APPLIED MATHEMATICAL DISCIPLINES IN THE CONTEXT OF INTERDISCIPLINARY CONNECTIONS

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Abstract: The article is devoted to the role of interdisciplinary connections in the process of improving the quality of mathematical education in an economic university. Due to the transition of the Russian economy to market relations and the expansion of the use of mathematical methods in various fields of economics, the requirements for the level of mathematical training of graduates have increased. The author analyzes the role of applied economic and mathematical disciplines in the education of an economist using the example of a specific discipline. The author's main conclusion is that applied economic and mathematical disciplines developed on the basis of an interdisciplinary approach actually continue the mathematical education of an economist and meet modern requirements for the competencies of graduates of economic universities.

Keywords: mathematics, economics, education, disciplines, interdisciplinary.

1 Introduction

The topic of the quality of mathematical education at the university before the country's transition to a market economy was relevant mainly for technical universities. In connection with the transition of the Russian economy to market relations in the 90s of the twentieth century, the role of mathematical methods and economic and mathematical modeling in economic analysis increased, which, in turn, caused an increase in the requirements for the level of mathematical training of graduates of economic universities. Proposals to improve mathematical education have also become relevant for economic universities. In principle, all these proposals imply the achievement of the goal of teaching mathematics, formulated as follows: "Its level after completing studies at a higher educational institution should provide the ability to understand mathematical methods necessary for work in the specialty, but not studied at the university, the ability to read the literature necessary for this, the ability to independently continue mathematical education" (Kudryavtsev, 1985, p. 114). This statement was formulated in 1985 in relation to teaching mathematics at a technical university. Currently, it has become relevant for graduates of economic universities, as well as the statement formulated much later, which actually confirms the previous statement: "In recent years, among the tasks of higher education, the task of acquiring skills of constant self-education by young specialists throughout their working life has been put forward among the priorities. The pace of intellectual re-equipment of science and technology today is such that a student in his future activity will encounter laws, processes and technologies that he could not get acquainted with in principle at the university" (Knyazeva, 2009, p. 17).

The interest of specialists in the problem of improving the quality of mathematical education in an economic university is obviously due not only to the increased requirements for the level of mathematical training of graduates, but also to the fact that, as formulated by A. N. Ilchenko and B. Ya. Solon (2010), "mathematics is a fundamental component in the system of higher professional education in the Russian Federation" (p. 119). In this regard (Kudryavtsev, 1985; Podoprigora, 2004) argue about the necessity for continuous mathematical education, including in an economic university.

A. N. Ilchenko and B. Ya. Solon (2010) draw attention to the connection between the quality of basic mathematical training and the assimilation of economic and mathematical disciplines: "Without a full-scale study of mathematics, without knowledge of the basics of abstract logical thinking, mathematical economics is not assimilated, there is no need to talk about the practical application of its methods in production management" (p. 125). This statement is consistent with the conclusion of I. E. Denezhkina and colleagues (2012) "high requirements for the quality of mathematical training are becoming an urgent problem of economic education" (p. 101). As you can see, almost all the authors come to the conclusion that there is currently a need for high-quality mathematical training at an economic university.

However, there are difficulties in solving this problem. The main difficulties are connected both with teaching mathematics to students and its applications in economics, and with the joint work of teachers of mathematical and economic departments.

A. N. Ilchenko and B. Ya. Solon (2010) emphasize: "Our authorities have realized the necessity to strengthen fundamental training in the curricula of economists" (p. 124). However, despite the awareness of the problem at the state level, in practice there are serious problems in the field of teaching mathematics and its applications in economics. One of the problems is connected with the established practice of teaching mathematics at an economic university, according to which a limited number of hours are allocated for the study of higher mathematics, which does not allow achieving the required level of training. L. V. Dobrova (2014) formulated the problems arising in this regard: "At the present stage of the development of higher professional education, there is a serious problem associated with the low level of mathematical training of students of economic specialties. ... The problem is caused by contradictions between: the intensive flow of accumulation of mathematical knowledge and the limited possibilities of their assimilation by a person with an insufficient level of mathematical competence formation; between the increased requirements of employers to the level of mathematical training of economists-managers and the level of mathematical competence of graduates of economic specialties of universities" (p. 288). The tendency to reduce the number of hours for studying mathematics in some economic universities in recent years has contributed to the superficial study of mathematics with a predominance of applied orientation in teaching from the very beginning. A. N. Ilchenko and B. Ya. Solon (2010) write about the undesirability of such training: "Specialists who have received mathematical knowledge in the form of a set of formulas and algorithms may be powerless in solving many problems that require developed abstract thinking" (p. 125). Thus, teaching mathematics in economic universities is in contradictory circumstances – increased requirements for the level of mathematical training of graduates on the one hand, and a decrease in the number of hours to study mathematics with an "insufficient level of mathematical competence" of students, on the other one. These circumstances require their consideration in the organization of mathematical education at the university (Ilchenko & Solon, 2010, p. 125).

2 Literature Review

As already noted, modern requirements for the training of graduates of economic universities assume a level of mathematical training sufficient for the construction, analysis and forecasting based on economic and mathematical models.

To solve the problem of the quality of mathematical education in economic universities in the conditions of contradictions and difficulties mentioned above, the authors propose various approaches to teaching mathematics.

It is obvious that the fundamental mathematical training that students receive in junior courses is crucial for the quality of the graduate's mathematical training. Kudryavtsev L.D. (1985) talking about the necessary changes in the formulation of mathematical education as a result of new requirements, argues that this is primarily an increase in the level of fundamental mathematical training and, on this basis, strengthening the applied orientation of the mathematics course.

A. N. Ilchenko and B. Ya. Solon (2010) assign a special role to the fundamental mathematical training of a graduate. According to the authors, "the main goal of teaching mathematics is the development of intelligence based on fundamental mathematical training acquired in the 1-2 courses. It is the full-scale study of mathematics, and not shortened and cut courses, which can ensure formation of an intellectual level of a graduate sufficient for self-improvement of his qualifications and competitiveness in the new economy" (p. 128). There is no doubt about the validity of the statements about the importance of increasing the level of fundamental mathematical training. However, a full-scale study of mathematics in an economic university seems unrealistic due to the tendency to reduce the number of hours for studying mathematics in such universities, as mentioned above.

One of the solutions to the problem is to take into account the needs of special departments in mathematical courses. L. D. Kudryavtsev (1985) speaks about the necessity to build a mathematical education that takes into account the needs of special disciplines: "Teaching applied problems by mathematical methods is not the task of mathematical courses, but is the task of specialty courses. ... The correct organization of the training of mathematical models is possible only with good coordination of the efforts of mathematicians and specialists in the relevant fields" (p. 161). O. G. Knyazeva (2009) emphasizes that "the implementation of the requirements of the professional orientation of the mathematics course involves the interaction of mathematics teachers and teachers of special disciplines. For a full-fledged mathematical education, it is necessary to build mathematical courses taking into account the requirements of these disciplines" (p. 17).

I. E. Denezhkina and colleagues (2012) are sure that "the mathematical component of professional training of students is a joint matter of mathematical and "graduating" economic departments. The specificity of mathematics in universities of economic orientation is that mathematics cannot exist here without its demand from the "graduating" departments" (p. 102). However, as already noted, it is in this part of the formulation of education in an economic university that there are difficulties "what is not a problem in the case of "mathematics- physics" is a problem that requires discussion in the case of "mathematics-economics" (Denezhkina, 2012, p. 104). The approach in accordance with the principle of professional orientation of teaching mathematics is considered in a number of works (Kudryavtsev, 1981; Knyazeva, 2009; Baigusheva, 2014a; Baigusheva, 2014b). A competence-based approach to teaching mathematics is being developed by many specialists (Dobrova, 2014; Drobysheva & Drobyshev, 2018; Pirogova & Kulikova, 2017; Nikitina, 2013; Burmistrova et al., 2013; Anisova, 2018. The concept of fundamentalization of education is consistent with this approach, which also assumes an orientation towards personal development in the learning process (Popov, 2009). These are modern approaches proposed in research on this problem. However, the interdisciplinary approach seems to be the most promising. The role and significance of this approach is profoundly and comprehensively formulated by L. N. Sinelnikova (2016) who is sure that "modern science defines the concept of interdisciplinarity as the main direction in the development of scientific knowledge and, accordingly, in the formation of educational policy. ... It is necessary to pay attention to the importance of interdisciplinary connections in the educational process that can improve the quality of education, ensure the integrity of the competence approach in teaching, the possibility of mobility and adaptability in practice" (p. 101-102).

As an example of the successful application of an interdisciplinary approach, we can cite a project-oriented teaching method, the introduction of which is reported at Nizhny Novgorod University (Kuznetsov, 2011; Kuznetsov & Semenov, 2012). This technology has been used very successfully for quite a long time in a number of European and American universities. However, it is emphasized that this method is effective only at the final stage of training and is actually unacceptable in junior courses when teaching mathematical and natural sciences disciplines to students. Another positive example is given by Zasyadko O.V., Moroz O.V. (2016) and report on an electronic resource developed at the Kuban State University, in which the study of mathematics is accompanied by tasks in economic disciplines studied in parallel with mathematics. Applied economic and mathematical disciplines, the object of study of this article, can be considered as the result of interdisciplinary interaction. According to their purpose, economic and mathematical disciplines cannot be purely mathematical. Their content requires an interdisciplinary approach. N. V. Popova (2018a, 2018b) considers the role of applied mathematical disciplines in the education of an economist. I. E. Denezhkina and her colleagues (2012) speak about the need for such disciplines in economic universities: "Teaching mathematics in junior courses should have a logical continuation.... The methodological potential of mathematics can be provided only by mathematicians with sufficient erudition in the relevant special field. Students can be taught to apply mathematics in economics either by economists with sufficient erudition in quantitative methods, or by the above-mentioned mathematicians. At the economic departments, painstaking work is needed to introduce applied mathematical methods into the teaching of special subjects with the involvement of mathematicians" (p. 110). It should be noted that the interdisciplinary approach in teaching mathematics to undergraduate students attracts the attention of many specialists, and not only in economic universities. The interdisciplinary approach has become widespread both in science and in education (Calvo & D'mello, 2010; Chojak, 2018; Cornelius-White et al., 2013; Karunan et al., 2017; Lattuca, 2001; Repko & Sostak, 2011; Reynolds & Dacre, 2021; Szostak, 2007; Sostak, 2012; Wagner et al., 2011).

3 Research Methodological Framework

The purpose of this study is to generalize the experience of applying an interdisciplinary approach on the example of an applied economic and mathematical discipline. The objectives of the research are the following: to analyze the process of studying the economic discipline using mathematical methods; to characterize the results of training both in terms of the economic content of the discipline and in terms of the role of mathematical methods in the assimilation of the discipline. Among research methods used were analysis, synthesis, generalization.

4 Results and Discussion

The results of the study were obtained on the basis of the development and application of an educational and methodological complex of applied economic and mathematical discipline, taking into account the level of basic mathematical training of students. The discipline "Mathematical methods of financial analysis" was developed at Plekhanov Russian University of Economics at the Department of Higher Mathematics for students of economic specialties. The discipline "Mathematical Methods of Financial Analysis" was developed under a grant from the National Foundation for Personnel Training as a part of an innovative educational project under the program "Support for Innovations in Higher Education" for students of economic specialties. The work program of the discipline primarily takes into account the volume and content of mathematical disciplines studied by students in junior courses, as well as the content of economic disciplines related to finance. It was necessary to make sure that the economic content of the discipline being developed allows the student to gain new knowledge in the field of finance and investment. The discipline is devoted to one of the most important issues of modern economics – the analysis of investments in terms of certainty. To study the discipline, knowledge of mathematical analysis and other branches of mathematics is required. In the presentation of the discipline, such concepts of mathematical analysis as the exact bound of numerical sets, the limit and convergence of numerical sequences, continuity of functions, theorems of differential calculus, elements of convex analysis are used. The main object of study is fixed income financial investments.

The first part of the discipline contains the mathematical foundations of financial analysis in terms of certainty. The main attention here is paid to the definition of fundamental concepts and the derivation of formulas, which is necessary to understand the processes of increasing and discounting monetary amounts. Based on the decomposition of functions into power series, a comparative analysis of the methods of accrual and discounting is carried out, some important concepts of the theory of interest rates and their applications are considered.

The theory of financial flows and its applications are considered to the extent necessary for the study of production and financial investments in conditions of certainty. In particular, on the basis of the theorem on intermediate values of a continuous function, the theorem on the existence of a solution to the equation of profitability of the financial flow is proved.

In the second part of the discipline, methods of evaluating investment projects with a classical investment scheme are given, the economic meaning and properties of project performance indicators are considered in detail. On the basis of the theorems on continuous and differentiable functions, the dependences of efficiency indicators on the parameters of the investment project are studied. The latter is particularly important, since the correct evaluation of the project is determined not only by the values of performance indicators, but also by their behavior when changing project parameters.

The third part of the discipline is devoted to fixed income financial investments. Here we study in detail the factors influencing the valuation of an investment in a bond, such as the time structure of interest rates, internal yield, coupon rate, maturity, duration and convexity index of the bond, as well as the characteristics of the bond portfolio without credit risk, strategies for managing the bond portfolio. Special attention is paid to the immunization strategy. The study of the discipline is accompanied by the solution of a large number of tasks. The numerical result obtained as a result of solving problems, as a rule, requires economic analysis. According to the presentation, the discipline is mathematical, according to the content economic.

As a result of studying the discipline, students acquire the skills of applying mathematical methods in financial analysis and gain the knowledge necessary for a modern specialist in the field of investment. The use of mathematical methods in the course of studying the discipline contributes to a better understanding of financial instruments and transactions by students. Based on the experience of conducting the discipline, it can be argued that applied economic and mathematical disciplines can be considered as a continuation of mathematical education received by students in junior courses. In conditions of increased requirements to the level of training and simultaneous reduction of time for studying mathematics, applied mathematical disciplines to some extent compensate for this decrease, thereby improving the quality of mathematical education and, in general, economic education. It can be said that applied mathematical disciplines are one of the forms of implementation of the principle of continuous mathematical education (Kudryavtsev, 1985; Podoprigora, 2004). One more aspect of such disciplines can be mentioned – their ability to bring both students and teachers closer to scientific activity, since mathematics is the language of science. A teacher of an applied discipline can contribute to the development of this field of knowledge. In this case, the logic of the presentation of the discipline required proof of new theorems that are missing in investment textbooks.

5 Conclusion

There are difficulties in solving the problem of improving the quality of mathematical education and teaching students to use mathematical methods in an economic university. The interdisciplinary approach, which results in applied economic and mathematical disciplines, seems to be real and has significant potential in improving the level of mathematical training of graduates. Applied economic and mathematical disciplines developed with the participation of teachers of mathematical departments or mathematicians with knowledge in a special field can be considered as a continuation of mathematical education received by students in junior courses. Disciplines contribute to the consolidation of mathematical knowledge, which means improving the quality of mathematical training, and the assimilation of mathematical methods used in solving economic problems. Being mathematical by the method of presentation, the disciplines have an economic content, are practice-oriented and have scientific potential.

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