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DEVELOPMENT OF AN INTERACTIVE TRAINING PACKAGE ON THE DISCIPLINE «DESIGN THINKING» IN THE CONTEXT OF AUTOMATION AND MANAGEMENT

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Abstract
The article discusses the development and implementation of an interactive training complex in the discipline «Design Thinking» in the bachelor's degree program «Automation Systems Engineering». The relevance of the research is due to the active digital transformation of higher education, increased requirements for practice-oriented learning and the need for future graduates in the field of «Electrical Engineering and Automation» to develop not only professional and technical knowledge, but also creative design, analytical and communicative competencies. In the context of automation and increasing complexity of engineering activities, the integration of interactive and digital technologies into the educational process is of particular importance.
The paper uses methods of theoretical analysis of scientific publications, generalization of pedagogical experience, pedagogical observation, student and teacher questionnaires, as well as comparative analysis of learning outcomes. Based on the conducted research, a mixed learning model has been developed that provides for a pedagogically sound combination of online and offline forms of work with students. The practical implementation of the model was carried out using the eXe Learning platform and a specially developed set of interactive tasks focused on the step-by-step development of the methodology of design thinking.
The results of the pilot implementation showed a steady increase in students' involvement in the educational process, an increase in the level of educational motivation, activation of independent cognitive activity and improvement in the quality of learning compared with the traditional teaching format. The data obtained confirm the pedagogical expediency of using interactive technologies in engineering education. Promising areas of further research related to the development of adaptive educational systems, the use of learning analytics and the expansion of the functionality of digital learning complexes have been identified.
Keywords — design thinking, interactive technologies, electronic learning aid, blended learning, learning automation, digital platforms, eXe Learning.

АВТОМАТТАНДЫРУ ЖӘНЕ БАСҚАРУ КОНТЕКСТІНДЕ «ДИЗАЙН-ОЙЛАУ» ПӘНІ БОЙЫНША ИНТЕРАКТИВТІ ОҚЫТУ КЕШЕНІН ӘЗІРЛЕУ

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Абстракт
Мақалада «Автоматтандыру жүйелерінің инженериясы» білім беру бағдарламасы бойынша бакалаврларды даярлау жүйесінде «Дизайн-ойлау» пәні бойынша интерактивті оқыту кешенін әзірлеу және енгізу мәселелері қарастырылады. Зерттеудің өзектілігі жоғары білім берудің белсенді цифрлық трансформациясымен, оқытудың тәжірибеге бағдарлануына қойылатын талаптардың күшеюімен және «Электротехника және автоматтандыру» бағыты бойынша болашақ түлектердің кәсіби-техникалық білімдерін ғана емес, сонымен қатар шығармашылық-жобалық, аналитикалық және коммуникативтік құзыреттіліктерін қалыптастыру қажеттілігімен байланысты. Автоматтандыру және инженерлік қызметтің күрделенуі жағдайында интерактивті және цифрлық технологиялардың білім беру процесіне интеграциясы ерекше маңызға ие.
Жұмыста ғылыми жарияланымдарды теориялық талдау, педагогикалық тәжірибені жалпылау, педагогикалық бақылау, білім алушылар мен оқытушыларға сауалнама жүргізу, сондай-ақ оқу нәтижелерін салыстырмалы талдау әдістері қолданылды. Жүргізілген зерттеу негізінде білім алушылармен онлайн және офлайн жұмыс нысандарының педагогикалық негізделген үйлесімін көздейтін аралас оқыту моделі әзірленді. Модельді практикалық іске асыру eXe Learning платформасын және дизайн-ойлау әдіснамасын кезең-кезеңімен игеруге бағытталған арнайы әзірленген интерактивті тапсырмалар кешенін қолдану арқылы жүзеге асырылады.
Пилоттық енгізу нәтижелері дәстүрлі оқыту форматымен салыстырғанда білім алушылардың оқу процесіне тартылуының тұрақты өсуін, оқу уәждемесінің деңгейін арттыруды, дербес танымдық іс-әрекетті жандандыруды және оқу материалын игеру сапасын жақсартуды көрсетті. Алынған мәліметтер Инженерлік білім беруде интерактивті технологияларды қолданудың педагогикалық орындылығын растайды. Адаптивті білім беру жүйелерін дамытуға, оқыту аналитикасын пайдалануға және цифрлық оқыту кешендерінің функционалдық мүмкіндіктерін кеңейтуге байланысты әрі қарайғы зерттеулердің перспективалық бағыттары айқындалды.
Кілт сөздер — дизайн ойлау, интерактивті технологиялар, электронды оқу құралы, аралас оқыту, оқытуды автоматтандыру, сандық платформалар, eXe Learning.

РАЗРАБОТКА ИНТЕРАКТИВНОГО ОБУЧАЮЩЕГО КОМПЛЕКСА ПО ДИСЦИПЛИНЕ «ДИЗАЙН-МЫШЛЕНИЕ» В КОНТЕКСТЕ АВТОМАТИЗАЦИИ И УПРАВЛЕНИЯ

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Аннотация
В статье рассматриваются вопросы разработки и внедрения интерактивного обучающего комплекса по дисциплине «Дизайн-мышление» в системе подготовки бакалавров по образовательной программе «Инженерия систем автоматизации». Актуальность исследования обусловлена активной цифровой трансформацией высшего образования, усилением требований к практико-ориентированности обучения и необходимостью формирования у будущих выпускников по направлению «Электротехника и автоматизация» не только профессионально-технических знаний, но и креативно-проектных, аналитических и коммуникативных компетенций. В условиях автоматизации и усложнения инженерной деятельности особое значение приобретает интеграция интерактивных и цифровых технологий в образовательный процесс.
В работе использованы методы теоретического анализа научных публикаций, обобщения педагогического опыта, педагогического наблюдения, анкетирования обучающихся и преподавателя, а также сравнительного анализа

результатов обучения. На основе проведённого исследования разработана модель смешанного обучения, предусматривающая педагогически обоснованное сочетание онлайн- и офлайн форм работы с обучающимися. Практическая реализация модели осуществлена с применением платформы eXe Learning и специально разработанного комплекса интерактивных заданий, ориентированных на поэтапное освоение методологии дизайн-мышления.

Результаты пилотного внедрения показали устойчивый рост вовлечённости обучающихся в учебный процесс, повышение уровня учебной мотивации, активизацию самостоятельной познавательной деятельности и улучшение качества усвоения учебного материала по сравнению с традиционным форматом преподавания. Полученные данные подтверждают педагогическую целесообразность использования интерактивных технологий в инженерном образовании. Определены перспективные направления дальнейших исследований, связанные с развитием адаптивных образовательных систем, использованием аналитики обучения и расширением функциональных возможностей цифровых обучающих комплексов.

Ключевые слова — дизайн-мышление, интерактивные технологии, электронное учебное пособие, смешанное обучение, автоматизация обучения, цифровые платформы, eXe Learning.

I. INTRODUCTION

The modern higher education system is undergoing an intensive digital transformation, which leads to a revision of traditional approaches to the organization of the educational process. A deep understanding of the mechanisms of this transformation is crucial to ensure the competitiveness of engineering personnel in the context of industry 4.0. The development of information technology, automation of production and management processes, as well as the growing requirements for the flexibility of professional competencies of specialists necessitate the introduction of new pedagogical models focused on the active participation of students and the practical orientation of learning.

This problem is becoming especially relevant for technical training areas, including educational programs in the field of automation and control. A modern university graduate should possess not only deep technical knowledge, but also developed systems thinking, the ability for interdisciplinary interaction, creative problem solving and project activities. In this regard, the methodology of design thinking is of considerable interest, which has proven to be an effective tool for forming a user-oriented approach to solution development.

At the same time, interactive learning technologies are being actively introduced into educational practice, ensuring increased student engagement, the development of their independence and the formation of sustainable professional skills. However, an analysis of current educational practice shows that the issues of system integration of design thinking and interactive digital tools remain insufficiently developed. The lack of a single methodological framework for the introduction of creative technologies into the rigid structures of engineering education creates a significant barrier that limits the development of students' design competencies. This gap in existing knowledge and methodological support determines the need for this study.

This work aims to fill the identified niche by developing a methodology for integrating interactive technologies into the teaching of the discipline «Design Thinking» and evaluating their effectiveness based on the pilot implementation of an electronic textbook. The article discusses the implementation of the blended learning model and the creation of a specialized training complex on the eXe Learning platform for students of the ISA-23s-1, ISA-23s-2, ISA-23v groups.

The relevance of this study is determined by the need to:

1) improving the effectiveness of teaching the discipline «Design Thinking» to future engineers;

2) integration of interactive digital media into the educational process;

3) developing a methodically based model of blended learning;

4) empirical verification of the effectiveness of the proposed solutions.

The aim of the work is to develop a methodology for integrating interactive technologies into teaching the discipline «Design Thinking» and evaluating their effectiveness based on the pilot implementation of an electronic textbook.

To achieve the goal, the following tasks were set:

1) analyze the theoretical foundations of interactive learning and design thinking;

2) to investigate the existing practice of teaching the course;

3) develop a model for the implementation of interactive technologies;

4) create an electronic training manual;

5) conduct a pilot implementation and evaluate its results.

II. LITERATURE REVIEW

According to E.S. Polat, Doctor of Pedagogical Sciences, interactive technologies are a set of teaching methods and tools that ensure the active participation of students in the learning process through joint activities, information exchange, reflection and decision–making [1].

According to the definition of IDEO founder T. Brown, design thinking is a way to combine analytical and intuitive thinking to create effective user-oriented solutions [2].

In the educational context, design thinking is a technology of project activity that helps students develop the following skills:

1) identification and analysis of user needs;

2) generation of innovative ideas;

3) teamwork and iterative testing of solutions.

Automation of the educational process is the use of software and hardware tools to optimize, manage and control educational activities.

According to A.T. Glukhov, automation of education is one of the key factors in the transition to an intelligent educational environment, where the processes of learning, control and analysis are integrated into a single digital system [3].

The analysis shows that interactive technologies, design thinking and automation of the educational process are interrelated components of modern digital pedagogy:

1) interactive technologies ensure the active involvement of students in educational interaction;

2) design thinking develops creative and design competencies;

3) automation of education creates an infrastructure for effective management and personalization of education.

The combined use of these approaches contributes to the formation of a new model of education based on the principles of flexibility, adaptability and digital interaction.

An analysis of the pedagogical and psychological aspects of interactive learning shows that its effectiveness is based on the active involvement of the student in the learning process. From a pedagogical point of view, interactive methods create conditions for joint search for solutions, exchange of experience and comprehension of acquired knowledge. In this model, the teacher becomes not only a source of information, but also an organizer of educational interaction, who guides, supports and helps to build the logic of reasoning. The student gets the opportunity to learn through action, rather than passive perception of the material, which enhances understanding and promotes more solid assimilation.

The psychological aspect of interactive learning is primarily related to increased motivation and engagement. When a student sees the results of his own participation, he feels in control of the learning process and takes the initiative more confidently. At the same time, the feeling of belonging to a group increases, the level of anxiety decreases, and a willingness to openly express thoughts is formed. The dialogical form of work develops communication skills, and the constant need to evaluate one's own decisions contributes to the formation of reflection and critical thinking.

Interactive learning combines a pedagogical focus on cooperation and psychological support for an active, motivated student position. This allows you to build the educational process in such a way that it is both meaningful, emotionally intense and developing.

As part of the preparation of the study, a systematic search was carried out for scientific articles, monographs and dissertations dealing with the application of interactive technologies and design thinking in the educational process, including the fields of automation and control. The analysis made it possible to identify the main approaches and conclusions relevant to the topic under consideration.

The analysis of scientific literature [4-9] shows:

1) interactive technologies in universities provide tangible educational benefits: increased motivation, engagement, critical thinking, and self-organization skills;

2) the methodology of design thinking, when it is introduced into educational programs, becomes not just a theoretical construct, but part of the practical formation of creativity, flexibility, and project thinking skills among future specialists;

3) the combination of design thinking and digital/interactive platforms looks promising, as it allows adapting educational programs to modern requirements, stimulating students' independence and improving their technological literacy;

4) in conditions of mass education and with the growing role of technology, automation of some processes is possible (for example, job evaluation, support through AI), but research shows that it is not

yet possible to completely replace a live teacher, especially when it comes to creative, contextual tasks;

5) there is no «universal recipe», despite many successful examples, even in one discipline, effectiveness strongly depends on the context (technical equipment, teacher training, student motivation, learning culture);

6) in a number of works, approaches have not yet been systematically worked out, a traditionally constructive approach is often used, and the role of digital/automated elements is minimal, which reduces the portability of these models to courses with a technical bias;

7) in studies where AI is used for evaluation or support, difficulties are noted in assessing "human" qualities: empathy, innovation, contextual thinking.

III. MATERIALS AND METHODS

The discipline «Design Thinking» in the educational program 6B07106 «Automation Systems Engineering» is aimed at developing the competence to select optimal engineering solutions based on the analysis of user needs.

The purpose of studying the discipline is to develop creative thinking, the ability to innovate and solve problems taking into account human needs.

The structure of the discipline includes:

1) lecture material (stages of design thinking, tools, business modeling);

2) practical work (problem identification, idea generation, prototyping, etc.);

3) final term paper.

As part of the educational program 6B07106 «Automation Systems Engineering», this discipline enhances the interdisciplinary nature of training, ensuring the integration of technical knowledge with methods of creative solution search, prototyping and testing. This helps students develop practice-oriented thinking and flexibility in developing automation systems.

The analysis showed that the applied teaching methods are quite diverse (brainstorming, SCAMPER, teamwork), but their digital support and system interactivity are used to a limited extent.

The study revealed the key limitations of the traditional format.:

1) insufficient activity of students;

2) limited practical focus;

3) weak digital integration;

4) uneven student engagement;

5) insufficient support for independent work.

These factors necessitated the development of a new learning model.

The development of a methodology for integrating interactive tools into the teaching process of the Design Thinking course requires taking into account both the specifics of the subject itself and the needs of students for a high degree of engagement, creative activity and practical orientation of learning. The inclusion of interactive tools involves a combination of digital platforms, team techniques, creative techniques, and practical tasks that provide a dynamic and flexible educational environment.

The key principle of developing such a methodology is the transition from an explanatory and illustrative format to activity-based learning, where students participate in mini-research projects, solve real or simulated tasks, and interact with each other in flexible group structures.

The proposed model is based on the following principles:

1) an activity-based approach;

2) blended learning;

3) digital support for all stages of design thinking;

4) a combination of individual and team work;

5) continuous feedback.

The model assumes a rational distribution of learning activity between online and offline environments. The online component is focused on the preliminary development of theoretical material and individual work of students and includes theoretical modules, interactive tasks, self-test tools, work with digital whiteboards and testing. The face-to-face component is aimed at developing practical and communication skills and is implemented through brainstorming, team prototyping, collective discussions and defense of developed solutions.

To develop interactive tasks in the form of an electronic textbook, the eXe Learning platform was chosen, which is a freely distributed tool for creating electronic educational resources without the need for programming skills. It allows you to create structured modules that include text blocks, multimedia content, interactive elements, and built-in assessment tools.

The following interactive elements were used to create an electronic training manual for the «Design Thinking» course on the eXe Learning platform:

1) in the theoretical material:

- the «Accordion» effect – prefabricated content panels for presenting information in a limited space;

- the «Tab» effect – a simple content area with multiple panels;

- the «Page numbering» effect – splitting the content into different pages;

- the «Definition» hint – when you hover the cursor over the word pinned in the hint, a window pops up with the definition of the term;

2) in section assignments:

- a cloze assignment is a task in which you need to type the missing word in the appropriate window;

- in closed form (one correct) – a test task in which it is necessary to select one answer as correct;

- a drop–down activity – a task in the form of a text with gaps with a drop-down list of options;

- a dump list - randomly shuffled statements that need to be placed in the correct order.

This structure ensures a gradual transition from studying the material to its practical application.

IV. RESULTS AND DISCUSSION

Defining criteria for evaluating the effectiveness of implementing interactive tools in teaching the Design Thinking course requires an integrated approach that takes into account both learning outcomes and the level of student engagement, the quality of interaction, and the degree of practical applicability of the acquired skills.

To assess the implementation, groups of indicators were identified:

1) learning outcomes: understanding the stages of design thinking, quality of prototypes, reasoning solutions;

2) behavioral indicators: activity in classes, participation in discussions, initiative;

3) communication indicators: teamwork, quality of interaction, ability to make joint decisions;

4) subjective indicators: student satisfaction, convenience of the platform, perceived usefulness.

The pilot implementation was carried out on the ISA-23s-1, ISA-23s-2, ISA-23v groups (21 respondents). During the experiment, empirical data was collected using the following methods:

1) pedagogical supervision of the activity and involvement of students in the classroom;

2) a survey of students in order to assess the convenience, clarity and educational value of the electronic manual.

Table 1 provides general information about the respondents.

Table 1 – Summary profile of the study participants [10]

Parameter	Category	Number (people)	Share (%)
Digital technology proficiency level	Elementary	1	4,8
	Average	17	80,9
	Advanced	3	14,3
Frequency of course usage	Rarely	8	38,1
	Periodically	10	47,6
	Regularly	3	14,3

A qualitative analysis of the open responses made it possible to refine the results of the quantitative assessment and identify the key advantages and problem areas of using the interactive electronic manual [10].

In the block with open questions, students highlighted the advantages and disadvantages of this manual, and also made their suggestions for its improvement [10]:

1) analysis of the advantages:

– methodological value: convenient structure, visibility and the possibility of immediate practical testing of the theory;

– psychological and pedagogical aspects: increased motivation, development of autonomous work skills and the possibility of learning at an individual pace;

– technological factor: the availability of quick feedback on tasks;

2) disadvantage analysis:

– technical barrier: lack of adaptive mobile version and dependence on internet connection quality;

– dialogue deficit: there is an internal contradiction in the answers, in the presence of automated feedback, students acutely feel the lack of prompt "live" help from the teacher and advice on complex issues.;

– cognitive barriers: uneven complexity of tasks and insufficient explanations for certain highly specialized topics;

3) suggestions for improvement:

– optimization of the interface for smartphones and tablets;

– implementation of a multi–level complexity system (differentiated approach);

- integration of a communication module for direct communication with the teacher within the environment.

To assess the effectiveness of the implementation, a comparison of learning outcomes in the traditional format and in the format using an interactive learning package was carried out. A comparative analysis

showed a positive trend in learning outcomes and a higher level of student engagement when using interactive technologies compared to traditional teaching methods.

The results of the pilot implementation confirmed the expediency of using an electronic textbook in teaching the course "Design Thinking" and its potential to improve the quality of teaching in the field of automation and control.

V. CONCLUSION

In the course of the research, the scientific and practical task of developing and testing an interactive training complex in the discipline «Design Thinking» for training specialists in the field of automation and control was solved.

The results obtained allow us to draw the following conclusions:

1) the integration of interactive technologies into the teaching of the discipline contributes to a significant increase in the involvement of students and their learning activity, the transition from an explanatory and illustrative model to an activity-based one ensures deeper learning of the material and the formation of practical skills;

2) the use of design thinking methodology in combination with digital tools effectively develops user-oriented thinking, creativity and teamwork among future engineers;

3) the developed model of blended learning has shown high pedagogical effectiveness due to the rational distribution of activity between the online and offline environment;

4) the use of the eXe Learning platform has confirmed its technological and methodological feasibility for creating interactive learning resources.

The results of the work confirm the high potential of interactive technologies and design thinking as tools for modernizing engineering education in the context of digital transformation.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTION OF THE AUTHORS

Spichak Ye.V.: conceptualization (moderator), methodology, scientific guidance, writing — reviewing and editing.

Klopov Yu.S.: research, formal analysis, writing – the first option.

All the authors approved the final version of the work.

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