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## **WEB RESOURCE FOR STUDYING THE ARDUINO PLATFORM FOR SOFTWARE ENGINEERS IN HIGHER EDUCATION OF UKRAINE**

**Abstract.** The process of studying in higher education institutions is transformed from the system of knowledge transfer to the system of their independent acquisition by students, the search for solutions to problems through research activities, inherent models of studying the Master's degree level. The development of future software engineers' professional competencies in the context of a modern university has the following contradictions: insufficient consideration of demands of the specialization according to which training of masters in specialties 121 "Computer Sciences" and 122 "Software Engineering" is conducted, in the content of academic disciplines; implementation of only a general development function in the process of teaching these disciplines is carried out, while improving the skills of designing and developing software products in the training of future IT specialists remains a secondary task; the motivation for the research and creative activity of students undergoing training within the framework of the Master's program is not clearly identified. The article is devoted to the design of an educational Web resource for the study of the platform for Arduino's amateur constructing as a computer tool for the professional competence formation of 121 "Computer Sciences", 122 "Software Engineering" specialties students. The modeling of this web-resource is focused on systematization of knowledge and development of practical design skills in the Arduino hardware computing platform in the study of "Quality Management of Electronic Educational Resources" and "Information Technology Management" Master's courses. In the process of course design, students determine the purpose and objectives of learning through electronic educational resources, analyze existing analogues of Arduino study sites, identify major requirements groups, design information architecture, present a chart of precedents for roles specific to an educational website. The application of this topic into the educational process of the Kherson State University is aimed at the development of professional competences for future programmers through the active introduction of new educational technologies, the use of opportunities for the information space, and the partnership between teachers and students.

**Keywords:** Arduino Platform; Educational Web Resource; Software Engineer; Digital Competency

**Problem statement.** Information technologies have become essential components of the development of a modern educational environment at all its levels - from student to management of educational institution and educational system. This is due to the fact that the priority task of education in the training of specialists and scientists who are competitive in the modern labor market is the ability to operate with such technologies and knowledge that can meet the needs of the information society and are able to prepare for the implementation of complex tasks in the future. It is not just about the ability to apply the acquired knowledge, but also to be prepared to change and adapt to the new needs of the labor market, to manage information in the educational and scientific spheres, to actively act, to study throughout life.

In the context of reforming education, the model of higher education changes, as well as the role of the teacher as a participant in the educational process. The process of studying in higher education institutions is transformed from the system of knowledge transfer to the system of their independent acquisition by students, the search for solutions to problems through research activities, inherent models of studying the level of higher education "master". A student of a master's program in the process of learning is gradually becoming the manager of his future. But the development process of such a person requires constant updating of knowledge and self-improvement of the teacher himself. That is why the electronic educational resources, which are an integral part of the educational process, are actively used in the training of students of the "master" higher education level.

**Analysis of recent research and publications.** In order to ensure the quality of education for obtaining an educational degree, the master's degree in specialties 121 "Computer Sciences" and 122 "Software Engineering" must take into account the peculiarities of vocational training of the second (master's) higher education level and the selection of innovative technologies for conducting studies on the basis of personality-activity, competence and system-based approach. As O. Spivakovsky points out, today in most higher education institutions traditional approaches to the organization of vocational education are used, in which the student feels as the object of pedagogical influences that does not require his initiative, creativity, activation of reflection, does not contribute to solve these problems and does not provide proper level of education, scientific and professionalism (Spivakovsky, 2010, pp. 8-24). Creation of pedagogical conditions, namely, the partnership activities of the teacher and the student, introduction of web technologies, interactive forms and methods of work, optimization of the educational process for the formation of professionally important qualities, provision of motivation to the students for research and creative activity in the final result lead to the achievement of the goal - the development of professional competence of program engineers with the level of higher education "Master".

The use of modern web technologies enables to significantly expand the tools of higher education system, in particular through the use of electronic educational resources.

H. Stetsenko gives the following definition of educational Web resources: "These are educational digital resources located in the web space of a local or global network in the form of various formats (text, graphics, archival, audio and video formats)" (Stetsenko, 2010, pp. 8-16).

Educational web resources include electronic learning tools, which are the basis for the use of web technologies. Scientists R. Hurevych, M. Kademiia, M. Koziar (Hurevych, 2012, pp.26-37), M. Shyshkina, M. Popel (Shyshkina, 2016, pp.149-152), H. Tkachuk (Tkachuk, 2011, pp.38-44), T. Zaytseva (Zaytseva, 2016, pp.688-690), M. Sherman (Sherman, 2019, pp.122-126), O. Spivakovsky, N. Kushnir (Spivakovsky, 2017, pp.177-184), M. Vinnyk (Samchynska, 2014, pp. 535-538) are defined as information technologies, the use of which enables the processing and use of web resources (text, graphics, audio, video), connected by hypertext links and computer networks hosted in the web space (local or global).

H. Tkachuk pointed out the peculiarities of the operation of web technologies: the technical basis - local and global networks (such as the Internet); the organization of web resources in the network is carried out using hypertext technology; browsing web resources is done with the help of a bug viewer; use of search systems for web resources; an unlimited number of users who can download and browse web resources (Tkachuk, 2011, pp.40-42).

R. Hurevych, M. Kademiia, M. Koziar classified educational web resources for the purpose of application in the following way: for the independent work of students or pupils; in order to prepare the teacher for classes; for self-education of a teacher; with the purpose of organizing practical work in class; for the organization of extra-curricular work on subject (Hurevych, 2012, pp.34-52). At the same time, the researchers identified the following forms of conducting classes in universities with the use of webresources: presentation, research,

virtual experiment, laboratory work, thematic project, electronic quiz, knowledge control, elective course, network project, individual training, consultations, network game, virtual tour, press conference, creative report, remote olympiads, telecommunication projects, web quests, etc. To improve the skills of the teacher, the researchers pointed out the following forms: work in network methodological associations, virtual pedagogical meetings, distance learning, participation in network projects, web quests.

L. Raitskaya attribute the attractiveness of Internet technologies for the education sector to the fact that they create an environment that promotes the development of students' creative abilities by stimulating curiosity, irregularity and multivariate learning, the formation and development of a divergent (non-stereotyped) thinking, growth of motivation (Raitskaya, 2011, pp. 86-110).

In the computerization of higher education institutions, the use of electronic resources, in particular sites for educational purposes, electronic textbooks, video collections, is aimed at increasing the level of students' professional training.

However, the following main contradictions are inherent in the development of the professional competencies of future programmers-engineers who acquire a "master's" degree in a modern university:

- insufficient consideration of the content of the educational disciplines "Management of electronic educational resources quality" and "Information technologies governance" in the direction of training of future masters in specialties 121 "Computer sciences" and 122 "Software engineering";
- realization in the process of teaching these disciplines only a general development function, while improving the skills of designing and developing software products in the training of future IT professionals remains a secondary task;
- the motivation for research and creative activities of students undergoing master's degree programs is not clearly identified.

In our opinion, solution of the above-mentioned contradictions is possible, provided that the system of knowledge creation and the development of practical skills for designing web resources in the Arduino hardware computing platform during the study of the subjects of "Electronic Education Resources Quality Management" and "Information Technologies Governance" disciplines is developed.

**Unresolved aspects of the problem.** The current state of computer-information training of students of specialties 121 "Computer Sciences and 122 "Software Engineering" does not fully meet the requirements of their future scientific and professional activities. Despite a large number of scientific publications and publications that cover the use of electronic educational resources in studying, the development of educational web resources aimed to improve the quality of students' professional training in computer specialties and students-programmers who acquire a higher education level "Master" is not sufficiently solved.

**The aim of our study is** using electronic educational resources as an example of designing a website for studying the Arduino platform as a means for the formation and development of digital competence of future masters in specialties 121 "Computer Sciences" and 122 "Software Engineering".

**Research results.** According to the curriculum of the discipline "Quality Management of Electronic Educational Resources", which is taught at the Kherson State University, students of the Master's program acquire knowledge and practical skills of working with Arduino, a hardware computing platform for amateur design. The main components of the platform are the microcontroller board with I / O elements and the Processing / Wiring development environment in the programming language, which is a subset of C / C ++. Arduino manages sensors, motors, lighting, transmits and receives data and acts as an important software and hardware tool in the world of robotics (11).

Topic "Designing and simulating a web resource for training purposes for the study of the Arduino platform", which is taught within the framework of the "Information Technologies Governance" course, aims at generalizing theoretical knowledge and developing the practical skills of graduate students in designing in the Arduino software environment. The tasks addressed to students during the study of this topic include:

- search and systematize information on the Arduino platform;
- compile a dictionary of terms and categories related to this software environment;
- find practical tasks that teach how to design in Arduino;
- find or develop tests to check your knowledge of work at Arduino;
- combine the found information and library resources into a single informational system of educational purposes, which will provide operational access to teaching materials for students of distance learning courses or for users who study robotics.

Before designing an educational Web resource, the teacher suggests that students look at similar training Web resources related to the work technology systems, including Arduino, to benchmark them and draw some conclusions. Basically, these sites are aimed at teaching not only children and students but also adults who are interested in robotics (12). The result of such educational activity is shown on the example of research carried out by students of Kherson State University (Table 1).

Table 1.  
A comparative feature of web resources that contains helpdesk information on the Arduino platform

Web resource	Features	Forms of educational materials' presentation	Description of Arduino's functions	Video tutorials	Examples of Arduino usage	Tasks to strengthen knowledge
Edurobots	Convenient navigation. Quick access to the purchase of the required items, a comment block is present	Lectures contain schemes and code	-	+	+	-
Arduino.ru	Convenient navigation, quick search on the site, there is a personal account	Details of how to get started with Arduino	+	-	+	-
habr	There is a personal account and a block of comments	Lectures are based on real life examples of Arduino usage	-	+	+	-
Arduino	There is a personal account, quick site search, convenient navigation	The volume of the theory is small. The site has a list of books to beef up knowledge	-	-	+	-
Arduino.ua	Quick search on the site, easy navigation	The site has step-by-step instructions for installing the program	+	-	-	-

Table 1 provides a comparative overview of the main information resources that describe the Arduino platform:

1. Edurobots;
2. Arduino.ru;
3. habr;
4. Arduino;
5. Arduino.ua.

The following criteria have been chosen to compare Arduino's information resources for educational purpose:

- functional of resource;
- the form of educational materials' presentation;
- description of Arduino functions;
- presence of video tutorials (video lectures);
- the presence of examples of Arduino use,
- the presence of tasks for fixing the strengthening the knowledge.

Magistrates have considered each of the mentioned software products, and in the course of the educational discussion with the teacher concluded that the data resources have both advantages and certain functional disadvantages.

In particular, *Edurobots* is best suited for teaching robotics to children and students. The information web resource contains lectures on necessary material, but there is no list of operators, variables and constants, functions and libraries. The resource provides lecture courses on "Raspberry Pi", "Robotics on VEX IQ" and other interesting materials on robotics.

*Arduino.ru* – the site details how to get started with Arduino, but there are no video tutorials. The lack of opportunity visually, with the help of video tutorials, to consider the methodology of work at Arduino, students attributed to the disadvantages of the educational Web resource. The advantage of the resource is the presence of a complete list of operators, variables, constants and functions.

*Habr* - the basics for the lectures of this web resource have become examples of real life use of Arduino. Students noticed this as an obvious advantage of the resource, because using examples helps the user to know immediately how and where one or the other device can be used.

*Arduino* – this site contains only an introductory lecture on Arduino, followed by a list of books to deepen knowledge. According to students, this demonstrates the very limited possibilities of using this resource for educational purposes.

*Arduino.ua* – the site provides a detailed, step by step instruction for installing Arduino software, as well as a complete list of operators, variables and constants, functions and libraries.

Conclusions made by students as a result of an analysis of the functionality of information resources that contain information about the Arduino platform:

- all reviewed sites has a general drawback - the lack of tasks to strengthen knowledge. In distance learning courses it is the basis for testing knowledge and self-control, eliminating this disadvantage students plan to take into account when designing their own site for educational purposes;
- only 40% of the mentioned sites contain video tutorials.

The Arduino training web resource is designed as a single point of access to resources and services that is an integrative information system connection in which resources such as lectures, tasks for laboratory work, tests, examples of works on Arduino, new Arduino publications, news and additional links to Internet resources.

"Practical" step in creating the undergraduates of the Web resource for the study of Arduino is the design of information architecture, that is, the organization and systematization of all information on the site in a convenient and understandable way. Students split the web

resource into sections with logically based "on paper" titles, and then begin to visualize the architecture, that is, directly before creating a graphical design and convenient navigation.

Students are familiar with the criteria for creating a site:

- clear organizational structure and obtaining the necessary information in the shortest possible way (the rule of "three clicks");
- color scheme of the site should never go beyond the comfort of perceiving the color and be unobtrusive;
- meaningful information content (13).

The information structure of the site developed by students during the study of the discipline "Quality Management of Elementary Educational Resources", includes the following sections:

- lectures;
- laboratory work;
- test tasks;
- dictionary of terms;
- news.

There is a description of the above sections on the main page of the site, which gives user the opportunity to easily navigate them. From the main page, you also have the transition and access to all sections of the site.

The section "Lectures" contains a certain number of units with topics of lecture classes.

The section "Laboratory Works" contains the number of units with topics of laboratory work for each lecture.

Similarly, the section "Test Tasks" contains topics with test tasks. The selection of information sources for the content of the web resource is related to the training materials for familiarizing the Arduino platform.

The "Glossary of Terms" section contains a list of new and obscure categories for each topic.

The "News" section displays information about Arduino's new features and devices that can be built on this platform.

Students are encouraged to use the Google Analytics program to collect statistical information about site visitors and their sections. It is a freeware application-counter for web resource attendance.

The use of the website is designed in three roles:

1. Teacher - has extensive opportunities to work on the site, such as adding educational materials, deleting or editing them, as well as evaluating students, participating in discussion on forums and chats, sending personal statements to the participants of the course.

2. Student - has certain limitations, in particular, he can only review already posted material, participate in discussion in forums and lectures and send out personal messages to other registered users.

3. Guest - is free to review already outlined material.

Fig. 1 provides a precedent diagram illustrating the roles specific to the Arduino study site, compiled by students.

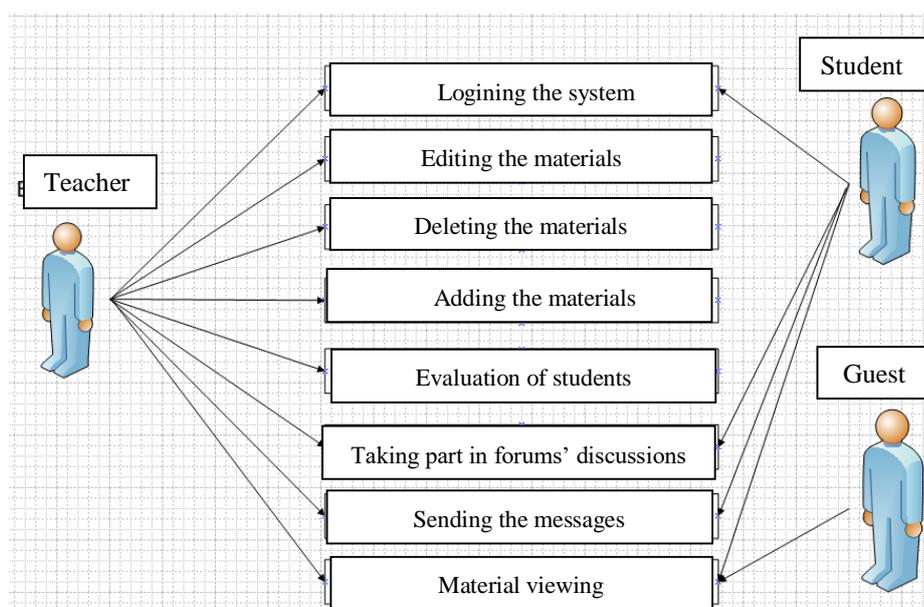


Fig. 1. A diagram of precedents, compiled by students during the design of a website for platform Arduino studying

Thus, the organization of training on the basis of personality-activity, computer-aided approaches, which involves the involvement of masters in solving the tasks of designing and programming of information resources, as well as the creation of conditions for cooperation between the teacher and the student ensures the effective formation of the professionally important qualities of future engineers-programmers and IT professionals.

**Concluding remarks and future work.** The development of professional competencies of future software engineers who acquire master educational degree in the conditions of a modern university has such contradictions as: insufficient consideration in the contents of the educational discipline needs of the direction by which the training of future masters in specialties 121 "Computer Science" and 122 "Software Engineering"; realization in the process of teaching these disciplines only a general development function, while improving the skills of designing and developing software products in the training of future IT specialists remains a secondary task; the motivation for the research and creative activity of students undergoing training within the framework of the Master's program is not clearly identified.

The solution of the above-mentioned contradictions is possible subject to the systematization of knowledge and the development of practical skills in the design of web resources in the study of graduates of the disciplines "Quality Management of Electronic Educational Resources" and "Information Technologies Governance".

As a computer tool for the formation of professional competence of 121 "Computer Science", 122 "Software Engineering" specialty students of the higher education level "Master" is proposed to use the design of an educational web resource for the study of hardware computing platform for the Arduino design.

During the design, students determine the purpose and tasks of learning through the use of electronic educational resources, analyze existing analogs of the Arduino study sites, identify the main requirements groups, design information architecture, and present a precedent diagram on the roles specific to the website for educational purposes. The application of this topic in the educational process of the Kherson State University is aimed at developing the professional competence of future programmers-engineers through the active introduction of new educational technologies, the use of opportunities for the information space, and the partnership between the teacher and the listener.

Further research is required on the features of data storage in the design training web site, database structure, browser supports and mobile devices.

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## ВЕБ-РЕСУРС З ВИВЧЕННЯ ПЛАТФОРМИ ARDUINO ДЛЯ ПРОГРАМНИХ ІНЖЕНЕРІВ У ВИЩІЙ ОСВІТІ УКРАЇНИ

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**Анотація.** Процес навчання в закладах вищої освіти перетворюється з системи передачі знань на систему їх самостійного здобування слухачами, пошук шляхів розв'язання проблем через дослідницьку діяльність, притаманну моделі навчання рівня вищої освіти «магістр». Розвитку професійних компетентностей майбутніх інженерів-програмістів в умовах сучасного університету властиві такі суперечності, як: недостатнє врахування у змісті навчальних дисциплін потреб напряму, за яким здійснюється підготовка магістрів зі спеціальностей 121 «Комп'ютерні науки» та 122 «Інженерія програмного забезпечення»; реалізація у процесі викладання цих дисциплін лише загальнорозвивальної функції, при цьому покращення навичок проектування та розробки програмних продуктів в підготовці майбутніх ІТ-фахівців залишається другорядною задачею; недостатньо чітко виявлена мотивація для науково-дослідницької та творчої діяльності студентів, що проходять навчання в рамках магістерської програми. Стаття присвячена проектуванню освітнього веб-ресурсу з вивчення платформи для аматорського конструювання Arduino як комп'ютерного засобу формування професійної компетентності студентів спеціальності 121 «Комп'ютерні науки», 122 «Інженерія програмного забезпечення». Моделювання даного веб-ресурсу орієнтовано на систематизацію знань та розвиток практичних навичок конструювання в умовах апаратної обчислювальної платформи Arduino при вивченні магістрантами навчальних дисциплін «Управління якістю електронних освітніх ресурсів» та «Управління інформаційними технологіями». В ході проектування студенти визначають мету та задачі навчання за допомогою електронних освітніх ресурсів, аналізують існуючі аналоги сайтів по вивченню Arduino, виділяють основні групи вимог, проектують інформаційну архітектуру, представляють діаграму прецедентів щодо ролей, характерних для веб-сайту навчального призначення. Застосування даної теми у навчально-виховному процесі Херсонського державного університету спрямоване на розвиток професійних компетенцій майбутніх програмістів завдяки активному впровадженню нових освітніх технологій, використанню можливостей інформаційного простору, а також партнерству педагога й слухача.

**Ключові слова:** платформа Arduino; навчальний веб-ресурс; програмний інженер; цифрова компетентність