UDC 378:372.851

N.F. Abayeva[1], I.I. Yerakhtina[1], G.E. Samashova[1], O. Cernasejus[2]

[1]Karaganda State Technical University, Kazakhstan;
[2]Vilnius Gediminas technical university, Lithuania
(E-mail: a_nella@mail.ru)

Role of mathematical knowledge in the educational process at technical educational institution

The article is devoted to the place and role of mathematical disciplines for technical specialists. At technical university mathematical training is necessary for understanding the principles of design and modern methods and technologies use for the perception of scientific and technical concepts and ideas. Many processes are modeled, studied and predicted by its means. It must be taken into account that the scientific progress rapid development exacerbates the need in highly qualified personnel training in the field of engineering and technology. Mathematics provides the basis for other special disciplines study. The methods of educational activities enhancing in teaching mathematical disciplines are considered. The article draws a parallel: professional orientation of mathematics — result of academic achievement — the result of the EEEA (external evaluation of educational achievements) in mathematics. The working curriculum of Vilnius Gediminas technical university for mathematical cycle disciplines study is analyzed. Mathematical disciplines in accordance with specialties of KSTU (Karaganda State Technical University), compulsory and elective components are listed. The carried out analysis comes to the following conclusion — students' mathematical training is not enough for modern technical specialists.

Keywords: professional orientation of mathematics, educational process at technical educational institution.

Introduction

On 16 June, 2006 in L.N. Gumilyov Eurasian National University, N.A. Nazabayev, the president of the Republic of Kazakhstan, in the message to the youth at the lecture «To economics knowledge through innovations and education» mentioned: «In their structure our universities should have highly qualified specialists in the field of chemistry, physics, chemical technology, economics. Such a connection of specialists allowed the Massachusetts, California and Tokyo institutes of technology to become the best in the world. It is necessary to qualitatively change the teaching level in mathematical applied departments at all universities. Everyone should know mathematical methods of data analysis — engineers, economists, lawyers, constructors, government officials. As world practice shows, the high level of mathematical training will ensure a qualitative breakthrough in all sectors. Education system reform centerpiece should be the modern information technologies comprehensive introduction into educational processes. At this stage the particular attention should be paid to necessity of teachers' retraining and advanced training. Moreover, it is necessary to reframe curricula for compliance with international standards and modern world requirements. … Educated, literate people are the main motivation of human development in XXI century» [1; 2].

The country's socio-economic status and possibility of further sustainable economic growth depend on educational system development including technical education. Therefore, to increase students' interest in getting qualitative education is one of the prior tasks of higher education improvement.

Historically, there are two aspects of mathematics purpose: practical, associated with the tools creation and application needed in human's productive activities, and spiritual, associated with human's thinking, mastering a certain method of world and knowledge transformation — mathematical method.

Main part

Mathematical training at technical university is necessary for understanding design principles and modern methods and technologies use, for perception of scientific and technical concepts and ideas. Many processes are modeled, studied and predicted by means of it. Mathematics provides the basis for the study of other specialized disciplines. Therefore, the role of mathematics course professional orientation in the educational process is significant, it directly affects the achievement of educational, developing and cognitive learning goals. At the same time, the professional orientation develops students' scientific worldview, helps to see the world in achievement and development, helps to establish logical links between concepts, thereby developing students' logical thinking, acts as a means of formalism preventing and eliminating in students' knowledge, allows to form a system of knowledge realized by students, not as frozen, but as dynamic, qualitatively changing.

The teacher's task is to equip students with teaching and learning instruments and ways of working. In turn, it requires development of students' certain system of skills and knowledge. In our opinion, all academic skills can be divided into two groups: special developed on the basis of one discipline, and general developed on the basis of the system of many disciplines. These include: general logical, educational, informational, organizational and cognitive. Special skills development occurs within the discipline, but it is possible to transfer them into the field of related disciplines. For example, in the course of mathematics skills and abilities of statistical information processing are developed by students for further use in research results processing in the course of different technical disciplines. And statistical data processing obtained in both experiment and through daily accounting is required to check the degree of results reliability, their correct generalization and identify patterns processes. The role of statistical methods is especially important in technological systems and processes modeling followed by the use of these models to make the right decisions in the conditions of indeterminacy.

It should be also taken into account that the scientific progress rapid development exacerbates the need for highly qualified personnel training in the field of technology corresponding to modern requirements. Such leading scientists as G.I. Schukina, L.I. Bozhovic and etc. defined that success in acquiring knowledge and, in particular, mathematics largely depends on their cognitive interests. At the same time, the experience of mathematics teaching shows that a significant part of students has an extremely low level of cognitive interest development in mathematics [2; 47].

In our opinion, one of the effective approaches to this problem solving is the approach, including the following essence: teaching mathematics should be represented not only in modern mathematics logic, but also in the student's future professional activity logic. In this case, the aim of student's educational activity will be not only mastering mathematical apparatus as an integrated scientific system, but also professionally significant personal qualities development based on the mathematics logic [3; 39]. This approach should provide optimal conditions for students' cognitive interest development in advanced mathematics at any university.

In order to arouse desire to study mathematics, it is necessary to develop student's need to be engaged in cognitive activity, so it means that student must find attractive sides in learning process so that the learning process contains positive portions of interest [4; 21]. Above all, the path to it is through a variety of students' independent work organized in accordance with students' interest peculiarity in studying mathematics. According to V.M. Vergasova, — «Independent work activates thinking, contributes to own views and opinions development. The specialist, who has not learned to work independently, will not transfer ideas arisen into projects and designs. Man truly owns only those that he earns by his own labor» [5; 63]. Independent task fulfillment is the most reliable indicator of student's knowledge and skills quality [6; 127].

– Tasks aimed at attention development. It is necessary to use means causing learners to have feeling, consciousness of their own growth in order constantly to support cognitive interest and to receive impulses for further development.

– Tasks aimed at perception and imagination development. Perception is a main cognitive process of reality sensual reflection, its objects and phenomena. It is the basis of human orientation in the outside world and in society. Psychological and pedagogical studies have shown that comparison is one of the effective methods of observation perception and organizing education. So, the perception becomes deeper.

– Tasks aimed at the logical thinking development. Human intelligence is primarily determined not by the amount of accumulated knowledge, but by a high level of logical thinking. Today's students of technical university, who will become specialists in the near future, will never become highly qualified specialists in their field without logical thinking. Therefore, students must be taught to analyze, compare and summarize information. Nothing like mathematics itself contributes to the thinking development, especially logical, since abstract concepts and patterns are subject of its study.

– Tasks aimed at memory development. Memory is one of the basic properties of personality. But a good memory does not always guarantee its owner a good intellect. Memory is one of the required conditions for intellectual abilities development. Students have to memorize definitions, proofs, explanations, formulas. By teaching students to memorize logically related meanings, we encourage their thinking to develop.

Studying mathematics makes decisive contribution to human intellectual development. In the learning process, induction and deduction, generalization and concretization, analysis and synthesis, classification and systematization, abstraction, analogy are naturally included in the range of human thinking techniques and methods. The objects of mathematical reasoning and the rules of their organization reveal mechanism of logical structures, develop ability to formulate, substantiate and prove judgments, thereby, develop logical thinking. The leading role belongs to mathematics in the formation of algorithmic thinking, developing skills to act on a given algorithm and design new ones. In the course of mathematics studying, mental skills are systematically and consistently formed: planning work, finding rational ways to do it, and critically results evaluating. When solving problems, and this is the main type of educational activity in mathematics, the creative and applied aspects of thinking are developed. Revealing the inner harmony of mathematics, forming mathematical reasoning understanding of beauty and elegance, contributing to geometric forms perception, mastering symmetry concept, mathematics makes a significant contribution to future specialist's aesthetic perception. Its studying develops students' imagination, significantly enriching their spatial representations [7; 93891].

Since 2011 in KSTU, teaching disciplines of mathematical cycle in some specialties, presented in Table 1, was carried out taking into account specialists' professional orientation in the future activities. We started to use active teaching methods, which main task was to develop cognitive interest in mathematics study.

As a result of mathematical disciplines study taking into account professional orientation, we obtained the following data on knowledge survival after EEEA (external evaluation of educational achievements) (Table 1).

Table 1

Results of EEEA average point on Mathematics in accordance to specialties

№	Specialty	Average point at KSTU	Average point in the RK
1	Mathematical and Computer Modeling	116,50	106,53
2	Radio engineering, electronics and communication	113,85	76,04
3	Metallurgy	88,49	74,75
4	Mining	86,20	73,24
5	Automation and control	103,94	75,99
6	Standardization, certification and metrology	70,26	69,47
7	Computer Science	98,83	86,78
8	Construction	79,69	76,11
9	Mechanical Engineering	83,54	71,46
10	Biotechnology	90,40	79,37

The analysis of EEEA results for the last five years: 2014–2015, 2015–2016, 2016–2017, 2017–2018 showed that students, whose educational process was designed taking into account the above conditions for cognitive interests development, have higher math results in EEEA in comparison with the republican one (Fig.). This leads to the following conclusion: the knowledge rate survival in mathematics is higher among students whose educational process was focused on future professional activity.

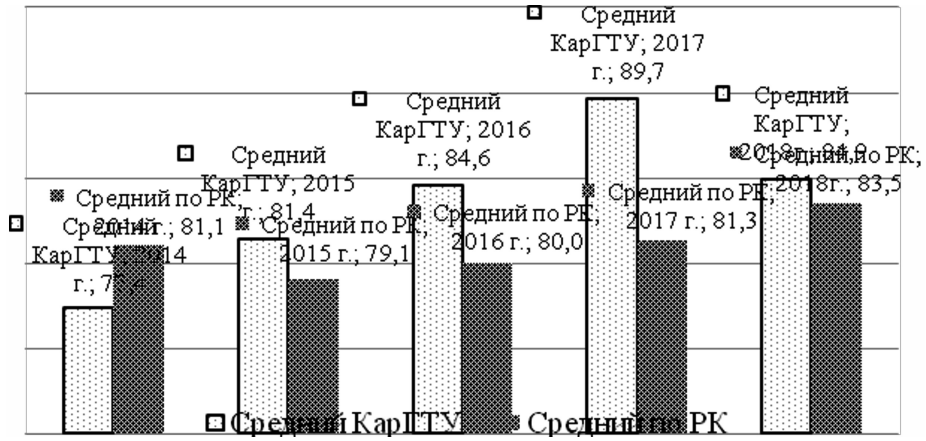

Figure. Comparative analysis of EEEA, KSTU — average in the RK

It should also be noted that in a technical high school, according to the SCES, very few hours are provided for mathematical disciplines study. We considered the curriculum of Vilnius Gediminas technical university for comparative analysis. This university provides Bachelors' training in the following programs:

– Business management;
– Civil engineering;
– Engineering economy;
– Information technology;
– Engineering of finance;
– Engineering of information systems;
– Engineering mechanics;
– Computer engineering;
– Creative industries;
– Mechatronics and robotic;
– Transport engineering;
– Power of buildings;
– Architecture;
– Piloting of aircraft [8; 2].

Compulsory mathematic disciplines teaching in Vilnius Gediminas technical university is provided in the amount of:

1) Methods for differential equations asymptotical analysis — 2 credits;
2) Application basics of mathematical modelling packages — 6 credits;
3) Numerical methods for solution of differential equations — 6 credits [9; 1].

In KSTU Mathematical studying disciplines is carried out in the volume presented in Table 2, only 9 are of elective components, and the rest 49 are of compulsory components. Thus, only 15.5 % are students' choice, and 84.5 % are mathematical disciplines provided by the SCES.

Table 2

Mathematical disciplines in accordance to specialties

№	Code and name of specialty	Name of discipline	Cycle based on Curriculum (BD- basic disciplines)	Compulsory component (CC) or elective component (EC)	Course of study	Load (in credits)
1	2	3	4	5	6	7
1	5B071700 «Heat Engineering»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	3
2	5B071800 «Power Engineering»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	3

1	2	3	4	5	6	7
3	5B071900 «Radio engineering, electronics and communication»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	3
4	5B072100 «Chemical technology of organic substances»	Advanced mathematics	BD	CC	1	4
5	5B072400 «Technological machinery and equipment»	Mathematics	BD	CC	1	4
6	5B072900 «Construction»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	EC	1	2
7	5B073000 «Production of building materials, products and designs»	Mathematics I	BD	CC	1	3
8	5B073000 «Production of building materials, products and designs»	Mathematics II	BD	EC	1	2
		Mathematics	BD	CC	1	4
9	5B073200 «Standardization and certification»	Mathematics	BD	CC	1	4
10	5B073700 «Minerals»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	3
11	5B074500 «Transport construction»	Advanced mathematics I	BD	CC	1	3
		Advanced mathematics II	BD	CC	1	3
12	5B090100 «Organization of transport, traffic and transport operation»	Advanced mathematics	BD	CC	1	4
13	5B090800 «Assessment»	Mathematics	BD	CC	1	3
14	5B090900 «Logictics»	Advanced mathematics	BD	CC	1	4
15	5B050700 «Management»	Mathematics in Economics	BD	EC	1	2
		Advanced course in mathematics	BD	EC	1	3
16	5B050800 «Accounting and auditing»	Mathematics in Economics	BD	CC	1	3
17	5B051000 «State and local governing»	Mathematics in Economics	BD	EC	1	3
		Advanced course in mathematics	BD	EC	1	3
18	5B051100 «Marketing»	Mathematics in Economics	BD	EC	1	3
		Advanced course in mathematics	BD	EC	1	3
19	5B060200 «Computer science»	Mathematical analysis	BD	CC	1	3
20	5B070100 «Biotechnology»	Mathematics	BD	CC	1	3
21	5B070200 «Automation and control»	Advanced mathematics I	BD	CC	1	3
		Advanced mathematics II	BD	CC	1	3
22	5B070300 «Information systems»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	2
		Mathematics III	BD	CC	2	3
23	5B070400 «Computers and Software»	Mathematics	BD	CC	1	3
24	5B070500 «Mathematical and Computer Modeling»	Mathematical analysis 1	BD	CC	1	3
		Mathematical analysis 2	BD	CC	1	3
		Linear algebra	BD	CC	1	2

1	2	3	4	5	6	7
		Differential equation	BD	CC	2	3
		Data science of physical processes	BD	CC	3	3
25	5B070600 «Geology and exploration of mineral deposits»	Mathematics	BD	CC	1	2
		Mathematics 2	BD	EC	1	2
26	5B070700 «Mining»	Mathematics	BD	CC	1	3
		Mathematics	BD	CC	1	2
27	5B070800 «Oil and gas engineering»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	3
		Mathematics III	BD	CC	2	2
28	5B070900 «Metallurgy»	Mathematics I	BD	CC	1	3
		Mathematics II	BD	CC	1	3
29	5B071000 «Materials studying and new materials technology»	Mathematics 1	BD	CC	1	3
		Mathematics 2	BD	CC	1	2
30	5B071100 «Geodesy and cartography»	Mathematics	BD	CC	1	4
31	5B071200 «Mechanical engineering»	Mathematics	BD	CC	1	4
32	5B071300 «Transport, transport technology»	Advanced mathematics I	BD	CC	1	3
		Advanced mathematics II	BD	CC	1	3
33	5B071600 «Instrument making»	Mathematics	BD	CC	1	5

In Vilnius Gediminas technical university there are two departments of mathematics: «Department of Mathematical Modeling» and «Department of Mathematical Statistics», but in our university volume of mathematical disciplines is reduced to an incredible minimum, mathematical disciplines were studied 4–6 semesters depending on specialty, and now, the average number of credits is 5, and these are only 1–2 semesters.

Conclusions

However, in spite of the importance of mathematical cycle disciplines studying, at our university, students study mathematics mostly only in the amount provided by the «Compulsory Component». Elective mathematical disciplines, which today's students can choose, remain unclaimed, as students are simply afraid of them, low knowledge level scares them to choose mathematics among additional subjects. Due to the reasons above, students' mathematical training is not sufficient for today's technical specialists, for several reasons:

1) students do not have a sufficient knowledge level, formed due to a lack of interest in studying, since today's students do not see the area of its application in their future professional activity;

2) number of mathematical disciplines does not meet modern requirements for specialists in the field of engineering and technology.

References

1 [Электронный ресурс]. — Режим доступа: http://www.inspp.ru/index.php? option=com_content&task=view&id=112&Itemid=6

2 Абаева Н.Ф. Развитие познавательного интереса как фактор устойчивости знаний по математике. Проблемы и перспективы развития педагогики и психологии: материалы Междунар. науч.-практ. конф. (25 октября 2011 г.) /Н.Ф.Абаева, .М.Т. Мизамбаева / Сибирская ассоциация консультантов. — Новосибирск, 2011. — С. 47–51.

3 Абаева Н.Ф. Развитие познавательного интереса студентов медицинского вуза к изучению математики / Н.Ф. Абаева, В.Н. Головачева // Вестн. Караганд. ун-та. Сер. педагогика, 2007. — № 1. — С. 37–42.

4 Набатникова Н.В. Развитие познавательных интересов студентов гуманитарных факультетов на занятиях по математике / Н.В. Набатникова // Методические проблемы в курсе математики. — Липецк: ЛГПУ, 2000. — 4. — С. 19–26.

5 Вергасов М.В. Активизация мыслительной деятельности студентов в высшей школе / М.В. Вергасов. — Киев: Вища шк., 1979. — 174с.

6 Талызина Н.Ф. Управление процессом усвоения знаний / Н.Ф. Талызина. — М.: Педагогика, 1975, 214 с.

7 Abayeva N.F. About Professional Orientation of the Mathematics as a Discipline for Students Majoring in Biotechnology / N.F. Abayeva, V.V. Yegorov, V.N. Golovachyova, L.M. Mustafina, I.I. Yerakhtina, B.M. Mustafina // Indian journal of science and technology. — Vol. 9, Issue 19. — 2016. — May. — C. 93891.

8 [Электронный ресурс]. — Режим доступа: https://www.vgtu.lt/files/2849/142/7/14_0/tsc_web.pdf.

9 [Электронный ресурс]. — Режим доступа: http://www.vgtu.lt/files/1772/88/4/7_0/ANNEX_2017.pdf.

Н.Ф. Абаева, И.И. Ерахтина, Г.Е. Самашова, О. Černašėjus

Техникалық жоғары оқу орнында оқу үрдісінде математикалық білімнің рөлі

Техникалық жоғары оқу орнында математикалық дайындық ғылыми түсініктер мен идеяларды қабылдау үшін заманауи әдістемелер мен технологияны пайдалану мен құрылғылар принциптерін түсіну үшін қажет. Оның көмегімен көптеген үрдістер үлгіленеді, игеріледі және болжамдалады. Ғылыми прогрестің қарқынды дамуымен техника мен технология саласында жоғары білікті мамандар дайындау қажеттілігі арта түсетінін ескеру керек. Математика басқа бейінді пәндерді игеру үшін базаны қамтамасыз етеді. Математикалық пәндерді оқыту кезінде оқыту қызметін активизациялау әдістемелері қарастырылды. Мақалада математиканың кәсіби бағдары — оқу нәтижесі — математика бойынша ОЖСБ (оқу жетістіктерінің сыртқы бағалауы) параллель келтірілді. Математикалық цикл пәндері бойынша Vilnius Gediminas technical university жұмыстық оқу жоспары талданады. Қарағанды мемлекеттік техникалық университеті мамандықтарына сәйкес міндетті компонент және таңдау бойынша компонент математикалық пәндер тізбесі келтірілді. Жүргізілген талдауда келесідей қорытынды жасауға болады: студенттердің математикалық дайындығы техникалық бейіндегі бүгінгі мамандар үшін жеткіліксіз деңгейде.

Кілт сөздер: математиканың кәсіктік бағдары, жоғары оқу орнындағы оқу үрдісі.

Н.Ф. Абаева, И.И. Ерахтина, Г.Е. Самашова, О.Černašėjus

Роль математических знаний в учебном процессе технического вуза

Математическая подготовка в техническом вузе необходима для понимания принципов устройства и использования современных методов и технологий, для восприятия научных и технических понятий и идей. С ее помощью моделируются, изучаются и прогнозируются многие процессы. Необходимо учитывать, что стремительное развитие научного прогресса обостряет необходимость в подготовке высококвалифицированных кадров в области техники и технологий. Математика обеспечивает базу для изучения других профильных дисциплин. Рассмотрены методы активизации учебной деятельности при преподавании математических дисциплин. В статье проведена параллель: профессиональная ориентация математики — результат успеваемости — результат ВОУД (внешняя оценка учебных достижений) по математике. Проанализирован рабочий учебный план Vilnius Gediminas technical university по изучению дисциплин математического цикла. Приведен перечень математических дисциплин в соответствии со специальностями Карагандинского государственного технического университета, обязательных компонентов и компонентов по выбору. На основе проведенного анализа авторы приходят к следующему выводу: математическая подготовка студентов находится на недостаточном уровне для сегодняшних специалистов технического профиля.

Ключевые слова: профессиональная ориентация математики, учебный процесс в вузе.

References

1 *inspp.ru.* Retrieved from http://www.inspp.ru/index.php? option=com_content&task=view&id=112&Itemid=6

2 Abayeva, N.F., & Mizambaeyva, M.T. (2011). Razvitie poznavatelnoho interesa kak faktor ustoichivosti znanii po matematike [The development of cognitive interest as a factor in the stability of knowledge in mathematics]. Proceedings from Problems and prospects of development of pedagogy and psychology: *Mezhdunarodnaia nauchnaia-prakticheskaia konferentsiia* (25 oktiabria 2011 h.) – *International Scientific and Practical Conference.* Sibirskaia assotsiatsiia konsultantov (p. 47–51). Novosibirsk [in Russian].

3 Abayeva, N.F., & Golovachyova, V.N. (2007). Razvitie poznavatelnoho interesa studentov meditsinskoho vuza k izucheniiu matematiki [The development of the cognitive interest of students of medical higher education institution to the study of mathematics]. *Vestnik Karahandinskoho universiteta. Seriia pedahohika – Bulletin of the Karaganda University. Series. pedagogy 1,* 37–42 [in Russian].

4 Nabatnikova, N.V. (2000). Razvitie poznavatelnykh interesov studentov humanitarnykh fakultetov na zaniatiiakh po matematike [Development of cognitive interests of students of humanitarian faculties in mathematics classes]. *Metodicheskie problemy v kurse matematiki. 4 – Methodical problems in the course of mathematics. 4,* 19–26. Lipetsk: LHPU [in Russian].

5 Vergasov, M.V. (1979). *Aktivizatsiia myslitelnoi deiatelnosti studentov v vysshei shkole [Activization of mental activity of students in higher school]*. — Kiev: Vishcha shkola [in Russian].

6 Talyzina, N.F. (1975). *Upravlenie protsessom usvoeniia znanii [Managing the process of learning]*. Moscow: Pedahohika [in Russian].

7 Abayeva, N.F., Yegorov, V.V., Golovachyova, V.N., Mustafina, L.M., Yerakhtina, I.I., & Mustafina, B.M. (2016). About Professional Orientation of the Mathematics as a Discipline for Students Majoring in Biotechnology. *Indian journal of science and technology, Vol. 9, Issue 19,* May. P. 93891.

8 *vgtu.lt.* Retrieved from https://www.vgtu.lt/files/2849/142/7/14_0/tsc_web.pdf

9 *vgtu.lt.* Retrieved from http://www.vgtu.lt/files/1772/88/4/7_0/ANNEX_2017.pdf