ISO 9241-210 standard [29], user experience is “a person's perceptions and responses that result from the use or anticipated use of a product, system or service”.

Uniqueness of this project is proved by its source code. It is original and was made specifically for this webpage. The developed design and written styles underlie the original content. The idea of grade monitoring possibility and communication with a teacher, being relatively new, simplifies the educational process a lot. At the moment only 20% [30] of the web content is dedicated to research activities, and it is by far insufficient.

This project is highly promising in terms of further data operation and systematization development, concerning didactic materials, articles and grades. There is a possibility of its further extension to other academic courses or even entire university system. Such a service increases the rate of university information provision and opens new possibilities for department or university management in terms of analysis, data exchange with students and

monitoring statistics. In general, this service makes a powerful impact on development and implementation of new modules and solutions to facilitate university-student collaboration.

The structure of the EIP will be expanded with the addition of new materials, while ensuring ease of use. Currently, the EIP is aimed mainly at one course (Physics). In the future, there is an opportunity to provide extension to two or more academic courses, which will increase the audience and popularity of the portal among students and teachers. To accomplish this, a new, more up-to-date structure with simplified content access for users is to be developed.

However the development of such a structure can cause a problem because of multitude of education materials to be categorised. The problem concerns the access to these materials, as users' search will take a lot of time. To solve this problem, a system of intelligent search for all materials should be developed.

Moreover, the prospects of further work require collaboration with the university management to transfer EIP to the university domain, which will facilitate the portal promotion. Another challenge is digitization of education matter that currently exists only in printed form (laboratory guides, manuals, textbooks, grades, reports etc.). This will significantly contribute to the website development optimization.

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Text of the article was accepted by Editorial Team 07.08.2017

РОЗРОБЛЕННЯ НАВЧАЛЬНО-ІНФОРМАЦІЙНОГО ПОРТАЛУ ДИСЦИПЛІНИ ФІЗИКА: ОСОБЛИВОСТІ ВЕБ ДИЗАЙНУ

Сліпухіна Ірина Андріївна
доктор педагогічних наук, доцент, професор кафедри загальної фізики
Національний авіаційний університет, м. Київ, Україна
ORCID ID 0000-0002-9253-8021
slipukhina@i.ua

Ольховик В'ячеслав Вікторович
студент
Національний авіаційний університет, м. Київ, Україна
ORCID ID 0000-0001-5044-8282
mcflobots@gmail.com

Курчев Олександр Олександрович
студент
Національний авіаційний університет, м. Київ, Україна
ORCID ID 0000-0002-7793-005X
samson.alex97@gmail.com

Капранов Віталій Дмитрович
студент
Національний авіаційний університет, м. Київ, Україна
ORCID ID 0000-0002-9439-4033
youtrouble1@gmail.com

Анотація. Статтю присвячено розгляду основних компонентів й особливостей проектування і дизайну навчально-інформаційного порталу для студентів. Добір персональної траєкторії реалізується через використання персонального кабінету, до контенту якого входять електронні документи лабораторної звітності, матеріали, які стосуються навчального процесу, засоби комунікації з викладачем. Створений портал дає можливість адміністратору легко контролювати й перевіряти лабораторні роботи, вести електронний журнал з оцінками. Для проектування дизайну сайту, функціональних модулів і компонентів було використано середовище Adobe Photoshop ™, а також HTML та CSS верстку веб-порталу. Застосовано сучасну технологію Bootstrap для адаптації інтерфейсу веб-сторінки. Розглянуто дидактичні можливості застосування такого порталу з урахуванням індивідуалізації процесу навчання фізики.

Ключові слова: веб-дизайн; навчально-інформаційний портал; верстка; HTML; CSS; Bootstrap; фреймворк; дисципліна фізика.

РАЗРАБОТКА УЧЕБНО-ИНФОРМАЦИОННОГО ПОРТАЛА ДИСЦИПЛИНЫ ФИЗИКА: ОСОБЕННОСТИ ВЕБ ДИЗАЙНА

Слипухина Ирина Андреевна
доктор педагогических наук, доцент, профессор кафедры общей физики
Национальный авиационный университет, г. Киев, Украина
ORCID ID 0000-0002-9253-8021
slipukhina@i.ua

Ольховик Вячеслав Викторович
студент
Национальный авиационный университет, г. Киев, Украина
ORCID ID 0000-0001-5044-8282
mcflobots@gmail.com

Курчев Александр Александрович
студент
Национальный авиационный университет, г. Киев, Украина
ORCID ID 0000-0002-7793-005X
samson.alex97@gmail.com

Капранов Виталий Дмитриевич
студент
Национальный авиационный университет, г. Киев, Украина
ORCID ID 0000-0002-9439-4033
youtrouble1@gmail.com

Аннотация. Статья посвящена рассмотрению основных компонентов и особенностей проектирования и дизайна учебно-информационного портала для студентов. Отбор персональной траектории реализуется через использование персонального кабинета, контент которого содержит электронные документы лабораторной отчетности, материалы, касающиеся учебного процесса, средства коммуникации с преподавателем. Созданный портал дает возможность администратору легко контролировать и проверять лабораторные

работы, вести электронный журнал с оценками. Для проектирования дизайна сайта, функциональных модулей и компонентов была использована среда Adobe Photoshop™, а также HTML и CSS верстка веб-портала. Применена современная технология Bootstrap для адаптации интерфейса веб-страницы. Рассмотрены дидактические возможности применения такого портала с учетом индивидуализации процесса обучения физике.

Ключевые слова: веб-дизайн; учебно-информационный портал; верстка; контент; HTML; CSS; Bootstrap, фреймворк; дисциплина физика.

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