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CREATING AN INFORMATIONAL WEBSITE FOR PHYSICS ACADEMIC COURSE: WEB DESIGN SPECIFICS

Abstract. The article is devoted to the analysis of means and methods of creating an educational informational website for the Physics academic course. The stages of technical task creation, design of the main and typical pages of the website, layout, programming, content filling and publication are considered. The analysis of libraries, frameworks and popular WordPress and Joomla CMSes has been carried out as well as usability testing. Features of ready-made tools suitable for efficient creation of such web applications are considered. The contents of the front end and back end components of the given specification, as well as their connection with AJAX, are determined. The features of the WordPress architecture and the location of JSON files for the transmission of structured information are revealed. An original Student Score plugin for WordPress, that allows managing the contents of the e-register and displaying them for a teacher and students, as well as plugins for managing electronic laboratory reporting and user administration have been created.

Keywords: Web development; web site; web design; server configuration; content management system; graphics software; content; usability testing; WordPress; Joomla; plugin; AJAX; JSON; Physics academic course; educational informational portal; electronic laboratory reporting.

1. INTRODUCTION

Problem statement. Under the influence of global socioeconomic processes, in particular caused by the convergence of the NBICS technologies, technical universities are now turning into hubs where the interactions between business structures are carried out by the means of production, science and education [1]. At the level of education there is a tendency towards the introduction of transdisciplinary approaches, integration of training in the Natural Sciences, the Humanities and specialist disciplines. The competence of a modern engineer is determined by the level of their knowledge (first of all, Physics, Mathematics and Computer Science) and the ability to innovate. Value-motivational orientation of the future specialist exercises the decisive influence on the formation of skills that determine the readiness for successful employment in the 21st century [2].

In the conditions of global informatization and massification of education, as well as its transformation into educational networks, there is a question of flexibility in the construction of curricula that have to combine fundamental science and applied skills. It is realized through

a variety of pedagogical technologies: PBL, project training, case studies, etc. Implementation of such teaching methods is also facilitated by the fact that today's secondary school graduates who choose Computer Science as their B.Sc. major are fluent in programming languages (e. g. C++), have skills in using programming environments (for example, Delphy, Adobe Flash) [3]. It is obvious that the creation of the educational and information portal dedicated to the "Physics" academic course by students is based on the understanding of the training course structure and the availability of practical skills for creating web pages.

Analysis of recent studies and publications. The essence and content of engineering education in the fifth to sixth technological processes has a degree of uncertainty [4]. The genesis of this complex and multifaceted problem is influenced by a number of factors of external and internal origin. These include, first of all, global changes in the labour market, which are now characterized by high technology, orientation of business towards the service sector, large-scale migration processes, etc. This requires the formation of, in addition to the basic knowledge, relevant life skills of the youth [4]. Secondly, the classical system of school education, which is mainly aimed at adhering to the standard, while neglecting the personalization of education, is currently undergoing a crisis [5]. This situation leads to a significant reduction in the level of value-motivation factors of learning, in particular, in the field of Natural Sciences and Mathematics. The STEM approach to learning is one of the most effective ways of resolving the existing conflict between the needs of the economy and education [5]. It should be noted that such pedagogical technology is transdisciplinary, it actively develops mainly in secondary school [6].

An interdisciplinary approach to the study of fundamental disciplines in higher education has gained new insight with the development of multimedia, network access to data, digital measurement complexes and various software tools [6]. In particular, the important role is played by means of remote access to educational resources and teacher – student operational communication in the 24/7 mode. These include web portals.

Web portal or Internet portal is a computer network website, which functions as a point of access to the necessary information on the Internet. It is able to browse the Web, provide access to various Internet services, such as e-mail, newsfeeds, and many others. Today, Internet portals are large and complex network information and technology complexes, aimed at providing reference, analytical, communication, educational and other information services [7].

A special place in the global network belongs to *educational portals* through which effective learning environments are implemented. They contain systematic study and research materials (study guides, plans and programs of disciplines, seminars, practical and laboratory classes, systems of evaluation, control and self-control, etc.), means of communication and obtaining various data, including experimental and multimedia. Educational portals are the basis and integral tool of distance learning technologies; they provide opportunities for creating a personal educational space and learning trajectory.

The purpose of a web portal is, first of all, providing a specific user with the necessary information during the minimum time. It should be noted that the content of the Internet portal (the quality and quantity of information resources, their interactivity, structuring, updating, administration and personalization) determines its value, and appears as a means of motivation to visit such a resource by the user.

The criteria for the classification of the portals may be their content and the service provided (informational, collaborative portal, expertise, knowledge acquisition), versatility (vertical, e.g. by branches of knowledge, and horizontal, e.g. Google) and globality (e.g. state or regional) [7].

The Educational and Information Portal (EIP) dedicated to the Physics academic course is an educational website that contains relevant teaching materials, tools for evaluation

and communication with the teacher, convenient tools for processing experimental data, for example, the database of electronic laboratory reports [8] and the electronic grades register.

It should be noted that the creation of the EIP requires prior careful study of its structure and features of its usage, the possibilities of future expansion of its functionality, as well as the ability to adapt its interface (for example, e-register) for a wide range of digital devices, which differ, in particular, by the size of their screens[1].

Therefore, **the purpose of the article** is to reflect the results of the study of the procedure and features of the development of an EIP for the Physics academic course in a high school.

2. THE RESULTS AND DISCUSSION

Web development is the process of creating a website or web application. The main components of the process are setting up a web server, web design, pages layout, development of software for the user (client) and servers.

Stages of website development. Nowadays, there are several stages of website development:

- designing website or web application (gathering and analysis of needs, development of technical specifications, interface design);
- development of creative site concept;
- creating a design concept for the site;
- creating page layouts;
- pages and templates layout;
- programming (functional tools development) or integration into content management system (CMS);
- optimization and site distribution of materials;
- testing and correction of mistakes;
- opening the project for users;
- maintenance of the finished site or its program basis.

Depending on your current task, some of the steps may be absent, or closely related to each other.

Creation of specification. The project manager has a task to create a technical task for professionals. The work with the customer begins with filling the brief, in which the client gives their comments about the visual presentation and structure of the site, indicating errors in the previous versions of the site and gives an example of competitors' sites. After the discussion, the manager creates the technical task which includes opportunities of design and technical tools. This stage must be discussed with the developer and the designer.

The stage ends after the establishment of technical specifications, which are received from the customer. It should be noted that the phases of website designing depend on many factors such as the size of site, its functionality, tasks that must be executed by future resource etc.

Design of basic and standard pages. As usual, the work on making the design starts in a photo editor. The designer creates one or more design options, according to specifications. Main page design and design of standard pages (news, products) are created separately. Actually *page design* is a graphic file, a picture that is divided into layers which consist of the smallest pictures – element layers of the actual picture.

The designer should consider the limitations of the World Wide Web Consortium

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[1] This criterion significantly reduced the ability to select finished products

standards [1], and also features of the future use of the web site. Design which would be convenient only for several devices should not be created.

Number of thumbnails and order of presentation is discussed with the project manager. Also, the project manager controls the timing of the project. Art director is involved in leading web studios. Also, he controls the quality of graphics. The stage also ends with the approval of thumbnails.

HTML layout. Approved design is transmitted to HTML-coder, who, if necessary, "cuts" a graphic image into separate drawings, and creates elements, visually identical to the ones presented on the layout model. Then he starts work on HTML-page creating. The result of work is a code that can be viewed using a browser. Typical elements eventually will be used in templates.

Programming. Ready HTML-files are transmitted to the programmer after the process of layout. The site programming can be carried out "from scratch" and, also, based on CMS, various frameworks and libraries. Web developers often call CMS "an engine".

CMS, in some meaning, is a ready site, which consists of parts that can be replaced. Programmer (in this case, it would be right to call them a CMS specialist) should replace the default template that comes with CMS with the original. The programmer has to create this template using established models.

While programming, a specialist is assigned with the schedule checkpoints. The final stage of the development of the site is usually called testing.

Testing process includes various verifications, such as testing the page look with enlarged fonts, in different window sizes, without flash-player; usability testing, etc.

Found errors undergo correction until they are eliminated. Project manager controls timing. Also, at this stage, the designer is involved (to make sure that the site design is under control).

Hosting site on the Internet. Files are hosted on server and the necessary adjustment is made. At this stage the site is closed to users.

Content filling and publication. The site is filled with text, images, files for download etc. Sometimes, the studio specialist writes the text. Sometimes, a responsible person from the customer deals with the content. It is decided on the stage of resolving technical problems. If the content is made by the studio, it is agreed in parallel with other phases of the project.

Finishing the project. The customer or the responsible person views the finished project and, if everything is alright, signs documents approving the project. Also, at this stage, customers are trained in site administrator skills.

Web programming. Web programming is a term for development of the web applications (applications used for the normal functionality of dynamic World Wide Web sites).

Web programming languages are languages that are mainly designed to work with web technologies (although, in case of JavaScript, they may create application software for home PCs; and, also, PHP, but in this case the main purpose of the language is violated). Their development typically involves server side coding, client side coding and database technology.

CMS choice. The most popular content management system is WordPress. WordPress is an open source web content management system that can be easy installed. And it is widely used for building websites [2]. Its application area ranges from blogs to complicated websites. Built-in themes and plugins allow to design any web projects by WordPress.

The program is written in PHP programming language using MySQL database [3]. Source code meets the GNU General Public License v2 conditions [4].

CMS initially established itself as an innovative blogging platform with a wide range of applications. But the development of the functional system secured its high popularity also

among websites of other formats. Today the industry of web design has the high demand on services in the field of development which uses WordPress. WordPress is used everywhere, from personal blogs and portals to e-commerce sites.

The following advantages of CMS WordPress were discovered.

- ✓ Technical experience is not required. The administrative panel is much simpler than other CMS: PHP and CSS theme files and plugins can be edited directly in the panel.
- ✓ User-friendly content editor. Content can be copied from any text editor, even Microsoft Office Word, without the loss of images and text formatting.
- ✓ Wide set of plugins, themes, widgets, galleries, forums, localizations, various directories.
- ✓ It is the most popular content management system; more than half of users prefer WordPress [5].

The following disadvantages of CMS WordPress have to be noted.

1. The system provides a huge field for selection, so the main problem is how to use all of its possibilities properly. Among the extensions of CMS there are many instances of redundant functionality that only cause additional loading on the server and the browser. In order to optimize this, CMS must be correctly configured to your needs. Choose plugins with the necessary features to optimize server for optimal load distribution and resources.
2. WordPress begins to lose its relevance, because it cannot offer a comfortable environment for debugging code to software developers, and that causes a long process debug [6].
3. The architecture of the CMS is poor. Global variables, own class for managing database queries makes it one of the worst among modern CMS. That is because of its age, as in 2003 MVC architecture was not so popular as it is now and at that time that architecture was enough [7].

This CMS may be the best option if you want a site that is easy to administer. It is an advantage for inexperienced users, because the time for its development is quite small (from a few hours to several days). Using this system provides wide, but at the same time, simple functionality. WordPress is ideal choice for portals and blogs, but it also can be used in development of other sites.

The next most popular content management system is Joomla. About 9% of users use this CMS. That system combines ease of WordPress and functionality of Drupal. And it provides opportunities targeted to developers, with more features for development.

It was noticed that the advantages of Joomla are:

- ✓ Despite the simplicity, compared to Drupal, Joomla is a powerful tool for development.
- ✓ Access control protocol support.
- ✓ The presence of convenient admin panel with lots of features, templates, styles, menu management etc.
- ✓ Easy install process.

The following significant disadvantages of Joomla were discovered:

- − The system is rather superficial and weak, in spite of all its versatility.
- − More paid plugins, compared to WordPress.
- − For inexperienced users it may seem that Joomla is overloaded with functionality and for advanced users it is too simple.

There are a lot of site management systems. The most famous among them are Drupal [8], MODx [9], OpenCart [10], but the most popular and most convenient is WordPress.

To create the educational website, we had to choose a blog platform that offers the possibility of expanding its functionality. Considering all advantages of WordPress, we used that CMS. And now let us learn more about stages of creating a website based on it.

The work on creating a website on WordPress can be divided into several stages. Site development begins with the WordPress install distribution on hosting or on a local server, and the next step is to layout a site template in WordPress. After all this, setting the parameters of the CMS is done. Also, installing and configuring the necessary plugins, development of individual modules and components is done. The final stage of creating the site is filling the site with unique content.

WordPress distribution installing on hosting site is quite simple and does not require any complicated actions. Distribution must be downloaded from official WordPress web site [2]. Then, it should be installed in a specific folder which should be placed in the root of the site on a web server. Then you need to create a web server database for new WordPress MySQL users, give access to them and make changes to the database.

In the distribution files of WordPress, hosted on a web server, we need a few changes. We must rename the file *wp-config-sample.php* in *wp-config.php*, and then open the file *wp-config.php* in any text editor and write it connection settings to set up the database. Next, open the browser and type in the address bar text *http://example.com/wp-admin/install.php*, where *example.com* is a domain name for the created site. This starts the WordPress installer, at the end of which CMS WordPress will be ready for the next stages of the site creation.

Plugins. In terms of software engineering "front end" and "back end" are distinguished by the principle of the division of responsibility between the level of presentation and the level of access to data, respectively.

Front end is an interface for interaction between the user and the back end. Front end and back end may be distributed between one or more systems.

There can be many levels in software architecture, between the hardware and the end user. Each of these levels can have both front end and back end. Front end is an abstraction that simplifies basic component by providing a user with convenient (user-friendly) interface. Back end is the code that manages data server, providing access to content, creates it, defines access policies etc.

In the software design, the Model-View-Controller architecture, for example, provides the front end and back end for the database components and processing user data. The separation of software systems for front end and back end simplifies development and shared support. The rule of thumb is that the front (or "client") aspect is that any component is managed by the user. Server side code (or "back end") is stored on the server. Confusion arises when someone wants to make changes in front end file on the server side. Most of HTML-designers, for example, should not be on a server while HTML is developing; and server engineers do not have to be anywhere other than on the server. Both developers need to create an ultimately functional, interactive website.

WordPress plugins are elements that expand the functionality of CMS. To realize the students grade journal, plug *Student Score* was created, that allows you to control student grades, to structure them into groups, faculties.

An interface is transferred on the front end, while the operation with requests to API (Application Programming Interface) – on the back end of plugin. Connection between the back end and front end is done by using AJAX.

AJAX (Asynchronous JavaScript and XML) is a set of web development techniques using many web technologies on the client-side to create asynchronous Web applications. With Ajax, web applications can send data to and retrieve it from a server asynchronously (in the background) without interfering with the display and behavior of the existing page. By decoupling the data interchange layer from the presentation layer, Ajax allows for web pages,

and by extension web applications, to change content dynamically without the need to reload the entire page.

The results of data processing on the server are sent in the format JSON.

JSON (JavaScript Object Notation) is an open-standard format that uses human-readable text to transmit data objects consisting of attribute-value pairs. It is the most common data format used for asynchronous browser-server communication, largely replacing XML which is used by Ajax.

Student Score Plugin. Convenient plugin is needed for controlling student grades, which would provide access to information editing for students, groups, departments, and have a responsive design that is easy to use. In WordPress plugins directory, we did not find any plugin that would meet these criteria. Also, we had to put grades only in one object, and for each column of the journal it should be a separate entry. Since these plugins did not help, we decided to write our own. It was the first experience of creating the plugin on WordPress, so we had to handle some difficulties.

In this CMS we found some unpleasant facts:
− all plug-ins were connected by regular *require_once*, before they passed several function wrappers, and some of them were identical (*add_action*, *add_filter*);
− absence of any encapsulation, and global variables are used throughout, although the OOP in the WordPress code is present;
− absence of any namespaces, so it is easy to encounter the problem of conflicts of variable names;
− the use of *add_shortcode*, *add_action* to transfer callbacks. Therefore, encapsulation in this case does not help, because these functions work only with static or the public methods, which are not using any class members.

Considering these features of WordPress, we had to think of a plugin architecture without objects. The plan was to decide what will be used at the back end and the front end.

On the frontend, the use of Angular JS was originally proposed. An advantage of this was the speed and ease of software development using reactive programming. This would realize user-friendly interface with interactiveness for a short time. However, connection of this framework would be impractical only because of one plugin, and it was necessary to rewrite the whole theme.

Another option was React JS – a library that realizes the principle of reactive programming, but its study takes a long time.

In this case, the best choice was to create a plug-in using a minimal set of reactive programming features in JavaScript, without using frameworks and libraries, because we had an experience in creating similar projects. It was enough to add the following features:
1) variables are overwritten, when events onchange are operated;
2) callbacks were tied to these events, and they carried the value of input element into some variable.

Also because of WordPress code complexity and problems with the organization, it was decided to save all the information of the database in JSON file. As a result, the back end should only read the file, transfer it via AJAX frontend and work with it. All changes were made on the client side. If you change the values of certain items, it will redraw related items again. For example, after the change of settings, the structure of departments, groups, data on students may change. Therefore, after the closing of the modal window the unit will redraw.

Usability. Due to reactive programming we were able to combine plugin with all necessary functionality for managers and students on the same page, which is quite handy when you need to make changes quickly. Administration of the plugin loaded after checking on the back end whether a user is an administrator, and then the changes to expand the functionality are applied in the standard version for students.

The plugin code:

Method for appendage of controls for a new student:

```
"addStudent": function(event, faculty, group) {
                event.preventDefault();
                var id = curObject.addStudent(faculty, group);
                curObject.journal.renderMarksTable(faculty, group);

                //sounds funny
                var newStudentInputs = $(".marks-table tr:last input");
                newStudentInputs.change(function(){

curObject.journalData.faculties[faculty].groups[group].students[id]         =
$(this).val();

                });
        },
Method for removal information about student:
                "removeStudent": function(event, faculty, group, id) {
                event.preventDefault();
                curObject.removeStudent(faculty, group, id);
                $(event.target).parents("tr").remove();
        },
Method for new student appendage:
this.addStudent = function(faculty, group) {
        console.log("ADD STUDENT");
        var newStudent = new Proxy (
            {
                "state": "new",
                "name": "Ім&acute;я",
                "totalscore": 0,
                "columns": [[]]
            },
            this.dataBinder
        );
        var                         curGroup                        =
curObject.journalData.faculties[faculty].groups[group];
        if (curGroup.students === undefined) {
            curGroup.students = [];
        }

        var studentsCount = curGroup.students.push(newStudent);
        this.updateSemestersStructure();
        return studentsCount;
    };
```

Plugin used for laboratory works controlling. Our labs are designed in the form of HTML pages and tables set in a xls, xlsx format, it was decided to create a special plugin for their processing.

The operation principle of the plugin is as follows.

✓ Firstly, directory */wp-content/up loads/labs* is scanned, where each directory has a name identical to the name of the module.

✓ The names of these directories are recorded in an array.

✓ Next level directories are scanned in each of the previous ones. Their names are the names of the laboratory work.

3. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

In the development process, we created a new plugin called Student Score, which is unique in its kind, because we have not found ready solutions with similar functionality.

In the future, the plugin Student Score can be used on other school sites after reorganization of its formation logic.

WordPress CMS is ideal for inexperienced users, or for those who need to create a site quickly, based on ready plugins. But in terms of its architecture, it cannot be classified as the best. In its code, many modern code standards are insulted, since development started in 2002, with no code having been rewritten. But such a move could be a mistake, because it automatically means the complete incompatibility with the previous versions, and therefore none of the plugins can be used with those that currently exist. The audience would switch to similar products, and some experienced developers would choose CMS Drupal type, or Laravel, Zend, Symphony frameworks, etc.

This CMS was selected as the deep analysis and for the most convenient use by the client. The site and plugins development cannot be called difficult, but there were some questions about the realization of functional that had no sense. Duplication of the functions and not standardized, less effective realization of turnkey solutions can confuse the newbie.

There are plans to develop the site further by using it in the classroom, correcting existing errors, improving functionality.

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СТВОРЕННЯ ІНФОРМАЦІЙНОГО ВЕБ-САЙТУ ДЛЯ АКАДЕМІЧНОГО КУРСУ ФІЗИКИ: ОСОБЛИВОСТІ ВЕБ-ДИЗАЙНУ

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Анотація. Стаття присвячена аналізу засобів і методів створення навчально-інформаційного сайту з дисципліни «Фізика». Розглянуто етапи створення технічного завдання, дизайну основної і типових сторінок сайту, верстки, програмування, наповнення контентом і публікацію. Проведено аналіз бібліотек, фреймворків та популярних CMS WordPress та Joomla, а також висвітлено юзабіліті-тестування. Розглянуто характеристики готових інструментів, придатних для ефективного створення таких веб-застосунків. З'ясовано зміст «front end» та «back end» поставленого технічного завдання, а також їх

зв'язок за допомогою AJAX. Виявлено особливості архітектури WordPress і місце JSON файлів для передачі структурованої інформації. Створено оригінальний плагін Student Score для WordPress, який дає можливість керувати змістом електронного журналу і його відображенням для викладача і студентів, а також плагіни адміністрування користувачів, керування електронними документами лабораторної звітності.

Ключові слова: Веб-розробка; веб-сайт; веб-дизайн; конфігурація сервера; CMS; графічний редактор; контент; юзабіліті-тестування; WordPress; Joomla; плагін; AJAX; JSON; навчально-інформаційний портал; дисципліна фізика; електронний документ лабораторної звітності.

СОЗДАНИЕ ИНФОРМАЦИОННОГО ВЕБ-САЙТА ДЛЯ АКАДЕМИЧЕСКОГО КУРСА ФИЗИКИ: ОСОБЕННОСТИ ВЕБ-ДИЗАЙНА

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Аннотация. Статья посвящена анализу средств и методов создания учебно-информационного сайта по дисциплине «Физика». Рассмотрены этапы создания технического задания, дизайна основной и типовых страниц сайта, верстки, программирования, наполнения контентом и публикации. Проведен анализ библиотек, фреймворков и популярных CMS WordPress и Joomla, а также проведено юзабилити-тестирование. Рассмотрены характеристики готовых инструментов, пригодных для эффективного создания таких веб-приложений. Выяснено содержание "front end" и "back end" поставленного технического задания, а также их связь с помощью AJAX. Выявлены особенности архитектуры WordPress и место JSON файлов для передачи структурированной информации. Создан оригинальный плагин Student Score для WordPress, который дает возможность управлять содержанием электронного журнала и его отражением для преподавателя и студентов, а также плагины администрирования пользователей, управления электронными документами лабораторной отчетности.

Ключевые слова: Веб-разработка; сайт; веб-дизайн; конфигурация сервера; CMS; графический редактор; контент; юзабилити-тестирования; WordPress; Joomla; плагин; AJAX; JSON; учебно-информационный портал; дисциплина физика; электронный документ лабораторной отчетности.