RUDN Journal of Informatization in Education
Вестник РУДН. Серия: Информатизация образования
2020 Vol. 17 No. 3 229–236
http://journals.rudn.ru/
informatization-education

DOI 10.22363/2312-8631-2020-17-3-229-236
UDC 378

Scientific article

Integration of natural science and humanities knowledge in the teaching of applied mathematics to students in the conditions of informatization of education

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Abstract. *Problem and goal.* The success of a variety of applied research based on achievements in applied mathematics presupposes the existence of highly qualified professionals with not only fundamental knowledge in applied mathematics, but applied mathematical thinking and the world of information, able to apply environmental technologies in applied research, to formulate and justify inferences about the results of the study. Such specialists in applied mathematics are able to identify and understand the new information obtained as a result of research in terms of its scientific and humanitarian value. That is why much attention is paid to the training of such highly professional specialists in the field of applied mathematics in Russia.

Methodology. In the process of teaching applied mathematics to students of physics and mathematics and natural science areas of higher education, it is advisable to integrate natural science, humanities, and information technology. At the same time, it is necessary to attract specialists in the field of applied mathematics who have experience in using information technologies to solve applied mathematical problems.

Results. The integration of natural science, humanities, and information technologies in the process of teaching applied mathematics allows students to develop a scientific worldview and information culture, to better understand the approaches and methods of applied mathematics as well as the scientific potential of applied mathematics. In addition, this integration allows to identify the fundamental concepts of scientific disciplines, which may not be the basic disciplines for teaching in the field of applied mathematics, but at the same time, play an important role in the methodology of applied mathematics. For example, such disciplines include computer science, philosophy, etc.

Conclusion. Training classes with students in applied mathematics, which integrates natural science, humanities, information technology allows to identify the humanitarian, scientific-educational and scientific-educational potential of teaching applied mathematics to justify the positive contribution of information technology to develop students' ICT competence.

Keywords: training in applied mathematics, natural science and humanities, informatization of education, information technology, student

Problem statement. Achievements of applied mathematics are used in many areas of human activity – space exploration, research of the air space, the earth's environment, the bowels of the world ocean; nuclear power, thermonuclear syn-

thesis, etc.; industrial production, economics, agriculture; biology, medicine, chemistry, physics, computer science, engineering, etc.; sociological and humanitarian research, and other areas of human activity.

A great contribution to the formation and development of applied mathematics was made by the research of A.A. Andronov, S.N. Bernstein, O.M. Belotserkovsky, E.P. Velikhov, V. Velkovich, N.M. Gunter, J.L. Dalembert, N.E. Zhukovsky, M.V. Keldysh, A.N. Kolmogorov, S.P. Korolev, N.E. Kochin, N.N. Krasovsky, A.N. Krylov, M.A. Lavrentiev, A.M. Lyapunov, O.E.H. Love, D.K. Maxwell, G.I. Marchuk, I. Newton, M.V. Ostrogradsky, Yu.N. Pavlovsky, L. Prandtl, S.D. Poisson, A.A. Samarsky, L.I. Sedov, S.L. Sobolev, V.A. Steklov, D.G. Stokes, A.N. Tikhonov, J.B.J. Fourier, S.A. Chaplygin, V.N. Chelomey, E. Schrodinger, L. Euler and other authors.

Modern applied mathematics has been enriched with new features, including the scientific and cognitive potential of mathematical models, humanitarization, distribution of optimality ideas, algorithmization, increasing the role of general mathematical structures, and other features (see, for example, [1–8]).

New methods and directions of applied mathematics are being developed that allow to study objects, processes and phenomena that may be located at large distances from the researcher and are inaccessible for direct study. This can be water space, land space, air space, or outer space. At the same time, new methods of applied mathematics allow to determine not only their location, but also, for example, their shape, structure of inclusions, and cause-and-effect relationships (see, for example, [5; 6; 9; 10]). It is also obvious that information is a mobile means of studying both analytical and discrete mathematical models and allows to visualize their solutions.

Method of research. Currently, Russian universities provide training for bachelors and undergraduates in such areas as “Applied mathematics and computer science” (01.03.02 – bachelor's level, 01.04.02 – master's level), “Mechanics and mathematical modeling” (01.03.03 – bachelor's level, 01.04.03 – master's level), “Applied mathematics” (01.03.04 – bachelor's level, 01.04.04 – master's level), “Applied mathematics and physics” (03.03.01 – bachelor's level, 03.04.01 – master's level) [11].

The relevant state educational standards specify the characteristics of such areas of training and professional activity, requirements for the results of educational programs, the structure of educational programs, and other requirements.

In modern conditions, the system of higher mathematics education focuses on the training of creative highly qualified specialists who have not only solid and deep scientific knowledge, analytical and informational thinking, but also are able to show interest in modern problems of world science (see, for example, [12–21]).

Integration of natural, humanities, and information technologies in applied mathematics classes helps motivate students to take an interest in learning and acquire deep and solid knowledge of applied mathematics. Students develop the skills to apply effective mathematical methods and approaches to solve sometimes complex mathematical problems. In addition, students gain invaluable experience in conducting humanitarian analysis of mathematical models that can be used to explore a variety of processes. Students develop a scientific outlook, creative abilities, and ac-

quire deep knowledge not only in the disciplines that are included in the training program in applied mathematics, but also in some disciplines that are not included in the training program. For example, philosophy. The fact that using modern methods of applied mathematics, namely with the theory and practice of inverse and ill-posed problems it is possible to identify the causal relationships of the studied processes. So by studying cause-and-effect relationships and new scientific information, students master important methods of understanding the world around them, such as theory, experiment, and philosophy. Of course, students pay attention to the fact that new scientific information obtained as a result of research of an applied problem is organically intertwined with fundamental philosophical questions of natural science.

Integration of natural, humanitarian knowledge, and information technologies in teaching applied mathematics makes it possible to implement environmental education of students. The fact is that today more than ever, specialists in the field of ecology are required. Therefore, higher education institutions train specialists in such areas of training as “Ecology and natural use”, “Geoecology”, “Environmental management”, etc. In these areas of training, students are introduced to disciplines whose content is developed on the basis of such scientific fields as ecology, geoecology, applied ecology, biosphere, hydrosphere and other scientific fields. Of course, students are also taught to apply modern environmental technologies in their professional activities.

Currently, a great interest in environmental problems is shown by specialists of various professions-ecologists, physicists, biologists, mathematicians and other specialists. Note such authors as N.V. Bolotelov, Yu.I. Brodsky, A.V. Gagarin, M.M. Elanova, A.V. Ivashchenko, I.S. Ilyasova, G.I. Kushnikova, L.V. Mantatova, E.V. Muraveva, Yu.N. Pavlovsky, A.P. Petrov, E.V. Rakhmatullina, S.A. Stepanov, S.M. Fayrushina and other scientists (see, for example, [22]).

For example, it can also be noted that the integration of natural, humanitarian knowledge, and information technologies in the teaching of applied mathematics allows to identify fundamental concepts of computer science, such as information, modeling, formalization, algorithmization, computational experiment, syntax, semantics, computer graphics, information technology, and other basic concepts of computer science.

Results and discussions. The integration of natural science, humanities, and information technologies in lectures, seminars, and laboratory classes dedicated to teaching applied mathematics allows students to master new subject knowledge not only in applied mathematics, but also in computational mathematics, information technology, and other areas of scientific knowledge.

During the seminars, students are taught the skills to study mathematical models, followed by humanitarian analysis, which involves a deep analysis of environmental aspects, such as the environmental state of the air space, the earth's environment or the water environment.

It is obvious that the knowledge and skills gained by students as a result of such training in applied mathematics will help them to be successful and qualified specialists.

Integration of information technologies in the process of teaching applied mathematics is successfully implemented in laboratory classes, where it is possible to use a wide range of information technologies to solve applied mathematical prob-

lems. Computer algebra systems, or as they are also called – computer mathematical packages, are among such information technologies. Widely known and widely used in teaching are *Mathematica*, *Maple*, *Matlab*, *MathCad* and other computer mathematical packages (see, for example, [23–25]).

Such computer technologies with a friendly interface have a great potential that allows to effectively and quickly find solutions to many mathematical problems from the fields of applied mathematics.

Among the advantages of such computer technologies is undoubtedly the ability to demonstrate the obtained solutions in analytical, graphical, and numerical form. Of course, these opportunities are attractive when conducting lectures, since it is possible to implement a visual demonstration method of training. Such computer technologies allow students to quickly find analytical or approximate solutions to various mathematical problems by consistently applying commands.

Conclusion. Integration of natural science and humanitarian knowledge, as well as information technologies in the teaching of applied mathematics in the process of teaching students of higher educational institutions allows students to form a system of fundamental knowledge in applied mathematics; to acquire the skills to apply various information technologies to solve applied mathematical problems and conduct their humanitarian analysis; to realize the role of information technologies in mobile research of applied mathematical problems; to develop their mathematical creativity.

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Article history:
Received: 10 March 2020
Accepted: 13 April 2020

For citation:
Kornilov VS. Integration of natural science and humanities knowledge in the teaching of applied mathematics to students in the conditions of informatization of education. *RUDN Journal of Informatization in Education.* 2020;17(3):229–236. http://dx.doi.org/10.22363/2312-8631-2020-17-3-229-236

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DOI 10.22363/2312-8631-2020-17-3-229-236

Научная статья

Интеграция естественно-научных и гуманитарных знаний в преподавании прикладной математики студентам в условиях информатизации образования

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Аннотация. *Проблема и цель.* Успешность проведения разнообразных прикладных исследований на основе достижений прикладной математики предполагает наличие высокопрофессиональных специалистов, обладающих не только системой фундаментальных знаний в этой области, но и прикладным математическим мышлением и информационной культурой, умеющих применять природоохранные технологии в прикладных исследованиях, способных самостоятельно формулировать и обосновывать логические выводы о полученных результатах проведенного исследования. Такие специалисты по прикладной математике могут выявить и осмыслить полученную в результате исследования новую информацию с точки зрения ее научности и гуманитарной ценно-

сти, поэтому подготовке именно таких высокопрофессиональных кадров в области прикладной математики в России уделяется большое внимание.

Методология. В процессе обучения прикладной математике студентов физико-математических и естественно-научных направлений подготовки высших учебных заведений целесообразно интегрировать естественно-научные и гуманитарные знания и информационные технологии. При этом необходимо привлекать для обучения прикладной математике специалистов в данной области, которые имеют опыт применения информационных технологий для решения прикладных математических задач.

Результаты. Интеграция естественно-научных и гуманитарных знаний и информационных технологий в процессе обучения прикладной математике дает возможность студентам развить научное мировоззрение и информационную культуру, глубже осмыслить подходы и методы прикладной математики и понять ее научный потенциал. Кроме того, отмеченная интеграция способствует выявлению фундаментальных понятий научных дисциплин, которые могут и не являться базовыми при обучении по направлению прикладной математики, но при этом играют важную роль в ее методологии. Среди таких дисциплин, например, информатика, философия и др.

Заключение. Проведение учебных занятий со студентами по прикладной математике, в которых реализована интеграция естественно-научных и гуманитарных знаний и информационных технологий, позволяет выявить гуманитарный, научно-образовательный и научно-познавательный потенциал обучения прикладной математике, обосновать позитивный вклад информационных технологий в развитие у студентов ИКТ-компетентности.

Ключевые слова: обучение прикладной математике, естественно-научные и гуманитарные знания, информатизация образования, информационные технологии, студент

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История статьи:
Дата поступления в редакцию: 10 марта 2020 г.
Дата принятия к печати: 13 апреля 2020 г.

Для цитирования:
Kornilov V.S. Integration of natural science and humanities knowledge in the teaching of applied mathematics to students in the conditions of informatization of education // Вестник Российского университета дружбы народов. Серия: Информатизация образования. 2020. Т. 17. № 3. С. 229–236. http://dx.doi.org/10.22363/2312-8631-2020-17-3-229-236

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