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Humanitarian knowledge in the learning content to the inverse problems for differential equations

V.S. Kornilov

Moscow City Pedagogical University
29 Sheremetyevskaya St., Moscow, 127521, Russian Federation

Problem and goal. Currently, humanitarization is a trend in the development of many scientific and educational fields, among which, undoubtedly, is applied mathematics.

The significant contribution of applied mathematics to the development of human civilization is obvious. At the same time, it is widely known that in some cases the practical implementation of applied research entails global environmental problems. There are irreversible negative processes in the environment. Such situations inevitably lead to a contradiction between the modern achievements of world science and its social and moral aspects. This problem is recognized not only by scientists. It is no coincidence that one of the directions of improvement of the Russian education system is the humanization of mathematical education, the concept of the content of which has been developed since the nineties of the last century.

One of the aspects of humanitarization of mathematical education is ecological education of students. A certain contribution to the formation of environmental education of students of physical and mathematical specialties of universities makes teaching inverse problems for differential equations, the content of which is formed on the basis of the theory of inverse problems for differential equations.

In this connection, in the process of teaching inverse problems for differential equations are realized such goals as: familiarity of students with the basics of humanitarian analysis of applied research, teaching students to formulate their own logical conclusions of applied and humanitarian character on the results of the study of the inverse problem for differential equations.

Methodology. The achievement of the above mentioned didactic goals of teaching inverse problems for differential equations is largely provided by how successfully will be implemented in practice such didactic learning tasks as:

1) realization of humanitarian potential of teaching inverse problems for differential equations;

2) formation of students' skills and abilities of independent analysis of applied and humanitarian nature of the results of the study of inverse problems for differential equations;

3) substantiation of the role of applied and computational mathematics in the development of human civilization.

In addition, in the process of teaching students inverse problems for differential equations it is advisable to implement a system of humanitarian-oriented training sessions.

This is due to the fact that in the process of such training students acquire fundamental knowledge not only in the field of mathematical methods of research of such applied problems. In the process of learning the inverse problems students are instilled features of humanization.

Results. In the process of teaching inverse problems for differential equations, students acquire the ability and skills to analyze the solutions of inverse problems, to formulate logical conclusions about the ecological state of the air space, the earth's environment or the aquatic environment, to apply numerical results of solutions to inverse problems in the humanitarian analysis of applied research.

Conclusion. Fundamental knowledge in the field of inverse problems for differential equations, skills of using this knowledge in their professional activities, the possession of humanitarian culture, awareness of the humane relations of their applied activities with the environment and society contributes to the formation of students' spirituality, the development of worldview and awareness of involvement in the civilized development of society.

Key words: teaching inverse problems for differential equations, humanities, applied mathematics, student

Problem statement. Applied mathematical education is an important component of fundamental training of students of higher educational institutions. In the process of modern scientific research is characterized by the integration of science, the desire to get the most accurate representation of the overall picture of the world. At the same time, the achievements of modern nature sciences, which have general educational value, can not remain the property of only scientists. The essence and practical role of these achievements should be disclosed at a level accessible to students of higher educational institutions. These ideas are reflected in the concept of modern higher education. An important link in the implementation of the task of university training of future specialists in the field of applied mathematics, comprehensively developed, with a broad outlook, possessing deep theoretical knowledge and applied mathematical culture, is the mastery of their integrative system of knowledge. The principle of integrative knowledge involves the widespread use of interdisciplinary connections in the study of applied mathematics. This allows us to reveal the importance of applied mathematics in the development of world science.

Training in applied mathematics in organic connection with its history, scientific methods, people who made discoveries in it, the dependence of any science on applied mathematics allow to involve future specialists in the applied field to human culture as a whole. Applied mathematicians, as noted by Yu.N. Pavlovsky in the article [31], the humanitarian culture is necessary, humanists must have the basics of mathematical culture. This is possible only as a result of profound changes in the education system.

A significant contribution to the development of humanization of mathematical education introduced by A.D. Aleksandrov, N.In. Belotelova, Yu.I. Brodsky, N.I. Vilenkin, G.D. Glezer, G.V. Dorofeev, T.A. Ivanova, M.S. Kagan, S.A. Komissarova, G.V. Lavrent'eva, L.V. Mantatova, N.N. Oleneva, Yu.N. Pavlovsky, Yu.V. Senko, M.V. Simonova, N.L. Stefanova, A.A. Joiner, L.M. Fridman, I.M. Yaglom and other authors (see for example, [2; 3; 7; 8; 10; 13—16; 24; 28; 29; 31; 35; 37]). Humanitarization of mathematical education involves the study of mathematics in the context of all the achievements of world science and culture, which undoubtedly contributes to the development of students not only fundamental subject knowledge, but also cultural thinking.

Humanitarization of mathematical education involves the study of mathematics in the context of all the achievements of world culture, which undoubtedly contributes to the education of high spirituality, the formation of culture of future graduates, including graduates of physics and mathematics faculties. This should be formulated the value of mathematics in the intellectual, moral and spiritual formation of the individual, the role and place of the process of mastering mathematical culture in the education system, revealed the relationship of mathematics with the disciplines of the humanitarian cycle.

According to A.D. Alexandrov, mathematics is a humanitarian Science in the sense that it deals with the study of human activity, without alienating It from the object of activity. A.V. Dorofeev thinks that a mathematical theory with a formalized presentation seem artificial, out of touch and incomprehensible. But if you approach them from the perspective of historical development, you will see their deep meaning of life and naturalness.

M.S. Kagan, analyzing the subject of the study of humanities and humanitarian knowledge, concludes that although mathematics has no special section associated with humanitarian knowledge, yet it has a certain specific humanitarian aspect — this is the aesthetics of mathematics. In the opinion of M.S. Kagan, this aspect was revealed by Pythagoreans at the beginning of the development of science on the number, and in the XX century, from judgments. Poincaré, mathematicians increasingly began to celebrate the beauty of human constructions (formulas, equations, theorems, geometric structures) and their aesthetic evaluation, thereby linking the humanitarian aspect of mathematics with its aesthetics. N.I. Vilenkin and I.M. Yaglom see the solution to the problem of humanization of teaching mathematics in the study of the history of mathematics and application of mathematics in humanities. G.D. Glazer draws attention to the aspect of scientific knowledge in mathematics and the history of mathematics associated with the humanization of mathematical education.

G.V. Dorofeev humanitarian focus of mathematics education discloses for the purpose of teaching: mastering the complex mathematical knowledge and skills; the formation and development of thinking skills, including heuristic and algorithmic; the formation and development of abstract thinking; the implementation opportunities of mathematics in the formation of scientific outlook; the formation of mathematical language; introduction to the role of mathematics in the development of civilization; introduction to the mathematical nature of scientific knowledge; formation and development of moral and ethical qualities of the person, adequate to process of full-fledged mathematical activity.

In their research, the authors combine the approach to the humanization of education as an integral part and means of the humanization process, aimed at familiarizing students with the humanitarian culture as a holistic social phenomenon, that such education is aimed at the development of deep and effective knowledge, mental operations, experience of creative activity. The authors draw attention to the fact that humanitarization is necessary in the logic of the educational process. In the real pedagogical process do not interact teacher and student, and real people, which the meanings of education brought together and, in in this context, as the subject of the training is not a goal, but a condition for the interaction of the participants of the pedagogical process.

With this approach, it becomes clear that no academic discipline has the privilege of being considered humanitarian in advance. Each may or may not be humanitarian, depending on how it is taught. Human knowledge is one and always humanitarian, because it is aimed at obtaining information about the world and at solving practical problems facing it. Therefore, it is impossible to divide knowledge, as noted by Mikhailov, into knowledge of nature and human knowledge. The humanitarization of education involves the rethinking of all components of the learning system: goals, content, methods, forms and means of learning (T.A. Ivanova).

One of the aspects of humanitarization of mathematical education is ecological education of students. Currently, environmental specialties are in demand and function in many universities, including "Ecology and environmental management", "Geoecology", "Environmental management", etc. in the process of training in such specialties, students acquire fundamental knowledge of general ecology, social ecology, geoecology, applied ecology, the atmosphere, the biosphere, hydrosphere, etc. They form skills and abilities to apply modern environmental technologies in applied research.

The problem of formation of ecological culture among students finds its development in the research of not only ecologists, but also mathematicians, physicists, biologists, philosophers and other specialists. Among them N.V. Belotelov, Yu.I. Brodsky, A.V. Gagarin, M.M. Elanova, A.V. Ivashchenko, I.S. Ilyasov, G.I. Kushnikova, E.V. Muravyova, Yu.N. Pavlovsky, A.P. Petrov, E.V. Rahmatullina, S.A. Stepanov, S.M. Fairushina and other authors. Yu.N. Pavlovsky drew attention to the creation of a higher level of mutual understanding of mathematical and humanitarian studies that would allow the introduction of nature-saving technologies.

Method of research. Currently, humanitarization is a trend in the development of many scientific and educational fields, among which, undoubtedly, is applied mathematics. A certain contribution to the formation of ecological culture of University students makes teaching inverse problems for differential equations, the content of which is formed on the basis of the theory of inverse problems for differential equations.

Scientific approaches and mathematical methods of inverse problems for differential equations as a scientific direction of modern applied mathematics are widely used in applied research (see, for example, [4—6; 9; 12; 32—34; 36; 38]). The rapid development in the 40—50-ies of the last century of the theory and numerical methods for solving inverse problems for differential equations is largely due to the proposed in 1943. Tikhonov physically justified the concept of correctness of a mathematical problem and formulated In 1956 M.M. Lavrentiev's definition of conditional correctness of the mathematical problem, involving the use of additional information about the properties of the solution of this mathematical problem.

A significant contribution to the development of the theory of inverse problems for differential equations has made the study of Z.S. Agranovich, A.S. Alekseev, A.V. Baev, M.I. Belishev, A.S. Blagoveshchenskaya, G. Borg, A.L. Bukhgeim, P.N. Vabishevich, V.V. Vasin, A.O. Vatulyan, I.M. Gelfand, M.L. Gerver, V.B. Glasko, A.V. Goncharskii, A.M. Denisov, S.I. Kabanikhin, M.G. Krein, M.M. Lavrent'ev, V.A. Marchenko, A.I. Prilepko, V.G. Romanov, A.N. Tikhonov, V.A. Yurko and other authors.

The great need for the application of the theory of inverse problems for differential equations in applied research is explained by the possibility of effective study of hard-to-reach or inaccessible to human objects and processes of different nature, determining their location, shape, structure of inclusions, etc., identifying their cause-and-effect relationships. All this, in many respects, became possible thanks to the use of modern information and telecommunication technologies. These circumstances explain the widespread introduction in the educational process of higher education students of physical and mathematical areas of training teaching inverse problems for differential equations (see, for example, [1; 5; 6; 9; 11; 12; 14; 16—27; 32—34; 36; 38]).

In the process of teaching inverse problems for differential equations, students acquire fundamental knowledge not only in the field of mathematical methods for the study of such applied problems.

In the process of learning the inverse problems students are instilled features of humanization. Students acquire the ability and skills to analyze the obtained solutions to inverse problems for differential equations, to formulate logical conclusions about the ecological state of the air space, the earth's environment or the aquatic environment, to apply numerical results of solutions to inverse problems in the humanitarian analysis of applied research.

Results and discussion. Such logical reflections in the process of teaching inverse problems for differential equations contribute to the formation of students' skills in the humanitarian analysis of the nature of pollution of the earth's environment and air space, the system of knowledge about the role of inverse problems for differential equations in the humanitarian analysis of the properties of the water environment, the earth's environment and air space.

Fundamental knowledge in the field of inverse problems for differential equations, skills of using this knowledge in their professional activities, the possession of humanitarian culture, awareness of the humane relations of their applied activities with the environment and society contributes to the formation of students' spirituality, the development of worldview and awareness of involvement in the civilized development of society.

Conclusion. Orientation of higher mathematical education on humanitarian development of students is one of the actual principles of functioning of the system of modern Russian educational space.

Humanitarian-oriented training sessions on inverse problems for differential equations are aimed at creating situations that require students, based on the results of solving the inverse problem, to make logical conclusions of applied and humanitarian character, to overcome moral contradictions, to make a reasonable choice of the right position in society. From this point of view, inverse problems for differential equations can be considered as a moral application to various physical, environmental, social, economic, and other processes and phenomena.

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Bio Note:
Kornilov Viktor Semenovich, doctor of pedagogical sciences, candidate of physical and mathematical sciences, full professor, deputy head of the department of informatization of education of the Moscow city pedagogical university. *Contact information*: e-mail: vs_kornilov@mail.ru

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Гуманитарные знания в содержании обучения обратным задачам для дифференциальных уравнений

В.С. Корнилов

Московский городской педагогический университет
Российская Федерация, 127521, Москва, ул. Шереметьевская, 29

Проблема и цель. В настоящее время гуманитаризация является тенденцией развития многих научных и образовательных областей, к числу которых, бесспорно, относится и прикладная математика.

Очевиден существенный вклад прикладной математики в развитие человеческой цивилизации. Вместе с тем широко известно, что в некоторых случаях практическая реализация прикладных исследований влечет за собой глобальные экологические проблемы. Происходят необратимые негативные процессы в окружающей среде. Подобные ситуации неизбежно приводят к противоречию современных достижений мировой науки и ее социально-нравственных аспектов. Это проблема осознается не только учеными. Неслучайно одним из направлений совершенствования российской системы образования является гуманитаризация математического образования, концепция содержания которой разрабатываться с девяностых годов прошлого столетия.

Одним из аспектов гуманитаризации математического образования является экологическое воспитание студентов. Определенный вклад в формирование экологического воспитания студентов физико-математических специальностей вузов вносит обучение обратным задачам для дифференциальных уравнений, содержание которого формируется на основе теории обратных задач для дифференциальных уравнений.

В связи с чем в процессе обучения обратным задачам для дифференциальных уравнений реализуются такие цели, как: знакомство студентов с основами гуманитарного анализа прикладных исследований, научение студентов самостоятельно формулировать логические выводы прикладного и гуманитарного характера по результатам исследования обратной задачи для дифференциальных уравнений.

Методология. Достижение отмеченных выше дидактических целей обучения обратным задачам для дифференциальных уравнений во многом обеспечивается тем, насколько успешно будут осуществлены на практике следующие дидактические задачи обучения:

1) реализация гуманитарного потенциала обучения обратным задачам для дифференциальных уравнений;

2) формирование у студентов умений и навыков самостоятельного анализа прикладного и гуманитарного характера результатов исследования обратных задач для дифференциальных уравнений;

3) обоснование роли прикладной и вычислительной математики в развитии человеческой цивилизации.

Кроме того, в процессе обучения студентов обратным задачам для дифференциальных уравнений целесообразно реализовывать систему гуманитарно-ориентированных учебных занятий.

Это обусловлено тем, что в процессе такого обучения студенты приобретают фундаментальные знания не только в области математических методов исследования подобных прикладных задач. В процессе обучения обратным задачам студентам прививаются черты гуманитаризации.

Результаты. В процессе обучения обратным задачам для дифференциальных уравнений студенты приобретают умения и навыки анализировать полученные решения обратных задач,

формулировать логические выводы об экологическом состоянии воздушного пространства, земной или водной среды, применять численные результаты решений обратных задач в гуманитарном анализе прикладных исследований.

Заключение. Фундаментальные знания в области обратных задач для дифференциальных уравнений, умения и навыки использования этих знаний в своей профессиональной деятельности, обладание гуманитарной культурой, осознание гуманных отношений своей прикладной деятельности с окружающей средой и обществом способствует формированию у студентов духовности, развитию мировоззрения и осознания сопричастности к цивилизованному развитию общества.

Ключевые слова: обучение обратным задачам для дифференциальных уравнений, гуманитарные знания, прикладная математика, студент

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Сведения об авторе:
Корнилов Виктор Семенович, доктор педагогических наук, кандидат физико-математических наук, профессор, заместитель заведующего кафедрой информатизации образования Московского городского педагогического университета. *Контактная информация*: e-mail: vs_kornilov@mail.ru