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VERIFICATION OF THE SYSTEM OF FORMING FUTURE ENGINEERS' INTEGRATIVE READINESS FOR PROFESSIONAL ACTIVITIES

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Abstract. The formation of future engineers' integrative readiness is a relevant problem: a) an engineer works in the open world and performs professional tasks that have significance for different countries or even for the whole planet; b) import substitution tasks lead to the need to study and apply world experience in the field of technical solutions. Thus, we have developed a system to form future engineers' integrative readiness for professional activities. The system needs to be verified to become part of scientific knowledge. The article aims at characterizing the verification procedure of the results gained through the scientific research of the problem of forming future engineers' integrative readiness to solve professional problems in a foreign language. The article describes the steps and means of the experiment (criteria, levels, indicators, measurement techniques, experimental methods) and the technology of forming future engineers' integrative readiness to solve professional problems in a foreign language. The results of verification are presented. This study has shown that the results of theoretical research (on the system of forming future engineers' integrative readiness to solve professional problems) can be recognized as true knowledge.

Keywords: professional skills, language skills, English for professional activities, technical documentation, interdisciplinary approach, technical major students

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ВЕРИФИКАЦИЯ СИСТЕМЫ ФОРМИРОВАНИЯ ИНТЕГРАТИВНОЙ ГОТОВНОСТИ БУДУЩИХ ИНЖЕНЕРОВ К ПРОФЕССИОНАЛЬНОЙ ДЕЯТЕЛЬНОСТИ

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Аннотация. Проблема формирования интегративной готовности будущих инженеров актуальна, поскольку: а) инженер работает в открытом мире и решает профессиональные задачи, имеющие значимость для разных государств либо даже для всей планеты; б) задачи импортозамещения приводят к потребности изучения и применения мирового опыта в области технических решений. В соответствии с этой потребностью нами разработана система формирования интегративный готовности будущих инженеров к профессиональной деятельности. Согласно требованиям к достижению истинного научного знания, она требует верификации. Целью данной статьи является характеристика процедуры верификация результатов научного исследования проблемы формирования у будущих инженеров интегративной готовности к решению профессиональных задач на иностранном языке. В статье охарактеризована схема и средства эксперимента (критерии, уровни, показатели, методики измерения, экспериментальная методика); технология формирования интегративной готовности

будущих инженеров к решению профессиональных задач на иностранном языке. Представлены результаты верификации. Сделано заключение о возможности признания результатов теоретического исследования (системы формирования интегративной готовности инженеров к профессиональной деятельности) истинным знанием.

Ключевые слова: профессиональные навыки, языковые навыки, английский язык в профессиональной деятельности, техническая документация, междисциплинарный подход, студенты технических специальностей

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Introduction

The verification of theoretical knowledge is an obligatory stage of pedagogical research. Our system of forming future engineers' integrative readiness for professional activities in a foreign language is theoretically justified [4]. However, this is not enough to claim that true knowledge has been obtained. It is necessary to test the results in practice in order to make such a conclusion. The results tested in practice may be considered verified. In accordance with the goal of verifying the results of scientific research on the problem of forming future engineers' integrative readiness to solve professional problems in a foreign language, we set the following research tasks: a) to develop a criterion-level scale for measuring the integrative readiness; b) to develop a technological-level system for the formation of future engineers' integrative readiness for professional activities in a foreign language; c) to verify theoretical results.

Materials and methods

A lot of research is devoted to solving the problem of getting specialists ready to perform professional tasks in a foreign language. We can single out major directions used in today's educational system: creating an artificial language environment; vocation-oriented foreign language teaching. N.I. Gez, N.D. Galskova study the formation of a language competence, they referred to a foreign language as an integral part of language education in an artificial language environment [6]. So, this theory of teaching a foreign language is widely used today especially for linguistic major students. According to O.V. Nemirovich a professional foreign language is a part of a professional competence of a future specialist and stages of its formation are connected with performance of educational and professional tasks by non-linguistic major students [9]. Other researchers study the introduction of vocation-oriented foreign language teaching for technical major students [7, 12, 15]. Many other scientists also try to introduce such ideas into the educational process as: profession related translation [3, 10, 13]; making presentations in English [1, 14]; use of social media and online resources [5, 11] and so on. The suggested theories form the basis for teaching a foreign language for specific purposes developing the educational content related to students' profession, but this content is not aimed at achieving the goal of mastering any professional competences. Thus, today professional standards are not considered when teaching a foreign language for specific purposes. Having studied numerous textbooks of a foreign language for specific purposes we can say that the main principle according to which they are written is compliance with regulations of the Federal State Educational Standard where regardless of the specialty a foreign language is one of the universal competences. According to this approach, the result of learning a foreign language is the ability to use it in everyday and professional situations. In this case, foreign language skills don't contribute to the formation of professional competences, which is the purpose of higher education. The analysis of professional standards of future engineers helps point out the function of a foreign language: it contributes to the professional competencies development, manifested in the ability to perform professional tasks using language skills. The study of professional standards of technical specialties helped choose the most relevant and common for a large number of specialties job function, so such basic job function as work with technical documentation was chosen due to its special importance and position among other job functions. Development of technical documentation is the first stage of work that accompanies the entire design and production process. The discipline of English for professional purposes which is taught by an English teacher for the sake of acquiring language

skills will not fully meet the requirement to use English in the performance of a basic job function.

Our research aims at forming integrated readiness to use a foreign language in a professional sphere by introducing an interdisciplinary system into the educational process. Students' readiness to use a foreign language in their professional sphere is studied through the analysis of the concept "readiness for activity" [2]. We define future engineers' integrative readiness for professional activities in a foreign language as an integrative property of a personality, characterized by awareness of values, a strong will to realize one's potential, and the ability to apply integrated professionally important knowledge, skills and personal qualities in the field of research, design and development, production and technology and technical maintenance activities in a foreign language in communication, information and documentation aspects [4, 8].

The future engineers' integrative readiness for professional activities in a foreign language is a necessary quality of a modern engineer. The system is developed to form this readiness, based on dialectical, system, integrative, interdisciplinary and activity-based approaches [4]. It is important for current research, as we are to describe the system at the technological level. The components, links, functions of the system are specified at its technological-level system, constructed according to these approaches. At the technological level of our system presentation, the integrative approach appears in the form of the interdisciplinary approach, since it involves the integration of educational content of different disciplines on the basis of which the collaboration between teachers is organized. The development of educational content as a type of educational activity is ensured by the application of the activity-based approach to the process of teaching technical-major students to use a foreign language to perform professional tasks. Tasks' solving is also based on these approaches.

To verify the system, first a criterion-level scale for measuring integrative readiness has been developed. Criteria are defined on the basis of general and specific signs of integrative readiness. In accordance with the criteria, a level scale has been developed. For all scale point indicators were determined by means of the criteria specification.

The verification was carried out in the process of a comparative pedagogical experiment. The technological system was implemented in practice to validate the obtained theoretical results of our research. The system was developed using the methods of modeling and specifying the components, relationships, functions and mechanisms for the development of the pedagogical system. When introducing the developed system, we have carried out two procedures. The first procedure was to assess the level of students' readiness to use a foreign language in their professional activities. The following tasks were completed:

- A diagnostic test was carried on the level of students' readiness to use English in their profession;
- Students were divided into experimental and control groups;
- The initial level of students' readiness was identified according to the developed criteria.

The second procedure was aimed at the implementation of the developed system into the educational process. The following tasks were completed:

- The system was introduced into the educational process in an experimental group of students;
- A control group was taught English using an ordinary textbook according to the existed educational program;
- Progress and final tests were carried out;
- The level of students' readiness was identified.

To participate in the experiment, homogeneous groups of students were selected, characterized by the same level of formation of the studied parameter. This made it possible to measure the results of its application in the experimental and control groups. Quantitative assessment of students' readiness formation in experimental and control groups according to the developed criteria was carried out using average grades. Before the introduction of the system statistical processing was conducted by means of non-parametric χ^2 criterion at 0.05 error probability and critical value equal to 5.991.

Results

The criteria of integrated readiness for professional activities in a foreign language correspond to our definition of this phenomenon and include: guiding criterion (awareness of values), action setting criterion (a strong will to realize one's potential), and professional-integrative criterion (the ability to apply integrated professionally important knowledge, skills and personal qualities).

Table 1

Criteria and levels of readiness

Criteria of formed readiness	Levels of readiness		
	high	medium	low
Guiding criterion	Students know job functions that require English	Students have some idea of job functions that require English	Students cannot name any job functions that require language competence
Action setting criterion	Students can easily identify difficulties, deal with them, students have a clear plan of action	Students have some idea of possible difficulties and don't quite know how to deal with them to follow their plan of action	Students cannot identify difficulties at all and don't have any plan of action
Professional-integrative criterion	Students use tech vocabulary appropriately, understand profession related, tech information. Students synthetize their knowledge, skills and personal qualities	Student uses tech vocabulary properly, understands profession related, tech information but makes mistakes. Students combine their knowledge, skills and personal qualities	Student has no idea on how to use tech vocabulary properly, doesn't fully understand information. Knowledge, skills and personal qualities are separated

Table 2

Structure of guiding component

Purpose: forming students' attitude, beliefs, motivation	
Tasks	Means to achieve these tasks
Get students to understand the structure of their professional activity	Organize classes to present and discuss main groups of job functions within the scope of activities according to the Federal State Educational Standard. Final task: "Classification of job functions according to the main types of professional activity"
Show students how the obtained knowledge can be used to perform interdisciplinary professional tasks	Organize classes to study professional standards and specific job functions. Final task: "Study professional standards for specific job roles and prepare a short occupation summary, e.g. aircraft certifying technician"

Levels of students' readiness to use English in their profession were identified according to the selected criteria which come from our definition of readiness and they are presented in table 1.

To determine the students' levels of the integrated readiness for professional activities in a foreign language at all stages of the experiment the following methods were used: observation, study of students' assignments, synthesis, generalization, analysis, comparison.

Components of the system are the following: guiding component, integrative content component, interdisciplinary process component and assessment component. The structure of the guiding component is presented in table 2.

The structure of the integrative content component is presented in table 3.

This component consists of three modules.

1. Introduction module

• Content: introduction of topics corresponding to basis engineering disciplines; tasks to practice the use of technical terms. Topics to study: careers in technology, diverse engineering subjects, design, dynamics, energy, electricity, engine and motors.

• Means: textbook "English for professional purposes".

• Procedure: the textbook is written by an English teacher with the help of a teacher of a professional discipline. The material is divided into several thematic sections depending on students' major; each section contains a glossary, key vocabulary and phrases, a set of lexical exercises. Examples of tasks: read the article and say how math is important nowadays; read the article and offer a solution to the problem; study the terms and complete the crossword puzzle.

• Result: mastery of the main thematic vocabulary.

2. Language use module:

• Content: work with video materials and articles. Topics to study: technology of the future;

Table 3

Structure of the integrative content component

Purpose: new material introduction	
Tasks	Means to achieve these tasks
Introduce specifics of a technical field in a foreign language	Implementation of "Introduction module". Topics to study: careers in technology, diverse engineering subjects, design, dynamics, energy, electricity, engine and motors
Practice skills acquired in the introduction module, master reading, listening and writing skills	Implementation of "Language use module". Final tasks: provide a short summary of a chosen job; write a few examples of calculations you did recently, describe a machine you know about that contains parts which undergo angular motion etc.
Apply knowledge of two disciplines to do one common task	Implementation of "Interdisciplinary module". Names of tasks (examples): trends in CFD; technical documentation development; stages of a product manufacturing process; machinery breakdown

engineering subjects; aerospace engineering; materials and technology; dynamics; energy, electricity; engines and motors.

- Means: an e-learning course based on LMS Moodle.
- Procedure: The e-learning course helps master language skills gained studying the textbook of English for professional purposes. Students have additional lexical, listening and watching exercises to do at home. The use of the textbook along with the e-learning course appears to be a blended learning module. Examples of tasks: read the article from an engineering journal and explain the terms in your own words; listen to the introduction to the subject of physics and fill in the gaps with the appropriate words; watch the video about the way solar panels convert solar energy into electrical energy and answer the suggested questions.
- Result: mastering language skills in the context of the technical discipline being discussed.

3. Interdisciplinary module:

- Content: study of theory and performance of an interdisciplinary task. Types of tasks: research, design and development, production and technology and technical maintenance.
- Means: developed guidelines.
- Procedure: Teachers make a list of technical terms related to the design stages of product development including the terminology contained in the standards of technical documentation. Students receive a ready-made list of terms. Teachers develop a plan and guidelines for the student's work which are given in two languages. Students work on technical specifications of the product they develop and they give it to the special discipline teacher in order to find mistakes and to correct them; the foreign language teacher assesses the presentation of the same information in English. Examples of tasks: study some common challenges in the manufacturing industry and offer possible solutions to overcome them; think of a product you would like to create, write about its properties, main features and the sphere of application including maintenance issues and develop your own sample of technical documentation.
- Result: developed technical documentation in English.

The interdisciplinary process component includes means and forms of interaction between teachers and students organizing the component of educational content (discussion, work in groups, case study, self-study). Example of "case study" assignment: give a report on the studied technical documentation (study the product assembly documentation and prepare a report on the complex description and application of the product). Example of "self-study" assignment: choose a problem you're interested in and write an abstract on strategy when facing threats related to aircraft electrical systems.

The assessment component measures the levels of students' readiness to use English in their profession. The first criterion is assessed using a survey among students. They are asked such questions on the area of their professional activity, its objectives, possible outcomes and the purpose of English. The second criterion is assessed during an interview with students. They are asked to choose main difficulties in mastering English for professional purposes, explain their choice and suggest a solution how to overcome existed difficulties. The proposed list of difficulties contains the following positions: mastering a new language as a new unusual way of thinking (language barrier), poor vocabulary, lack of speaking skills. The third criterion is assessed according to

students' results that they gain performing two tasks. The first task is to do a test that checks grammar skills, general and professional vocabulary knowledge. The second task is to develop a troubleshooting guide when working with some equipment and present the result. Students' work according to the all criteria is assessed the following way: if a student gives a logical answer providing appropriate explanation and reasoning, he gets max points; if a student's answer is quite short and he makes a couple of small mistakes, he gets average points; if a student's speech contains serious mistakes making it hard to understand what he means, he gets minimum points.

The developed system was introduced into the educational process among students of the polytechnic institute at SUSU. The results before and after the system introduction are presented in figures 1 and 2.

The effectiveness of the developed system has been validated. The experimental group shows progress: no students possessing a low readiness level. The number of students with a high level of readiness has increased.

Conclusion

The developed system of gaining integrated readiness for professional activities turns a disciplinary educational process into interdisciplinary one and makes the introduction of interdisciplinary tasks possible. The developed system

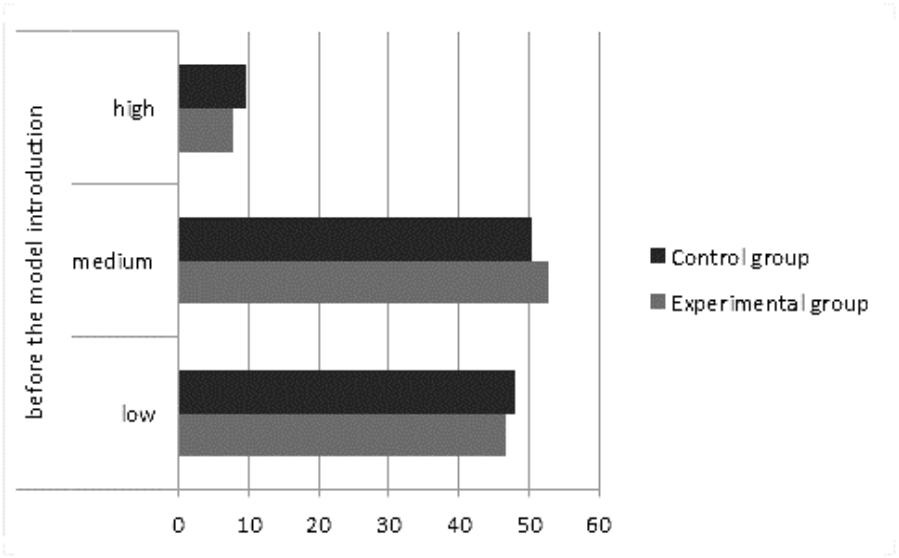

Fig. 1. Levels of students' readiness before the system introduction

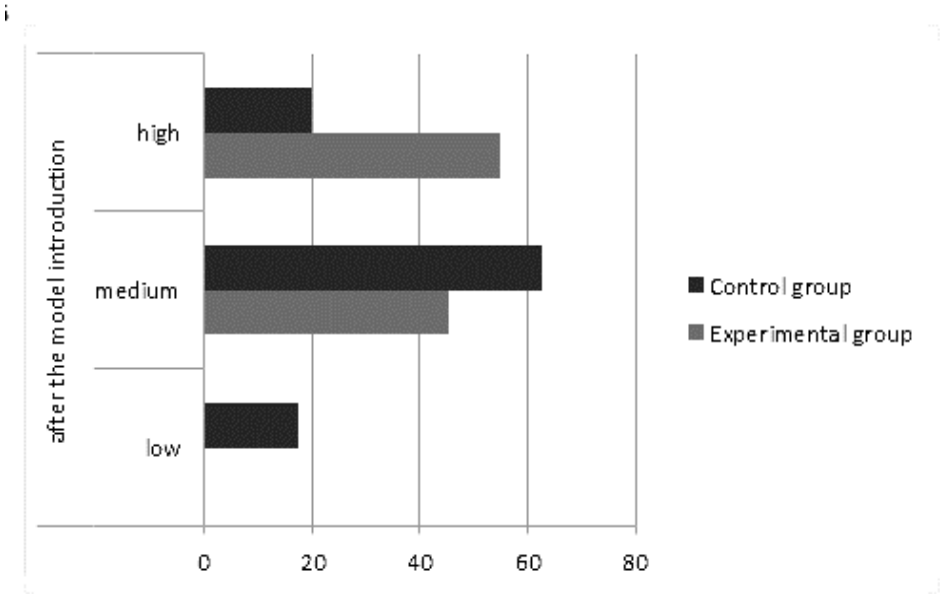

Fig. 2. Levels of students' readiness after the system introduction

appears to be effective in getting technical major students ready to use English in the future professional activity. That allows to state that the system is verified and can be considered as a new element in the theory of engineering education.

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