The use of real technical tasks for the implementation of websites for the formation of professional skills of web developers

V Glagolev, R Bazhenov, G Kuldyshева, I Ledovskikh and V Maximov

1 Sholom-Aleichem Priamursky State University, 70a, Shirokaya st., Birobidzhan, 679015, Russia
2 Osh State University, 331, Lenin st., Osh, 723500, Kyrgyz Republic
3 Pacific National University, 136, Tihookeanskaya st., Khabarovsk, 680035, Russia
4 North-Eastern Federal University, 58, Belinsky st., Yakutsk, 677000, Russia

E-mail: glagolev-jar@yandex.ru

Abstract. The paper deals with the problem of the formation of professional skills in web development. The task is solved through the use of real technical tasks for the implementation of websites in teaching, the inclusion in the curriculum of the educational program of the disciplines "Methods and tools for designing information systems", "Programming network databases" and "Web programming". The developed methodology was tested at Sholom-Aleichem Priamursky State University, Osh State University, Pacific National University and North-Eastern Federal University during the 2019-2020 and 2020-2021 academic years. 42 students of the direction "Information systems and technologies" took part in the training. The content of the disciplines included obligatory project team work on an assignment from an industrial partner. An important element of preparation was the final exam conducted in the format used in WorldSkills championships. The developed websites were assessed by independent qualified third-party experts in the following areas: work organization and management, communication and interpersonal skills, design and layout, server and client-side programming, database and web portal design. As a result, 74% of students implemented the web portal and submitted the project on time. As a result of passing disciplines and implementing web portals, students studied the principles of rapid development of web systems, received professional competencies and interaction with real organizations.

1. Introduction

Modern companies cannot exist without a presence on the Internet, the basis of which is a website. In most cases, for smooth operation, not a simple display of information is required, but a full-fledged web-oriented information system (web portal). The training of specialists capable of ensuring the development and maintenance of an efficient web portal is an urgent task, and the formation of professional skills in the development of websites for students studying in IT areas is an urgent problem. As the practice of training shows, it is necessary to maintain the correct balance of academic and practical orientation. For example, Connolly identified a significant mismatch between the type of web development that is typically taught at university and web development in industry practice [1].

The development of a web-oriented information system is the result of data analysis, development and support of the work of the customer's organization [2]. When developing software products, it is necessary to be guided by the work plan, the use of a large number of tools, knowledge of the basics of web programming [3, 4], and the terms of reference of existing customer organizations. The idea of
introducing practice-oriented tasks for the development of websites into the training of IT students is not new, for example, in [5] it is shown how the practical participation of students forms professional competencies for future employment. It is required not only to use practice-oriented tasks, but to change the content of training and teaching methods.

When developing the content, it is necessary to refer to the experience of good web programming practice and teaching. The general principles of object-oriented programming make it possible to use modern web frameworks, for example, Yii2 with the concept of model-controller-view (MCV), in the development of websites, to involve database management systems and attribute queries implemented in the framework controllers and track the speed of their work and the impact on the performance of the web portal. When creating a website, Rapid Application Development (RAD) technology is used, especially in the context of operational development and passing testing in a short, compressed period of time [6]. When implementing a software product, students must adhere to strict rules for documenting software code, depending on their role in the development group [7; 8]. Web programming is the basis for the consistent development and maintenance of a client application to automate the activities of external users and employees of organizations [9]. The work [10] proposes a layout, design and structure of the sequence of development of web applications, the training of which can be presented in interactive, classroom or mixed formats. Project-based learning is shown in [11] as the main active learning strategy. Optimization of the design of assignments for a course on web programming with a lack of classroom hours is considered [12]. It is proposed to build training in web programming based on tasks to improve a real web application [2]. The article [13] presents the experience of industrialization of the project in the course of developing web applications.

The aim of the study is to develop the content of an educational program for the formation of professional skills of web developers based on the use of real technical tasks for the implementation of websites in teaching.

2. Materials and methods

The experiment was conducted during the 2019-2020 and 2020-2021 academic years at Sholom-Aleichem Priamursky State University, Osh State University, Pacific National University, and North-Eastern Federal University. 42 students of the third and fourth courses of the direction "Information systems and technologies" took part in the training.

The study used Project-based learning [14], the technology of changing the content of the discipline [15], the survey method [16]. Polls were created in google-forms, the results were processed using MS Excel.

It was decided to add the disciplines "Methods and tools for designing information systems", "Programming of network databases" and "Web programming" to the curricula of educational programs for preparing students. Practice-oriented tasks from industrial partners have been introduced into the content of the proposed disciplines. The training involved teamwork on the project.

The main tools for teaching web development were Apache web server, MySQL and MariyDB database management systems, PHP7 programming language, Yii2 framework, Composer and Docker program repositories, Zeal instructions [17].

To control the level of formation of professional skills, a final comprehensive exam was used, in which it was required to develop a web portal for a technical assignment from a company - an industrial partner of the university. The technology was the same as at the WorldSkills championships. The exam was carried out over two days for six hours with one hour breaks. Student papers were evaluated by three independent information technology experts. The assessment was carried out in the following areas: work organization and management, communication and interpersonal skills, design and layout, server and client side programming, database and web portal design.

3. Results and Discussion

According to the authors, the development of web portals should be studied at the university sequentially, with the complication of the level of practical tasks and requirements for the design of
the material from the analysis of the subject area to practical implementation. The development process covers all stages of the software product life cycle: domain analysis, design, development and maintenance. Training in the implementation of a website, according to the authors, needs to be built on the basis of basic disciplines in the curriculum [18-20]: Methods and tools for designing information systems; Network database programming; Web programming.

When studying the discipline "Methods and tools for designing information systems" customers are small businesses (industrial partners of the university), whose representatives formulate the task in the form of a short description.

Next, students work, they describe the problem of automating data processing in the selected department (a list of tasks to be solved, interconnection, information links with others, input, output and information stored in the department). The final formulation provides the rationale for solving the automation problem in a particular department. As a justification, arguments can be put forward: lack or lack of automation, outdated web portal for data processing or its absence. It is also necessary to indicate in full the purpose of the web portal: the place and purpose of the portal, its purpose; requirements for the timing of the implementation of the portal; filling in the data and methods of processing them; consumers of attributive and visual information, methods of its formation; integration of the web portal with online services.

Based on the description of the task, together with the customer, a technical task is formed for the development of a web portal. This document contains a description of all forms of submission and filling, a sequential description of all actions on the portal, control of data input and output, the amount of data and the planned workload of the web portal. The description of the work is performed by means of CASE-technologies.

When forming the technical task, the expected effect of the developed web portal is given: what functions will be automated; what documents will be available to the user; what are the expected results. The task is carried out with modern means of Rational Rose, Microsoft Visio. The expected results can be a reduction in the time of registration and data search by various filters, data processing and their operational multidimensional presentation, online chats, interaction with portal users, support for mobile access to the portal on devices running Android and IOS [21-22].

When studying the discipline "Programming network databases", students are offered to solve a real problem from an industrial partner, in which it is required to develop a conceptual model of a database, a list of thematic queries and forms of their display, to describe options for interaction and data accumulation. The task is transferred to students in the form of a technical task.

The experience of good web programming practice and participation in competitions, hackathons have shown that the choice of a relational data structure is due to the requirements for professional competencies in the IT field, knowledge of database migration technology and the means of modern frameworks Yii2, Laveral, NodeJS.

Designing and implementing the database structure includes preliminary preparation in MySQL / MariyDB and the creation of a script for its migration. Migration allows you to control the version of the database, as well as connect the version control services Github, Bitbucker to the implementation of the web portal. Services assign roles to each student in the team, which serve as a designer, designer, developer, and tester. Migrations are created according to the requirements of the framework in the programming language, in the case of using Yii2 scripts in PHP version 7. Testing the connection to the database is carried out using standard means of the Yii2 GII interface. The MVC model creates models, controllers, and form views for all tables in the database, and tests the streaming populations of the tables.

The formation of professional skills of web developers continues with the implementation of practice-oriented tasks in the discipline "Web programming". For example, Notepad ++, JetBrains PhpStorm 2020 and Netbeans IDE 8.2 are used to develop the skill of loading and editing a web portal, which support the GIT version control protocol. Deployment and management of modules is carried out using the basic and extended versions of the Yii2 framework, the Composer and Docker container packages. The visual display of web pages and checking them for errors in the browser is
examined through developer mode and the Postman plugin. Web portal security mechanisms are implemented by Yii2 modules using the user and rbac extensions, additionally connecting JSON and RESTful. The appearance of the web portal is set by the BootStrap and Materialize CSS frameworks.

The final control of the level of formation of professional skills in web programming was an exam in the WorldSkills format. Students need to design and develop a web portal for a technical assignment from a company using the Yii2 framework in the PHP7 programming language. The assessment was carried out in the WorldSkills format by three experts in positions: work organization and management, communication and interpersonal skills, design and layout, server and client side programming, database and web portal design.

The pedagogical experiment was carried out during the 2019-2020 and 2020-2021 academic years, 42 students of the "Information Systems and Technologies" direction participated in it. To conduct exams during the experiment, 14 organizations provided technical specifications for the automation of their activities. As a result, 14 development teams were formed with two to three people. The final grade was normalized to one hundred points on a scale: low (up to 33 points), medium (34-66 points) and high levels (more than 67 points). The results of assessing the formation of professional skills among students are presented in table 1.

| Skill categories                        | Completed the task, % |
|-----------------------------------------|-----------------------|
| Organization of work and management     | 74                    |
| Communication and interpersonal skills  | 72                    |
| Design and layout                       | 66                    |
| Server and client side programming      | 76                    |
| Database and web portal design          | 82                    |

As a result, on average 74% of students completed the assigned tasks. At the end of the exam, several teams received job offers from IT experts.

A survey of students after the exam showed that the majority (78%) positively assess their professional skills in web programming, consider themselves ready (71%) to get a job as a web developer, the exam format, similar to WorldSkills, is acceptable (83%).

4. Conclusion
Thus, the practical interaction of students with representatives of organizations for the coordination of technical specifications and the rapid development of web portals show the importance of professional competencies in the field of web programming. Inclusion in educational programs of the disciplines "Methods and tools for designing information systems", "Programming network databases", "Web programming" allows you to build a trajectory for training web developers. The use of real assignments from customers-companies in the content of courses, teamwork and the conduct of the final exam in a format similar to WorldSkills forms students' professional skills. Planning activities, defining development and design tools, working in a team, making agreed decisions, presenting results determine the key points of learning and consolidation of knowledge.

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