Artículo de investigación

Development of training content for master students in course "mechatronics and robotics" at the University

Desarrollo de contenidos de capacitación para estudiantes de maestría en el curso "mecatrónica y robótica" en la Universidad

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Abstract

In the conditions of active development of Informatization and technologization of society there is urgent need for specialists carrying out pedagogical activity with the help of mechanical systems and robotics. The purpose of the article is to identify the features of content development for training master students in course "Mechatronics and Robotics" at pedagogical University. On the basis of Federal state educational standard, relevant documentation and necessary methodological support were prepared in higher educational institution. The article presents the process of developing the content of training masters in course "Mechanics and robotics". The development of a new profile of training is based on competence, activity and system approaches taking into account aspects of personal-oriented training and practice focus. On the basis of Federal state educational standard basic educational program, modules of educational programs, test content and methodical support are developed. The article reveals requirements and procedure for the development of theoretical content of training, as well as educational and industrial practices.

Keywords: Robotics, mechatronics, competence approach, higher education institution, practice, module.

Resumen

En las condiciones de desarrollo activo de la informatización y la tecnologización de la sociedad, existe una necesidad urgente de especialistas que realicen actividades pedagógicas con la ayuda de sistemas mecánicos y robótica. El propósito del artículo es identificar las características del desarrollo de contenido para la formación de estudiantes de maestría en el curso "Mecatrónica y robótica" en la Universidad pedagógica. Sobre la base del estándar educativo del estado federal, se preparó la documentación relevante y el apoyo metodológico necesario en la institución de educación superior. El artículo presenta el proceso de desarrollo del contenido de los maestros de formación en el curso "Mecánica y robótica". El desarrollo de un nuevo perfil de capacitación se basa en los enfoques de competencia, actividad y sistema, teniendo en cuenta aspectos de la capacitación orientada al personal y el enfoque práctico. Sobre la base del programa educativo básico del estándar educativo estatal federal, se desarrollan módulos de programas educativos, contenido de pruebas y apoyo metódico. El artículo revela requisitos y procedimientos para el desarrollo del contenido teórico de la capacitación, así como las prácticas educativas e industriales.

Palabras clave: Robótica, mecatrónica, enfoque de competencia, institución de educación superior, práctica, módulo.

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Introduction

With the development of science and technology in higher education there are innovations directly related to this process (Abramova, 2018). In the conditions of Informatization and computerization, there is an objective need to train students ready to carry out activities in a new actively developing direction "robotics". Today robotics is one of the most promising branches of the industry of advanced technologies and is an integrative direction of scientific and technological progress (Kutepov, 2017).

Robotics is a vast field. Initially, robotics was considered only from the point of view of automation of production or assistance in performing dangerous or heavy work (in order to replace a person), then robotic became household items that facilitate everyday tasks (Nikonova, 2019a). And only after that robots began to appear in education. As students' technical creativity, this direction has existed for more than 15 years, which began with the advent of robotic sets of Lego. Over the years, more than one generation of automated kits were designed for both pupils and students. However, the main consumer was still considered a schoolboy. Training and manuals that support the spread of practical work with robots have been 6-7 years ago (Nikonova, 2019b).

Many countries of the world, such as China, Korea, USA, Singapore and Japan show an active interest in educational component of scientific and technical direction (Kamenez, 2019). Universities in these countries, both independently and in collaboration with production companies (RoboticsAmericaInc, MobileRobotsInc) are engaged in development of educational areas (e.g. ILERT) to attract students to this field (Markova, 2019).

The activity of Russian students in the field of robotics began relatively recently, and its full potential has not yet been realized in practice of training, although the importance and value of robotics is a recognized fact for the country (Sedykh, 2019). Therefore, domestic educational institutions are implementing activities in their respective pathways (Smirnova, 2019).

In total, 49 higher educational institutions carry out training in major "Mechanics and robotics" in Russia. This major takes 48th score.

Nizhny Novgorod state pedagogical University named after Kozma Minin also identified a new priority direction of development and established the importance of development of training content for master students in course "Mechatronics and Robotics", so necessary educational and methodological support for training in this profile was developed.

It is worth noting that robotics includes many areas, but in the field of education it has not yet been disclosed (Denysenko, 2018). The urgency of a new course emergence and the development of training robotics content is due to increased need for appropriate staff.

Mechatronics is a field of science and technology based on integration of precision mechanics units, environmental sensors and the object itself (Makhometa, 2018). Mechatronic systems are complexes of Electromechanical, electrohydraulic, electronic elements and computer equipment among which there is a constant exchange of energy and information, which is United by a common process of automatic control which contains elements of artificial intelligence (Smirnova, 2017).

Robotics is a field of science and technology aimed at creating robots and robotic systems based on various mechatronic modules: information-sensor, Executive and control (Pliushch, 2018). Assignment of robots and robotic systems will allow performing working operations from micro to macro dimensions (Ilyashenko, 2019b).

Higher education institutions are actively solving the problem of training in the field of pedagogy, capable of organizing and conducting events using mechanical systems and robotics (Natalie, 2019).

Literature review

Modern educational process is different from traditional richness of technical means (Vaskovskaya, 2018). Their development in education is carried out over a fairly long period of time, from the use of recording devices to the use of modern, providing large-scale capabilities of technology (Ilyashenko, 2019a). Among the authors who supported the idea of introduction and development of technical means in education it is worth noting S. I. Arkhangelsky, N. M. Shakhmaev, I. I. Tikhonov, N. V. Kuzmina, T. A. Ilyina.

Technical means is a set of technical devices with didactic support used in educational process for information presentation and processing (Sazhienko, 2017). Among functions of technical means the following are noted: reducing time, information transfer and detailed study of objects or phenomena of interest; ensuring students and teachers' activities (Vaganova, 2019).

Introduction of technical equipment occurred gradually and, to date, formed their special classifications: functional (technical means for information transfer, control of knowledge, training facilities and support from our tool combination that integrates functionality of various purpose); transfer of educational information (convert information in a readable form, these include projectors of various types); control (devices and systems that contribute to the assessment of learning by students); training facilities (training device for the formation and development of specific skills); technical AIDS (are small-scale automation of teaching: interactive whiteboards, amplifiers, microphone technique, devices for remote control of computer systems technology) (Pometun, 2018); a combination of technical means (computer system for groups of students in separate educational space).

Technical means of the presented classifications simplify the process of presenting information, give high dynamics of learning, but today's stage of development of educational process in higher education requires a more advanced type of technical support to activate the process of formation of a competent graduate (Natalie, 2019). Therefore, the use of robotics comes to the first position in students' training (Zhytukhina, 2019). Robotics performs the following functions in education: research (provides the ability to use the information with the research purpose, modeling of the content and forms of presenting information); communicative (providing the opportunity for a better perception of educational material); management (to prepare the learners to perform tasks and organize these tasks, and get feedback in the assimilation of information by students); cumulative (allows you to combine, organize, store academic information in technical systems) (Myalkina, 2018). The main requirements of robotics are: functional (ensuring the necessary operation); teaching (according to the possibilities of robotics forms and methods of modern educational process); ergonomic (the number of operations to achieve the result, ease of operation and transport).

The use of robotics in educational process was engaged in both domestic (A. P. Alexandrov, D. Koposov, V. V. Maximov, Yu. a. Berkana) and foreign scientists research (D. Alimasi, M. bers, I. Ponte, K. Gulish, A. VIERA, John. Shenker).

Robotics training helps students to master mathematical and automated systems; provides mathematical, algorithmic, software and information support; gives methods of design, production, debugging and operation; research and production tests.

Methodology

The paper presents the experience of developing training content of master students in the direction 44.04.01 "Pedagogical education" (master level) for the major "Mechatronics and robotics", which includes basic educational program, modules of educational programs, funds of assessment tools and methodological support.

The volume of basic professional educational program is 120 credits, 66 of which fall on the discipline (modules), practice (45 credits) and state final certification – 9 credits.

The normative basis of the development was Federal state educational standard, professional standard of the teacher, Regulation on students practice.

The content of the profile "Mechatronics and robotics" is designed to prepare a competent highly qualified master with wide employment opportunities, as the graduate has a high technical training for self-development of robotic tools, and for their use in educational process.

Analysis and discussion

Nizhny Novgorod state pedagogical University named after Kozma Minin is preparing undergraduates in the new profile of training "Mechatronics and robotics".

In accordance with Federal state educational standard in the direction of training 44.04.01 "Pedagogical education" the content and organization of educational process in realization of basic professional educational programs of higher education is regulated by the curriculum, work programs, programs of educational and industrial practices, as well as specially prepared teaching materials allowing to implement appropriate educational technology.

The content of undergraduates training is built on a modular principle and involves development of general scientific and professional cycles.

The development of a new training profile is based on the conditions of competence-based approach, personal-oriented training and systematic, activity-based approaches taking into account practice focus.

Development of basic educational program was carried out on the basis of the following requirements. The content and organization of educational process is regulated by the curriculum, taking into account its profile; annual calendar curriculum; working programs of training courses, subjects, disciplines (modules); programs of educational and industrial practices; methodological materials that ensure implementation of appropriate educational technologies. The curriculum reflects the sequence of blocks of basic educational program developing certain competencies. For each course, module, practice types of educational work and forms of intermediate certification are specified. Basic education program shall specify work programs of all courses, subjects as a compulsory part and a part formed by participants of educational relations, including courses for student choice and electives. Practice is mandatory and is a type of training sessions focused on professional and practical training of students.

Normative and methodological support of current progress monitoring and intermediate certification of students is carried out in accordance with "Order of organization and implementation of educational activities for educational programs of higher education" in this case, master's program. The system of assessments in interim certification as well as form, order and frequency of "Regulations on current control and interim certification of students" In accordance with Federal state educational standard of higher education for certification of students for compliance of their achievements with the stated requirements of basic educational program, the University created and approved evaluation tests for the purpose of interim certification and ongoing control. The state final certification is provided after mastering basic professional educational program in full. Monitoring and measurement of training quality is carried out in accordance with internal and external regulations.

Control methods of the study include: oral and written exams; independent contractors; protection of coursework; a current control (survey, control and laboratory works); protection of works on educational and industrial practice. The results of monitoring and measurements: the results of entrance examinations (issued in the form of minutes of the Central admission Commission); the results of the midterm achievement (logged attendance sheets and attendance); the results of the intermediate certification (tests and exams) are noted in the test and examination sheets, in the student's record book; results of final certification (issued by the Protocol of the certification Commission, students receive the relevant documents-state diplomas with annexes).

It should be noted that the main professional educational program is implemented without use of e-learning in order to maximize the study of mechatronics and robotics in real time. Form of training is full-time. The volume of the compulsory part of the basic professional educational program without the state final certification is not less than 40% of the total volume of the master's program (120 credits, of which – discipline – 66 credits, practice – 45, state final certification – 9).

The training process includes lectures, seminars, practical classes, workshops and laboratory work, group and individual consultations.

Each training cycle contains basic (mandatory) and variable (profile) part, established by the higher school. The profile part helps to expand and deepen knowledge, skills and competencies defined by basic courses (modules).

In the course of mastering General professional educational program, master's students develop the ability to apply mechatronic and robotic systems in their professional activities, as well as to solve non-trivial tasks for various spheres of human activity in conditions of digital economy development.

Graduates who have completed master's program can hold such positions as a lecturer in educational organizations; teacher of additional education; teacher-organizer; employee training center; during the implementation of project tasks of professional activities: specialist of educational organization in the field of robotic systems; a designer in the field of educational robotics.

Technological practice is provided for students during which they generate initial ideas about

project activities with the help of specialists in General and further education through direct participation in design and technological work; shape experience of independent professional activity in departments of educational institutions, acquire skills of scientific organization of their work; develop professional commitment to design and control of mechatronic and robotic systems used in educational process.

Students learn regulatory, technical, software and methodical documentation for design of mechatronic and robotic systems; manufacturing equipment, technical equipment, safety at work with equipment and facilities laboratories and workshops in design, programming and control of mechatronic and robotic objects, participate in technological process of designing, programming and control of mechatronic and robotic objects; engaged in the development of engineering and software documentation for the design of mechatronic and robotic systems.

Undergraduates improve and expand professional competence in the process of practical training and production. The total complexity of training practice is 6 credits (216 hours). Educational practice is conducted on the 1st course in the 2nd semester and lasts 4 weeks. Development of educational practice content is represented by several stages. At the first (preparatory) training on safety, acquaintance with the program of practice, issue of the task, planning of work for the period of practice is carried out. The total complexity of the preparatory stage is 54 hours of which 30 hours are devoted to activities in organization (practice base), 10 hours of contact with the head of practice from the higher educational institution and 14 hours – independent work. The second (production) stage involves performance of tasks according to individual (group) work plan of the trainee; collection, processing and systematization of theoretical and factual material; participation in research work. The second stage is given 108 hours, of which 4-contact work with the head of practice, 84 hours-work in the organization, 20 hours-independent work. At the final stage, the undergraduate is engaged in processing and analysis of received information; prepares a report and presents the results to the head. The final stage takes place in 54 hours. 30 are assigned to work in organizations, 10 – contact work head, 14 in independent work. Total of 216 hours 144 student works directly in organization (on the basis of practice); 24 hours for contact work with the head, 48 hours – independent work.

Industrial practice is carried out on the 2nd course in the 4th semester for 10 weeks. The total amount of practice is 15 credits (540 hours).

The first stage of the internship takes 48 hours (30 hours-work in the organization, 9-contact work with the head, 9 hours-independent work). The second (production) stage is 444 hours (363 hours of work in the organization, 9 hours of contact work with the head, 72 hours independent work); the Final stage contains 48 hours (30 hours to work in the organization, 9 hours of contact work with a teacher, 9 hours independent work). 423 hours are given to work in organization, 27 hours to work with the head, 90 hours for independent work.

It provides independent work of students at all stages of educational practice, during which students work with scientific, educational and methodical literature.

Control is carried out in the following forms: control of keeping a diary; assessment of individual tasks.

The form of interim certification of practical training is set-off with evaluation, conducted in the form of written reports protection.

Assessment of practice is carried out according to the following criteria: evidence of business activity; course; quality of individual tasks performance; literacy of oral answers presentation during report submission; accuracy of report execution; evaluation of practice supervisors from the Department; a review of internship supervisor from the host organization. Offset takes the head of practice from the University.

In the organization of practice-oriented technologies are used to create conditions for students to resolve professional issues, developing skills of self-organization on the basis of special scientific knowledge. It also includes personality-oriented technologies that provide an opportunity to individualize the content and forms of work performed; technologies based on the project approach allowing students to carry out independent cognitive and practical activities; activity-oriented technologies (goal setting, introspection of process and results).

Conclusion

Training of master students in major "Mechatronics and robotics" will meet the need

of society for qualified staff to ensure functioning of automated systems. Master course graduates will be able to carry out their activities in pedagogical sphere providing it with mechanical electronic elements. Developed by us, on the basis of requirements and principles of design of a new training profile and documents will allow carrying out process of preparation of undergraduates at a high level providing corresponding combination of theory and practice. Training in major "mechatronics and robotics" provides ample opportunities for future graduates employment as an important feature of this training is formation of a competent master not only in the field of robotics, but also their use in educational process. Masters who have mastered basic professional educational program in this profile will be able to carry out their professional activities in educational organizations, robotic clubs, training centers, public and commercial organizations for training personnel in the field of programming, information technology and robotics.

References

Abramova N.S., Vaganova O.I., Kutepova L.I. (2018). Development of educational and methodological support in the context of the implementation of information and communication technologies. Baltic Humanitarian Journal. t. 7. no. 2 (23). pp. 181-184. https://elibrary.ru/item.asp?id=35327269 (in Russian).

Denysenko S.M. (2018). Application of quest technology in the professional training OF Bachelor of Publishing and Polygraphy in Higher School. Balkan Scientific Review 2018 No. 1 pp. 29-33.

Ilyashenko, LK; Gladkova, MN; Kutepov, MM; Vaganova, OI; Smirnova, ZV (2019 b). Development of communicative competencies of students in the context of blended learning. AMAZONIA INVESTIGA Vol. 8 Núm. 18: 313-322.

Ilyashenko, LK; Markova, SM; Mironov, AG; Vaganova, OI; Smirnova, ZV (2019 a). Educational environment as a development resource for the learning process AMAZONIA INVESTIGA Vol. 8 Núm. 18: 303-312.

Kamenez, N.,Vaganova, O., Smirnova, Z., Kutepova, L., Vinokurova, I. (2019). Development of content of educational programs of additional education for professor-teaching composition in organization of educational services of training with disability. AMAZONIA INVESTIGA Vol. 8 Núm. 18: 267-278.

Kutepov, M.M., Vaganova, O.I., & Trutanova, A.V. (2017). Possibilities of health-saving technologies in the formation of a healthy lifestyle. Baltic Humanitarian Journal, 6(3), 210-213. https://elibrary.ru/item.asp?id=30381912 (in Russian).

Makhometa T.M., Tiahai I.M. (2018). The use of interactive learning in the process of preparing future math teachers. Balkan Scientific Review 2018 No. 1 pp. 48-52.

Markova, SM; Zanfir, LN; Vaganova, OI; Smirnova, ZV; Tsyplakova, SA (2019). Department of educational process in conditions of implementation of interactive training of future engineers. AMAZONIA INVESTIGA Vol. 8 Núm. 18: 450-460

Myalkina E.V., Sedhyh E.P., Zhitkova V.A., Vaskina V.A., Isaykov O.I. (2018). University resource center as an element of social development of the region // Vestnik of Minin University. Vol. 6, no. 3. P. 1. DOI: 10.26795/2307-1281-2018-6-3-1.

Natalie V. Kamenez, Zhanna V. Smirnova, Olga I. Vaganova, Natalia V. Bystrova and Julia M. Tsarapkina (2019). Development of Instructing Techniques in Professional Training, International Journal of Mechanical Engineering and Technology, 10(02), pp. 899–907

Nikonova, NP; Vaganova, OI; Smimova, ZV; Bystrova, NV; Markova, SM (2019a). Providing partnerships and promotion of additional educational services. International journal of applied exercise physiology. 2019b, Vol. 8 (2.1) pp. 347-355.

Nikonova, NP; Vaganova, OI; Smirnova, ZV; Chelnokova, EA; Kutepov, MM (2019b). Methodological support in partnerships with the institution of additional education and teachers (2019a) International journal of applied exercise physiology. 2019, Vol. 8 (2.1) pp. 339-346.

Pliushch V.M. (2018). Independent work of students as a factor of improving education quality Balkan Scientific Review 2018 No. 1 pp. 69-71.

Pometum O. I., Gupan N. M. (2018). Studying history as an educational space of students'critical thinking development. Humanitarian Balkan Research 2018. No. 1 pp. 60-63.

Sazhienko A. P. (2017). Characteristics of components, criteria and levels of faculty competence in the future bacalaurs of computer technologies. Scientific Vector of the Balkans 2017 No. 1 pp.22-35

Sedykh, EP; Zanfir, LN; Vaganova, OI; Smirnova, ZV; Bulayeva, MN (2019).Use of training technology in the preparation of students of engineering specialties. AMAZONIA INVESTIGA Vol. 8 Núm. 18: 461-470.

Smirnova, ZV; Kamenez, NV; Vaganova, OI; Kutepova, LI; Vezetiu, EV (2019). The

experience of using the webinar in the preparation of engineering specialists AMAZONIA INVESTIGA Vol. 8 Núm. 18: 279-287.

Vaganova, O. I., Smirnova, Zh. V., Markova, S. M., Chaikina, Zh. V., & Bulaeva, M. N. (2019). Organization of partnerships for additional educational services on the example of the interaction of the educational institution with the health and cultural centre. Perspektivy nauki i obrazovania – Perspectives of Science and Education, 39 (3), 500-514. doi: 10.32744/pse.2019.3.38

Vaskovskaya G.A. (2018). FEATURES OF IMPLEMENTATION OF PEDAGOGICAL TECHNOLOGIES OF PROFILE TRAINING. Balkan Scientific Review 2018 No. 1 pp. 76-79.

Zhytukhina K. P. (2017). Realization of the pedagogical condition for improving the process of formation of responsible attitude to future profession in students of pedagogical universities. Scientific Vector of the Balkans 2017 No. 1 pp.26-30