DOI 10.52209/1609-1825_2022_4_332 UDC 378.016

The Role of Mathematical Knowledge Development of Higher Education Students in the Formation of Critical and Analytical Thinking

[1]***ABAYEVA Nella,*** *Cand. of Ped. Sci., Acting Associate Professor, a_nella@mail.ru,*
[1]***ZHUROV Vitaliy,*** *Cand. of Tech. Sci., Acting Associate Professor, zhurvitv@yandex.ru,*
[1]***MUSTAFINA Lezzetzhan,*** *Cand. of Phys. and Math. Sci., Associate Professor, muhamed_l29m1956@mail.ru,*
[1]***SMIRNOVA Galina,*** *Cand. of Ped. Sci., Associate Professor, smirnova_gm@mail.ru,*
[2]***ABAEV Rafkat,*** *Master, SITS Developer, rabaev@gmail.com,*
[1]*NPJSC «Abylkas Saginov Karaganda Technical University», Kazakhstan, Karaganda, N. Nazarbayev Avenue, 56,*
[2]*University College London, United Kingdom, London, WC1E 6BT, Gower Street,*
**corresponding author.*

Abstract. *Introduction. Nowadays specialists with critical and analytical thinking skills are required in labor market. Acquiring these skills is a long process, requiring time and appropriate mental invest-ment. The study of mathematics provides the basis for the development of logical thinking, atten-tion, accuracy, starting from the school.*
Methodology. Theoretical analysis and generalization of pedagogical experience; questioning; scholarly and popular scientific literature analysis; mathematical statistics methods application in processing the results of experimental research.
Discussion. Identified pedagogical conditions contribute to the interest development in the mathematics study. To study the criteria for the development of critical and analytical thinking stu-dents of each presented specialties were divided into control and experimental groups.
Results. The average point of the initial level of mathematical knowledge in the control group was 2,98, in the experimental group – 3,04 (the difference 1%). As a result of the experimental test-ing of the effectiveness of the development of interest in the study of mathematics positive results were obtained – the level of mathematical knowledge of students in the experimental group was 9% higher than among students studying by the classical technology. The study of the level of critical and analytical thinking was carried out according to developed criteria. The results: at the first stage, there was no difference between the results of the survey of the control and experimental groups, at the second stage the difference – 5%, at the third stage – 7.1%. Students of experimental groups were able to demonstrate a higher level of critical and analytical thinking.
Conclusion. Successful learning of the mathematics in the higher professional education's sys-tem will lead to an increase in the critical and analytical thinking level of future bachelors, which in turn will be affected by the demand in the modern labor market.

Keywords: *interest development, teaching mathematics, cognitive interest, learning process, higher education, critical thinking, analytical thinking, pedagogical conditions, questionnaires.*

Introduction

At the present time a necessary condition for improving the quality of scientific research in various branches of science and technology was the widespread use of mathematical methods. In order for a specialist to successfully apply mathematical methods in further professional activity, to model various technological and biochemical, economic processes, first of all, it is necessary to have the necessary knowledge and to be able to handle the mathematical apparatus correctly. Mathematical methods play an increasingly important and necessary role in the training of specialists, as they allow a sufficient degree of reliability to analyze the results of theoretical and practical activities. They are used to process data from observations and experiments, which are not only subject to measurement errors and random interference, but also to the influence of internal variability.

The modern labor market requires specialists who are able to think critically and analytically, and as we know these qualities can be developed by means of mathematics. Therefore, in the modern educational process of a technical university it is necessary to increase the level of mathematical knowledge. After analyzing the pedagogical literature to identify

methods that contribute to improving the quality of knowledge, we chose – the development of interest.

Thereby there is a contradiction between the increased requirements for the ability to think critically and analytically to the graduates of technical universities in the conditions of the modern labor market, and the conditions contributing to the development of these qualities. The insufficient development of this problem in pedagogical science and practice led us to the process of identifying conditions that promote the development of critical and analytical thinking. Thus, the idea of the research was formed: successful mastery of the mathematics course in the system of higher professional education will lead to an increase in the level of critical and analytical thinking of future Bachelors.

The aim of the research: theoretical substantiation of the importance of the level of mathematical knowledge of students in the formation of critical and analytical thinking skills.

Achievement of the intended purpose and solution of the main problem are connected with **the hypothesis:** if in the process of learning mathematics in a technical university students show interest and have a good performance, their critical and analytical thinking will be developed.

Methodology. Modern pedagogical science considers several ways to improve the quality of mathematical knowledge, here are some of them: teacher-centeredness (collective preparation for classes helps teachers discuss problems and improve pedagogical skills) [1, P. 28]; learning mathematics using technology [2, P. 66]; personalization (to create a situational interest, thus evoking individual interest) [3, P. 17]; the applied orientation of mathematics [4, P. 56]; the model of productive cognitive activity (formation of concepts, theorem proving, problem solving) [5, P. 132].

The methodological basis of the conducted research was: the concept of problem-based learning and theoretical developments in the field of professional education of well-known scientists – I.Y. Lerner [6, P. 31], M.I. Makhmudov [7, P. 5]).

Analyzing the methods, classifications of I.Y. Lerner and M.N. Skatkin [8, P. 1] we identified the following methods as contributing to the development of interest in the study of mathematics by university students: problem-based; reproductive; exploratory; partially exploratory (heuristic) [9, P. 5].

In order to prove the hypothesis that if in the process of learning mathematics in a technical university students show interest and have good performance, then they develop critical and analytical thinking, we have developed pedagogical conditions for the development of cognitive interest. These pedagogical conditions were based on the following instructions:

1) it is necessary to pay more attention to teaching methods: maximum development should be given to the methods that stimulate students' activity and educate them to work independently;

2) it is necessary to revise the methodology of lectures and practical classes in order to strengthen interdisciplinary links with theoretical and special disciplines in technical universities.

To test the idea of the research that the development of interest in mathematics will increase the level of mathematical knowledge of students, which will further lead to the formation of critical and analytical thinking in the educational process of the university, the following work was carried out:

- the students of the following specialties of Karaganda Technical University participated in the experiment: «Mechanical engineering», «Standardization and certification», «Technological machines and equipment», «Biotechnology», «Material science and technology», «Metallurgy», «Organization of transportation, traffic and operation of transport», «Logistics (Transport)»;

- first-year students studying the discipline «Mathematics» were divided into control and experimental groups;

- the students in the experimental and control groups were taught according to the same curriculum, but special methods and means of developing interest in the study of mathematics by university students were introduced in the educational process of students in the experimental group [10, P. 162].

Thus, we used the following research methods: theoretical analysis and generalization of pedagogical experience; conversations; questioning; analysis of special and popular scientific literature; use of mathematical statistics methods in processing the results of the experimental study.

Results. To determine the level of formation of critical and analytical thinking, before studying the discipline «Mathematics» students were offered a questionnaire:

1. Can you analyze in advance the information you will need in the future?

2. Will you verify the data provided in your future professional life?

3. How often do you analyze for yourself a situation?

4. Can you foresee variants of development of any situations?

5. Can you observe?

6. Can you pick up details on observing the information?

7. Can you highlight what is important to you in a situation?

8. Can you make decisions in a situation that requires a quick decision?

9. Do you think you can objectively evaluate a situation?

10. Are you able to reasonably prove your point of view?

11. Do you make decisions «like the majority»?

12. Can you be easily persuaded to change your point of view?

13. If you have heard some information, do you trust what you have seen or heard?

14. Do you argue your point of view with people?

15. Do you know how to make a logical connection?

The survey was conducted as an online, incognito test. The answer options offered to students were the same for all Yes-Sometimes-No questions, and the results of the survey are presented in Table.

According to the results of the questionnaire at the first stages of the study of mathematics in the students of the control and experimental groups, the data do not differ either from the specialty or from the group (control or experimental).

The next stage of our research work was to implement in the educational process of teaching mathematics presented innovations for students in the experimental groups. The results of implementation showed that at the stage of the final control in mathematics students in the experimental groups had an average score higher than students in the control groups.

Thus, it was revealed that having the same initial training in the discipline, the students of the control group have lower results than the students studying in the experimental group. In the 2013-2014 academic year the average grade point average left 3.8, in the 2014-2015 academic year it was 3.7 points. Since 2015-2016, when students began to study in the control and experimental groups began to observe a sharp difference, as the result of the control group became equal, it was 3.6 points, but at the same time the results of the experimental group increased to 4.0 points, the difference between the groups was 0.4 points. Similar is the case in the 2016-2017 academic year, but only the control group had the same average score 3.6, and the experimental had 4.1.

So, the average score of the initial level of mathematical knowledge in the control group was 2.98, in the experimental group was 3.04 (the difference was 0.06 points, which is 1%), and the final level of mathematical knowledge in the control group it was 3.60, in the experimental group it was 4.05 (difference 0.45 or 9%). The above stated indicates that the students of the experimental groups had a higher level of mathematical knowledge.

The next stage of our study was to check how this implementation would affect the level of critical and analytical thinking of future bachelors. For this purpose, we also conducted a questionnaire on the same conditions as at the beginning of mathematics training.

The obtained results allow us to conclude: if in the process of learning mathematics in a technical university students show interest and have a good performance, then they develop critical and analytical thinking, this was the leading hypothesis of this study. Continuing the study that, critical and analytical thinking is formed in the process of learning, during all 4 years of undergraduate education, we conducted a similar questionnaire before the defense of diploma projects in the same students who participated in this experiment in the 1st year. Thus after 3.5 years (2019, 2020) students were questioned under the same conditions and questions.

Let's analyze the obtained data in general, not dividing into specialties:

1) The answer «yes»:

- the average score of the experimental group was 38.4% on the answer «yes» in the 1st year, and in the 4th year it was 80.7%, i.e. the level of critical and analytical thinking increased by 210%;

- the average percentage in the control group, in the 1st year was 38.5%, in the 4th year was 73.6%, we have an increase of 191%.

The difference in results was 29%.

2) Response «sometimes»:

- experimental group's result in the 1st year was 39.4%, in the 4th year was 13.5%, the result improved by 34%;

- the control group in the 1st year chose this answer in 39.3%, and after 3.5 years it was 19.9%, the result changed 50.8% for the better.

The difference was about 16.8%.

3) The answer «No»:

- the average score of the experimental group: 22.2%, in the 1st year, and 5.8% in the 4th year, the difference for the better result was 383%;

- the average score of the control group in the 1st year: 22.1% and in the 4th year: 6.4%, the results improved by 345%.

The difference was 38%.

Thus, the analysis shows that the level of critical and analytical thinking of students who studied the discipline «mathematics» developed much better, the average result of the difference was 27.9%.

Conclusion

275 students of Karaganda Technical University (until 2020 Karaganda State Technical University) of the following specialties participated in the conducted scientific and pedagogical experiment: mechanical engineering (38 students), standardization and certification (40 students), technological machines and equipment (42 students), biotechnology (38 students), material Science and Technology (16 students), metallurgy (51 students), organization of transportation, traffic and operation of transport (17 students), logistics (33 students).

There were 138 students in the control group and 138 students in the experimental group. All students were trained by the same program, but in the educational process of the experimental group were introduced special methods and developed interest in learning mathematics. Thus, having the same initial level of knowledge in mathematics the data of the experiment show that the difference between the average values of the performance of the control and experimental groups is 9%, that is, students in the control group got the final percentage of achievement was 72%, and students in the experimental group had 81%, if considered on a five-point scale of achievement then, 3.60 and 4.05 respectively. (Figure 3). At this stage of the study we confirmed the first part of our hypothesis: if in the process of learning mathematics in a technical university students show interest and

Quantitative results of the students critical and analytical thinking initial level

No. Criteria	Specialties in % (control/ experiment.)								Average result, c/e (in %)
	ME	St.	TM	BT	MS	Met.	OT	Log.	
1 Yes	32/31	40/39	28/30	31/30	37/39	27/26	30/29	28/29	31,6/31,6
Sometimes	48/50	45/45	41/40	46/47	37/36	41/40	45/45	46/45	43,6/43,5
No	20/19	15/16	31/30	23/23	26/25	32/34	25/26	26/26	24,8/24,9
2 Yes	47/46	49/50	46/45	48/46	50/51	45/44	46/45	47/49	47,3/47,0
Sometimes	38/39	38/38	40/38	42/42	42/39	38/39	34/36	33/31	38,1/37,8
No	15/15	13/12	14/17	10/12	8/10	17/17	20/19	20/20	14,6/15,2
3 Yes	15/12	19/18	17/17	21/22	23/21	22/20	15/14	23/25	19,4/18,6
Sometimes	60/61	62/65	62/63	62/59	61/63	60/61	60/58	60/56	60,9/60,8
No	25/27	19/17	21/20	17/19	16/16	18/19	25/28	17/19	19,7/20,6
4 Yes	22/23	25/26	25/26	26/26	26/26	21/22	22/19	22/21	23,6/23,6
Sometimes	25/22	23/24	20/19	23/24	21/20	24/22	24/24	24/24	23,0/22,4
No	53/55	52/50	55/55	51/50	53/54	55/56	54/57	54/55	53,4/54,0
5 Yes	48/49	51/53	46/47	47/46	50/50	46/46	47/46	50/49	48,1/48,3
Sometimes	39/40	38/35	39/38	41/42	41/40	38/37	34/36	33/33	37,9/37,6
No	13/11	11/12	15/15	12/12	9/10	16/17	19/18	17/18	14,0/14,1
6 Yes	32/29	34/32	30/30	34/33	34/33	31/32	30/29	31/30	32,0/31,0
Sometimes	30/31	33/37	41/40	36/36	33/35	35/33	35/36	32/32	34,4/35,0
No	38/40	33/31	29/30	30/31	33/32	34/35	35/35	37/38	33,6/34,0
7 Yes	59/60	58/58	57/55	60/59	61/62	57/56	56/55	58/59	58,2/58,0
Sometimes	36/36	38/38	33/36	34/34	34/34	37/39	35/36	32/33	34,9/35,8
No	5/4	4/4	10/9	6/7	5/4	6/5	9/9	10/8	6,9/6,3
8 Yes	36/35	37/37	34/32	35/36	38/37	33/31	32/30	31/32	34,5/33,8
Sometimes	39/38	40/39	38/39	39/39	40/41	40/43	38/41	39/40	39,1/40,0
No	25/27	23/24	28/29	26/25	22/22	27/26	30/29	30/28	26,4/26,2
9 Yes	28/29	27/29	27/29	28/30	31/32	28/30	27/26	26/26	27,7/28,9
Sometimes	50/51	52/52	53/50	50/50	50/48	52/51	49/50	51/53	50,9/50,6
No	22/20	21/19	20/21	22/20	19/20	20/19	24/24	23/21	21,4/20,5
10 Yes	68/66	70/70	66/65	69/70	72/74	65/66	65/65	68/69	67,9/68,1
Sometimes	27/28	27/28	27/28	26/25	20/20	28/25	28/30	28/25	26,4/26,1
No	5/6	3/2	7/7	5/5	8/6	7/9	7/5	4/6	5,7/5,8
11 Yes	32/31	30/28	28/32	25//29	28/29	32/32	33/29	32/32	30,0/30,3
Sometimes	32/35	40/41	37/35	41/37	34/36	40/39	39/44	41/42	38,0/38,6
No	36/34	30/31	35/33	34/34	38/35	28/29	28/27	27/26	32,0/31,1
12 Yes	24/24	24/26	26/25	27/30	23/21	29/30	31/28	28/29	26,5/26,6
Sometimes	52/50	50/51	49/50	48/50	48/54	46/45	45/47	31/28	46,1/46,9
No	24/26	26/23	25/25	25/20	29/25	25/25	24/25	41/43	27,4/25,5
13 Yes	46/45	47/46	50/53	52/54	52/55	50/53	52/53	54/52	50,3/51,4
Sometimes	34/35	35/35	35/35	33/34	36/30	38/33	36/35	31/32	34,8/33,6
No	20/20	18/19	15/12	15/12	12/15	12/14	12/12	15/16	14,9/15,0
14 Yes	33/32	35/34	31/33	36/36	31/30	30/32	32/32	36/33	33,0/32,8
Sometimes	36/38	38/35	36/34	35/38	37/37	38/35	37/36	34/37	36,4/36,2
No	31/30	27/31	33/33	29/26	32/33	32/33	31/32	30/30	30,6/31,0
15 Yes	48/43	52/50	50/50	47/44	51/51	47/48	43/45	44/44	47,8/46,9
Sometimes	45/52	44/44	43/40	45/47	43/41	43/44	51/49	48/49	45,2/45,8
No	7/5	4/6	7/10	8/9	6/8	10/8	5/6	8/7	7,0/7,3
Total									
Average, %	38,0/37,0	39,9/39,7	37,4/37,9	39,1/39,4	40,5/40,7	37,5/37,9	37,4/36,3	38,5/38,6	38,5/38,4
	39,4/40,4	40,2/40,5	39,6/39,0	40,1/40,3	38,5/38,3	39,9/39,1	39,3/40,2	37,5/37,3	39,3/39,4
	22,6/22,6	19,9/19,8	23,0/23,1	20,8/20,3	21,0/21,0	22,6/23,0	23,3/23,5	24,0/24,1	22,2/22,2
Number of students in the groups	20/18	19/21	19/23	19/19	9/7	27/24	9/8	16/17	138/137

Note: (abbreviations used in the table)
e./c. – experimental / control group,
ME – specialty «Mechanical Engineering»,
St. – specialty «Standardization and certification»,
TM – specialty «Technological machines and equipment»,
BT – specialty «Biotechnology»,
MS – specialty «Material science and technology»,
Met. – specialty «Metallurgy»,
OT – specialty «Organization of transportation, traffic and operation of transport»,
Log. – specialty «Logistics (Transport)».

have good performance, then they develop critical and analytical thinking, further formed and allows you to more successfully defend the diploma project. In order to confirm the second part of the hypothesis, about the development of critical and analytical thinking, we conducted a survey at three stages of training: at the beginning of the first year, before studying mathematics – stage 1, after the completion of mathematics – stage 2, stage 3 – before the defense of diploma projects.

This research work was begun in the 2013-2014 academic year, the first two academic years we investigated the level of students' performance, the mentioned specialties, studied scientific and pedagogical literature, determined the purpose, hypothesis and the main problem of pedagogical research. The next stage of the research work was aimed at confirming the hypothesis:

1) At the beginning of 2015-2016 and 2016-2017 academic years, we checked the initial level of critical and analytical thinking, implemented the specified methods and means of developing interest in learning mathematics.

2) At the end of the 2015-2016 and 2016-2017 academic years, we summarized the performance of the control and experimental groups, the first interim results of performance in the discipline of «Mathematics» were obtained. At the same time the second stage of the questionnaire was conducted to determine the level of development of critical and analytical thinking.

3) In May 2018-2019 and 2019-2020 academic years, completing their studies at the university, students underwent the third stage of the questionnaire in order to determine the final level of critical and analytical thinking.

Thus, the scientific and pedagogical experiment lasted for 5 years (2015-2020). The goal, which was set at the beginning of the study: substantiation of the significance of the level of mathematical knowledge of students in the formation of critical and analytical thinking skills, was achieved. The hypothesis: if technical university students show interest and have good performance, then they develop critical and analytical thinking has been confirmed in the process of learning mathematics. Figure shows how the level of critical and analytical thinking changed in the control and experimental groups at three stages of questioning.

The following conclusions can be briefly made based on the developed theoretical provisions and obtained results of experimental and pedagogical work:

1. The study of the level of mathematical knowledge, as well as critical and analytical thinking allowed to identify the need for its development, because the modern labor market needs specialists who can think critically and analytically, and as it is known these qualities can be developed by means of mathematics.

2. The paper analyzes the content of mathematical knowledge of technical university students in accordance with the future professional activity of students.

3. The analysis of psychological and pedagogical literature allowed to determine that by developing interest in mathematics it is possible to achieve a steady growth of critical and analytical thinking.

4. Identified pedagogical conditions that contribute to the development of interest in the study of mathematics: teaching methods (problem-based, reproductive, exploratory, partially exploratory).

5. The criteria for the development of critical and analytical thinking are determined.

6. As a result of the experimental testing of the effectiveness of the development of interest in mathematics positive results were obtained, the level of critical and analytical thinking increased.

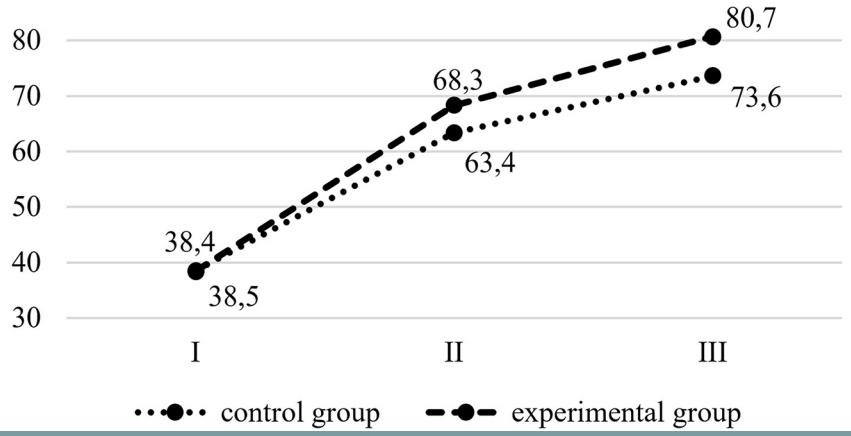
Based on the results obtained during the experimental-pedagogical work, the following recommendations were developed:

- successful development of critical and analytical thinking depends on the level of mathematical abilities of the student, as well as on the interest in learning; methods of interest development in learning are advisable to implement in a complex;

- the developed pedagogical conditions of the interest development in the study of mathematics for the students of the presented technical specialties can be applied in the educational process of other universities;

- the criteria for determining the level of critical and analytical thinking can be used in the educational process of any higher education institution, training specialists in technical profile, as a tool necessary for the formation of an integral structure of a specialist.

This study is one of the possible ways to solve the problem of improving the level of mathematical



The level of critical and analytical thinking (in %)

knowledge and the development of critical and analytical thinking of technical university students.

Further prospects of this study can be carried out in the following directions:

- to check how the level of mathematical knowledge affects the formation of the holistic structure of a technical specialist;
- the influence of the level of mathematical knowledge and its development on the quality of scientific papers of students.

Acknowledgmens: *This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP14869933).*

REFERENCES

1. Evrim Erbilgin, Two mathematics teacher educators' efforts to improve teaching and learning process: An action research study, Teaching and Teacher Education: Vol. 78, February 2019, pp. 28-38. Mode of access: https://doi.org/10.1016/j.tate.2018.11.005 (date of reference: 10.06.2021).
2. Alison Clark-Wilson, Celia Hoyles, From curriculum design to enactment in technology enhanced mathematics instruction – Mind the gap! International Journal of Educational Research, Vol. 94, 2019, pp. 66-76. Mode of access: https://doi.org/10.1016/j.ijer.2018.11.015 (date of reference: 05.03.2022).
3. Sigve Hogheim, Rolf Rebera, Supporting interest of middle school students in mathematics through context personalization and example choice, Contemporary Educational Psychology, Vol. 42, July 2015, pp. 17-25. Mode of access: https://doi.org/10.1016/j.cedpsych.2015.03.006 (date of reference: 10.06.2021).
4. K.M. Berkimbayev, Kh.S. Abdullayeva, Applied orientation in teaching mathematics, BULLETIN of L.N. Gumilyov Eurasian National University. Pedagogy. Psychology. Sociology Series – 2021. – No. 3 (136). – pp. 56-63. Mode of access: https://bulpedps.enu.kz/article/archive/view?id=applied-orientation-in-teaching-mathematics (date of reference: 06.03.2022).
5. Costică Lupu, The Model Object-product-cognitive Operation Through Mathematical Education. Procedia – Social and Behavioral Sciences, Vol. 163, 19 December 2014, pp. 132-141. Mode of access: https://doi.org/10.1016/j.sbspro.2014.12.298 (date of reference: 10.06.2021).
6. Osmolovskaya I.M. I.Y. Lerner on the learning process: a modern reading – Domestic and foreign pedagogy. 2017. T.1, no. 3 (39). pp. 31-41.
7. Makhmutov M.I. Selected works: in 7 vol. Vol. 6 / co-creator. D.M. Shakirova – Kazan: Magarif – Vakyt. 2016. – 375 p.
8. https://students-library.com/library/read/56449-klassifikacia-metodov-obucenia-po-stepeni-usloznenia-samostoatelnoj-deatelnosti-ucasihsa-ia-lerner-mn-skatkin (date of reference: 06.03.2022).
9. Щукина Г.И. Педагогические проблемы формирования познавательных интересов учащихся / АПН СССР. – М.: Педагогика, 1988. – 203 с.
10. N.F. Abayeva, V.V. Yegorov, V.N. Golovachyova, L.M. Mustafina, I.I. Yerakhtina, B.M. Mustafina, About Professional Orientation of the Mathematics as a Discipline for Students Majoring in Biotechnology. Indian journal of science and technology: Volume 9, Issue 19, May 2016. C: 93891. Mode of access: https://doi.org/10.17485/ijst/2016/v9i19/93891 (date of reference: 06.03.2022).

ЖОО студенттерінің сыни және аналитикалық ойлауды қалыптастыруда математикалық білімдерді дамытудың рөлі

[1]***АБАЕВА Нелла Фуатовна,*** *п.ғ.к., доцент м.а., a_nella@mail.ru,*
[1]***ЖУРОВ Виталий Владимирович,*** *т.ғ.к., доцент м.а., zhurvitv@yandex.ru,*
[1]***МУСТАФИНА Лэззэтжан Мухамеджановна,*** *ф.-м.ғ.к., доцент, muhamed_l29m1956@mail.ru,*
[1]***СМИРНОВА Галина Михайловна,*** *п.ғ.к., доцент, smirnova_gm@mail.ru,*
[2]***АБАЕВ Рафкат,*** *магистр, СИТС әзірлеушісі, rabaev@gmail.com,*
[1]*«Әбілқас Сағынов атындағы Қарағанды техникалық университеті» КеАҚ, Қазақстан, Қарағанды, Н. Назарбаев даңғылы, 56,*
[2]*Лондон колледж университеті, Ұлыбритания, Лондон, WC1E 6BT, Гауэр көшесі,*
**автор-корреспондент.*

Аңдатпа. *Кіріспе. Қазіргі уақытта еңбек нарығы сыни және аналитикалық ойлау дағдылары бар мамандарға мұқтаж. Бұл дағдыларды игеру ұзақ уақытты және тиісті ақыл-ой инвестицияларын қажет етеді. Мектептегі математика курсынан бастап логикалық ойлауды, зейінді, дәлдікті дамытудың негізін қалайтын математиканы зерттеу екені бәріне белгілі.*
Әдістеме. Педагогикалық тәжірибені теориялық талдау және жалпылау; сауалнама жүргізу; арнайы және ғылыми-көпшілік әдебиеттерді талдау; эксперименттік зерттеу нәтижелерін өңдеу кезінде математикалық статистика әдістерін пайдалану.
Талқылау. Математиканы оқуға деген қызығушылықтың дамуына ықпал ететін педагогикалық жағдайлар анықталды. Сыни және аналитикалық ойлауды дамыту критерийлері анықталды. Ұсынылған мамандықтардың әрқайсысы бойынша студенттер бақылау және эксперименттік топтарға белгіленді.
Нәтижелер. Бақылау тобында математикалық білімнің бастапқы деңгейінің орташа балы – 2,98, эксперименттік деңгейде – 3,04 (айырмашылық 1%-ды құрады) құрады. Математиканы оқуға деген қызығушылықтың тиімділігін тәжірибелік тексерудің нәтижесінде оң нәтижелер алынды-эксперименттік топ студенттерінің математикалық білім деңгейі классикалық технология бойынша оқитын студенттерге қарағанда 9% жоғары болды. Сыни және аналитикалық ойлау деңгейін зерттеу әзірленген критерийлер бойынша. Нәтижелері: бірінші кезеңде бақылау және эксперименттік топтар сауалнамасының нәтижелері арасында айырмашылық жоқ, екінші кезеңде айырма 5%-ды, үшінші кезеңде 7,1%-ды құрады. Осылайша, эксперименттік топтардың студенттері сыни және аналитикалық ойлаудың жоғары деңгейін көрсете алды.
Қорытынды. Жоғары кәсіптік білім беру жүйесінде математика курсын сәтті меңгеру болашақ бакалаврлардың сыни және аналитикалық ойлау деңгейінің жоғарылауына әкеледі, бұл өз кезегінде қазіргі еңбек нарығындағы сұранысқа әсер етеді.

Кілт сөздер: *қызығушылықты дамыту, математиканы оқыту, танымдық қызығушылық, оқу процесі, жоғары білім, сыни тұрғыдан ойлау, аналитикалық ойлау, педагогикалық шарттар, сауалнамалар.*

Роль развития математических знаний у студентов вуза в формировании критического и аналитического мышления

[1]***АБАЕВА Нелла Фуатовна,*** *к.п.н., и.о. доцента, a_nella@mail.ru,*
[1]***ЖУРОВ Виталий Владимирович,*** *к.т.н., и.о. доцента, zhurvitv@yandex.ru,*
[1]***МУСТАФИНА Лэззэтжан Мухамеджановна,*** *к.ф.-м.н., доцент, muhamed_l29m1956@mail.ru,*
[1]***СМИРНОВА Галина Михайловна,*** *к.п.н., доцент, smirnova_gm@mail.ru,*
[2]***АБАЕВ Рафкат,*** *магистр, СИТС разработчик, rabaev@gmail.com,*
[1]*НАО «Карагандинский технический университет имени Абылкаса Сагинова», Казахстан, Караганда, пр. Н. Назарбаева, 56,*
[2]*Университетский колледж Лондона, Великобритания, Лондон, WC1E 6BT, ул. Гауэр,*
**автор-корреспондент.*

Аннотация. *Введение. В настоящее время рынок труда нуждается в специалистах, имеющих навыки критического и аналитического мышления. Приобретение данных навыков – процесс долгий, требующий времени и соответствующих умственных вложений. Изучение математики закладывает основы развития логического мышления, внимания, аккуратности еще начиная со школьного курса математики.*
Методология. Теоретический анализ и обобщение педагогического опыта; анкетирование; анализ специальной и научно-популярной литературы; использование методов математической статистики при обработке результатов экспериментального исследования.
Обсуждение. Выявлены педагогические условия, способствующие развитию интереса к изучению математики: методы. Определены критерии развития критического и аналитического мышления. Студенты по каждой из представленных специальностей были определены на контрольную и экспериментальную группы.
Результаты. Средний балл исходного уровня математических знаний в контрольной группе составил – 2,98, в экспериментальной – 3,04 (разница 1%). В результате проведенной экспериментальной проверки эффек-

тивности развития интереса к изучению математики получены положительные результаты – уровень математических знаний студентов экспериментальной группы оказался на 9% выше, чем у студентов, обучающихся по классической технологии. Изучение уровня критического и аналитического мышления проводилось по разработанным критериям в три этапа. Результаты: на первом этапе, разницы между результатами анкетирования контрольной и экспериментальной групп – нет, на втором этапе разница составила 5%, на третьем этапе – 7,1%. Таким образом студенты экспериментальных групп смогли продемонстрировать более высокий уровень критического и аналитического мышления.
Вывод. Успешное овладение курсом математики в системе высшего профессионального образования приведет к повышению уровня критического и аналитического мышления будущих бакалавров, что в свою очередь отразится на востребованности в условиях современного рынка труда.

Ключевые слова: *развитие интереса, преподавание математики, познавательный интерес, процесс обучения, высшее образование, критическое мышление, аналитическое мышление, педагогические условия, анкетирование.*

REFERENCES

1. Evrim Erbilgin, Two mathematics teacher educators' efforts to improve teaching and learning process: An action research study, Teaching and Teacher Education: Vol. 78, February 2019, pp. 28-38. Mode of access: https://doi.org/10.1016/j.tate.2018.11.005 (date of reference: 10.06.2021).
2. Alison Clark-Wilson, Celia Hoyles, From curriculum design to enactment in technology enhanced mathematics instruction – Mind the gap! International Journal of Educational Research, Vol. 94, 2019, pp. 66-76. Mode of access: https://doi.org/10.1016/j.ijer.2018.11.015 (date of reference: 05.03.2022).
3. Sigve Hogheim, Rolf Rebera, Supporting interest of middle school students in mathematics through context personalization and example choice, Contemporary Educational Psychology, Vol. 42, July 2015, pp. 17-25. Mode of access: https://doi.org/10.1016/j.cedpsych.2015.03.006 (date of reference: 10.06.2021).
4. K.M. Berkimbayev, Kh.S. Abdullayeva, Applied orientation in teaching mathematics, BULLETIN of L.N. Gumilyov Eurasian National University. Pedagogy. Psychology. Sociology Se-ries – 2021. – No. 3 (136). – pp. 56-63. Mode of access: https://bulpedps.enu.kz/article/archive/view?id=applied-orientation-in-teaching-mathematics (date of reference: 06.03.2022).
5. Costică Lupu, The Model Object-product-cognitive Operation Through Mathematical Education. Procedia – Social and Behavioral Sciences, Vol. 163, 19 December 2014, pp. 132-141. Mode of access: https://doi.org/10.1016/j.sbspro.2014.12.298 (date of reference: 10.06.2021).
6. Osmolovskaya I.M. I.Y. Lerner on the learning process: a modern reading – Domestic and foreign pedagogy. 2017. T.1, no. 3 (39). pp. 31-41.
7. Makhmutov M.I. Selected works: in 7 vol. Vol. 6 / co-creator. D.M. Shakirova – Kazan: Magarif – Vakyt. 2016. – 375 p.
8. https://students-library.com/library/read/56449-klassifikacia-metodov-obucenia-po-stepeni-usloznenia-samostoatelnoj-deatelnosti-ucasihsa-ia-lerner-mn-skatkin (date of reference: 06.03.2022).
9. Shhukina G.I. Pedagogicheskie problemy formirovanija poznavatel'nyh interesov uchashhihsja / APN SSSR. – Moscow: Pedagogika, 1988. – 203 p.
10. N.F. Abayeva, V.V. Yegorov, V.N. Golovachyova, L.M. Mustafina, I.I. Yerakhtina, B.M. Mustafina, About Professional Orientation of the Mathematics as a Discipline for Students Majoring in Biotechnology. Indian journal of science and technology: Volume 9, Issue 19, May 2016. C: 93891. Mode of access: https://doi.org/10.17485/ijst/2016/v9i19/93891 (date of reference: 06.03.2022).