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EDUCATIONAL CONTENT OF MODERN WEB-DEVELOPER TRAINING

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Abstract

The article provides an answer to the frequently asked question about what to teach students so that they can easily enter the area of web development and become sought-after specialists in the modern IT industry upon graduation. We completed a review of publications and scientific discussions on this subject, performed an analysis of the relevant professional standards as well as the transformation dynamics of the requirements set out by employers for web developers. In addition, the paper examines the demand for designing educational programs. We interviewed representatives of professional communities and university graduates to understand the challenges which former students face while seeking employment in the field of web development and design. Six main skill groups of a modern successful specialist have been identified. They include basic web development skills, web programming skills, web design skills, development skills and development management skills, web resource promotion skills, universal skills. For each group, we identified the main skills and tools which are advisable to be studied as part of the educational program. It has been discovered that training should be based on using skill-oriented educational technologies since solving specific practical problems will enable each student to form their own future workspace. We also created a model of a graduate who aspires to work in the field of web development.

Keywords: web developer, web development tools, required skills, educational program, professional and educational standards.

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ОБРАЗОВАТЕЛЬНЫЙ КОНТЕНТ ПОДГОТОВКИ СОВРЕМЕННОГО ВЕБ-РАЗРАБОТЧИКА

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Аннотация

В статье дается ответ на часто задаваемый вопрос: чему учить студентов, чтобы по окончании высшего учебного заведения они могли легко войти в сферу веб-разработки и были востребованными современной IT-индустрией специалистами? Выполнен обзор публикаций и научных дискуссий по данной тематике, анализ соответствующих профессиональных стандартов, динамики трансформации требований, предъявляемых работодателями к веб-разработчикам, и потребностей в формировании образовательных программ. Проведено интервьюирование представителей профессиональных сообществ и выпускников университета для понимания трудностей, с которыми сталкиваются выпускники при дальнейшем трудоустройстве в сфере веб-разработки и дизайна. Выделено шесть основных групп навыков современного успешного специалиста: базовые навыки веб-разработки, навыки веб-программирования, навыки веб-дизайна, навыки ведения разработки и управления разработкой, навыки продвижения веб-ресурсов, универсальные навыки. Для каждой группы выделены основные навыки и инструментарий, изучение которых целесообразно включить в образовательную программу. Установлено, что обучение нужно строить на основе применения навыково-ориентированных образовательных технологий, так как решение конкретных практических задач позволит каждому обучающемуся сформировать свое будущее рабочее пространство. Сформирована модель выпускника, стремящегося трудиться в сфере веб-разработки.

Ключевые слова: веб-разработчик, средства веб-разработки, необходимые навыки, образовательная программа, профессиональные и образовательные стандарты.

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1. Introduction

About 30 years have passed since the first web page appeared. While the first pages presented information in the simplest form, which was already a good thing, the modern web page is practically an art, the result of a mixture of creativity and technology, because the modern user can no longer get enough information. It requires everything to be beautiful, clear, accessible and work on a wide range of devices. This has led to a significant increase in the number of new technologies, appearing and changing so frequently that it is difficult to keep up with them, let alone learn or constantly retrain.

The authors of this article have been teaching web-related subjects for more than 20 years. We can note that year after year, learners ask the same typical questions:

Why do we study this particular technology stack?

Why are we learning this particular software product and not another?

What will we need when we get a job?

And so on.

Questions such as whether it is possible to teach students modern technology so that they do not have to learn anything new for a given amount of time are much debated. On the other hand, does a modern graduate really have to have a broad outlook or is it enough to review some basic concepts? We have already discussed these questions and some similar ones concerning trends in IT training in previous works, e. g. [1, 2].

The aim of this paper is to present and substantiate a desirable set of knowledge and skills required for a future web-developer in the preparation of IT-specialists in a modern university and, thus, try to answer the question - what to teach modern students so that upon graduation they could easily enter the field of web-development and be in demand in the modern IT-industry? Or, in other words, what the current and near future educational standards in this field might include.

The analysis of the strategy of educational programmes formation should be conducted taking into account the most significant factors that significantly influence the conclusions. In our opinion, the evolution of technologies and the following changes in economic and labour market demands, as well as the results of graduates' competence matching monitoring (feedback of the effectiveness of the "educational programme-employer" system interaction) should be paid the most attention to.

Due to the enormous popularity of the web and, consequently, the demand for specialists in web-development, the issues of web-technology study and developer training are given quite a lot of attention. Such studies do not lose relevance, although they have been carried out continuously for many years [3].

The article [4] presents an ontological generalized portrait of a software developer. Such a portrait can be complemented by data from [5], in which the au-

thors identify factors that significantly influence and contribute to programmer productivity. In particular, software knowledge, analytical skills, level of best practice management, knowledge of business processes, and others are taken into account.

In forming this material, professional and educational standards such as [6–10] and others were examined, and the links between educational and professional standards were analyzed and experiences of different approaches to training using such standards were examined such as [11], using web-based learning platforms [12], as well as case studies of web programming training described in [13–15] and others.

2. Methods

This study is based on the use of theoretical and empirical research methods. The application of theoretical method allowed for analysis of modern professional standards, analysis of the dynamics of transformation of the requirements of employers to the knowledge and skills of web developers and analysis of the needs in the formation of appropriate educational programmes. An analysis of publications and academic discussions on the subject was also carried out. The empirical method was applied in the process of observation and comparison of data obtained over the years of the authors' practice, interviewing representatives of professional communities and university graduates to better understand the problem described, in particular, the difficulties faced by graduates in further employment in the field of web development and design.

3. Results and Discussion

The analysis of literature sources and employers' requirements, professional standards, professional-oriented web-resources, interviewing representatives of professional communities, analysis of employment and career of university graduates, as well as personal experience have given grounds to highlight several main topical areas of training, which can form the basis for educational standards in the field:

- Basic web development skills;
- Web programming skills;
- Web design skills; Web design skills;
- Skills in leading development and managing development;
- Web promotion skills;
- Universal (General) skills.

Let us elaborate on them by identifying what we think the educational programme content and the model of a graduate wishing to work in web development should be.

3.1. Basic web development skills

The basic skills that prospective web developers should learn first include the basic 'building blocks' of layout and programming — HTML, CSS and JavaScript. They form the web user interface, defining style,

design, layout and how different elements should be displayed. HTML is responsible for the layout of the page, CSS stands for styles and looks, and JavaScript is responsible for how elements respond to the user.

We think it is useful to take a quick look at the history of versioning and show simple examples of how one technology has affected another. For example, the advent of XML led to the requirement for paired tags in HTML.

Students need to understand the anatomy of HTML page layout, learn basic tags, their attributes, and nested elements, understand the advantages and limitations of the technology, have a good command of CSS styles, be familiar with CSS frameworks, and have mastered at least one SASS/LESS preprocessor. For JavaScript, knowledge of the version of EcmaScript6, its libraries and frameworks is a minimum requirement. Particularly useful is the ability to work with React, Vue, Angular, jQuery, Foundation, Bootstrap, Material and Ajax technology.

In addition, basic skills, in our opinion, can include data handling skills based on the use of XML and JSON — simple text-based ways to store and transfer structured data, which allows linking arrays and objects, creating complex data structures. Many modern programming languages have functions and libraries for reading and creating XML and JSON structures, as they are extensively used in the integration of different information systems.

Basic skills can also include the ability to solve current development problems and skills related to the ability to test the resulting product.

However, we believe that basic skills include not only knowledge and ability to apply markup and programming languages, but also understanding and competent application of basic development principles and approaches.

In particular, understanding the principles of the Model-View-Controller (MVC) model, a design pattern that greatly saves time and simplifies development by separating the application into three different layers. Many high-level frameworks such as Laravel, Angular are based on MVC patterns, where the model is associated with the interaction with the database, the view is responsible for everything the user sees on the screen, and the controller provides the interface between the model and the view. Learning MVC makes it easy to understand the basics for any programming language. It may also be of interest to study other models — e. g. Model-View-Template (MVT), close to MVC (Django framework), Model-View-Presenter (MVP), Model-View-View (MVV), understanding the features and selection criteria.

It is important to give an understanding of current approaches being developed by IT industry giants such as Google (<https://material.io/design/>), “accelerated mobile pages” (<https://www.ampproject.org/>) and PWA technology or a similar technology called “turbo-pages” (<https://tech.yandex.ru/turbo/>) to improve user experience.

That is, in our opinion, it is crucial not only to teach how to use these or those tools, but also to give an understanding of industry trends and basic elements of the web developer’s philosophy.

3.2. Web programming skills

Web programming skills are probably the thing that largely determines the professionalism and future employability of a future developer. It should be noted that there are several types of developers.

A Front-End web-developer — a specialist in the development of user interface and layout templates, that is, the external representation of the project.

A Back-End web developer is a specialist in developing server-side logic, with an understanding of the context in which it will be executed. Such a developer must be proficient in at least one of the programming languages PHP, Java, Python, ASP.NET technology and be ready to actively learn and apply other technologies. He or she is also required to know APIs and understand the principles of servers.

A good knowledge of database theory, understanding of the relational data model, knowledge of SQL language, understanding of database scaling principles, a good command of at least one of the popular database management systems — MySQL, Microsoft SQL Server, PostgreSQL, SQLite, etc., as well as MongoDB as one of the classic examples of NoSQL-systems, which uses JSON-like documents and database schema and is actively used in web-development, in particular within the framework of JavaScript-oriented MEAN stack. In addition, a working knowledge of and ability to use in-memory database management (Redis, Memcached) and web storage for storing sessions, cookies and caches in the browser are not excessive.

In addition to this, he/she should be familiar with the principles of network information security.

Nowadays, there are also widespread vacancies for Full-stack developer — a specialist who is ready to cover the entire development stack of a web resource, which is due to many reasons, including the emergence and popularity of microservices development architecture application [16].

When teaching programming, it would be useful to pay attention to the application of technologies related to the implementation of integration of corporate information systems into the web space, development and use of widgets and web services (e. g. Google Maps or Yandex.Maps).

Application programming interface (API) is an application interface that serves to enable communication with other applications. An API provides a set of functions available to other applications through which they can interact with a service. Almost every major service has an API that is open to the user. Today REST API is widely used by websites, services, mobile applications, so it’s important to know how to work with it, because sooner or later there will be a need to create a client (e. g. mobile application for a website).

Also of interest would be experience in developing chat-bots, which are now being actively implemented in various Web-services.

In [17] it is pointed out that there are two paths among the current trends in web-development. The first is simplification and orientation towards mobile devices, whose Internet traffic has already exceeded that of desktop devices, and the second is the introduction of relatively new, but considered very promising in this area, virtual, augmented and mixed reality (VR and AR) and 3D technologies. Accordingly, in our opinion, it would be useful to pay attention to teaching modern tools and development of artifacts of these technologies in an educational programme designed to train competent specialists for the long term. Every year there are more and more tools that facilitate the creation of such products. Some related technologies and tools can be learned more about, for example, at resources [18].

This requires the inclusion of large modules such as “Web Programming Technologies” (or a set of individual disciplines specifying which language is studied, e. g. “Programming in PHP” etc.), “Databases” and individual disciplines such as “Secure Programming”, “Web Interoperability Architecture”, “Advanced Web Development Technologies” or similar in the educational standard.

3.3. Web design skills

Many web studios place serious demands on the knowledge and skills associated with web design and computer graphics for potential employees. This is especially true of front-end developers, although others are no exception.

Trends in recent years [17] suggest that this issue cannot be overlooked in a good educational standard aimed at training web developers. What is required?

Firstly, knowledge and understanding of current trends in the industry. Understanding of the basic principles of visual design, UI and UX.

Secondly, skills in working with computer graphics — creating, processing and converting bitmap and vector images, including various formats, such as SVG. This requires mastering the basic principles of computer graphics and popular software for working with it. For example, Adobe (Photoshop, Illustrator, XD) and/or Corel (Graphics Suite, PaintShop Pro), Figma or Scetch, InVision Studio, GIMP, Inkspace or others.

3.4. Skills in leading and managing development

The issues of development management and governance are multifaceted and wide-ranging. Within the scope of this article, we will focus on some of them, while emphasizing that this list may be supplemented further.

One of the mandatory requirements of employers in almost any field of information systems development is an understanding of modern principles of software product development, including teamwork, and the ability to work with Version Control System. This requires the obligatory inclusion of skills in working with such tools into the educational programs. For ex-

ample, one of the most popular systems used in many organisations is Git.

In the professional standard “Web and Multimedia Application Developer” [8], a part of the work activities is related to knowledge and skills in managing processes and projects to create and modify information resources, as well as integration of web resources with various external and internal corporate services, as we mentioned earlier. This implies the necessity of introducing such academic disciplines as Information Resource Design and Web-integration of Information Systems. The discipline “Project Management”, that, however, has now become a universal subject, studied by almost all students, regardless of their field of study, may also be of great use and importance in the context under consideration. However, it would be useful to focus on IT project management within this course, taking into account its specifics, studying currently popular concepts, methodologies and approaches to software product development projects, in particular, Agile, SCRUM, Continuous delivery, DevOps, etc.

The job functions related to identifying customer requirements imply a good command of business process analysis skills. For example, describing business processes using SADT, UML and other types of diagrams and finding opportunities to optimise business processes. However, it is not enough to just find them, you need to suggest and explain the need for them to the customer. Academic disciplines such as Typology and Analysis of Business Processes, Reengineering and Optimisation of Business Processes or similar can provide such skills. This also correlates with the above.

According to the data cited in [19], a significant number of web development is done remotely. Regional studios can actively attract clients from large cities, at the expense of cheaper, but no less qualitative services. This determines the need to master the skills of remote teamwork tools (including full-spectrum customer communication and team development tools).

To this point, we can also refer skills in working with content management systems (CMS). CMSs often greatly simplify development by providing an almost finished website, unless we are talking about creating a unique product. The ability to deploy a CMS, use or create design templates for it, organize interaction with users [17], conduct initial content filling or full site administration based on CMS is also necessary for a learning web developer. This requires learning at least one CMS, such as WordPress or Joomla.

To conclude this point, a future professional should have the knowledge and skills to maintain, scale, migrate and deploy code across different platforms competently.

3.5. Web promotion skills

In our opinion, these skills are not of primary importance and can be acquired later in the course of practical activity. However, their availability and quality may be an additional positive factor in the employer’s hiring decisions.

These include SEO optimisation skills and, preferably, an understanding of the basics of Digital Marketing and Social Media and the application of technologies that personalise content [20].

3.6. Universal skills

The professional standard [8] places quite a strong emphasis on the skills related to customer relations at different stages (identifying customer requirements, handling customer enquiries, negotiating, etc.), in other words, communication planning skills with the customer. Speaking, negotiation and presentation skills are also required.

The rest of the skills described above can be acquired and developed within the subjects or modules of Business Communication (“Business Ethics” or similar), “Speech Culture”, “Psychology of Business Communication”, “IT-Consulting”.

Among the important personal skills that need to be formed, one can emphasize the ability to adequately perceive criticism, acknowledge mistakes and correct them, as well as the ability to properly decompose tasks, plan time and meet deadlines (i. e. well-formed time management, self-organization) and some others [21].

In addition, a web-development specialist may need developed universal competences of modern digital economy, as we have already mentioned in [2].

4. Conclusions

To summarise, it can be noted that in this material we have highlighted a wide range of what we believe to be the most needed knowledge, skills and competencies that need to be included in existing and prospective educational programmes or standards in web-development.

Learning should be based on the application of skill-oriented educational technologies. The study of information system design and development technologies, web technologies, and programming languages should be based on real-world projects. The solution of practical tasks allows each learner to shape his or her future workspace.

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